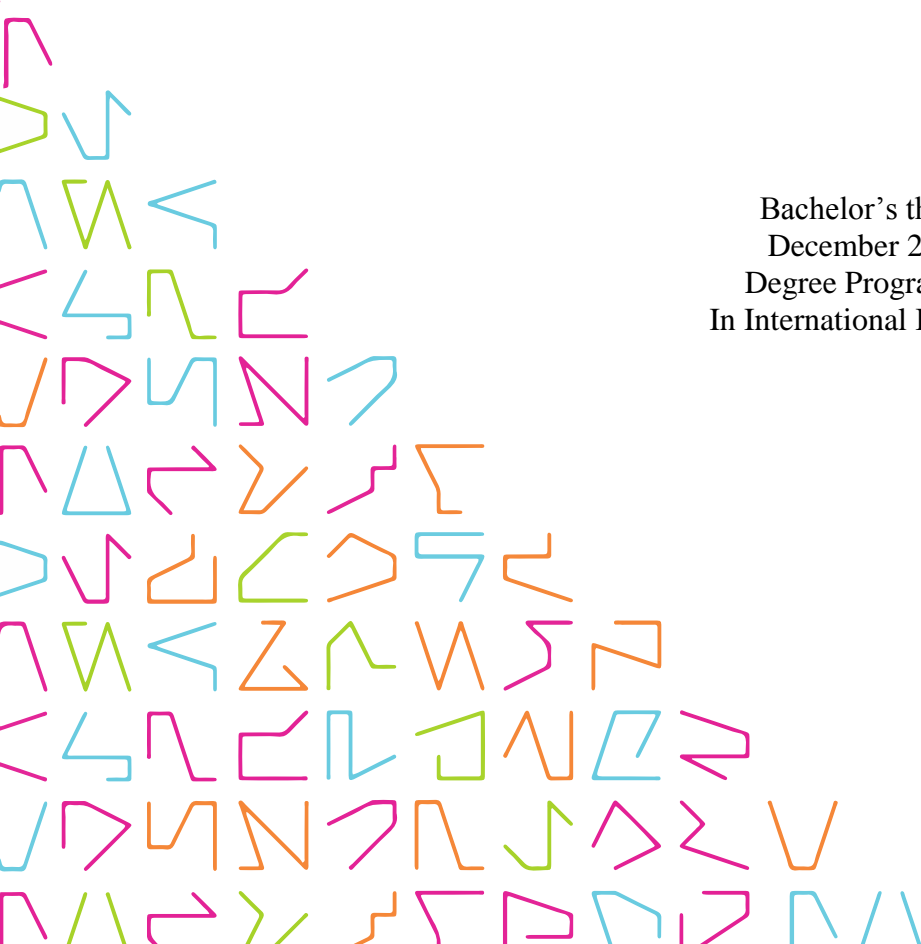


SUPPLY CHAINS AND GLOBAL DISTRIBUTION CHANNELS FOR PARTICLE FILTERS

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13IBA

Bachelor's thesis
December 2017
Degree Programme
In International Business



ABSTRACT

Tampereen ammattikorkeakoulu
Tampere University of Applied Sciences
Degree Programme in International Business

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Supply chains and global distribution channels for particle filters

Bachelor's thesis 26 pages, appendices 0 pages
December 2017

This thesis is made for an engineering group at Tampere University of Applied Sciences who has designed a new aerosol filter for controlling metal exhaust ventilation in metal working factories. This product has the protection of utility models since 2016 and the efficiency and accuracy have been tested by Finland's Occupational Health Institute.

The goal of the thesis is to give a view of the current situation for supply chains and distribution channels of current particle filters.

The source material is gathered from the competitor company's websites and annual reports. Other source is a survey made for the companies. The theoretical framework is gathered from various sources, both literature and online. The theory provides a view for supply chain management and distribution channels as concepts, and helps to clear out what this information can be used for.

The results of this thesis are not as extensive as intended, but the results that were able to be gathered were quite surprising. The hypothesis was that the filters would be assembled closer to the end customer, but in fact, they are fully built in the factories and distributed as readymade products. In addition, the variations in supply and distribution according to the market were quite interesting to find.

Key words: supply chain, distribution, particle filters

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ABBREVIATION AND TERMS

MTO	Make to order
MTS	Make to stock
MTA	Make to assemble
SCM	Supply chain management

1 INTRODUCTION

Particle filters are used in all machine workshops and facilities where the air needs purification from harmful particles. An engineering group from Tampere University of Applied Sciences have designed a new aerosol filter, and are considering to enter the market with a new product. The project group wanted to figure out, how their possible future competitors or partners handle their supply chains and distribution currently.

Six companies were named as the competitors; 3Nine, Nederman, Absolent, Losma, Dantherm and PPT-Filter. In this thesis, the competitors are introduced, and the supply chains and distribution channels they use are compared.

2 THESIS PLAN

2.1 Thesis topic

The topic of my thesis is the supply chain of particle filters. Mainly, what kind of supply chains six given companies in the area are using, and what kind of global distribution channels they have. The given companies are 3Nine, Absolent, Nederman, Dantherm, Losma and PPT-filter.

My goal is to figure out the current solutions, so that the project group could see and compare the supply and distribution channels, and see what could be a valid solution for them.

2.2 Purpose of the thesis and the research question

The aim of the thesis is to give out an extensive view of the current situation in the market; what kind of supply chains the competitors use and how their products are distributed globally. The objective is to give out useful information about the competitors to the project group, so they can figure out their future strategy and position in the global market.

The research question is: What kind of supply chains are used in companies that focus on air filtering, and how the companies distribute around the world.

2.3 Concepts and theory

The concepts that are explained more thoroughly in this thesis are supply chain, distribution, transportation, production models and particle filter.

2.4 Working methods and data

For this thesis, I am using secondary data, interviews, and a small survey to the given six companies. The data will be collected from the given company's web pages and other publications, and answers for the survey. I will interview few specialists, who have

worked closely with particle filters. For the theoretical framework, I will use sources from both on and offline.

2.5 Thesis structure

The theoretical framework will explain what a supply chain means, and what kind of supply chains are used globally. Distribution is a crucial part of any supply chain; the thesis will focus on that as well. Tightly connected to supply chains are transportation methods and production strategies, which are also introduced.

After the theoretical framework, the methods and results of the survey and research are introduced; how the six given companies handle their supply chains and delivery. The thesis will analyze the differences, and explain why there are differences, why not all companies work in the same way, even with very similar products.

3 THEORETICAL FRAMEWORK

3.1 Introducing the commissioner

The basic principle of the new aerosol filtering solution is the same as particle filters; it purifies the air in the workshops, so that the toxins created in the work, do not spread out in the air and harm the employees. The difference in this new solution is that it actually clears out all the harmful aerosols from the air, not just the particles as their competitors do. Currently, according to the commissioner, the existing solutions do not clear out as many toxins out of the air as they should. The new solution clears out more toxins, leading to better air and less health issues. This is one of their main goals; making people healthier, and reducing the amount of sick leaves caused by the toxins in the workshops.

Other improvements comparing to their competitors are material efficiency, maintenance efficiency, better fire safety and decrease of hazardous waste. These are all important factors, since they reduce costs.

What the new solution offers is a healthier and more cost effective way to filter aerosols and particles in machine tools environment. It has potential to become a big competitor in the global market of particle and aerosol filters.

The commissioner wishes to know, what kind of supply chains their competitors have, and how the competitors distribute to their customers globally. Since logistics are a huge part of any business, it is crucial to understand how things are done in other companies, and research if there are better, more economical and ecological ways to do logistics.

3.2 Particle filters

Modern manufacturing facilities contain equipment that give off oil mists, and require some form of filtering. Most common way to filter the oil mists, are particle filters. The machines that require filters are for example machines for welding, grinding and cutting, and machine tools for turning, grinding and milling (Brahm, Jorgen, 23.5.2012).

Oil mists and smoke get into the environment and cause harm to equipment and workers. To avoid the risks, companies must use filters to reduce the amount of mist and toxins in the air.

Three main ways are used to filter the particles and aerosols from the air. The first one is using a single filter for a single machine, filtering the aerosols from the breathing air. The second one is a single filter for multiple linked machines, filtering the aerosols from the breathing air. The third one is a single filter linked for multiple machines, filtering the air outside of the working space (Työterveyslaitos).

3.3 Supply chain and supply chain management

Donald Waters (2007, 38) defines supply chain in a following way: “*The simplest view of a supply chain has a product moving through a series of organizations, each of which add value to the product.*” Generally, supply chain is described as the flow of material, information and money from the suppliers to the end customer, as shown in figure 1.

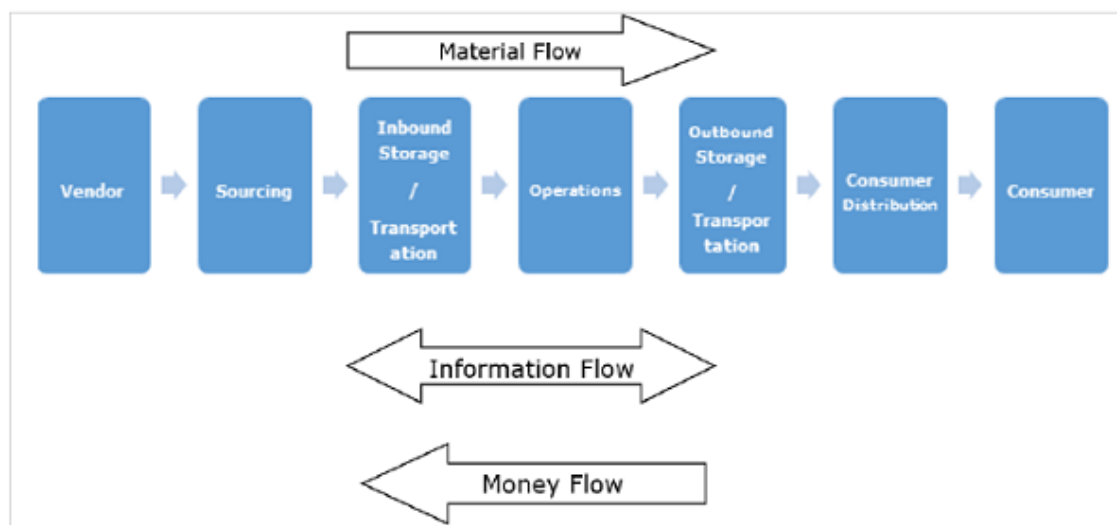


Figure 1 Supply chain

Supply chain management takes a broader view of the flow of material, information and money between and among all related organizations that form the supply chain. (Waters 2007, 37-38.) There are different ways of describing supply chain management.

Supply chain can be formed with suppliers, the organization including factory, warehousing and distribution, and consumers, as seen in figure 1. As it's simplest form, a supply

chain only forms from one supplier, one factory or other main organization, and one customer. In reality, especially with larger companies, there are usually several suppliers, one or more factories, warehouses, distribution centers and end consumers.

The supply chain consists of three main flows: information, material and money. The flow of information means the purchasing process and customer orders, forecasting and planning. Unlike information, material flow is physical, which means the actual material movements from one place to another. It can involve many stages of handling and transportation of parts and components and also the finished product. This means that personnel and equipment are needed. The flow of money in the supply chain is very much dependent on both information and material flow. When information flows smoothly, deliveries speed up and handled on time and stocks are build accordingly, which means that the circulation of money flows smoothly as well. (Sakki 2009, 22-23.)

3.4 Distribution

Distribution is the last stage of the supply chain. Without a working distribution, the end customers never receives their product. The distribution is closest to the end customer, and it can sometimes even be customer driven; customer's feedback forms the way delivery channels are used. (Skjott-Larsen, 2007,131)

3.4.1 Distribution channels

Distribution channels are described as “the movement of goods and services from the source through a distribution channel, to the final client, consumer or user and the movement of payment in the opposite direction, to the original producer or supplier” (Business Dictionary, 2015) Distribution channels include producers, wholesalers and retailers, and also the end consumer.

There are two kinds of distribution channels, direct and indirect. In the direct distribution channel, the consumer can buy the goods straight from the manufacturer. In the indirect distribution channel, the consumer may only buy the goods from a wholesaler or retailer. (Investopedia, 2017) The direct and indirect channels are yet categorized in

three main types of distribution channels, which all include a combination of a producer, wholesaler, retailer and end consumer. All these three main types can be seen in figure 2.

The first channel is the longest in that it includes all four, from producer to the end consumer. The second channel is one where the producer sells directly to a retailer, who then sells the producer's product to the end consumer. This means the second channel contains only one intermediary. The third and final channel is the direct channel, where the producer sells its product directly to the end consumer.

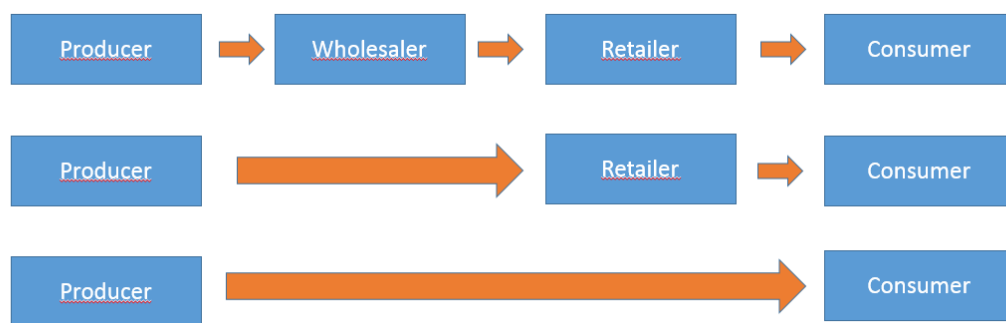


Figure 2 Distribution channels

3.5 Transportation

Transportation is usually the most expensive part of the supply chain. In 2007, U.S companies used over 600 billion dollars on transportation (Blanchard, 2007) and it is not likely to be any cheaper this year either. This is why companies should have a clear strategy on transport, and understand the factors on each transportation method.

The main factors when choosing transportation methods are the cost, speed and reliability. For more and more companies also sustainability is a key factor. The main rule is, that the cheaper the cost, the slower the mode. For example in international transports, airfreight is fast, but very expensive, when sea freight is slow but cost effective. Figure 3 shows a good example on how the transportation mode affects to the money and time spent.

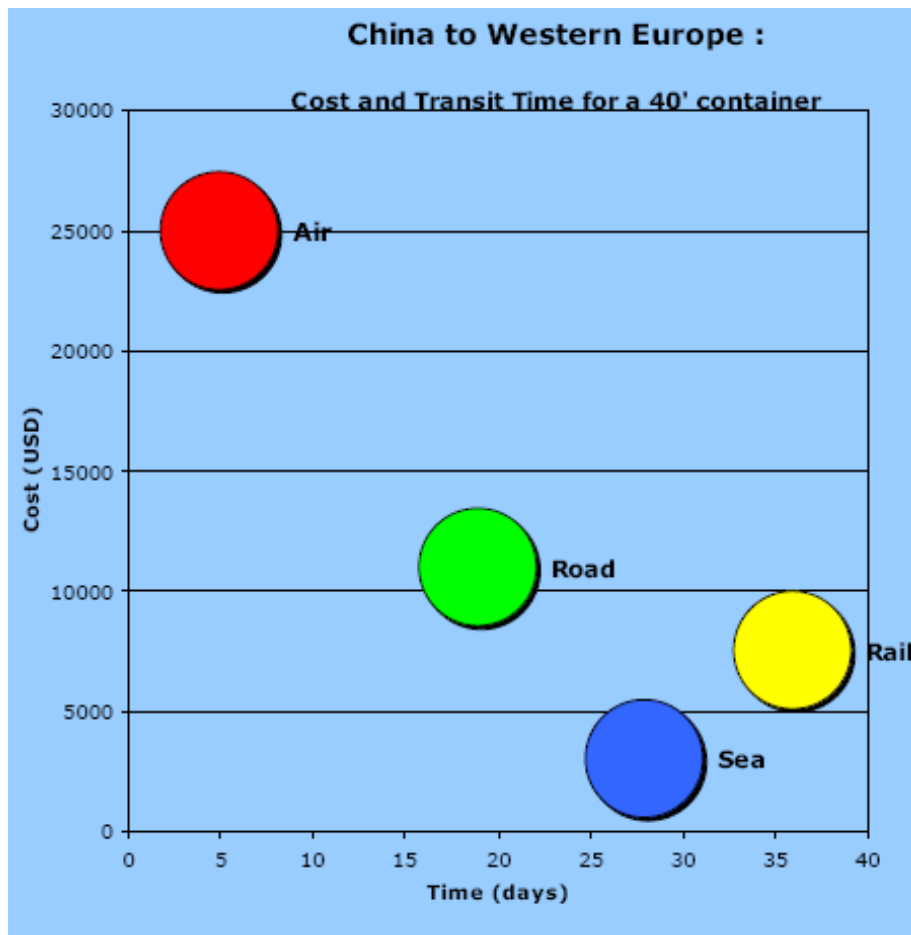


Figure 3 Cost and transit time (Container-Transportation.Com)

3.5.1 Transportation methods

There are four main freight transportation methods used to move products all around the globe; Road, rail, sea and air (Blanchard, 2007). Each of these methods have their own advantages and disadvantages, and it is important to make a strategy for transportation. Usually when transporting goods from place A to B there are more than one transportation method used, often two or three.

Road

Road transportation is the most common way of freight transportation, and usually part of all transportation at some point. Most common way of road transportation are trucks, and the most cost effective road transport is via full truckloads, where the shipper has filled the whole truck with his own products.

Road transport also includes basic modes of freight transport. These are such as bike or postal services.

Rail

Rail transportation usually refers to trains. Some freight transportations can happen with passenger vessels, but also cargo trains. For example in Finland rail transportation is a common way to transport goods from ports to further parts of Finland.

Sea

Sea freight carries the majority of global transportations. It is slow, but cost effective way to transport goods internationally as seen on figure 3.

Air

Airfreight is the way when speed is a high factor. It is often quite expensive to transport via air, but the speed is significantly faster than with sea freight, as seen on figure 3.

3.6 Production strategies

Production strategy explains how to plan a company's manufacturing and assembly. Different strategies work for different companies, and there isn't superior solution that would work for all businesses. When planning a manufacturing production, the things to keep in mind are lean-time, need to customize, and the costs of keeping stock.

With global companies, these strategies can also vary depending on the market. At some locations, the capability to deliver fast is more important than the ability to customize. When the delivery needs to be fast, there needs to be a number of stock to fulfill the need. This reflects on higher warehousing and inventory costs. On other markets, the fast delivery might not be the key factor, but the ability to modify the product to a certain need.

There are three basic production models that are explained here more thoroughly, make-to-order (MTO), make-to-stock (MTS) and make-to-assemble (MTA).

3.6.1 MTO

Make to order (MTO) allows consumers to purchase products that are customized to their specifications. This means that the company only manufactures the end product once the customer places the order. This creates additional wait time for the consumer to receive the product, but allows for more flexible customization compared to purchasing straight from stock.

3.6.2 MTS

Make to stock (MTS) is used by businesses to match production and inventory with consumer demand forecasts. This requires an accurate forecast of demand in order to determine how much stock should be produced. If demand for the product can be accurately forecasted, and is quite steady, the MTS strategy is an efficient choice for production.

3.6.3 MTA

MTA production is best described as a hybrid of the other two types of manufacturing production strategies: make to stock (MTS) and make to order (MTO). In make to assembly strategy, the company stocks the basic components of a product based on demand forecasts, but does not assemble them until the customer places an order. This allows for order customization, but a faster delivery compared to the MTO strategy.

4 EMPIRICAL STUDY

4.1 Interviews with specialists

For this thesis, I interviewed two experts, who have been working with particle filters, ordered them and done some maintenance on them. They have both a vision and practical experience on how these machines should ideally work, and what are the issues that are yet to solve with the current solutions.

The aim of these interviews was to get some insight on the subject, hear opinions on why they think the new aerosol filtering solution is better than the competitors' products, and what are the main things required for excellent particle and aerosol filtering.

4.1.1 Respondent 1

Respondent 1 is a Senior Lecturer in machine engineering in Tampere University of Applied Sciences. He has been involved in the project group of the new aerosol filtering solution, and has seen the benefits it can bring.

Respondent 1 has worked as a production manager for a machine workshop for several years, and has been in charge of the maintenance and care of the machines. In addition, the maintenance planning and procurement have been his responsibilities.

Respondent 1 thinks that the most important qualities for particle and aerosol filters are the ability not to clog, long maintenance cycles, trustworthiness and the filtering ability.

Respondent 1 has been ordering maintenance and new equipment for the workshops, and tells me, that most of the actual machines come straight from the manufacturers, but the maintenance company in charge has ordered the filters for them.

4.1.2 Respondent 2

Respondent 2 is a consultant, who has had a long career at a company that uses particle filters. Respondent 2 has been involved in the air quality studies made at the company,

and done own experiments and studies on the filters. Respondent 2 has been part of previous thesis studies and tests done in real life circumstances, and build prototypes that are still being tested. Respondent 2 was asked to be a consultant and a filtering expert for the engineering group that designed the new aerosol filtering solution.

During his career, Respondent 2 has ordered filters for various machines for post-installation and manufacturing. He has also been a part of purchasing and ordering activities. He also invented ways to maintain and repair parts without ordering new ones.

At his previous employers company, machines came straight from the manufacturers, avoiding intermediaries and/or agents. Respondent 2 has seen products from many of the companies presented in this thesis, and on his opinion, they did not fulfil all their promises on air filtering.

Respondent 2 thinks that the most important quality for particle or aerosol filter is the actual ability to filter. After that, comes the price and maintenance/repair cycles. On his opinion, the new aerosol filtering solution is truly groundbreaking in its filtering abilities.

4.2 The six given competitors

The six companies introduced in this chapter were named the biggest possible future competitors by the commissioner. Five of them are global companies, and one nationwide in Finland.

Most of the companies produce a variation of filters, not only particle filters for machine tools environment. Particle filters are still a big part of their business, so the information gathered for the companies is applicable, and at least on some level comparable to the new aerosol filtering solution.

4.2.1 3Nine

3Nine is a Swedish company that develops solutions for the purification of processed air. 3Nine's technology bases on disc stack separation, which resolves in a high degree of purification in a compact format and requires a minimum of maintenance. (3Nine.com)

3Nine has won many patents, and has a strong hold of the market both globally and in Finland. In Finland, 3Nines main partner is Konecranes, who also distributes in Finland.

4.2.2 Nederman

Nederman is a Swedish company that offers offer products and solutions within industrial air filtration. Nederman has operations in 25 countries and distributors in additional 30 countries, covering five continents. (Nederman.com)

Nederman has a wide coverage all over the globe. In Finland, Nederman works through a distributor, Teca Oy.

4.2.3 Absolent

Absolent is a Swedish air filtering company, that was founded 1995. It started to export globally in 1998, Finland being the second country they exported in. Absolent filter units contain several filter cassettes that contain filter materials, which are mixed to suit each customer's needs. (Absolent.com)

Absolent has tree key brands: Absolent AB, Bristol and Filtermist. They each operate independently, but are under the Absolent Group. In Finland, Absolent works through a distributor, MTC Flextec Oy Ab.

4.2.4 Dantherm

Dantherm is a Danish company that offers air purification solutions both to industrial and private use. Dantherm also provides solutions for military units and humanitarian organizations. Dantherm has a significant market position in Europe, but works also in a global market. (dantherm.com)

In Finland Dantherm works through a distributor, Munters Finland Oy.

4.2.5 Losma

Losma is an Italian company that has a group structure. Losma has branches in five countries, Italy, UK, Germany, USA and India. Losma has two product lines, one for air filtering, and one for the filtration of liquids. (Losma.com)

In Finland Losma works through a distributor, Knorring Oy AB.

4.2.6 PPT-Filter

PPT-Filter is a Kotka based company that offers industry solutions for dust removal. PPT-Filter plans, manufactures, and offers installation and service for both total solutions and individual items of equipment. PPT-Finland focuses only on the Finnish market, but has a strong hold in their chosen area. One of their reference companies is Sandvik, a company that AerOff is also in close contact with.

4.3 Survey for the companies

When trying to compare the supply chains and distribution between the given companies, I came in to a realization; the information is not public. Since logistics are a huge part of a company's business, they want to keep their full processes hidden. When the companies have found the most economical and ecological way of transporting their product, they do not want their competitors to know how it is done.

Some things I was able to find from the company websites and annual reports. Some of the factory and distribution center locations could be found, but not how the goods are transported from each part of the supply chain.

This made me realize, that if I wanted to know, how the companies actually manage their supply chains and distribution, I have to ask it from the companies directly. I contacted the six companies, and asked if they would be interested to answer a few questions for my thesis.

I send six e-mails, and two of them answered. Company 1 and Company 2 were kind enough to agree to answer my questions via e-mail. I sent them the following questions:

1. Where are your factories located?
2. Where are your distribution centers located?
3. Where does your assembly happen?
4. Do you also provide maintenance or any other reversed logistics?
5. What kind of transportation methods do you use? Does it vary depending on the location?

I also asked if they had anything else they would like to add, or thought would be beneficial for my thesis.

4.3.1 Answers to the survey

My survey got two answers, with a total of 33% return rate. The quantity is very small, but the quality is quite good. The answers are easily analyzable, and they give out information that was not public. The answers I got from the companies are the following:

4.2.1.1 Company 1

1. Where are your factories located?

Our factories are located in Sweden and Latvia

2. Where are your distribution centers located?

We have offices in Sweden, Germany, USA, France and sales people in these countries. There are also some distributors in different areas in Germany and also in other countries who sale our products in our name and get commission for it.

3. Where does your assembly happen?

The assembly happens fully in the factories in Sweden and Latvia

4. Do you also provide maintenance or any other reversed logistics?

We have some companies that are trained for maintenance, but it is also possible to send our machines back to our suppliers in Sweden and Latvia for renovation for example. Our machines do only need a minimum of maintenance

5. What kind of transportation methods do you use?

We normally use TNT

4.2.1.2 Company 2

1. Where are your factories located?

Sweden, Mexico, Lithuania

2. Where are your distribution centres located?

Sweden, USA, China

3. Where does your assembly happen?

Sweden, Mexico, Lithuania

4. Do you also provide maintenance or any other reversed logistics?

Yes, in Sweden, USA, Germany, China, in other countries we provide thru distributors.

5. What kind of transportation methods do you use?

Road, Boat, rail, and partly Airfreight.

My goal is to understand how the supply chains and global distribution works at the moment. If you have any other information you think would be beneficial for me, I would truly appreciate it.

One of our internal environmental goal is to reduce transports around the world by manufacturing close to its selling market, and of course, this also gives benefits in leadtime. We adapt warehousing to actual markets, for ex. In USA it is crucial to have units in stock, in EU we can produce after received order.

4.3.2 Results

Since I only got a 33% return rate for my survey, it is not possible to give out an extensive analysis. That said, from the two answers some similarities and some differences can be found, and they can be analyzed.

For me the most interesting thing was that both companies do the full assembly in their factories. My initial thought was that since the filters are quite large at size, some of the assembly would happen at the location, to save in transportation costs. Apparently, this is not a factor in these companies. Since the quantity of one order is not usually in hundreds or thousands, it might be easiest for them just to send the installation-ready product to the customer or distributor.

Other similarity is that the main factories are in Europe. When the business is global, I assumed that the factories would be more globally set as well. Manufacturing is usually cheapest in Asia, but maybe the transportation costs are higher than the saving of manufacturing. It also seems that the companies like to manufacture in their home countries.

Both companies offer maintenance through distributors, and it seems to be important part of their business. A significant distribution network was also a factor for all the companies that I studied. No company was in every country of continent without a partner. It seems that a good partner network is a crucial factor.

The biggest difference is in the transportation methods. Based on the answers, Company 1 only uses TNT, when Company 2 uses different transportation systems depending on where the end user is located. There are also different strategies used inside Company 2; MTO (make to order) and MTS (make to stock) depending on the market they operate. In Europe, it seems to be easiest to use MTO, but in the USA, there needs to be stock to reduce the lead-time.

Below are the answers easily comparable in a chart.

Companies:	Factories:	Distribution centres:	Assembly:	Maintenance	Transportation
Company 1	Sweden and Latvia	Sweden, Germany, USA, France	In the factories	Yes, in factories and through distributors	TNT
Company 2	Sweden, Mexico, Lithuania	Sweden, USA, China	In the factories	Yes, in factories and through distributors	Road, Boat, rail, and partly Airfreight.

Chart 1 Answers to survey

5 CONCLUSIONS

There are many ways to manage supply chains and distribution, and even with a similar product, the ways may differ a lot. With the survey result, I was only able to compare two of the six given companies. The two had similarities in assembly and the way they handle the after purchase process, but differences in their distribution and transportation methods.

I was not able to compare the full supply chains, since the companies did not reveal where they source parts and component. This is something that each company tends to keep as a secret. It may not also be too relevant when comparing the companies, since the products are not identical. Even with similar purpose and competitive situation, the components of the filters can be very different.

The supply chains starting from factory to the end customer are more useful to compare. With the limited results I got, it seems that the full assembly is done in the factories, and from there the products are transported in various ways (road, rail, sea and air) into distribution centers and warehouses around the world. There are not distribution centers in all of the countries the companies operate. The companies use MTO in smaller markets and MTS only when the coverage of one distribution center is larger, and time is a bigger factor. These companies did not reveal the use of other manufacturing strategies, but I believe some companies also use MTA with these kinds of products.

The companies use partners and distributors in the countries they do not have their own offices. The five foreign companies all use distributors in Finland (PPT-Filter operates mainly only in Finland). These partners or distributors present the company, and offer wide range of maintenance and installation services.

All the companies focus on air purification in a larger scale. They have different filters for different places, for filtering air, oil mist and else. Since the new aerosol filtering solution is only one product, it might be challenging to compete with companies with larger variation, capacities and networks. If the engineering group wishes to go in the market with its own company, it may be wise to think if there are ways to modify the product, and use the new solution in other forms of filtration as well. The competition

seems to be fierce, and it would require huge investments to get to the global market, at least as a serious competitor.

Most beneficial option could be to sell the new aerosol filtering solution to one of the companies studied here. With this tactic, the product could spread into wider markets more easily, and the goal of making people less sick in the workplace could happen in a bigger scale.

One company jumped out to me during this study, as a potential partner. This was Company 1. They have acquired many patents during the past years, and their values are in line with the values of the engineering group of the new aerosol filtering solution. Company 1 might be interested in the new solution the engineering group has developed, if selling the new solution is something they could see as a possibility.

If selling the new solution is not a tempting option, based on my study I would suggest similar kind of supply and distribution as the competitors have. Since the machines are quite expensive to make and stock, MTO or MTA strategies would be the best ones for the new solution. The ability to customize the product is a valuable thing, and could be a good competitive aspect.

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