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An Efficient Model for Supply Chain Logistics Case: Scanfil EMS Oy

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Bachelor's Thesis
Spring 2023
Degree programme in International Business
Oulu University of Applied Sciences

ABSTRACT

Oulu University of Applied Sciences
Degree programme in International Business

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Title of the thesis: An Efficient Model for Supply Chain Logistics
Thesis examiner(s): Jyrki Holappa
Term and year of thesis completion: Spring, 2023
Pages: 47 + 1 appendix

The objective of this thesis is to provide Scanfil EMS Oy with efficient supply chain logistics model recommendations for two selected commodities. These two commodities are printed circuit boards (PCB) and sheet metal mechanics. The aim of the supply chain logistics models is to reduce required warehouse space and tied-up capital in inventory, as well as increase flexibility in supply chain management. The study was requested by Scanfil EMS Oy as they are developing their supply chain logistics operations.

The study presents recommendations for PCB and sheet metal mechanics. The research methods chosen for the study were literature review, semi-structured interview, and a workshop in Pärnu, Estonia.

The research provided useful findings which were used to develop recommendations of supply chain logistics models for the two commodities. It was found that the classic purchasing model is the ideal option for printed circuit boards as of right now, but looking into the future, this should be re-evaluated whether Scanfil decides to switch PCB supply over from Asia to Europe. For the sheet metal mechanics, it was found that the call-off with lead time model is the ideal option. This was mostly due to supply being in Europe, making it easier to implement.

The recommendations provided in this thesis can help Scanfil reduce required warehouse space and tied-up capital in inventory, as well as increase flexibility in supply chain management. As supply chain management is an ongoing process of development, it is important for Scanfil EMS Oy to continuously evaluate and update their supply chain strategies and models. This will make sure that they remain competitive in the market and can effectively meet the changing demands of their customers.

The study considers topics such as supply chain management, supply chain models, logistics, inventory management, total cost of ownership, geographical location of production and different typed of geopolitical risks.

Keywords: Supply chain management, supply chain logistics, supply chain models, inventory management, geographical location of production, geopolitical risks

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1 INTRODUCTION

The objective of this thesis is to provide Scanfil EMS Oy with efficient supply chain logistics models for two selected commodities. These two commodities are printed circuit boards (PCB) and sheet metal mechanics. The aim of the supply chain logistics models is to reduce required warehouse space and tied-up capital in inventory, as well as increase flexibility in supply chain management.

1.1 Introduction to Scanfil

Scanfil EMS Oy is a contract manufacturer and system supplier for the international electronics industry. It was founded in 1976 by Jorma J. Takanen in Sievi, Finland. The company's headquarters are in Sievi. Scanfil has operations around the world and operates nine factories in Europe, North America, and Asia. In 2022, Scanfil's turnover was 844M€. Scanfil employs about 3,400 employees, from which 78% work in Europe, 16% in China, and 6% in the US. Scanfil's suppliers and customers are both domestic and international (Scanfil 2022).

Scanfil EMS Oy has a diverse customer base, having customers in industries including Advanced Consumer Applications (29%), Energy and Cleantech (26%), Automation and Safety (22%), MedTech and Life Science (18%), and Connectivity (5%). Scanfil is constantly looking to innovate and improve its services and is committed to quality, reliability, and sustainability (Scanfil 2022).

1.2 Development Tasks & Research Questions

Each of the two commodities will be provided with its own recommendation of a supply chain logistics model. The development tasks for the commodity of printed circuit boards include supply chain models, inventory management/development, total cost of ownership, geographical location of production, and geopolitical risks. The development tasks for the commodity of sheet metal mechanics include supply chain models, inventory management/development, quality risks regarding shipping, and geographical location of production.

The main research question for this study will be “what makes an efficient supply chain logistics process?” The supporting research question will be “how to develop a supply chain logistics model for printed circuit boards and sheet metal mechanics?” The objective is to provide Scanfil with a comprehensive study that could be of assistance in reducing warehouse space and tied-up capital in their inventory.

2 SUPPLY CHAIN LOGISTICS

This chapter will include a discussion on the theoretical foundation on which the thesis will be constructed upon. The different topics that this chapter will include are the supply chain, supply chain management, different types of supply chain models, logistics, inventory management, total cost of ownership, geographical locations, and geopolitical risks.

2.1 The Supply Chain

Supply chain management has evolved in a steady pace for the last 30 years. It was originally defined as only distribution and logistics, but now supply chain management refers to a whole business strategy that is inclusive and competitive. Instead of utilizing the old model of local competition between organizations, businesses now deal with each other supply chain by supply chain (network by network). The diagram below represents a global supply chain (Prater and Whitehead 2022, 4).

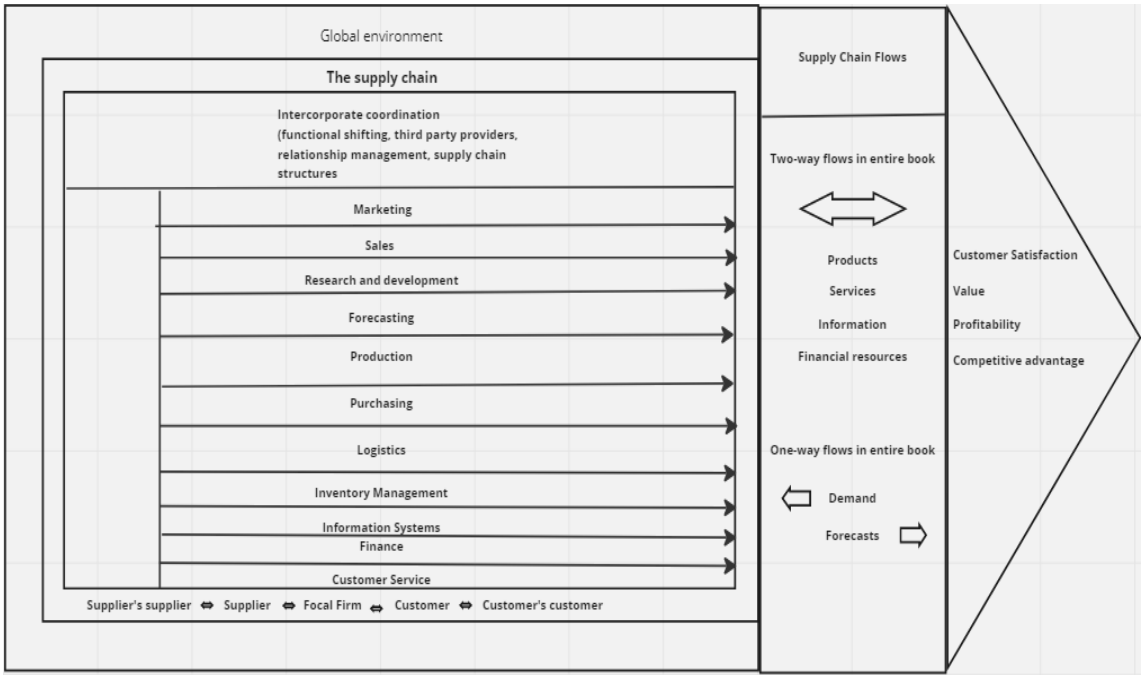

Figure 1. Applied from Prater and Whitehead 2022, 5. A representation of a global supply chain.

Supply chain management (SCM) is a phrase that includes a wide range of notions and ideas. It is important to know the main terms that will be used in order to make sure that we are all “on the same page”. This is crucial due to the reason that communication needs people to be able to grasp each other’s language (Prater and Whitehead 2022, 7).

The supply chain is made up of the businesses that work in order to produce and transport a commodity or service to its end customers. It starts at the raw materials and subcomponents and ends at consumption (Prater and Whitehead 2022, 8).

The businesses that collaborate to create and deliver a good or service to end customers make up the supply chain. It starts at the location of the raw material and component suppliers and ends at the consuming location. Supply chain management integrates different business processes. These processes are product design, planning/forecasting, order management, inventory management, order fulfilment, and return management. The main strategy for doing this is to build relationships with different supply chain partners (Prater and Whitehead 2022, 9-10).

To satisfy consumer needs, logistics refers to the management of the inventory and movement of products, services, and information inside a business or supply chain (Prater and Whitehead 2022, 10). Elements of logistics include:

Materials Management - Purchasing and receiving raw materials or unfinished goods to be used for production.

Material Flow System - The capacity to discover materials and plan their production all the way to transportation.

Physical Distribution – The act of delivering finished goods to the end customers.

2.2 Supply Chain Management

Two consultants named Oliver and Webber created the phrase "supply chain management" in 1982. They were very familiar with the Japanese and the Just-In-Time revolution in the 1970s, and therefore Oliver and Webber had a clear perspective of the future. Taking the role of traditional performance indicators (cost, speed, flexibility, reliability, and quality) into account and how they operate inside business processes helped them gain better knowledge of what makes up a supply

chain. Even though each indicator is crucial on its own, the indicators are all interconnected in a system of interdependence (Prater and Whitehead 2022, 11).

According to IBM (2022), the supply chain is the "face" of the company to customers and consumers. A company's supply chain management will protect its brand and long-term viability the better and more effective it is. Key features of supply chain management are defined by the five “Cs”:

Connected

Accessing data from social media, Internet of Things (IoT) and from ERP’s and other B2B tools.

Collaborative

Enabling and improving collaboration and engagement with suppliers through cloud-based commerce networks.

Cyber-aware

The supply chain needs to toughen its security against cyber threats and attacks.

Cognitively Enabled

By gathering, coordinating, and managing choices and activities across the supply chain, the AI platform transforms into the control tower of the supply chain. Most of the supply chain is self-learning and automated.

Comprehensive

Analytics abilities need to be scaled in real time with data. The insights of the analytics will therefore be comprehensive and quick. The supply chain of the future does not accept latency.

Many companies have already started this process due to involvement in cloud-based commerce networks being at an all-time high and lots of effort is being made to strengthen analytical capabilities (IBM 2022).

2.3 Different Types of Supply Chain Models

There are six different supply chain models used to manage and support supply chains. These models can be put into two different categories. The model can either be focused on **efficiency** or on **responsiveness**. Although, all six models include elements of both efficiency and responsiveness, they still have a primary focus (Box Around The World 2022).

2.3.1 The Continuous Model

According to IDB (2022), a supply chain that is made for continuous and scheduled delivery of commodities is known as the continuous model. With this model, constant flow of resources and goods is guaranteed, but it can only exist where there is stable supply and demand. These kinds of environments can usually be found where there are developed supply chains for global brands and little volatility in customer demand.

An example of the continuous supply chain model is Pepsi. The time of year nor the state of the economy affects the demand of Pepsi's drinks and foods. In order to make its goods, Pepsi has built up the logistics of its delivery system to continuously procure ingredients. Vendors are also continuously restocked. The continuous model is grouped in the **efficiency** category (IDB 2022).

2.3.2 The Fast Model

Businesses that produce goods that have short market lifecycles usually use the fast model. The fast model is commonly known to be used by businesses that deliver products that are trendy. This model is very useful for companies that release new goods when the old ones are starting to lose their appeal (IDB 2022).

An example of the fast model can be seen with Nike. A pioneer in activewear fashion, typically sets up supply and information distribution systems to manufacture and then sell new shoes and other gear before that specific trend has had chance to run its course. The business will shortly establish a fresh, efficient supply chain for the following wave of fashionable goods. The fast model is grouped in the **efficiency** category (IDB 2022).

2.3.3 The Efficient Model

The efficient model is perfect for companies that are operating in highly competitive markets where maintaining a competitive edge over competition requires a high level of efficiency in logistics and distribution. This model has a high priority on inventory management and trying to get the most out of all workers and their equipment (IDB 2022).

A business using the efficient model usually produces products that are of similar kind to the products of its competitors and potentially sells them to the same customers. These kinds of companies understand that a lot of its profit will be found in cutting costs along the supply chain while at the same time making sure they can keep their products in stock. The efficient model is grouped in the **efficiency** category (IDB 2022).

2.3.4 The Agile Model

IDB (2022) states, that for a supply chain to qualify as an agile model, it needs to have four characteristics: virtual integration, process alignment, a network base, and market sensitivity. The company should monitor changes in market demand in real time to implement virtual integration. Sharing supply chain responsibilities throughout the organization is what process alignment is defined as. This can be done by having a jointly managed inventory, using collaborative product design, and fully coordinating the whole supply chain. Network-based means that each participant in the supply chain works at an equal approach. Market sensitivity quickly changes the pace of manufacturing according to changes in demand (IDB 2022).

Businesses that operate in markets with a lot of volatility in demand could do well with this strategy. The agile model is a model that is excellent for companies that are dealing with specialized order products. It is a model that makes sure that it is possible to ramp up, but also stay stable in production. The agile model is grouped in the **responsiveness** category.

2.3.5 The Flexible Model

Businesses can do well with strong demand peaks as well as low demand periods by using the flexible model. Part segmentation, accurate stock levels, and flexible planning are the three characteristics for a supply chain to qualify as a flexible model. This is possible by automating production and having a diverse supplier base.

As an example, the flexible supply chain model is used to produce and transport the paper and writing supplies sold by Staples. For the back-to-school season, Staples expects strong demand,

so it overstocks its stores with extra notebooks, paper, pens, pencils, rulers, and other school supplies. The business must also make sure that some items are available all year. The flexible model is grouped in the **responsiveness** category (IDB 2022).

2.3.6 The Custom Model

The custom model is basically a hybrid of the agile and continuous models and is useful in situations when many product configurations are necessary. Anytime there are choices for customer customization, a custom model is probably being used. This is seen by businesses which allows customers to personalize orders for example, backpacks, before placing them. The market for backpacks is quite stable except for the increased demand during the autumn. Companies using customer customization need to be ready for when a personalization option has a decrease or increase in popularity and demand. The custom model is grouped in the **responsiveness** category (IDB 2022).

2.4 Logistics

As previously mentioned, to satisfy consumer needs, logistics refers to the management of the inventory and movement of products, services and information inside a business or supply chain. Physical distribution, or “logistics”, has three different primary concerns. These concerns are receiving, storing, and delivering. It is the business’s responsibility to transfer material from place to place. This also includes to the customer. The process of logistics can be faced with huge issues. An example could be a bottleneck in the process which would lead to huge issues. The consequences from the issues include increased lead-time, increasing costs, reducing profits, and even losing customers. Every company has logistics, and it should not be overlooked. It is important to remember that sales will not happen unless the proper products are available at the right time and at the right location (Prater and Whitehead 2022, 81-82).

Managers of supply chains must deal with lots of difficult logistics decisions. These decisions include the method of transportation to be used, the physical layout of the distribution system (including the amount and location of distribution warehouses) and choosing whether to have your own warehousing and transportation or to outsource it (Prater and Whitehead 2022, 82).

2.4.1 Transportation

Businesses have access to a wide variety of transportation options. The following figure shows the most typical. Multimodal combinations are also shown in the figure. Multimodal transportation techniques are created when two types or modes are merged. Piggybacking, for example, is the practice of loading trucks for long-distance shipment onto a railway (Prater and Whitehead 2022, 82).

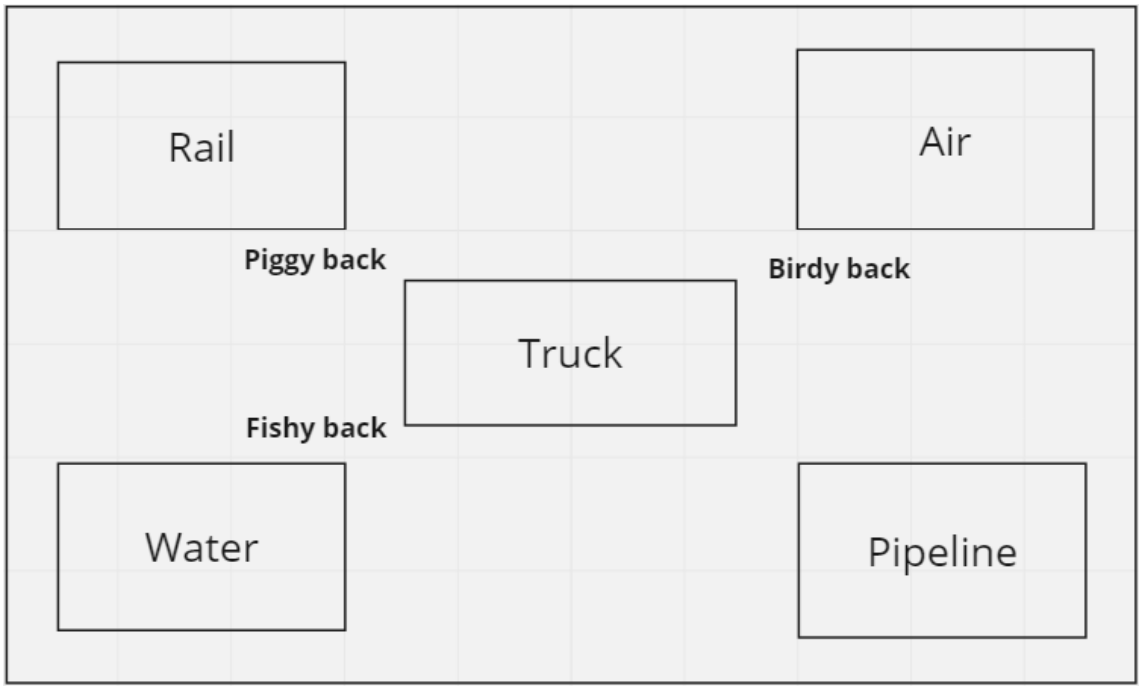

Figure 2. Applied from Prater and Whitehead, 82. A representation of multimodal transportation combination.

There are other forms of transportation but the size of them is tiny compared to the ones shown in the figure. As an example, it is sometimes more useful to use bicycles in large city areas due to roads being full of traffic and customers being close by. Pipelines are quite limited in their capability since they are mostly used by companies only to transport oil and natural gas. Truck, rail, air, and water are the most common transportation methods today (Prater and Whitehead 2022, 82-83).

Transportation by truck has the benefit of flexibility. In addition to that, trucks allow for reduced loss and damage shipping services, as well as tracking, accuracy, and a quite broad geographic area for shipping. Another benefit is that the transportation business is now characterized by intense pricing rivalry, which lowers prices. A disadvantage would be that bad weather and traffic sometimes cause truck shipments to be delayed (Prater and Whitehead 2022, 83).

The benefit of railroads is that they offer quite reasonably priced transportation for shipping for the size of a carload. For railroads, products must be packed differently to accommodate tougher handling. Although rail transportation might be a little slower, the cost savings can be rather significant. Additional cost-cutting alternatives for businesses include freight forwarders, piggybacking, and double-stacked containers (Prater and Whitehead 2022, 83).

The transportation form with the highest prices and shortest lead times is air transport. It is therefore mostly only appropriate for valuable, time-sensitive, and short-lived goods. Air transportation offers the fastest shipping times and reliable departure/arrival schedules. International trade has started to place more emphasis on this form of transportation (Prater and Whitehead 2022, 83).

For shipping large, lower valued, and long-lived items overseas, the form of water transportation offers an alternative to air transportation. Water transportation is a reliable option due to being able to pack several goods into a single well-protected shipment, good port management, and the growing number of ports around the world. Although it has the longest lead-time, this form of transportation is likely the best choice when time is not an issue (Prater and Whitehead 2022, 83).

It is thought that usually rail transportation is more efficient than truck transportation in Europe, where the geography is more compact, and the laws allow high-speed rail systems. In developing areas, the state of the roads may be poor that rail transportation outperforms truck transportation. To choose the appropriate transportation strategy, it is crucial to understand the infrastructure of the region (Prater and Whitehead 2022, 83).

2.4.2 Delivery Methods

As soon as the form of transportation has been chosen, it is important to set up the schedules for delivery. The two most common methods of transportation are called direct deliveries and milk runs (Prater and Whitehead 2022, 84).

Direct deliveries transport items from a starting location to a receiving location. Routing in this situation is simple and often involves selecting the shortest direct path. Since the transit is direct,

intermediary processes like warehousing and shipment combining are not necessary (Prater and Whitehead 2022, 84).

The milkman would make deliveries from a dairy business to several different family houses. Milk run is a delivery method that sends packages from a single location to more than one receiving location. Direct shipments are less complicated than milk runs. For instance, choices about quantity must be made prior to the delivery. After quantities have been determined, it is important to decide on the frequency of deliveries to be carried out. Lastly, it is all about scheduling and setting up the schedules for delivery (Prater and Whitehead 2022, 84).

2.4.3 Outsourcing Logistics

Logistics is one of the major areas in supply chain management that is being outsourced by businesses. There are a few different ways to outsource distribution, especially logistics.

Employing third party logistics to handle different logistical tasks has several advantages. These include greater flexibility and higher customer satisfaction. By decreasing the company's expenditures in extensive logistical networks, it allows for increased flexibility and frees up capital. For instance, Dell does not have an internal delivery service. Dell contracts with UPS to deliver their products overnight and at a lesser cost than they could do it themselves. This allows Dell to focus on their primary business rather than shipping (Prater and Whitehead 2022, 90).

Third party logistics service providers' outsourcing tendency gave rise to fourth party logistics. Relationships with 4PLs provide broader services than the ones with 3PLs, which only works with the logistics of the client's company. 4PLs frequently handle distribution and logistics. They also handle vendor and inventory management. (Prater and Whitehead 2022, 90-91).

A lot of businesses now outsource their international shipping to freight forwarders. Freight forwarders are businesses with logistics and distribution networks that are very established. Examples of these are FedEx and DHL. Customs, tariffs, and other transportation-related issues must be taken care of when handling foreign goods. This makes the procedure more difficult and generates more paperwork. A lot of the time businesses give over control of the shipping to freight forwarders until it has been cleared by customs in the destination location (Prater and Whitehead 2022, 91).

With all that said, it is crucial to prepare a detailed analysis of how a business will benefit and what the costs of outsourcing would be to the company and to its customers. If outsourcing is managed properly, it can benefit the strategies of a business significantly.

2.5 Inventory Management

A business must effectively manage its inventory by utilizing all the tools at its disposal. By doing this, the business may reduce costs like overhead while also increasing customer satisfaction through better inventory availability. For inventories to be handled effectively, both logical and physical, they must be always up to date. Inventory management's main purpose is to keep the proper level of inventory while preventing shortages and overstocking. Proper inventory management also depends on forecast accuracy and replenishing inventory at the right time (Prater and Whitehead 2022, 59-60).

Inventory management is the process of procuring, warehousing, using, and selling a business' inventory. This covers the management, warehousing and processing of raw materials, components, and finished goods. Depending on a business' demands, there are several types of inventory management. All these inventory management types have advantages and disadvantages (Hayes, Adam 2022).

One of the most valuable assets of a company is its inventory. A company's raw materials and finished goods are the core of its operations in industries with high inventories including retail, manufacturing, and food services. A shortage in inventory can be harmful, especially in the industries mentioned above. On the other hand, inventory can also be seen as a liability. Having a large inventory has risks. These risks include damage, decay, theft, and changes in demand. If a company is unable to sell its inventory in time, it is possible that they will have to either sell at a loss, or even scrap it. For these reasons, inventory management is crucial no matter the size of the business (Hayes, Adam 2022).

Depending on the industry, different inventory management techniques are appropriate. An oil depot may hold significant quantities of oil for lengthy periods of time, enabling it to wait for demand

to increase. There is little fear that the stock would decay or become outdated, even though oil storage is costly and can be dangerous. Sitting on inventory is not an option for companies that deal in perishable goods or products for which demand is time-sensitive, such as calendars or trendy products, and underestimating the lifecycle or volume of purchases can be expensive (Hayes, Adam 2022).

The four most common methods of analysing inventory are just-in-time (JIT), materials requirement planning (MRP), economic order quantity (EOQ), and days sale of inventory (DSI).

2.5.1 Just-In-Time Management (JIT)

The JIT model was founded in Japan in the 1960s and 1970s. Its development was mostly due to Toyota. By only keeping the inventory necessary to make and sell items, the strategy allows businesses to significantly cut waste and costs. This strategy lowers the price of warehousing, insurance, and helps get rid of surplus inventory. This all will reduce tied up capital that can be used to increase flexibility in the whole supply chain. However, JIT management does have its risks. In the event of unanticipated increase in demand, the manufacturer might not be able to have the inventory it needs to supply that increased demand. This will harm customer relationship and in the worst case, could send customers going to rival companies for business. In addition, a bottleneck may develop if a vital good is not received “just in time”, meaning that even the tiniest delays can transform into larger issues (Hayes, Adam 2022).

2.5.2 Materials Requirement Planning (MRP)

The MRP inventory management method relies on sales-forecasting. This means that manufacturer is required to maintain accurate sales records in order to accurately estimate their inventory needs and then inform their suppliers of those needs.

An MRP inventory strategy, for instance, may be used by a ski manufacturer to guarantee that materials like plastic, fiberglass, wood, and aluminium are available depending on forecasted demand. A manufacturer can’t meet orders if they can't effectively forecast sales and schedule inventory purchases from suppliers (Hayes, Adam 2022).

2.5.3 Economic Order Quantity (EOQ)

The economic order quantity (EOQ) method focuses on determining the number of units that a business should add to its inventory with each batch order to minimize the overall costs of its inventory while assuming continuous customer demand. In the model, holding and setup expenses are included in the costs of inventory.

The EOQ model aims to make sure that the appropriate quantity of inventory is ordered every batch so that a company does not have to place orders too often or have a surplus of inventory on hand. The model presumes that there is a compensation between inventory setup costs and inventory holding costs, and that the total inventory costs are reduced when both setup costs and holding costs are reduced (Hayes, Adam 2022).

2.5.4 Days Sale of Inventory (DSI)

The days of sale (DSI) is a financial equation that shows the typical number of days a business takes to convert its inventory, which includes work-in-progress goods, into sales. DSI may be understood in a variety of ways and can be referred to the average age of inventory, days inventory outstanding (DIO), days in inventory (DII), days sales in inventory, or days inventory. The DSI number indicates how long the current stock of an inventory will survive. Although the average DSI varies from industry to industry, in general, a lower DSI is desired since it shows a quicker time to clear out the inventory (Hayes, Adam 2022).

Inventory Management is an essential component of the operations of a business. The proper method of inventory management depends on the type of business and the type of goods it offers. As previously mentioned, each method of inventory management has advantages and disadvantages, therefore there may not be a single correct method. But using the most appropriate inventory management approach can assist in reducing costs and reduce tied-up capital that can be used to, for example, increase flexibility in the whole supply chain (Hayes, Adam 2022).

2.6 Total Cost of Ownership

Total cost of ownership (TCO) is the purchase price plus the cost of operation for an asset's lifespan. Analysing the total cost of ownership involves having a broad view of the product and how valuable it could be in the long term. It is important for buyers to consider the short-term price, also known as the purchase price, as well as the long-term price, also known as the total cost of ownership, when choosing between their options. The total cost of ownership includes the long-term costs incurred during the product's usage and eventual disposal. In the long term, the item with the lowest total cost of ownership has the better value (Twin, Alexandra 2022).

When businesses are seeking to purchase assets or make investments in different projects, they take the total cost of ownership into account. The purchase cost and the costs of production and maintenance are usually broken down separately on financial statements. While the costs of production and maintenance are classified as operational expenses, the purchase cost is recorded as a capital expense. Businesses frequently do an extensive cost of ownership study, and these studies are used as framework for analysing business deals in the long term and they provide a more comprehensive evaluation of the purchase from a wider angle (Twin, Alexandra 2022).

The purchase of a new computer is an example of a business expenditure that could involve a comprehensive evaluation of the total cost of ownership. The price of the computer system was only the purchase cost. New software, installation, transitional charges, staff training, security expenditures, disaster recovery planning, on-going support, and upcoming updates are operation and maintenance costs. The business would then analyse the advantages and disadvantages of buying the computer, as well as its total long-term value to the business, using these expenses as reference (Twin, Alexandra 2022).

Before purchasing anything, but especially larger goods, it's crucial to take the total cost of ownership into consideration. For businesses, this may refer to new tools or technologies required for production (Twin, Alexandra 2022).

2.7 Geographical Location of Production

The geographical location of production plays a big role in supply chain management. The geographical location of production can have positive and negative effects on the supply chain. This depends on many factors including transportation costs, raw material availability, and different types of regulations. Different industries can experience different effects based on their geographical location. For example, the location of production matters in the agriculture industry since it affects the quality and quantity of the produce. A geographical location with suitable soil and climate conditions is more likely to have better produce, and likely have a better supply chain. Also, the manufacturing industry's geographical location affects production costs, transportation costs, and access to raw materials (Mangan et al. 2016, 194-199).

Overall, a broad view of how geographical locations can affect production and supply chain management in different industries is very important. Companies need to consider many different factors including transportation costs, raw material availability, government regulations, and market demand while selecting a production location. Understanding the important relationship between geographical location and production allows companies to optimize their supply chain management and reduce costs (Mangan et al. 2016, 194-199).

2.8 Geopolitical Risks

One of the pillars of every modern economy is semiconductor technology. Everything from household appliances to cars to warfare systems uses them. But during the Covid-19 pandemic, they became very difficult to find. Since Taiwan and South Korea produce the majority of the world's semiconductor chips, shortages in global supply chains forced businesses in the United States to endure chip shortages of up to a year. The U.S. could have entered a difficult and fast recession if it was not able to access Taiwan's semiconductors, which means that The U.S. relies on manufacturing abroad and that can pose a threat to its national security (Lee, David S. 2022).

Leaders must change their operational expectations to be able to properly manage in this new world. Most CEOs today come from a time of globalization when trade and free markets were the norm. However, this has now changed. Supply chain challenges, trade regulations, and the struggle

for access to markets and technology are just a few of the problems that businesses and leaders are dealing with today. While these problems are frequently thought of separately, the new national security economy is increasingly pushing them (Lee, David S. 2022).

For example, Apple is being impacted by the worsening relationship between the United States and China. Apple became a famous success story of globalization by having its manufacturing in China. This is where labour costs are cheaper and it allows Apple to have access to China's huge market. Currently, China is where Apple manufactures 90% of its products. This is threatened by government involvement from both China and the United States because of the worsening of bilateral relations. For example, the Biden administration recently imposed limits on the export of semiconductor technology to China and on a Chinese chip manufacturer, whose goods Apple was supposed to use for some of its iPhone models (Lee, David S. 2022).

Another significant event this year was the Russian invasion of Ukraine. In 2014 when Russia annexed Crimea, many businesses stated that they are involved in business and not politics. However, the business reaction to the 2022 Russian invasion of Ukraine has shown that business and politics are closely interconnected. Stakeholder demands, sanctions, and consumer pressure enhanced by social media pushed businesses to respond quickly. Business owners and board members showed that they would like to reduce operations and leave the Russian market, but they also admitted that it would be harder to decide on reducing operations if Russia had more significance on the company's operations (Lee, David S. 2022).

There are four different steps that businesses can take to better be prepared for the geopolitical risks in today's world. The first step is to add expertise. Companies should develop geopolitical knowledge and look for board members who can help them better understand the ways that geopolitics and business work together. Companies should look for people and learning opportunities to develop this knowledge. This can be done through selecting new board members, hiring recent graduates, and regular executive training. There are not many executive education programs that connect business and geopolitics since most of them focus on conventional business subjects (Lee, David S. 2022).

The second step is to ask the right questions. Most of the plans a company takes should be viewed through national security and geopolitics. This may be done by asking, "What are the geopolitical

consequences of the decision we are making?" before making a choice. This type of question can help a business decide whether they want to pursue these kinds of plans (Lee, David S. 2022).

The third step is to accept that it is not possible to escape politics. In the West, business and politics have typically been kept apart by most companies. This is not the correct approach anymore, especially in global environments. For example, a Chinese business may make a deal just to acquire new technology, while its Western rival is just interested in making money. Western businesses are not used to this and should improve their understanding on the goals of others they do business with (Lee, David S. 2022).

The final step is to consider the reputational risks. A company may be affected by different types of increased reputational risk resulted by the new national security economy. Examples of this are Nokia selling technology to Russia, pressure on businesses to leave the Russian market, and Chinese consumers boycotting Western brands that criticize China. The risks have increased, and businesses need to be more sensitive to the effects of reputational risks (Lee, David S. 2022).

3 THE SUPPLY CHAIN LOGISTICS PROCESS

The supply chain logistics process consists of three main concepts within the supply chain. These concepts are sourcing, procurement, and warehousing. To be able to have an efficient supply chain logistics process, it is crucial to optimize these smaller processes within the whole process.

3.1 Sourcing

The first step of the supply chain logistics process is sourcing. Sourcing includes its own stages that have to be considered to be able to maximize its efficiency. The first stage is to define the sourcing commodity, as well as the volumes (quantity, size etc.) needed, suppliers and their prices and other specification details (Strickler, Leanne 2021).

The second stage is to create a supply market analysis that will help define which strategy approach fits with whichever commodity is being sourced. One of the most effective ways to divide the supplier base is to use the Kraljic's Matrix. It is a two-by-two matrix that considers two different dimensions. As seen in the figure below, these dimensions are risk and profitability. Risk is defined as how likely it is that something unexpected happens and can cause problems with daily operations. Profitability refers to the ability to affect the organization in an advantageous way (Strickler, Leanne 2021).

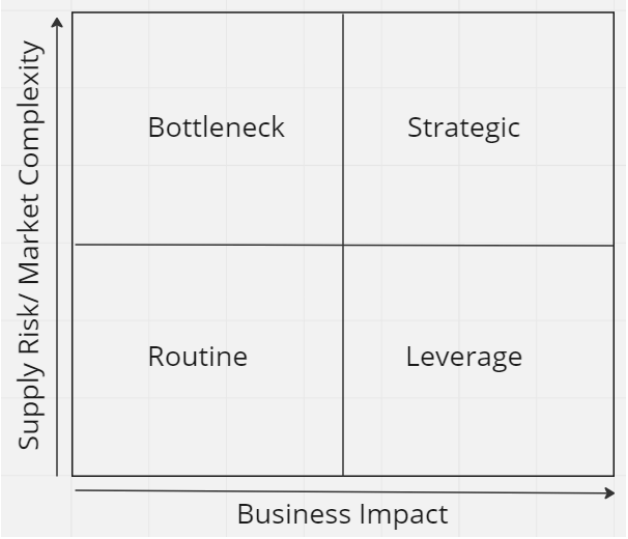

Figure 3. Applied from Strickler, Leanne 2021. A representation of the Kraljic's matrix.

The third stage is to negotiate with the suppliers that have been selected. It is needed to narrow down the potential suppliers and then you can interview them and get additional information if necessary. This will help make a better decision since more information will be gained from each potential supplier. The best team should be brought to the interview. This team needs to be knowledgeable about the commodity that is needed and can therefore ask proper questions from the potential suppliers (Strickler, Leanne 2021).

The fourth stage is the implementation stage. After the best supplier has been selected, it is important to have tight cooperation with them especially in the beginning. It is very important to include the new supplier to the daily/weekly meetings to make sure that they are up to date and have knowledge of the most recent issues or changes. This type of cooperation should continue throughout the lifetime of the relationship (Strickler, Leanne 2021).

The final and fifth stage of the sourcing process is to benchmark the supplier. This will help measure the quality and delivery performance of the supplier. This stage can sometimes be underestimated, but it can be a huge risk to skip it. By doing benchmarking, it is possible to see issues during implementation and contact the supplier to deal with the issues in a way that has the fewest negative effects on the company (Strickler, Leanne 2021).

3.2 Procurement

The second step of the supply chain logistics process is procurement. This is crucial in the supply chain since companies must have a plan to be able to adjust to their changing daily operations, and unexpected delays can happen every day. The first stage of procurement is to identify the need. Companies must determine what supplies each area of their factory needs to produce their goods and deliver their services. To make sure that resources do not run out, they must make sure they have thought of every option to meet their supply demands (Ruck, Moritz 2020).

The second stage is to select the right supplier. Usually, the sourcing team has already done this stage where potential suppliers are looked through and then one or a few are selected. If more than one supplier is available, it is important to remember that quality of service is often more important than pricing. Delays are quite common, and it is important that they are managed immediately to

prevent sales losses. In some situations, choosing a more expensive supplier could be one way to prevent delays (Ruck, Moritz 2020).

The third stage is to develop a purchase requisition and create the purchase order, also known as a PO. The purchase requisition will include the goods being bought, their quantity, the carrier, the supplier, and expected delivery times. The PO also reminds both parties of delivery expectations. It also makes it clear to all parties what is being transported and with what conditions. After the PO has been released, the supplier will get the purchase order and will start putting the order together based on the PO (Ruck, Moritz 2020).

The fourth stage of the procurement process is delivery. The supplier will ship the order to the buyer. When the order has been delivered, the buyer will check to make sure that everything is as stated in the purchase order. The buyer should also make sure that the materials were delivered on time and without damage (Ruck, Moritz 2020).

The last stage of the procurement process is the payment. The supplier will send the buyer an invoice of the quantity and kind of items the buyer ordered with the PO. The buyer will check the invoice and forward it to the finance team who will make the payment (Ruck, Moritz 2020).

3.3 Warehousing

Receiving, put-away, storage, picking, packing, and shipping are the six basic warehousing stages. It is possible to improve your warehouse operations, lower costs, reduce risks, and increase the percentage of perfect orders by optimizing these six procedures (Sunol, Hector 2022).

The first and most important warehousing stage is receiving. The warehouse needs to confirm that it has received the product in the right quantity. The products should also be in the right condition. If this is not done properly, it will have negative effects on all stages that follow later. Optimizing the warehouse reception process makes sure that products are received accurately and efficiently, while also helps prevent traffic at the receiving docks. This can be done through unloading the goods more quickly and effectively by using conveyors and power pallet trucks. To speed up the receiving process, parcel and pallet dimensioning systems can be used to automatically get the

weight and dimensions of parcels and pallets. Also, by forecasting incoming shipments, it is easier to have the right number of employees working at the receiving dock. Different kinds of dock scheduling software can help with this (Sunol, Hector 2022).

The second warehousing stage, put-away, involves moving the goods from the receiving dock to the most optimal location in the warehouse. The productivity of warehouse operations might be affected by not storing goods in their most optimal location. There are many advantages to properly storing goods. These advantages include faster and more efficient cargo storage, minimizing travel time, safety of both goods and employees, warehouse space is utilized to maximum capacity, and that goods are easier to receive and also find in the storage (Sunol, Hector 2022).

The third warehousing stage is the storage stage. Storing goods in a warehouse involves placing them in the most optimal location. When this is done correctly, it allows effective use of the available space in the warehouse and will also enhance productivity. To improve the storage process, it is important to track the proper KPIs (key performance indicators). By using software that automatically monitors the warehouse storage, KPIs will allow you to measure how effective each element of the storage process is (Sunol, Hector 2022).

The fourth warehousing stage is picking. Picking is the process in which products and material are collected from the warehouse. This can be for delivery or for production to fulfil purchase orders from customers. The picking stage is the most expensive out of the six stages. If optimized properly, it is possible to cut costs and increase the efficiency of the warehouse. A great way to optimize the picking stage is to implement mobile technology where the employees can view the picking list, scan products and have up to date information directly on their mobile phones (Sunol, Hector 2022).

The fifth stage is the packing stage. The packing stage is the process where picked and manufactured products are prepared to be shipped off to the customer. The most important task during the packing stage is to minimize damage that can be caused to the products during transportation. It is also important to have light packaging to keep the weight of the cargo as low as possible to have lower shipping costs. To optimize packing, all needed information of the products that are being shipped should be available. This includes packaging materials, dimensions, and weight. When all needed information is available, the packing process becomes effective and reduce packaging risks (Sunol, Hector 2022).

The final stage is shipping. The shipping stage is the when the products leave the warehouse to the customer. To have successful shipping, it is needed to load the correct product, transport it to the correct customer and have it arrive to the customer on the set date. It is crucial that the previous stages are carried out properly to make sure that shipping can be carried out properly and customer orders are fulfilled correctly (Sunol, Hector 2022).

4 RESEARCH METHODOLOGY

4.1 Research Objectives

The major objective of this thesis is to provide Scanfil with efficient supply chain logistics models for two selected commodities. These two commodities are printed circuit boards and sheet metal mechanics. The aim of the supply chain logistics models is to reduce required warehouse space and tied-up capital in inventory, as well as increase flexibility in supply chain management.

The main research question for this study will be “what makes an efficient supply chain logistics process?” The supporting research question will be “how to develop a supply chain logistics model for printed circuit boards and sheet metal mechanics?” The objective is to provide Scanfil with a comprehensive study that could be of assistance in reducing warehouse space and tied-up capital in their inventory.

4.2 Research Methods

The research methods that will be used for this thesis are qualitative methods. This is due to the thesis aiming to collect and analyse empirical data. This task was provided by Scanfil EMS Oy and the aim is to offer a recommendation that Scanfil EMS Oy can implement from theory to practice. The research for the thesis will be constructed by several different credible sources to ensure its credibility.

This thesis is a qualitative case study; therefore, its goal is to discover specific and in-depth knowledge about the subject that may be use in practice afterwards. The objective is to investigate new opportunities in supply chain logistics from the viewpoint of this specific business.

One employee of Scanfil was interviewed as part of the qualitative data gathering process. A semi-structured interview was used for the research since there are quite a few specific topics and questions about them, as well as new viewpoints which were helpful for the research. Open dialogue with the interview subject was therefore encouraged. The interview questions can be found in Appendix 1.

Due to its adaptability, an interview was chosen as a prominent qualitative data gathering approach. By conducting an interview, it is possible to ask questions in a precise order, to verify that the respondent has understood the questions correctly, and clarify the phrases and language used. In an interview, it is also simple to clear up any confusion and have an honest conversation with the subject, which may provide fresh viewpoints and facts that will be helpful for the research.

A workshop was hosted at the case factory in Pärnu, Estonia as the second method of the qualitative data gathering process. A workshop is a meeting where a group of invited people learn, provide new ideas, perform problem solving, and innovate in the context of a specific issue. Workshops can usually last from one hour to two full days. Most of the time, workshops are generally small in terms of attendees. This allows everyone in the attendance for a chance to be heard.

When conducting a workshop, it is important to take a few targets into consideration. Firstly, it is important to define the topic and to have an understanding what is being talked about. Secondly, it is needed to consider your audience and understand them, to help decide what to do and how to do it. Thirdly, it is important to know the amount of time that is available. Knowing how much time is allocated into the workshop will help in planning it, for example, on how deep the issues will be dived into.

The workshop that was hosted at the case factory in Pärnu, Estonia was split into two days. The first day was used to discuss the first commodity: printed circuit boards. The second day was used to discuss the other commodity: sheet metal mechanics. The number of attendees in the workshop was five. The attendees were the author of the thesis, the local supply chain manager, the global commodity manager (mechanics), global category manager (cables), global category manager (PCB), and the supply chain director.

The results were gathered on an excel spreadsheet which are explained in detail in the “Research Results” subchapter. The results will be analysed and used to provide Scanfil EMS Oy with supply chain logistics models for each of the two commodities.

The following table introduces the methods used in the qualitative data gathering process in this thesis.

Method	Attendees	Topic	Type	Date
Interview (Anonymous)	Supply Chain Consultant	Supply Chain logistics	Semi-structured interview, 40 min via Microsoft Teams	22.12.2022
Workshop	Local supply chain manager, global commodity manager (mechanics), global category manager (cables), global category manager (PCB), and the supply chain director.	Supply chain logistics models	Workshop, two days at Pärnu, Estonia factory	28.2.2023 - 1.3.2023

Table 1: Qualitative data gathering methods used in this thesis.

The thesis's qualitative technique also involves reviewing existing literature on the topic. The purpose of the literature review in the research is to provide a response to the issue of what makes an efficient supply chain logistics process. The literature review will take a dive into the supply chain and concepts related to it. These concepts will include different types of supply chain models, logistics, inventory management, total cost of ownership, geographical location of production, and geopolitical risks.

4.3 Research Results

The main research question for this study will be "what makes an efficient supply chain logistics process?" The supporting research question will be "how to develop a supply chain logistics model for printed circuit boards and sheet metal mechanics?" The objective is to provide Scanfil with a comprehensive study that could be of assistance in reducing warehouse space and tied-up capital in their inventory.

The research methods that will be used for this thesis are qualitative methods. One employee of Scanfil was interviewed as part of the qualitative data gathering process. A semi-structured interview was used for the research since there are quite a few specific topics and questions about them, as well as new viewpoints which were helpful for the research. Furthermore, a workshop was hosted at the case factory in Pärnu, Estonia as the second method of the qualitative data gathering

process. The workshop that was hosted at the case factory in Pärnu, Estonia was split into two days. The first day was used to discuss the first commodity: printed circuit boards. The second day was used to discuss the other commodity: sheet metal mechanics.

The research attained through the interview that was conducted with a source who wished to stay anonymous provides a good look into the present operations and Scanfil's view of the future regarding supply chain management and logistics. The research through the workshop provides a great deal of information that will be analysed in this chapter. The research provides five different supply chain logistics models. The research also provides what aspects need to be considered in decision making, benefits and risks to Scanfil, and aspects that need to be agreed with the supplier.

4.3.1 Interview Results

The interview with the anonymous supply chain consultant provided many interesting points related to Scanfil's supply chain logistics.

Supply Chain Operation	Advantages	Risks/ To Improve
Sourcing	Mostly defined, more integrated with SCM	Geopolitical and cyber threats, push to focus on European suppliers
Procurement	Functioning well	Order confirmations and order follow-up, work more closely with ERP system
Inventory Optimization	Sheet metal mechanics supplied from Europe (smaller lead time)	Have supplier own products for as long as possible, total cost of ownership
Quality During Transportation	PCB not as risky	Sheet metal mechanics need to be packed well
Customer Demand	Rolling 12-month demand forecast and project-based demand forecast	Forecast reliability
Inventory Management	Recently improved, inventory levels are monitored daily	Make sure inventory is always correct

Table 2: Advantages and risks/to improve of supply chain operations attained through interview.

Although the sourcing process at Scanfil has been mostly defined, there is still a need to determine how it will be utilized. Much of the process was defined in 2022 and is still ongoing, especially regarding sourcing. Previously, sourcing was a separate process mainly focused on pricing negotiations, but it has now been integrated more closely with supply chain management. However, the process has yet to be implemented, and as with anything related to supply chain management, it is an ongoing process of development. It is suggested that Scanfil's current sourcing process should consider geopolitical and cyber threats. There is a push to focus on European suppliers to reduce the dependence on the continent of Asia. This has been recently defined in the sourcing process but has not yet been implemented. Sourcing from Europe reduces risk, as seen during the COVID-19 pandemic, and can lead to smaller inventory due to shorter lead times.

The procurement process is functioning quite well, with both manual and robot purchases. However, order confirmations and follow-up could be improved by being more aggressive. The most important aspect is to work closely with the ERP system. This is due to sometimes important information being lost in email inboxes.

For inventory optimization, it is important to have the supplier own the products for as long as possible. This is where delivery terms come into play. Currently, Scanfil is responsible for the PCBs for 7-10 weeks when they are transported by sea. However, if the supply was moved to Europe, this would not be an issue. PCBs use air and sea transport, while sheet metal mechanics are primarily transported by truck from Europe with some coming from Asia through sea transport. Even though Europe may be more expensive in terms of purchase cost, the total cost of ownership can be the same or even less when considering shipping costs and smaller tied-up capital losses. It is important not to make the mistake of only considering the purchase price, as total cost of ownership is a more important metric to evaluate.

To minimize quality risks during the transportation of sheet metal mechanics, it is important to make sure that they are packed well. However, this may result in less products being transported at a time, and therefore lead to higher transportation costs. Quality issues during transportation typically occur with sheet metal parts that have already been painted where these products might rub against each other during transportation.

Scanfil receives a rolling 12-month demand forecast from its customers, which is defined as the long-term forecast model. Additionally, Scanfil also receives project-based demand forecasts for

smaller projects, which is defined as the project-based business forecast model. When the delivery date approaches, the long-term forecast model translates into purchase orders from the customer. However, one challenge is that a customer may provide a forecast for parts A, B, C, and D, but only send a purchase order for part A. This can be problematic for Scanfil as it may have already prepared to produce all the parts according to the demand forecast.

Scanfil's inventory management process has been recently improved. Each Scanfil factory monitors its inventory levels daily and Scanfil's overall inventory is monitored weekly. It is important to make sure that the inventory, in terms of capital and volume, is correct.

The interview with the anonymous supply chain consultant provided many interesting points on several aspects of Scanfil's supply chain logistics. While the sourcing process has been mostly defined, there is still a need to determine terms of implementation of geopolitical and cyber threats. Moving towards European suppliers can lead to lower inventory value and reduced risk, especially during times of crisis. The procurement process is functioning well but could be improved by being more aggressive with order confirmations and follow-up. Inventory optimization is crucial, and the supplier should own products for as long as possible to reduce the amount of tied-up capital. Packing sheet metal mechanics well is important to reduce quality risks during transportation, but this may result in higher transportation costs. Lastly, it is crucial to try and make sure that customers know purchase orders should match demand forecasts to keep production efficient.

4.3.2 Workshop Results

	Logistics Model	Classic Purchas-ing	Call-off with LT	Call-off with LT + min stock	Vendor Managed Inventory	Supplier Consignment
To be agreed with supplier	MOQ	X	X	X		
	Price per MOQ	X	X	X		X
	MPQ		X	X		X
	Lead Time	X	X	X		
	Call-off LT		X	X		
	Delivery Frequency		X	X		X
	Forecast Liability		X	X		X
	Flexibility agreement in time		X	X		X
	Minimum Stock Level			X		
	Insurance for materials in stock	X	X	X	X	X
	Audits					X
	Inventory Counting					X
Benefits to Scanfil	Clear lead time profile	X				
	Increased flexibility		X	X		X
	Warehouse space		X	X		
	Reduced Inventory		X	X		X
	OTD Improvement		X	X		X
	Supplier owns stock					X
Risks to Scanfil	No liability over lead time	X				
	Forecast accuracy		X			
	Long orderbook to be rescheduled	X				
	Warehouse fee		X	X		

Table 3: Supply logistics models with what needs to be agreed with the supplier and benefits / risks to Scanfil.

The results of the workshop were attained during the workshop in the Pärnu, Estonia factory. Five experts of the supply chain attended this workshop where the results were discussed and created. Basically, the attendees of the workshop decided on **five different logistics models** that have potential to be chosen as the recommended supply chain logistics models for the two commodities, which were printed circuit boards and sheet metal mechanics. The attendees also discussed what needs to be agreed with the supplier with each different logistics model. Lastly, the benefits and risks of each logistics model were discussed to get a clearer view and to help create recommendation decisions.

The five different logistics models that were discussed were the classic purchasing model, call-off with lead time model, call-off with lead time + minimum stock model, vendor managed inventory, and supplier consignment.

Classic purchasing: The traditional way of purchasing products, where the buyer places an order to the supplier for a specific quantity of goods at a specific price.

Call-off with lead time: In this model, a company places an order with a supplier for a specific quantity of goods but does not request delivery immediately. The delivery is made later when the company requires the products which is based on an agreed lead time.

Call-off with lead time + minimum stock: This model is like the above one but adds a feature of having a minimum stock level. The supplier is responsible for monitoring the stock levels and making sure that they do not fall below the minimum level that has been agreed.

Vendor Managed Inventory: The supplier is responsible for managing the inventory of goods for the company. The supplier monitors the inventory levels and makes sure that the company has enough stock to meet its demands.

Supplier consignment: The supplier maintains a stock of products at the buyer's inventory. The ownership of the inventory is with the supplier until it is used by the buyer. The buyer has access to these goods and only pays for them when they are used.

The matters that need to be **agreed with the supplier** are defined as:

	Logistics Model	Classic Purchas-ing	Call-off with LT	Call-off with LT + min stock	Vendor Managed Inventory	Supplier Consignment
To be agreed with supplier	MOQ	X	X	X		
	Price per MOQ	X	X	X		X
	MPQ		X	X		X
	Lead Time	X	X	X		
	Call-off LT		X	X		
	Delivery Frequency		X	X		X
	Forecast Liability		X	X		X
	Flexibility agreement in time		X	X		X
	Minimum Stock Level			X		
	Insurance for materials in stock	X	X	X	X	X
	Audits					X
	Inventory Counting					X

Table 4: To be agreed with supplier of each supply chain logistics model.

MOQ: Minimum Order Quantity is the minimum amount of a product that must be ordered from a supplier in a single purchase order.

Price per MOQ: The price per Minimum Order Quantity is the cost of the product per unit when ordered at the minimum amount.

MPQ: Minimum Package Quantity refers to the minimum quantity of a product that can be sold each single time.

Lead Time: This is the time it takes between placing an order and the delivery of the product. It includes processing, manufacturing, and shipping time.

Call-off with lead time: An agreement between a supplier and a buyer in which the buyer agrees to buy a specific quantity of a products within a specific time.

Delivery Frequency: The frequency of product deliveries which a supplier delivers to a buyer.

Forecast Liability: The potential cost to the supplier if they are not able to deliver a product as forecasted.

Minimum Stock Level: The minimum number of products that the supplier needs to always keep in stock.

Insurance for materials in stock: An insurance policy that covers damages or loss of inventory in stock.

Audits: Routine inspections that make sure industry standards and the correct practices are followed.

Inventory Counting: The process of manually or electronically counting the number of products in the inventory.

The **benefits** for Scanfil that can arise from these supply chain logistics models are defined as:

	Logistics Model	Classic Purchasing	Call-off with LT	Call-off with LT + min stock	Vendor Managed Inventory	Supplier Consignment
Benefits to Scanfil	Clear lead time profile	X				
	Increased flexibility		X	X		X
	Warehouse space		X	X		
	Reduced Inventory		X	X		X
	OTD Improvement		X	X		X
	Supplier owns stock					X

Table 5: Benefits to Scanfil of each supply chain logistics model.

Clear lead time profile: This means having a clear understanding of the time taken to deliver products, which allows the company to improve planning and forecasting to be more efficient and effective.

Increased flexibility: It is the ability of a company to quickly adapt to changes in market's supply or demand. These can be due to unexpected disruptions like natural disasters or worldwide pandemics.

Warehouse space: This refers to the physical inventory space required to store stock and other supplies. It can be a large cost factor for companies.

Reduced inventory: This involves minimizing inventory while making sure that goods are available when needed. This can lead to having more capital available.

OTD improvement: This refers to on-time delivery performance. It is important in meeting customer expectations and increasing customer satisfaction.

Supplier owns stock: This refers to the supplier owning inventory on behalf of the company. It can help with risks related to stock and allows the company to have more capital available.

The **risks** for Scanfil that can arise from these models are defined as:

	Logistics Model	Classic Purchasing	Call-off with LT	Call-off with LT + min stock	Vendor Managed Inventory	Supplier Consignment
Risks to Scanfil	No liability over lead time	X				
	Forecast accuracy		X			
	Long orderbook to be rescheduled	X				
	Warehouse fee		X	X		

Table 6: Risks to Scanfil of each supply chain logistics model.

No liability over lead time: This risk can happen when the lead time for delivering the products is not specified in a contract. It can lead to delays in delivery and can impact the operations of the company of the buyer.

Forecast accuracy: This is a risk when the forecast for demand is inaccurate. This can lead to overstocking or understocking, which can lead to running out of inventory space, or delays for the buyer's company.

Long orderbook to be rescheduled: This is a risk when there is a long orderbook that needs to be rescheduled. It can lead to delays in delivery and can impact the operations of the buyer's company.

Warehouse fee: It is a risk when the company must pay a fee for using warehouse space of the supplier. This can increase the cost of production and decrease the available capital of the buyer's company.

4.4 Results Analysis and Recommendations

The results of the qualitative research provide clear data that can be used to deduce proper recommendations for both printed circuit boards and sheet metal mechanics. The research stresses that the geographical location of production is crucial in determining the supply chain logistics model. The printed circuit boards are as of now supplied from Asia. Due to this factor, Scanfil should stay with the classic purchasing model. Looking into the future, Scanfil should look for opportunities to shift supply from Asia to Europe.

Sheet metal mechanics are as of now supplied mostly from Europe. Due to this factor, Scanfil should follow the call-off with lead time model for sheet metal mechanics.

4.4.1 Printed Circuit Boards

As the PCBs are supplied from Asia at the time and there is no imminent switch over to Europe, Scanfil should stay with the classic purchasing model. The classic purchasing model has been used in supply chain management for many years. This model refers to where the buyer places an order to the supplier for a specific quantity of goods at a specific price.

One of the biggest benefits of the classic purchasing model for this case is that there is a clear lead time profile. Having a clear lead time profile means that a company has good understanding of the time it takes for suppliers to deliver products. As most of these suppliers are not new to Scanfil, they have a good understanding of the delivery times and therefore have a clear lead time profile for the suppliers. A clear lead time profile also allows companies to plan and manage their inventory more effectively. This is due to being able to expect when the PCBs will be available. Having a clear lead time profile can also help Scanfil develop their customer service and customer satisfaction. This can be done by providing customers with accurate delivery dates.

The classic purchasing model also has some risks to it from the viewpoint of Scanfil. These risks are that there is no liability over lead time and that there is a long orderbook to be rescheduled. As there is no specified lead time for delivering the products in the contract, it can lead to delivery delays and can impact the operations of Scanfil. As these lead times and delivery dates will not be fully as demanded, it can lead to rescheduling of purchase orderbooks. Sometimes these can be very long. This can then lead to more delays in delivery and lead to miscommunication, which can also impact the overall operations of Scanfil on a bigger scale.

As soon as Scanfil sees that it could the right time to switch over PCB supply from Asia to Europe, they should do so. This is dependent on many factors, such as actually having PCB manufacturers in Europe that can compete with Asian PCB manufacturers. The main reasons that Scanfil should switch PCB supply from Asia to Europe are geopolitical risks and cyber threats. Also, sourcing from Europe reduces risk, as seen during the COVID-19 pandemic, and can lead to smaller inventory due to shorter lead times. A smaller inventory will then lead to more warehouse space and less

tied-up capital. Currently, Scanfil is responsible for the PCBs for 7-10 weeks when they are transported by sea. If the supply was switched to Europe, this would not be an issue. Even though Europe may be more expensive in terms of purchase cost, the total cost of ownership can be the same or even less when considering shipping costs and smaller tied-up capital losses. It is important to not only consider the purchase price. The total cost of ownership can usually be a more important metric to investigate.

To conclude the supply chain logistics model recommendation for the PCBs, Scanfil should stay with the classic purchasing model for now and when it is possible to switch supply from Asia to Europe, it should do so. The switch from Asia to Europe can have a significant positive impact on Scanfil's costs and tied-up capital, as well as reduce potential geopolitical and cyber risks.

4.4.2 Sheet Metal Mechanics

The recommendation for sheet metal mechanics is to implement the call-off with lead time model. The call-off with lead time model is a supply chain logistics model used in supply chain management that involves ordering products in advance with a specified lead time for delivery.

This model is usually ideal when where there is high demand and long production times, such as the manufacturing industry. Using this model, Scanfil would agree on a contract with the supplier to purchase a certain quantity sheet metal mechanics over a specified period. This period can be as long as several months or even years. Instead of specifying exact delivery dates for each order, Scanfil would provide the supplier with a lead time. The lead time is the amount of time the supplier needs to produce and deliver the goods or services. The supplier is then responsible for making sure that Scanfil receives the agreed quantity sheet metal mechanics within the agreed lead time.

The benefits of the call-off with lead time model include increased flexibility, warehouse space, reduced inventory, and OTD improvement. The call-off with lead time model ensures shorter lead times which therefore increases flexibility. According to information gathered at the workshop, the estimated reduction in lead time is from 30 days to 5 days. Having a shorter lead time allows more flexibility in responding to unexpected and fast market changes. In case of an unexpected market change, Scanfil can change the call-off quantities and lead times to meet with the new market conditions.

Implementing the call-off with lead time model will also reduce warehouse space needed. As the lead time shortens, so does the amount of product in the inventory. According to estimates from Scanfil, the call-off model would reduce the needed warehouse space by 150 pallets (120cm x 80cm x 120cm). In terms of volume, this would be around 173m^3. The call-off model reduces the physical amount of inventory and therefore reduces the needed warehouse space. The benefits of requiring less warehouse space include increased efficiency in material handling and order fulfilment. Also, as sheet meal mechanics require less warehouse space, the space can be for other areas of warehouse operations.

The call-off with lead time model will increase inventory space and decrease inventory value. According to Scanfil estimates, implementation of the call-off model with lead time will decrease inventory value of sheet metal mechanics by 83%. This is due to shorter lead times as less products in inventory are needed. The call-off with lead time model allows for smaller quantity deliveries which could also reduce quality risks during transportation. A lower inventory value results to having less tied-up capital in the inventory. This allows for capital to be used in other areas of business. In some cases, having lower inventory value can also have a negative impact on Scanfil's financing. This is because lenders may see that having a lower value of assets is a risk.

By using the call-off with lead time model, it is likely that on-time delivery (OTD) will improve. This is due to the model reducing the time needed to fulfil orders. As supply lead times are shorter, products can be manufactured and delivered faster. Therefore, lead time shortens for Scanfil's products as well. An improvement in OTD will increase customer satisfaction and loyalty, as well as having a competitive advantage in the market.

To conclude, the call-off with lead time model is a highly recommended model for sheet metal mechanics. Its benefits include increased flexibility, reduced needed warehouse space, lower inventory value, and improved on-time delivery. By implementing the call-off with lead time model, the reduction in lead times will result in increased flexibility. Also, the reduction in inventory value will lead to more efficient use of capital, and the improvement in on-time delivery will increase customer satisfaction and loyalty. Overall, the implementation of the call-off with lead time model can benefit Scanfil's operations and market position.

5 CONCLUSION

In conclusion, the objective of this thesis was to provide Scanfil EMS Oy with efficient supply chain logistics models for two selected commodities, printed circuit boards (PCB) and sheet metal mechanics. The aim of the supply chain logistics models was to reduce required warehouse space and tied-up capital in inventory, as well as increase flexibility in supply chain management. The main research question for this study was “what makes an efficient supply chain logistics process?” and the supporting research question was “how to develop a supply chain logistics model for printed circuit boards and sheet metal mechanics?”

Based on the qualitative research conducted in this study, several recommendations can be made for Scanfil to improve their supply chain logistics processes for these two commodities. Scanfil's current sourcing process should consider geopolitical and cyber threats. There is a push to focus on European suppliers to reduce dependence on the continent of Asia. This has been recently defined in the sourcing process but has not yet been implemented. Sourcing from Europe reduces risk, as seen during the COVID-19 pandemic, and can lead to smaller inventory due to shorter lead times.

For inventory optimization, it is important to have the supplier own the products for as long as possible. Currently, Scanfil is responsible for the PCBs for 7-10 weeks when they are transported by sea. If the supply was moved to Europe, this would not be an issue. PCBs use air and sea transport, while sheet metal mechanics are mostly transported by truck from Europe with some coming from Asia through sea transport. Although Europe may be more expensive in terms of purchase cost, the total cost of ownership can be the same or even less when considering shipping costs and smaller tied-up capital losses.

To minimize quality risks during the transportation of sheet metal mechanics, it is important to make sure that they are packed well. This could result in less products being transported at a time, and therefore lead to higher transportation costs, but it will help with quality issues. Quality issues during transportation usually happen with sheet metal parts that have already been painted where these products might rub against each other during transportation.

The research shows that the geographical location of production is crucial in determining the supply chain logistics model for each commodity. The printed circuit boards are currently supplied from Asia, and therefore Scanfil should stay with the classic purchasing model. In the future, Scanfil should look for opportunities to shift supply from Asia to Europe. Sheet metal mechanics are mostly supplied from Europe, and therefore Scanfil should follow the call-off with lead time model for sheet metal mechanics.

Overall, this study provides Scanfil EMS Oy with a comprehensive analysis and recommendations for their supply chain logistics models for printed circuit boards and sheet metal mechanics. The recommendations provided in this thesis can help Scanfil reduce required warehouse space and tied-up capital in inventory, as well as increase flexibility in supply chain management. As supply chain management is an ongoing process of development, it is important for Scanfil EMS Oy to continue to evaluate and update their supply chain strategies and models. This will make sure that they can remain competitive in the market and can effectively meet the changing demands of their customers. By implementing the recommended changes, Scanfil can achieve a more defined and efficient supply chain, which will then result in reduced warehouse space required, reduced tied-up capital, and increased flexibility in supply chain management.

6 DISCUSSION

I learned a great deal of new information during the writing of this thesis. The biggest learning points were the interview and the workshop that was hosted in Pärnu, Estonia. I believe that this was such a learning experience for me due to the thesis being very practical. Some of the practical things learned during the thesis process cannot be learned from online or books. On the other hand, the good thing about having supply chain management as a topic is that it is easy to find theoretical information related to it.

A good amount of the findings was found through the interview and workshop. This stresses that earlier experience is valuable in thesis' that are very practical. Different supply chain logistics models can be complex and may require in-depth knowledge of the subject area. This is why a lot of the time companies have supply chain consultants. The experts that were a part of the research methodology have years' worth of experience which makes the data gathering valid.

A lot of companies are looking to renew their supply chain strategies including supply chain logistics. This is due to the covid-19 pandemic and the war in Ukraine. Supply chains are not as reliable as they were a few years ago. That is why this kind of research is important and appropriate. Of course, different companies will have different results depending on their wants and needs, but overall, the topic is something a lot of companies are struggling with now.

To be honest, I thought the thesis process would not take as much time as it did. My original schedule for the thesis had me publishing it a few months earlier, but mostly due to not using my time as well as I could have, it is now being published in June. Some moments of joy and success were attained every time I reached a new stage in the thesis process. Examples of these could be the three different seminars. Overall, the thesis process taught me a lot of new practical information through the eyes of Scanfil, which will be important in my future endeavours.

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8 APPENDICES

Appendix 1. Interview Questions

1. Do you allow for this interview to be recorded?
2. Do you allow the use of your name in the thesis, or would you prefer to stay as an anonymous source?
3. Where do you work and what is your title?
4. How many years of experience do you have with supply chain management?
5. How would you describe the sourcing process at Scanfil? Is there a clear sourcing process that Scanfil is following?
6. Would you improve the sourcing process for PCB and sheet metal mechanics? If yes, how?
7. How would you describe the procurement process at Scanfil? Is there a clear procurement model that Scanfil is following?
8. Would you improve the procurement process for PCB and sheet metal mechanics? If yes, how?
9. What is the transportation method/mode for both PCB and sheet metal mechanics?
10. What could be done to reduce quality risks during the transportation of sheet metal mechanics?
11. What type of customer demand does Scanfil receive for the end products of these two commodities?
12. How would you describe the inventory management process at Scanfil? What is the warehousing process for these two commodities?
13. How can one calculate the total cost of ownership for the PCB? How long does this calculation take?
14. Would you recommend the PCB to be supplied from China? or from Europe? Why?
15. Would you recommend the sheet metal parts to be supplied from Estonia? or from elsewhere in Europe? Why?
16. Do you see geopolitical risks with Scanfil's operations now or in the near future? What could be done to lower the risks?