



Ville Kivioja

Outbound Freight Cost Structure and Profitability Analysis

Metropolia University of Applied Sciences

Bachelor of Engineering

Industrial Management, Supply Chain Management

Bachelor's Thesis

12 April 2022

Abstract

Author: Ville Kivioja
Title: Outbound Freight Cost Structure and Profitability Analysis
Number of Pages: 54 pages + 1 appendices
Date: 12 April 2022

Degree: Bachelor of Engineering
Degree Programme: Industrial Management
Professional Major: Supply Chain Management
Supervisors: Satu Forsblom, Manager
Harri Hiljanen, Senior Lecturer

Freight costs are a mandatory expense in the company's operations. Careless or poorly planned decisions regarding a company's logistics solutions can result in significant operating losses. To keep the business profitable, it is especially important to ensure that the gross margin on service products is high enough to cover the freight costs incurred for the order delivery.

This thesis is implemented for a global technology company located in Finland. It aims to study the freight cost structure of the case company from the perspectives of the recipient country and service products and to make the research results available to support future decision-making. The goal of this thesis is to provide suggestions for improving the current freight process, to increase the awareness of the case company's personnel about the impact of freight costs on profitability, to support the customer in ways to reduce freight costs and to offer the case company suggestions for lower-cost practices.

Researching this subject is necessary because the case company does not have previous research data on freight cost distribution specifically from the perspective of the recipient country or service product. The proposals offered in this thesis can be used by the case company directly in future to support logistical decisions. This thesis consists of two main parts: the first introduces a theoretical framework related to the topic, followed by the second part, which conducts a case study based on empirical research. During the research, the share of the case company's freight cost in sales profit is calculated, the deviating variables in the research source data are analysed and the most important factors are visualized to facilitate the interpretation of the figures.

Keywords: Freight, Profitability, Cost structure, Logistics

Contents

List of Abbreviations

1	Introduction	6
1.1	Case Company Introduction	6
1.2	Research Specifications	8
1.2.1	Objective and Outcome	8
1.2.2	Scope and Limitations	9
1.2.3	Structure	10
2	Current State of Outbound Logistics at the Case Company	12
2.1	Courier Services	13
2.2	Road Freight	14
2.3	Air Freight	15
2.4	Outsourced Logistics Operations	16
2.5	Small Order Fees	17
3	Profitability and Margin	19
3.1	Gross Profit Margin	19
3.2	Net Profit Margin	20
3.3	Operating Margin	21
4	Outbound Freight	22
4.1	Air Freight	22
4.2	Road Freight	23
4.3	Variables Affecting the Freight Costs	25
5	Implementation of Research	29
5.1	Phase 1: Finding Source Data	29
5.2	Phase 2: Editing Data	30
5.3	Phase 3: Calculations and Visualizations	33
5.4	Phase 4: Results and Conclusions	35
6	Research Results	36
6.1	Variations in Freight Costs	36

6.2	Differences between Carriers	38
6.2.1	Standard Air Carriers	39
6.2.2	Standard Road Carriers	40
6.2.3	Courier Carriers	43
6.3	Share of Freight Costs in Sales Profit	46
6.3.1	By Receiving Country	46
6.3.2	By Service Product	48
7	Conclusions	51
7.1	Summary	51
7.2	Development Proposals	52
7.2.1	LSU Perspective	53
7.2.2	Drives Service Perspective	54
7.3	Research Evaluation	56
	References	58

List of Abbreviations

- CSA: Current State Analysis. A type of analysis used to evaluate the present state of a process.
- SWOT: A type of analysis used to evaluate the strengths (S), weaknesses (W), opportunities (O) and threats (T) of a process.
- SCM: Supply Chain Management.
- LSU: Local ABB Sales Unit in a certain country.
- Row: Sales order line. Can contain multiple pieces of the item. Example: Two rows are delivered to customer. First row contains five pieces of spare part X. Second row contains three pieces of spare part Y.
- 3PL: Third party logistics (provider). A concept that means outsourcing logistics services to a third party / an external operator.
- BOL: Business Online. A web-based primary ordering channel for Drives Service.
- CS: Customer Service. In this thesis, CS refers to the customer service unit in Drives Service.
- OpDev: Operational Development. A team part of the operational area responsible for tools, processes and the majority of reports used in Drives Service.
- SAP: The main ERP-tool (Enterprise Resource Planning) used in Drives Service.
- OTD: On Time Delivery. A measure of delivery schedule accuracy.

1 Introduction

Freight costs, in other words the cost of transporting the goods sold from the seller to the buyer, might, with poor planning, turn the turnover of a profitable company into a loss. Therefore, a company must always consider the freight costs of a product delivery when pricing the service product. Factors that affect a company's freight costs include, for example, mode of transportation, nominated carrier, country of destination, weight and dimensions of the goods being transported, fuel price, and general temporary variables such as pandemics and crises.

This thesis examines the freight costs of the case company in 2020 and 2021 from the perspective of recipient country and service product. The need for such research was expressed from the direction of the case company, as the company's freight costs have not previously been studied from the perspective of recipient countries or service products. Thus, new information is created based on sales and freight data. This thesis focuses on the case company's outbound deliveries, or export freight, and aims to highlight points of development to support the case company in future decision-making as well as strengthen collaboration with its local sales units.

1.1 Case Company Introduction

ABB was formed in January 1988 by merging the electrical engineering businesses of a Swedish company called Asea and a Swiss company called Brown Boveri on a 50:50 basis. Now ABB is a leading technology pioneer, offering a range of electrification products, robots and motion control as well as industrial automation and power grid solutions. ABB's growth is based on its technological strength and strong local roots, represented in Finland by Strömberg. (ABB. "Historia".)

At group level, ABB has four globally leading business areas:

- Electrification
 - Distribution Solutions
 - Smart Buildings
 - Smart Power
- Process Automation
 - Marine and Ports
 - Process Industries
 - Measurement and Analytics
 - Energy Industries
 - Turbocharging
- Motion
 - Drives
 - Motors and Generators
- Robotics & Discrete Automation Robotics
 - Robotics

This thesis has been carried out exclusively for ABB Oy Drives Service business unit in Motion business area, which supplies drive service products to customers around the world.

Today, ABB Finland employs about 5,000 people, of whom about 1,300 work in AC drive production and its stakeholders at the Helsinki plant. The largest office, also “the Finland headquarters”, is located in Helsinki – other larger factories can be found in Vaasa (Motors and Generators, Wiring Accessories), Vuosaari, Kotka and Porvoo (Marine). (ABB. “ABB Suomessa”.)

ABB Oy Drives offers solutions for industrial companies of all sizes around the world. As ABB's website states very succinctly, the manufacturing industry consumes more than 40 percent of the world's electricity, and electric motors account for two-thirds of this. By continuously adjusting the speed of electric motors, a frequency converter (or a drive) can cut motor energy consumption by up to 50 percent. Thus, the business is well involved in the rising trend, as climate issues are more and more on the wall in operations of the manufacturing industry. (ABB. "ABB Oy, Drives".)

1.2 Research Specifications

All freight cost figures for this thesis are obtained from an online service called Consignor, which stores data on all deliveries sent in the last two years. The goal of this thesis was to support case company's decision-making in matters related to the selection of logistical solutions so that the case company would be able to reduce future freight costs. The study also aims at gaining better understanding on what the case company's local sales units and the service-responsible unit, Drives Service, can do to decrease freight costs. The outcome of this research aims to help the case company in future decisions regarding outbound freight.

1.2.1 Objective and Outcome

This thesis aims to find solutions to these questions:

- What is the current state of export freight costs of the case company?
- What is the share of the case company's freight costs in the sales profit?
- Which factors influence the formation of the case company's export freight costs?
- What measures can a local sales unit take to reduce freight costs?

- What measures can the service-responsible unit take to reduce freight costs?

The outcome of the research, as well as the development proposals based on them, are planned to be used in the future logistics decision-making of the case company.

1.2.2 Scope and Limitations

The limitations of the study were discussed in meetings with both the case company and the supervising teacher, where the following decisions were made:

- Only Business unit 4159 (Drives Service) will be covered in the research as the results will only be used in decision making in Drives Service.
- Research time frame is from the beginning of year 2020 to the end of year 2021 because Consignor shipment data from 2019 is not available. A two-year-set is vital for the research because it allows comparison.
- "FixedPrice" column is to be used as the primary price information. If this field is blank, "Price1" column is used. If that is also empty, "Price2" column is used. The differences in price information between these three columns is caused by the different methods in price confirmation. An Excel function for price inference has been created into the research Excel workbook.
- Special freight modes, such as Jetpak and World Courier, and sea freight are excluded from the research. Special transportation pricing is not visible on Consignor tool. Sea freight is always shipped in FCA incoterms, and the customer pays for seaworthy packing, creating no logistical costs for Drives Service.
- Only shipments with incoterm CPT will be covered in the research.

- The impact of the pandemic on freight costs incurred by Drives Service is not discussed in its own section but is addressed in the theoretical part as well as in the case study.
- Calculations will be made only from the cost perspective; non-liquid values will not be covered in statistics. In addition to price, another factor that significantly affects the nature of freight is the speed and punctuality of transportation. However, it has been decided to exclude this from the research to limit the scope only to study costs.
- An overall gross margin is used in all calculations for this research, regardless of product group, as it would be practically impossible to break down the margins by specific product groups. Both the researcher and the case company are aware that the product-specific margins can vary widely in reality.

1.2.3 Structure

This thesis was decided to be implemented as a case study due to its theoretic nature. The outcome is not a tool but rather more refined data in a more usable form. The theoretical study in this thesis is implemented by referring to literature – mostly online articles. The purpose of the theoretical study is to give the reader a broader understanding of the topics on which the case study is based.

The research section has been carried out by analysing a data file containing data from 2020-2021 on sales freight costs. This data is sorted and visualized to make it easier to understand and present. The modified data is then used to search for and delve into abnormalities using different kinds of calculations.

This thesis is divided into three main parts. The first section contains background information on the structure of the study and the case company. The second is the theory part, which aims to reinforce the arguments presented in the case study section and provide the reader with a more comprehensive picture of the

research topic. The third part introduces the case study with all its phases: the flow of the study, the results, and the conclusions.

The theoretical part is divided into three chapters. The first chapter contains information about the case company. The second chapter addresses profitability and margin calculations. The third chapter describes different aspects on outbound freight.

The case company research is divided into three main chapters. The first chapter contains the details of the process flow of implementing the study. The second chapter introduces the research results. The third and final chapter contains the conclusions and development propositions.

Due to the statistical nature of this thesis, numerous visualizations, such as diagrams, have been used to describe more broadly the results obtained from the calculations. The diagrams created are also intended to be used directly by the case company to support future decision-making.

The following section introduces the current state of case company from the perspective of logistic operations.

2 Current State of Outbound Logistics at the Case Company

The current state analysis is carried out through interviews. Interviewees were selected based on their work experience related to the research topic. The free-form interviews were conducted in a virtual chat environment, meaning that no written questionnaire was prepared for the interviews.

Freight costs, among other costs, are considered in product pricing at the case company. The basic principle in setting the selling price is to set it high enough to cover all general costs. Costs are taken into account by setting a minimum margin limit. The minimum margin includes all fixed and variable costs of the material. When the minimum margin limit is high enough and when it is taken into account in setting the selling price (the price is not set below the cut-off) there is no need to separately consider item-specific characteristics such as weight and dimensions. However, Drives Service has a few special product groups where weight is calculated into transfer price as well. The above calculation model also allows the recommended price of a product to be kept at the same level regionally. (Interview 3. Kati Ikonen, ABB Drives Service.)

Drives Service reserves outbound shipments via TMC, ABB's internal Transport Management Centre. TMC tenders the freight price and arranges reservations.

In addition to tracking freight costs, Drives Service also closely monitors carriers' OTD values. Even though schedule-related factors such as the speed and punctuality of freight transportation are important intangible factors in the overall value of the transportation, a deeper examination and figures related to OTD has been deliberately excluded from this thesis.

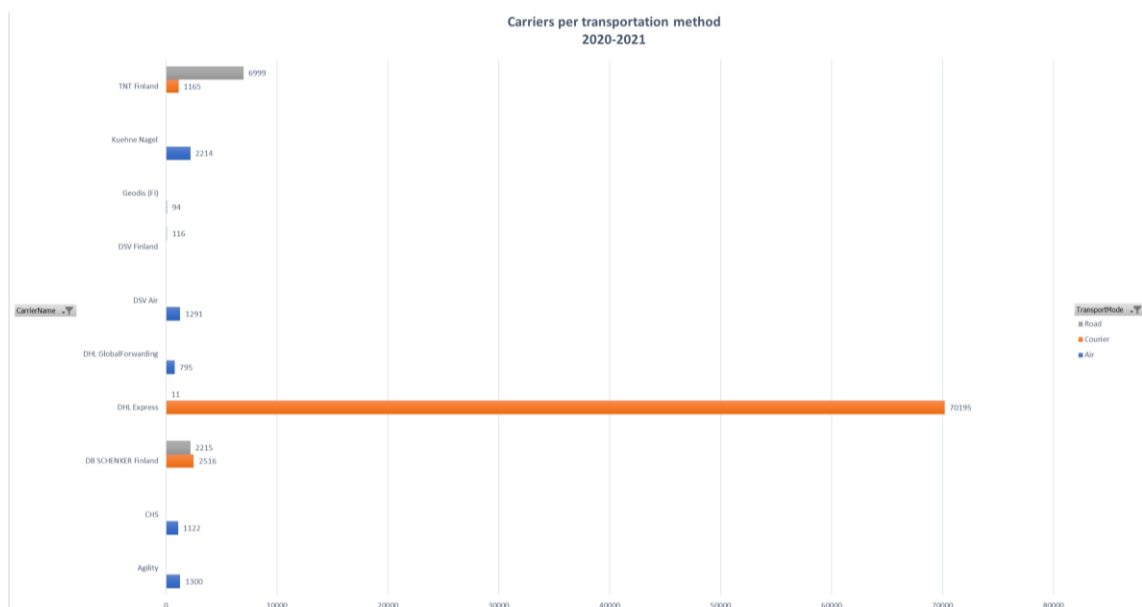
Currently, Drives Service uses four different main modes of export freight transportation: Courier, Air, Road and Sea (LCL). In addition to these modes of transport, the business unit also uses special modes of transport, such as freight taxis and charter services, such as Jetpak and World Courier. These special

means of transport, as well as sea freight, are excluded from this research framework due to their specific nature.

2.1 Courier Services

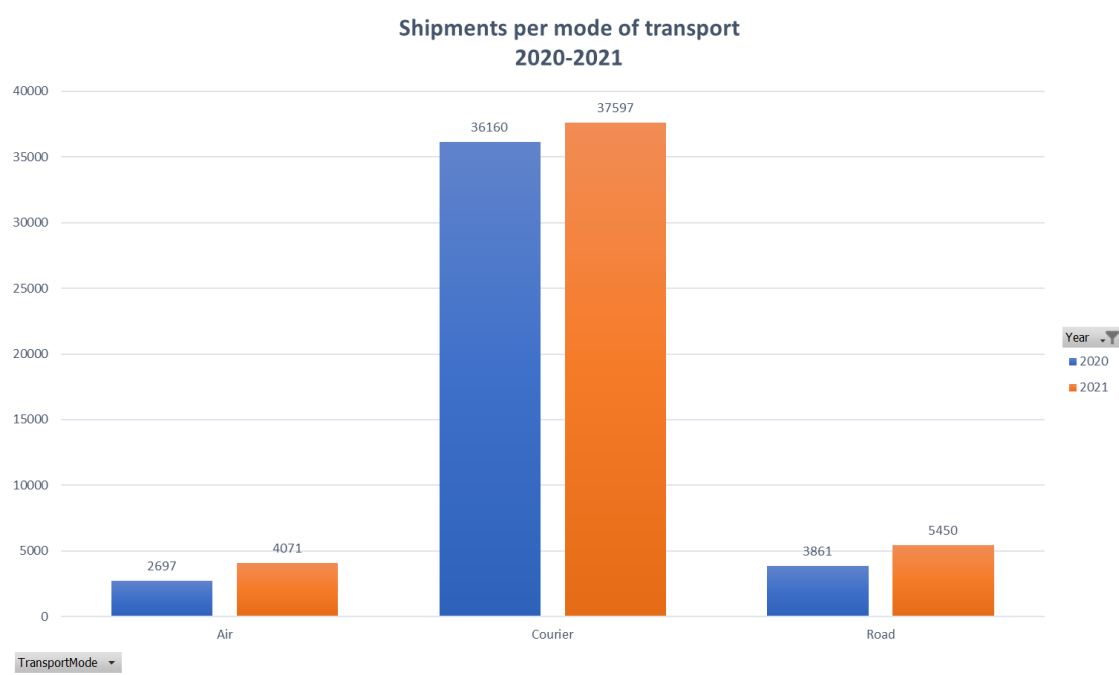
The courier service is usually used for urgent deliveries under 65kg and is most often carried out by plane. The courier delivers the products directly to the customer, not to the airport as in standard air freight. Courier and air transportation are subject to certain flight restrictions, such as the fact that lithium batteries may not be carried on an aircraft. The courier service may also deliver the goods by road. For example, a trip to Estonia is shorter by ferry than by flight via a cargo stopover. (Interview 1. Petra Potinkara, DHL Supply Chain.)

Courier transportation is offered to Drives Service by three carrier companies: TNT Express, DB Schenker Finland and DHL Express. Of these, the largest number of sold items run through DHL Express. DB Schenker only delivers domestic courier shipments, while DHL Express and TNT Finland deliver courier shipments around the world. DHL Express has delivered a total of 70195 Drives Service shipments as courier service during 2020 and 2021 which is significantly more than any other form of freight or carrier (Picture 1).



Picture 1. Number of delivered shipments by carrier and mode of transport.

Standard air freight was severely limited at times due to the pandemic, forcing Drives Service to utilize courier services more than under normal conditions. Courier carriers have their own aircrafts and distribution networks, which offers a speed advantage over standard air cargo. In situations where the order weighs more than 65kg but the customer still wants a courier delivery, Drives Service can invoice the freight cost from the customer, if agreed. (Interview 2. Heidi Pyykkö, ABB Drives Service.) Picture 2 shows the freight modes in 2020 and 2021.



Picture 2. Freight modes in 2020 and 2021. Courier is by far the most utilized mode of transport.

As seen in Picture 2, over the past two years in Drives Service, by far the most used mode of transport was Courier, which was followed by Road and Air.

2.2 Road Freight

The road shipping method covers all shipments carried by road. These, usually heavy and/or large shipments, are transported to the destination by truck. Over the past two years, Drives Service has used four different road carriers: TNT Finland, DB Schenker Finland, DSV Finland and DHL Express (road).

TNT Finland transports shipments throughout Europe when the weight is over 65kg but under 500kg. TNT is the fastest road carrier, commonly known in Drives Service as “Express Road”. DB Schenker Finland only transports domestic freight, as well as deliveries to Turkey and Russia. DSV Finland does not carry domestic freight but delivers goods to anywhere else in Europe. DSV is commonly used for shipments over 500kg and is usually the slowest road carrier. DHL Express (road) has carried only a few road freight shipments in the past two years, all of which have been transported from ABB warehouse in Vantaa to the United Kingdom.

2.3 Air Freight

The standard air freight mode is generally used for less urgent shipments which weigh over 65kg, making it more comparable to road than courier freight services, even though air freight is still noticeably faster than road freight in most cases. Drives Service has used a total of seven different air shipment carriers (non-courier) during 2020-2021: Agility, DSV Air, Kuehne & Nagel, CHS, DHL Global Forwarding, DB Schenker Finland and Geodis (FI). The most typical destinations for each air freight carrier are specified in the list below (Picture 3). In Picture 3, one + sign means about 10 delivered shipments, two + signs mean about 10-100 delivered shipments, and three + signs mean more than a hundred delivered shipments during 2020-2021.

Different air carriers have different nominated routes, which in practice means that a contract has been concluded with one carrier for a certain route (for example, from Finland to Singapore). This agreement is profitable for both parties in most situations: the carrier receives regular assignments from Drives Service and Drives Service receives transportation on the nominated route at a lower price and without tendering. (Interview 2. Heidi Pyykkö, ABB Drives Service.)

Consolidation means combining several orders or products into one scheduled shipment route. Consolidation can save significant amounts of money, but it is

often slower when products shipped may stand still for some time waiting for other orders. Direct flight refers to the delivery of an individual order or product that is not consolidated with other orders. A direct flight can be as fast as a courier if the flight schedules match. On the other hand, the price of a direct flight is higher than a consolidated standard air shipment. (Interview 2. Heidi Pyykkö, ABB Drives Service.)

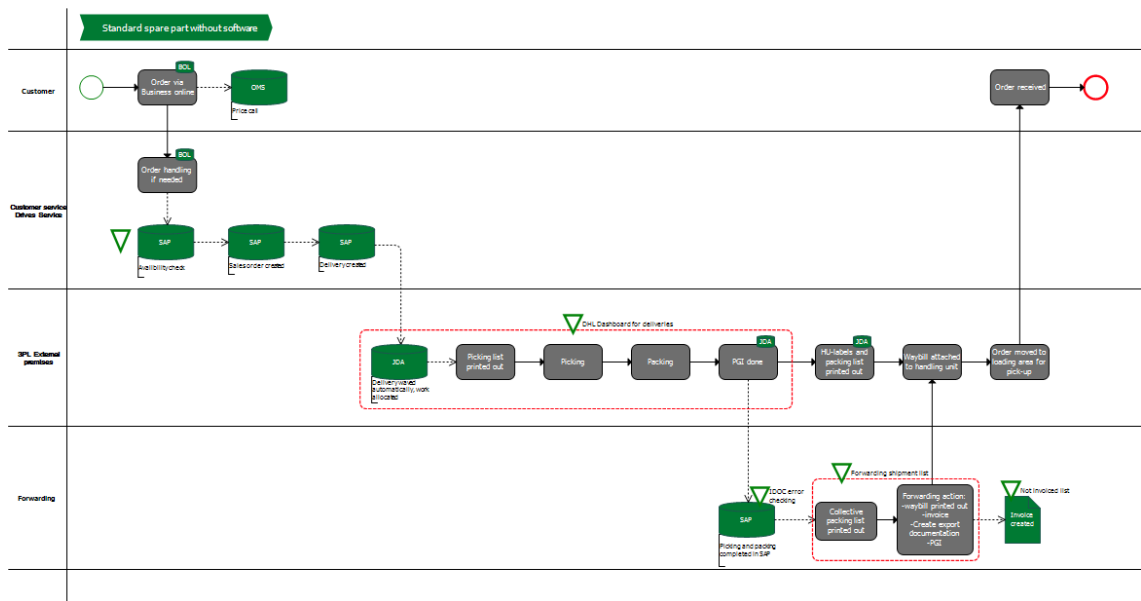
	Agility	CHS	DB SCHENKER Finland	DHL GlobalForwarding	DSV Air	Geodis (FI)	Kuehne Nagel
Asia	+	+++	+	+++	+++	+++	+++
Africa	+	++	-	++	+	+	+++
US / Canada	+++	+	-	+++	+	++	++
South-America	+	+	-	++	++	+	+++
Middle East	+	++	-	++	+++	++	+++

Picture 3. Air freight carriers in a classification table.

As seen in Picture 3, each carrier has its own main area(s) of competence. Regional competitiveness is largely reliable on carrier-specific nominated routes.

2.4 Outsourced Logistics Operations

Drives Service has outsourced all its logistics services to DHL Supply Chain. In addition to warehousing and inventory management, the partner company handles all tasks related to forwarding and cargo preparation, such as packing, tendering and booking of transport, preparation of freight documents and managing and reporting all logistics-related deviations, such as delays, damage to or loss of cargo, and material shortages. Smooth cooperation between Drives Service and DHL is a prerequisite for a healthy supply chain. Over the years, this co-operation has been developed, for example, in monthly management team meetings and in a quarterly co-operation meeting with the DHL Express Key Account Manager. The steps in the order-supply chain for Drives Service are shown in the swim lane diagram below in Picture 4.



Picture 4. Swim lane diagram of the Drives Service supply chain.

As seen in Picture 4, the 3PL partner (DHL) has the most steps in Drives Service order-supply chain.

Stakeholders working closely in the Drives Service supply chain, such as Customer Service, are usually in daily contact with DHL Supply Chain on various transportation related matters. Such matters usually regard customer requests for tracking of a shipment, a waybill, or a change in delivery details.

2.5 Small Order Fees

Drives Service uses a small order fee for low-value orders. The purpose of the small order fee is to cover the transport costs of a small delivery, because, for example, transporting a product of ten euros may well cost more than ten euros. Another important reason for Drives Service to use the small order fee is to encourage customers to place larger orders. (Interview 2. Heidi Pyykkö, ABB Drives Service.)

Some parallel units to Drives Service, such as Drive Products and System Drives, either do not use the small order fee at all or do not actively use it. The small

order fee has been calculated in the Consignor report as part of the order price.
(Interview 2. Heidi Pyykkö, ABB Drives Service.)

The theoretical part of this thesis is introduced in the next sections. The concept of profitability is described first, followed by topics related to outbound freight.

3 Profitability and Margin

The profitability of logistical solutions, calculated by deducting the costs from the sales profit, is important to keep in mind when making logistical decisions. For example, careless transportation planning may completely eat up the sales profit, causing the company to make a loss. Logistical costs should therefore always be considered in the pricing of goods and services. There exists several different calculation methods to help assess a businesses' profitability. Listed below are three common ways to value factors that affect profitability.

3.1 Gross Profit Margin

Gross margin is a useful measure of profitability as long as its user understands the costs involved. Gross margin is always industry and business-specific and can vary greatly between different industries. Gross margin is tied to the company's cost structure. Another company can make profit with a lower margin while another company in a similar industry makes zero profit with the same margin. This makes it impossible to determine an overall minimum gross margin. (Talousverkko 2017. "Mikä on myyntikate ja mitä se kertoo?".)

Gross profit is a simple measurement to use because it defines profit as all income remaining after calculating the cost of goods sold, COGS. The COGS includes only those costs that are directly attributable to the production or manufacturing of the goods sold, including raw materials and wages necessary for the manufacturing or assembly of the goods. The gross profit margin compares gross profit to total income, reflecting the percentage of each income euro that remains in profit after payment of production costs. (Investopedia 2022. "What Is the Formula for Calculating Profit Margins?".)

To summarize, gross margin measures production costs. The formula is:

$$\text{Gross margin} = \frac{\text{Gross profit}}{\text{Turnover}} \cdot 100$$

For example, if a company has a gross profit of 280,000€ and a turnover of 18,300,000€, the calculation goes like this:

$$\text{Gross margin} = \frac{280,000\text{€}}{18,300,000\text{€}} \cdot 100 = 1,53\%$$

A gross margin of 1,53% means that for every euro received from sales, around 98 cents is spent on making the product. (Grimsley, Shawn 2021. "What Is Profitability? – Definition & Analysis")

3.2 Net Profit Margin

Net profit reflects the total amount of revenue remaining after all expenses and additional income are accounted for. This includes not only the COGS and operating expenses mentioned above, but also debt payments, taxes, non-recurring expenses or fees, and investment income or ancillary activities. The net profit margin reflects the company's overall ability to turn revenue into profit. (Investopedia 2022. "What Is the Formula for Calculating Profit Margins?".)

To summarize, the net profit margin measures the overall profitability of a business. The formula is:

$$\text{Net profit margin} = \frac{\text{revenue}}{\text{turnover}} \cdot 100$$

For example, if a company has a net income of 500,000€ and a turnover of 1,000,000€, the calculation goes as below:

$$\text{Net profit margin} = \frac{500,000\text{€}}{1,000,000\text{€}} \cdot 100 = 50\%$$

This means that for every euro the company makes on a sale, fifty cents are made as income. (Grimsley, Shawn 2021. “What Is Profitability? – Definition & Analysis)

3.3 Operating Margin

Operating profit is a slightly more complex measure that also considers all overheads, operating, administrative and selling expenses that are necessary for the day-to-day running of the business. Although this figure still does not include liabilities, taxes and other non-operating expenses, it does include amortization and depreciation of assets. Dividing operating profit by revenue, this average profitability margin reflects the percentage of each euro remaining after all expenses necessary to maintain the business have been paid. (Investopedia 2022. “What Is the Formula for Calculating Profit Margins?”.)

The net operating margin is often referred to as earnings before interest and taxes or EBIT. The formula for this is:

$$\text{Operating margin} = \frac{\text{Operating profit}}{\text{Turnover}} \cdot 100$$

For example, if a company’s operating profit is 180,000€ and revenue is 2,000,000€, its EBIT is calculated by the following formula:

$$\text{Operating margin} = \frac{180,000\text{€}}{2,000,000\text{€}} \cdot 100 = 9\%$$

This tells that the company earns nine cents on every euro it makes in sales for business expenses not related to production. (Grimsley, Shawn 2021. “What Is Profitability? – Definition & Analysis”.)

4 Outbound Freight

The choice of transportation method, or freight mode, is influenced by several different factors, such as the urgency of the shipment, the price of transportation, and the weight and dimensions of the goods to be delivered. Each freight mode, as well as each carrier, has its own pros and cons. The differences between different carriers, for example in price and destination selection, can vary significantly.

This section introduces the concepts and variables related to export freight. The common forms of freight, air freight and road freight, are introduced first, followed by the factors affecting freight costs. Courier services are affected by the same variables as air freight and road freight.

4.1 Air Freight

The choice of air freight as the mode of transport is usually based on a need for minimizing the transport time and thus achieving overall savings or operational benefits from a broader point of view. (Logistiikan maailma. "Lentokuljetus".)

In terms of unit costs, air freight is the most expensive mode of transport. There are several typical criteria for choosing air transportation. Urgency can mean, for example, delivery needs that aim to support the life cycle of a product by reaching the end market of the product as quickly as possible. Various supplies of spare parts to repair equipment or to restore or secure the functioning of production lines are also common reasons to use air freight. JOT (Just On Time) deliveries are often directed at various events such as product releases, competitions or trade shows. Time optimization often involves keeping inventory levels low and replenishing inventories with a dense cycle using air freight, also known as Inventory in Transit. (Logistiikan maailma. "Lentokuljetus".)

The optimization of inventory levels supports the acceleration of the productivity of the company's investments. The globalization of procurement has also in many

places extended delivery distances between the supplier and the customer, emphasizing the importance of delivery speed and security. From time to time, the value, nature or handling requirements of the goods only allow the use of air freight. (Logistiikan maailma. "Lentokuljetus".)

Airlines have used passenger planes to carry cargo alone during the Covid pandemic. At the beginning of the year 2021, for example, Finnair flew almost 550 flights carrying only cargo. More than 400,000 similar flights were operated worldwide. In addition to its own aircraft, DHL uses capacity leased from other companies such as air cargo operators. Finnair, on the other hand, operates air freight to Asia and North America with Airbus A350 aircraft. Air freight rates have risen significantly, even tripling on some routes. (Tanskanen, Jari 2021. Yle Uutiset. "Lentorahdin hinta on rajussa nousussa – se nostaa Aasiasta tuotavan elektroniikan hintaa Suomessakin".)

In 2020, international air traffic operated at minimum capacity, which posed challenges to the operating conditions of air freight around the world. There were some difficulties in arranging transport globally due to the variation in transport prices and available air connections. The freight network was still operational, but capacity was limited. Demand for air cargo between Asia and Europe exceeded supply, and market prices rose. Strict restrictions of Chinese government caused delays in deliveries in and out of China. Additionally, size restrictions on individual shipments had to be introduced. (Huolintaliitto 2020. "Koronaviruksen vaikutukset huolinta- ja logistiikka-alaan".)

4.2 Road Freight

Road freight means the transportation of goods and materials by road. The biggest advantage of road freight is that it allows the door-to-door delivery of goods and materials and can be a very cost-effective way to transport, load and unload. Sometimes road freight is the only way to transport goods to and from rural areas that do not have access to rail, water or air transport. Delivery of goods between towns, villages and small villages is only possible by road. However,

despite several advantages, road traffic has major limitations. For example, there are more accidents and damage in road traffic. Thus, motor traffic is not as safe as other means of transport. (The Economic Times. "Definition of Road Transport".)

Road transport is also relatively less organized compared to other modes of transport. It is irregular and unreliable. Road transport prices are also volatile and uneven, which is a major drawback. Transporting large goods over long distances by road is inappropriate and expensive compared to sea freight, for example. (The Economic Times. "Definition of Road Transport".)

Today, road traffic has a serious negative impact on the environment. Building roads requires melting tar or formulating concrete, which harms the environment. As roads have been a major enabler of motor vehicles, these vehicles also cause a lot of pollution in the form of nitrogen dioxide, volatile organic compounds, carbon monoxide and several harmful air pollutants, including benzene, which have detrimental respiratory health effects and a serious threat of increasing global warming. (The Economic Times. "Definition of Road Transport".)

Approximately 90% of freight traffic is transported by truck. The prevalence is influenced by the role of road freight in the pre- and post-transportation of other freight modes. Compared to other freight modes, road freight is easy to implement. Road freight is suitable for transporting a wide range of goods from parcels to sea container transfers and special transports. Road freight is colloquially referred to as rubber wheeled transport, which distinguishes it from land transport by rail. In international traffic, road freight is often part of a supply chain consisting of different stages in which the goods to be dispatched are handled and transported by different means. (Logistiikan maailma. "Maantiekuljetus".)

In 2020, despite the pandemic, freight transport in Europe was allowed throughout the intra-EU market. In Europe, several countries closed their borders or severely restricted passenger traffic at their borders. Freight traffic was

excluded from the restrictions. However, border control measures, cancellations, checks on drivers and quarantine posed challenges for traffic and delays in crossing borders. Deliveries were delayed and congested. International road freight operates quite normally in relation to the conditions. (Huolintaliitto 2020. "Koronaviruksen vaikutukset huolinta- ja logistiikka-alaan".)

4.3 Variables Affecting the Freight Costs

The normal factors affecting the price of freight include transport distance, weight and dimensions of the goods being transported, freight mode, and fuel and authority fees. Currently, the covid pandemic and the global lack of cargo containers are special factors in the fluctuation of freight cost prices. Also, the fuel price index is peaking.

Cargo containers

All freight prices are currently affected by a global lack of cargo containers. The price index of cargo containers is seen in Picture 5. The shortage of containers and drivers exacerbated by the pandemic is expected to continue until the end of 2022. Disruptions in supply chains and the subsequent restructuring have pushed up transport prices, which has also been reflected in rising prices of transport service providers. (Huolintaliitto. "Huolinnan toimialakatsaus 2021")

Shanghai Shipping Exchange, Containerized Freight



Lähde: Shanghai Shipping Exchange, Macrobond, SHLL

Picture 5. The cargo container price index is peaking. (Huolintaliitto. “Huolinnan toimialakatsaus 2021”)

Freight cost of shipping a 40-foot container from Asia to Northern Europe have risen from about 2000\$ in November to more than 9000\$, according to shippers and importers. These prices are driven by customers struggling with a limited resource - containers. Thousands of empty containers were stuck in Europe and the United States in the first half of 2020 as shipping companies cancelled hundreds of trips due to the sudden slowdown in world trade caused by the Covid closure. As demand for Asian products in the West recovered in the second half of the year, competition between shippers for available containers pushed freight rates at a tremendous pace. (Steer, George; Romei, Valentina. Financial Times. “Shipping costs quadruple to record highs on China-Europe ‘bottleneck’”)

Disruptions and delays due to a lack of freight containers are affecting global supply chains. Some companies have reported consuming their stocks of raw materials and semi-finished products, which has led to declining stocks and rapid price increases. (Steer, George; Romei, Valentina. Financial Times. “Shipping costs quadruple to record highs on China-Europe ‘bottleneck’”)

The pandemic

Supply chains depend on the smooth flow of international goods. As passenger flights began to be cancelled and reduced to prevent people from moving around the world due to the pandemic, the freight that would typically be transported by these flights had to be transported by alternative transportation solutions. The search for alternative freight solutions is hampered by, for example, travel restrictions and closed borders due to the pandemic. As a result, the cost of air freight has risen further. Up to two-thirds of Finland's air cargo passes in the hold of passenger planes, and thus restrictions and stops on passenger flights have also had a significant effect on the mobility of Finnish air cargo. (Kilpelainen, Janna. "Covid-19-pandemian vaikutukset projektilogistiikkaan")

As the pandemic began to spread to other parts of the world, the effects began to be felt, among other things, in the closure of borders. In addition to these, additional protocols in the working environment, such as keeping safe distances at warehouses, restrict and hinder the movement of goods. In Europe, for example, 37 kilometres of truck queues formed on the A4 motorway after Poland announced it would close its border with Germany in March 2020. India's closure, in turn, created a shortage of drivers, piling more than 50,000 containers in the ports of Chennai, Kamajarari and Kattupalli. (Kilpelainen, Janna. "Covid-19-pandemian vaikutukset projektilogistiikkaan")

Fuel price

The price of oil has risen more than 60% during 2021, from around 60\$ a barrel in February 2021 to 98\$ in February 2022. After a brief downturn, the world market price of oil continued to rise towards 100\$ a barrel. In March 2022, the 100\$-mark was reached. The rise has led to an increase in demand for crude oil following the easing of Covid travel restrictions, as oil production among the world's largest suppliers has struggled to keep pace. (Ambrose, Jillian. The Guardian. "UK motorists face record fuel prices as global oil costs rise")

The conflict between Ukraine and Russia in February-March 2022 has also pushed up oil prices as Russia is the world's third-largest oil producer country. (Ambrose, Jillian. The Guardian. "UK motorists face record fuel prices as global oil costs rise")

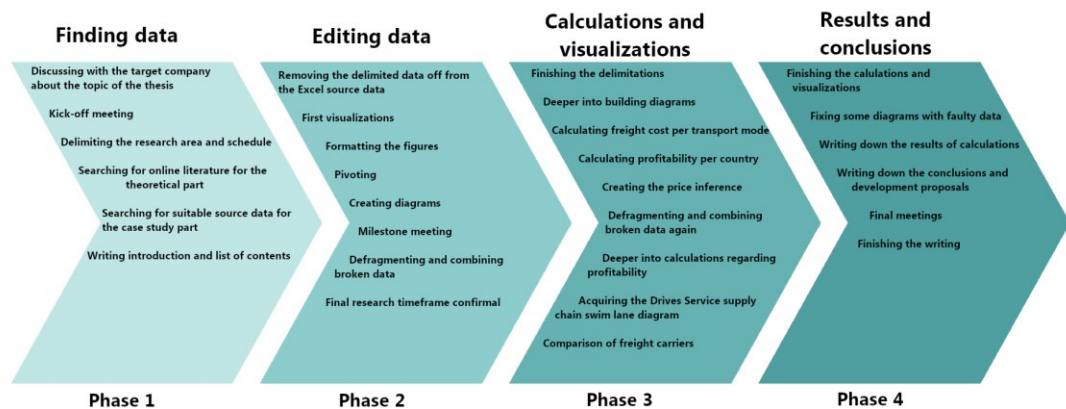


Picture 6. Petroleum price in 2020 – 2021 where dark blue is Brent-oil and light blue is Urals-oil. (Neste. "Raakaöljyn hinta")

The following section introduces the research phases. The implementation of the research is divided into four phases.

5 Implementation of Research

The research process is divided into three chronological phases from number 1 to number 4, as seen in Picture 7. The first phase is data retrieval. The second phase is editing the data. The third phase is the calculation and visualization of the data. The fourth and final step is the results obtained and the conclusions based on them.



Picture 7. Process flow chart of the thesis.

5.1 Phase 1: Finding Source Data

The research started in phase 1 after the kick-off meeting with Drives Service CS and OpDev managers by gathering as much organizational data as possible from the perspective of logistics operations. The search began by looking up online literature on the topics covered in the theory section. When a high-quality source was found, the web address of that source was added to the browser bookmarks as well as to the thesis source list. The search for sources and the preparation of the table of contents and introduction took the first two weeks of the research.

In addition to searching for theoretical sources, the search for financial data needed for the Case Study started with an email chain with CS and OpDev

managers. With the assistance of the OpDev team, the "Consignor OTD" (where OTD stands for On Time Delivery) Power BI report, already used by Drives Service, was discovered and made available for research. The report was then imported into an editable format from Power BI to Excel. The next step was to start delimiting unnecessary data out of the area. As there was a total of around 150,000 unedited rows in the Excel file, the application ran slow.

5.2 Phase 2: Editing Data

The first step of data editing involved detecting the most important data columns and moving them to their own tabs, as well as perceiving the entire data pack through pivoting. Next, a new meeting was held with the OpDev and CS managers about the data delimitations. First, it was agreed that the time frame for the research would be from the beginning of November 2019 to the end of November 2021. However, this time frame was later changed to start from the beginning of 2020 and stop in the end of 2021, as it became clear that the data in the Consignor tool from more than a year ago would not be available, and a period of two years would be essential to allow comparison. At the same meeting, it was also agreed that orders delivered by any other business unit than Drives Service would be excluded from the research source data pack.

After the meeting, the research continued with formatting the cell values, as several columns contained, for example, dates that were in American format. The research is designed to be used mainly by ABB Finland, so the dates and other values were changed to European format. In the same data editing phase, a pivot table was created from the source data, based on which a map diagram was created to visualize the number of shipments delivered to each country. The first diagrams were mainly created just to help gain a better understanding of the whole data and to point out any abnormalities worth noticing. At the same time, new columns were created to describe the weekday, month, and year of the delivery. For this purpose, the Excel functions "`=DAY`", "`=MONTH`" and "`=YEAR`" were used, for which data were retrieved from the "Submit date" column which included the creation date of each delivery.

The following week, in addition to editing the introduction, the possibility of making sales prices visible into the base data was explored with the help of OpDev. The visibility of sales prices in the Consignor report would be essential, as otherwise the sales price of each order would have had to be checked one at a time from SAP, which would have been an impossible solution in terms of the research schedule. OpDev got the issue resolved and the sales price line was added to the Power BI report, from where the file had to be imported again into Excel and merge the new price column as an extension to the already edited file.

At this point, it was noticed that Excel could only import a limited number of around 150,000 shipments from Power BI, causing much of the data in the previously retrieved data pack to miss. This problem was quickly fixed again with the help of OpDev, when a date slider was added to the Power BI report allowing the import of complete data one year at a time and combine them into the same file afterwards.

After the combining, the analysis of the data and the construction of the research framework continued. First, OpDev verified the date column to use as the primary date for the research calculations and visualization, as there were about ten different date columns in the Excel file, all with different values. It was concluded that the "Submit date" column is the most valid and would be used as the primary value in the research. The CS manager also confirmed that the new research time frame from 1 January 2020 to 31 December 2021 was sufficient. The new research time frame meant that data for the rest of 2021 would have to be retrieved from Power BI after the turn of the year and merged with the already existing Excel data, as at this stage of the research process it was still November 2021.

During the same study week, data editing and analysis continued in the form of various calculations and visualizations. At this point, the share of freight costs in the sales value was calculated into a new tab. The share was obtained by dividing the freight price of the shipment by the sales price of the order. The calculation

caused a lot of distortion to the data, as several columns contained blank cells and zeros that appeared in the cells as DIV/0 errors. It was found that several of the distorted lines were either warranty or contract orders. For these orders, the DIV/0 errors were changed to numerical value 0.00%. A table was created on the same tab, showing the country-specific average share of freight costs and the number of shipments delivered by mode of transport based on the slicer selection (Picture 8).

TransportMode	SumTurnover	OrderNumber	Price.calc	Price.calc / profit
Air	7231,22	1100554191	1000,85	4,84 %
Air	48946,4	1100553935	455,56	3,26 %
Air	10667,34	11005560467	605,08	19,85 %
Courier	19983,65	1100552068	273,38	4,79 %
Air	25061,83	1100547978	547,17	7,64 %
Courier	1335,18	1100531730	55,56	14,56 %
Air	18720,03	1100531192	750,48	14,03 %
Courier	3326	1100530999	181,31	19,08 %
Air	389,46	1100531124	156,31	140,47 %
Courier	735,5	1100530994	76,69	36,49 %
Air	4417,01	1100530674	421,18	33,37 %
Air	32207,28	1100529927	634,81	6,90 %
Courier	232,15	1100530109	30,36	45,77 %
Courier	100	1100530023	40,79	142,79 %
Road	11767,42	1100529748	270,79	6,05 %
Courier	799,25	1100530111	30,36	13,29 %
Courier	502,04	1100529497	28,29	19,72 %
Courier	837,68	NIF:099916001014190,EG:2091415763	38,08	15,91 %
Courier	4405,75	1100536839	407,41	32,37 %
Air	4345,93	1100536056	227,32	18,31 %
Air	3549,86	1100528915	329,23	32,46 %
Courier	87441,13	1100528757	21,51	0,09 %
Road	15518,81	1100528726	98,23	2,22 %
Road	10438,38	1100528730	141,59	4,75 %
Road	12003,58	1100528843	178,18	5,20 %
Courier	3720,82	1100528849	29,8	2,81 %
Courier	2219,37	1100529035	238,96	37,68 %
Courier	5854,05	1100528731	24,55	1,47 %
Courier	2126,05	1100529103	37,93	6,24 %
Road	4407,28	1100528724	55,27	4,39 %
Road	37568,56	1100528776	373,7	3,48 %
Air	8611,71	1100528978	618,28	25,13 %
Courier	2989,35	1100529072	234,48	27,45 %
Courier	9150	1100528736	75,59	2,89 %
Courier	313,83	1100528855	42,93	47,88 %
Courier	1443,4	1100528753	96,1	23,30 %

Freight cost share of profit, average	
Air	15,20 %
Courier	29,78 %
Road	22,15 %
Count of Cosignor PO's	
Air	210
Courier	677
Road	2
Overall	
Average	26,32 %
Count of PO's	889

ReceiverCountry

- MA
- KE
- PE
- AD
- AE**
- AR
- AT
- AU

Picture 8. Profitability per country tab with a slicer.

Based on the calculations made in Picture 8, the table cells were conducted by using the "AVERAGEIFS" Excel function. The table cells were also formatted by colour (Green = Low Freight, Yellow = Medium Freight, Red = High Freight) so that the report clearly shows the alarming costs. Finally, icons were added to the cells to make it even easier to spot abnormally high costs.

Next, the data editing proceeded into creating price inference because the source data contained three different price columns: "FixedPrice," "Price1Value," and "Price2Value." These price columns were formed from different stages of freight booking process. OpDev advised to use the "FixedPrice" column primarily, as it contains the latest and final freight price reported to Drives Service, and if the cell in the "FixedPrice" column was empty, the "Price1Value" would be used. If

"Price1Value" was empty, "Price2Value" would be used. At this point, it was found that the shipments missing "Price1Value" were removed from the source data by accident in the previous editing phase. Therefore, the entire source data and the visualizations and calculations already performed had to be defragmented.

After a successful defragmentation, the price inference was created using Excel's "VLOOKUP" function. For the function to work properly, shipments with all three price columns blank were removed from the data, as they would not be useful for calculations. The result of the function was transferred to a new column as an extension of the existing ones.

5.3 Phase 3: Calculations and Visualizations

After the turn of the year, data for the rest of 2021 was retrieved from Power BI and merged as an extension to the existing research Excel file. Now that the full two-year data had been collected for the study, the visualization and calculation could be deepened. The rest of the data had to be subjected to the same delimitations, calculations and formatting as before, after which the DIV/0 errors resulting from renewed freight cost share calculations were moved to their own "Warranty/Contract" tab. As a result, separate tabs were created for both "Standard" and "Warranty/Contract" orders. This change was necessary because with a zero sales value in warranty and contract orders, their profitability could not be calculated in terms of freight costs. The peripheral value for one Singapore consignment stock order, which emerged from the calculation, was removed as a distortion for the future calculations. The other values appeared to be correct and were left into the data.

In the next data editing step, two visualization tabs were created. "Freight cost per destination" presents the share of freight costs in the sales value by country on a map chart. "Carriers per transportation" shows how many shipments each freight company has transported by each freight mode.

After this step, composing the "Current State of Outbound Logistics at the Case Company" section began. For this section, the DHL freight forwarder was asked through Teams about the differences between Courier air freight and normal air freight. Also, another interview was composed for Drives Service global customer service manager who clarified the Drives Service freight profitability in total. The responses were compiled into multiple parts of the research. Next, for the current state analysis, a diagram was needed to describe the order-delivery process for Drives Service products. With the assistance of OpDev, a suitable chart was found from ABB's internal database and attached as an image into the "Current State of Outbound Logistics at the Case Company" section.

After that, more calculations were made. Next, the share of freight costs in the sales profit was to be calculated. A comprehensive overall margin was required for this phase of calculating, as it would have been impossible to check the margin of each product from SAP one at a time. The CS manager confirmed a margin percentage, from which a margin factor was formed. The share of freight costs in sales profit was obtained by multiplying the sales value by the margin. The results were transferred to all the different tabs of the Excel workbook at the same points where the share of freight costs in the value of sales calculation was initially used, meaning that the calculations were updated to include the newly formed "share of freight costs in trade profit" value set. Those deliveries, where freight costs exceed the value of sales, were moved to their own tab for a deeper investigation.

During this phase of research, the OpDev manager clarified that deliveries with Incoterm other than CPT would not be included in the scope of the research, so all the FCA, DDP, and DAP shipments were removed from the data. A new tab containing only CPT shipments was created. Other Incoterm rows were also left in the base data as they might be needed later during the research. As a result of this change, various Excel visualizations and calculations had to be re-performed again as the total number of shipments differed.

5.4 Phase 4: Results and Conclusions

Next, the research continued with writing the research results based on the data just calculated and visualized. At this stage, a histogram was needed to monitor the relationship between monthly freight prices and delivery weights by carrier. Broader charting continued around a variety of freight cost related topics. The design and writing of “Differences between carriers”-part began, as the study found that there were large differences between the different carriers.

At this point in the study, it was again found that too much data had been accidentally deleted from the source data, so all data had to be defragmented. After the defragmentation was completed, composing the theoretical part was finished. Finally, the research results and conclusions sections were constructed based on the calculations and visualizations just performed. The process ended with finishing the theoretical part.

Research results and conclusions are presented in the next sections.

6 Research Results

The research revealed several factors affecting the case company's freight costs that should be addressed in the future to improve the overall cost-effectiveness of the order-supply chain. The research results obtained from the calculations are presented in the following sections.

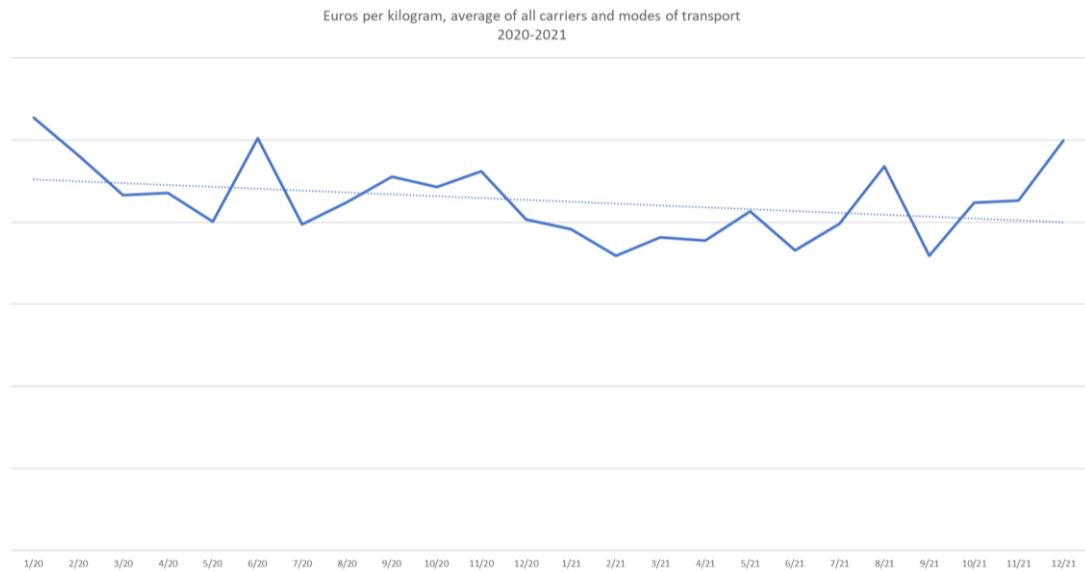
6.1 Variations in Freight Costs

The calculated research data shows that in the last two years Drives Service has been forced to use special freight arrangements, such as exceptionally large volumes of courier deliveries. Some shipments have completely eaten up the sales profit. Internal communication between DHL and ABB has brought up rising freight rates during the pandemic, particularly for long-haul flights concerning especially freight transportation to Australia and the Americas. This trend was also clearly visible in the research Excel data.

Long-distance freight costs more than, for example, intra-EU transport, as these deliveries consume more resources, such as time, employees, fuel and planning. Comparing the freight costs of the beginning of 2020, mid-2021, and the end of 2021, it can be seen that even a small percentage change in long-distance air freight cost has a huge impact on the total price of the transportation, as long-distance freight is high even under normal conditions. It can also be noted that the price trend for long-distance freight has started to level off.

It was decided to use a calculated freight per kilogram price (€/kg) as an indicator of freight cost variability due to its flexible and easy-to-calculate nature. Even though €/kg is not as accurate indicator as, for example, €/volume, it reflects the trend well. In addition to the weight of the cargo, the total freight price is also affected, for example, by the dimensions of the goods being transported. To illustrate the variation in freight rates during the past two-year period, the freight price profile for standard, warranty and contract orders can be viewed in the histogram below (Picture 9).

It is important to note that the Drives Service also maintains close OTD monitoring of different transport companies. (Interview 2. Heidi Pyykkö, ABB Drives Service.)

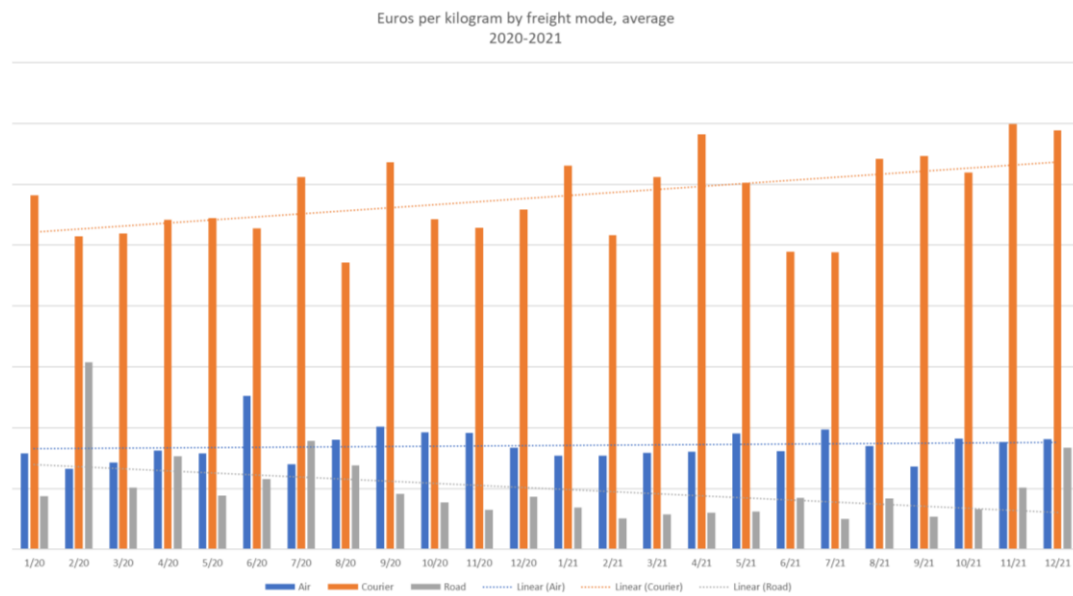


Picture 9. Average of all carriers and all freight modes. The trend in freight rates is downward. However, by the end of 2021, prices have started to rise again.

Compared to the current state, 2020 started with high freight rates. The price peak of the two-year research time frame was seen in March 2020. When comparing the end of 2020 and the end of 2021, more instability can be observed in 2020 as there is both upward and downward monthly variation. Throughout the second half of 2020, freight prices have been volatile, with larger fluctuations particularly in the fourth quarter.

The year 2021 started more promisingly as the average price per kilogram of freight fell lower than it was at any point in the previous year. Again, in July, a new low was reached, eventually remaining statistically lowest in the two-year research time frame.

Of the three main forms of freight – Air, Courier and Road – the Courier is by far the most expensive option, as seen in Picture 10. Drives Service has utilized much more courier services than usual due to the prevailing situation, as previously seen in Pictures 1 and 2. Drives Service has been advised to prioritize the use of either road freight or standard air freight, but due to the challenges posed by the pandemic, this provision has had to be deviated from. The nature of the Drives Service business also often requires the use of courier, as the spare parts delivered can sometimes be very small and urgently needed by the customer.



Picture 10. Price average by freight mode.

As seen in Picture 10, the price trend for standard air freight is on a small rise. Courier service is still clearly the most expensive option. Road freight is the cheapest option even though its price exceeded standard air freight in February 2020 and July 2020.

6.2 Differences between Carriers

The characteristics of the carriers, such as options for the country of destination, freight modes available, freight cost, urgency of the delivery and the flights

available at the time of booking the transport, will affect which carrier is chosen. The next section presents the differences between different carriers by freight mode. Annual average prices of carriers are used in this section as benchmarks, as they best describe long-term stability. The prefix standard in this context means non-courier carriers.

6.2.1 Standard Air Carriers

In 2020 Drives Service utilized a total of six standard air cargo carriers, all with different nominated routes and options for country of destination. It is important to note that the length of the nominated route significantly affects the total cost of freight transportation. The cheapest option was DSV Air for most of the year. The most expensive carrier that year was Kuehne & Nagel.

In 2021, the Drives Service used five different air carriers. The most expensive of these was Kuehne & Nagel. The cheapest carrier was DSV Air. The price peak occurred in July.

In 2021, there was clearly more instability in standard air freight prices than in 2020. DSV Air, along with Geodis, had the lowest annual price volatility in 2020, during which its freight prices remained within 62% fluctuation range while all the other carriers exceeded 87%. CHS was clearly the most stable air carrier in 2021, with the price trend remaining more or less the same throughout the year, except for the peak in May, when the price average was about 25% higher than in the surrounding months. In 2021, CHS remained a price fluctuation of 45% while the others exceeded 71%. The biggest change compared to the previous year was seen for DSV, whose maximum annual fluctuation increased to 618%.

The biggest factor in the price of standard air cargo over the past two years has been the various challenges posed by the corona pandemic. Globally, the air freight cargo capacity situation continues to be challenging, with most passenger flights cancelled and cargo plane capacity insufficient to meet aggregate demand. However, airlines have been able to successfully convert passenger planes to

operate cargo, and by the end of May, regular connections have been established for some routes. (DSV 2020. "Koronaviruksen vaikutukset lento- ja merirahtiin".)

Due to the limited air cargo capacity, it is still important to keep in mind that the availability of cargo capacity and freight rates can vary very quickly in both imports and exports. Due to the market situation, the rapid confirmation of transport orders is of paramount importance. (DSV 2020. "Koronaviruksen vaikutukset lento- ja merirahtiin".)

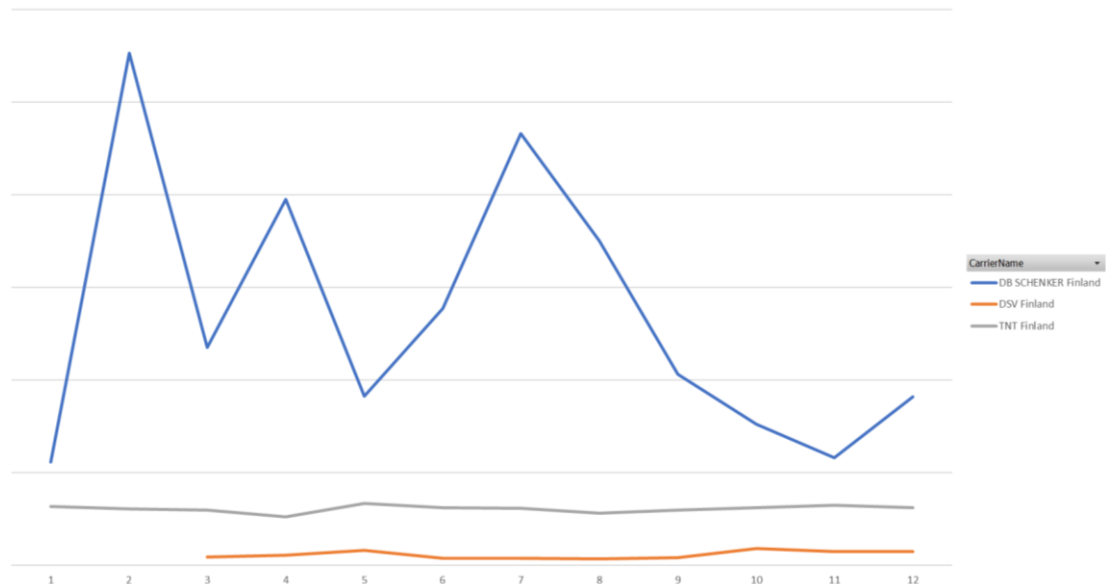
The latest ABB air freight update on 23 February 2022 tells about the impact of the pandemic on ABB's shipments. The text indicates that there is still a capacity shortage at Chinese airports and that current capacity is only about 40-50% of normal. Temporarily, a post-holiday increase in volume can also be seen. US customs operations are also causing severe delays due to staff shortages and shipping times to the US are exceptionally long. Also, frequency is low as most of the flights are freighters or charters. Due to the Omicron variant, passenger flights to/from India will not restart until the beginning of March. (Valsbrot, Jonathan 2022. "Status Update ABB Logistics".)

6.2.2 Standard Road Carriers

In 2020, Drives Service used three standard road carriers: DB Schenker Finland, DSV Finland and TNT Finland. DB Schenker had the highest annual average. DSV's annual average was the lowest. The significantly higher average of DB Schenker is noteworthy as it is not explained by transport distance; DB Schenker Finland only transports domestic freight whereas DSV and TNT transport to the rest of Europe. DSV's routing is usually longer than TNT's, which causes longer delivery time and affects freight cost. (Interview 2. Heidi Pyykkö, ABB Drives Service). The price peak of road freight carriers was seen in February by DB Schenker. For DSV, the first freight booking of 2020 took place in March, after which the company managed to keep its monthly average price somewhat stable throughout the rest of the year. TNT succeeded in keeping its annual fluctuation very stable.

In addition to the carriers used in the previous year, in 2021 the DHL Express (road) was also utilized. Of these four, the cheapest was DSV. The most expensive was DB Schenker. Only 11 shipments were sent via DHL Express, all of which were destined for the UK and shipped during April-June. The price peak of 2021 was in December. It should be noted that DHL Express has mainly carried courier deliveries, which strongly determines its overall average.

Year 2020 was expensive and very volatile for DB Schenker with a maximum annual fluctuation of 396%. The overall standard road freight price volatility softened towards the end of the year. DB Schenker's October-November fluctuation was only around 4%. DSV's lowest price average for the year was in August and the highest price average in October, giving a maximum annual fluctuation of 157%. TNT remained an annual average of 28%. In consecutive months, no similar extreme variability was seen for DSV or TNT as for DB Schenker. The differences of DSV, TNT and DB Schenker are visualized in Picture 11.

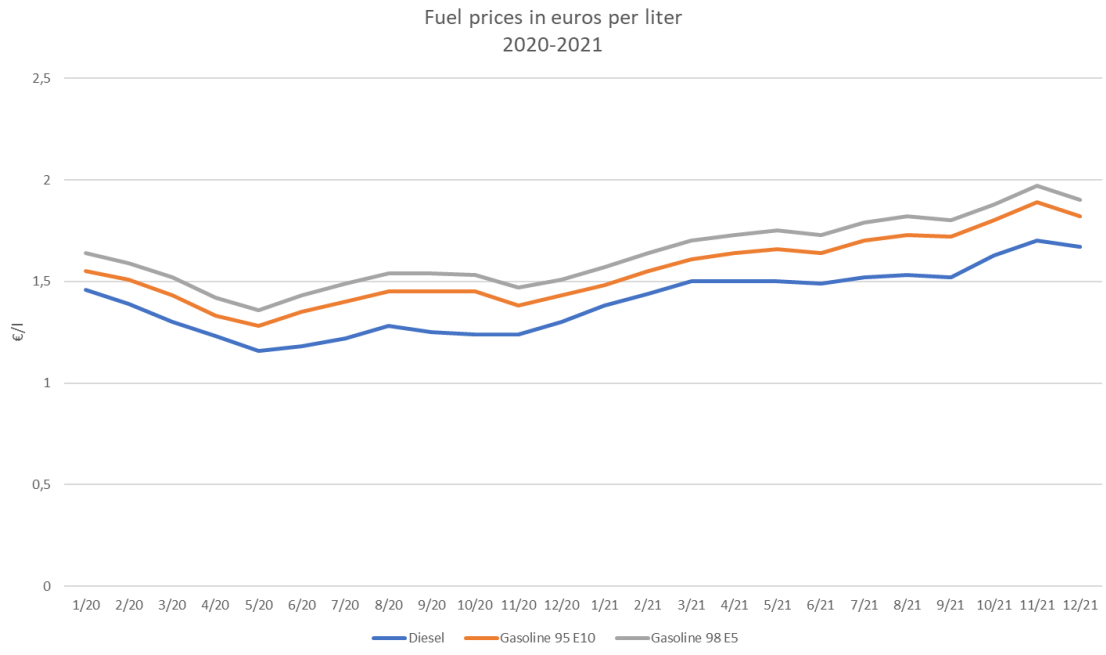


Picture 11. The monthly fluctuation of DB Schenker's average prices compared to DSV and TNT in 2020 is quite prominent.

In 2021, the overall price fluctuation was narrower, especially for DB Schenker. For the carrier, the lowest average price achieved was in February and the highest in December. DB Schenker's stability of 86% was maintained all the way from January to September, after which the prices started to rise very sharply again, ultimately giving the carrier a maximum annual fluctuation of 279%. DSV's annual fluctuation rate was also narrower at 108%. TNT's annual fluctuation remained within 21% range.

All in all, it can be said that the rise in road freight rates, among other minor factors, has been particularly affected not only by the challenges caused by the corona pandemic but also by the rising petrol prices in Finland as seen in Picture 12. Surprisingly, the rise in fuel prices is not reflected in a statistically equal increase in freight prices, although a small increase can be seen from 2020 to 2021. The effect of fuel price increase is more evident in DB Schenker's monthly average prices, as the company must refuel only from Finnish filling stations during its domestic transports. It should be noted, however, that these statistics may be distorted by the challenges posed by the pandemic.

The latest ABB road freight update indicates that EU Mobility regulations causes a pressure on freight rates. The regulations are not always justified as they are affected by multiple different measures with undetermined impact and different timelines. Several forwarders still want freight rate increases even before request for quotation -periods. Customs control in UK is stricter due to Brexit. The exporter must ensure the use of approved carriers so ABB UK can import the goods. Using "any" carrier might make the customs clearance impossible. Full vaccination or quarantine is now required for US and Canada cross-border trucking. Capacity will be affected as around 12% of the truckers will not operate. Deliveries to Canada are difficult to complete due to the protest and the lack of capacity. (Valsbrot, Jonathan 2022. "Status Update ABB Logistics".)



Picture 12. Fuel price development in Finland during years 2020 and 2021. (Autoalan tiedotuskeskus. “Bensiinin ja dieselin hintakehitys”.)

As can be seen in Figure 12, the price of fuel is on a sharp rise due to the global situation.

6.2.3 Courier Carriers

A total of three different carriers have been used by the Drives Service during 2020 and 2021: DB Schenker Finland, DHL Express and TNT Finland. Of these three, DHL Express has carried by far the most deliveries, as seen earlier in Picture 1.

In 2020, DHL Express was the most expensive courier. DB Schenker was by far the cheapest courier. The low was in June and the peak was in September.

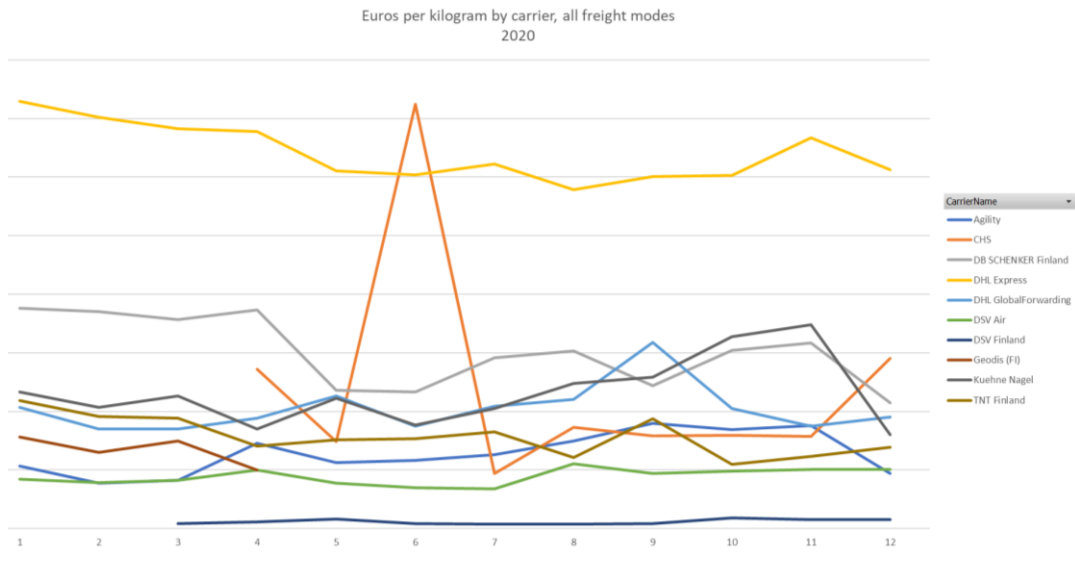
DB Schenker maintained its position as the cheapest courier in 2021. The most expensive courier of the year was TNT. The low was in July and the peak was in April.

For couriers, the year 2021 was slightly more stable than 2020. In 2020, DHL Express managed to maintain the lowest fluctuation rate, with a maximum annual fluctuation of 26%. Clearly the most volatile was TNT, with a maximum annual fluctuation of 114%. DB Schenker remained its prices within a 75% range throughout the year.

The most unstable courier in 2021 was again TNT with a 92% maximum annual price fluctuation. DHL Express was the most stable, keeping its monthly average prices within a 23% range. DB Schenker's maximum annual fluctuation rate was 41%.

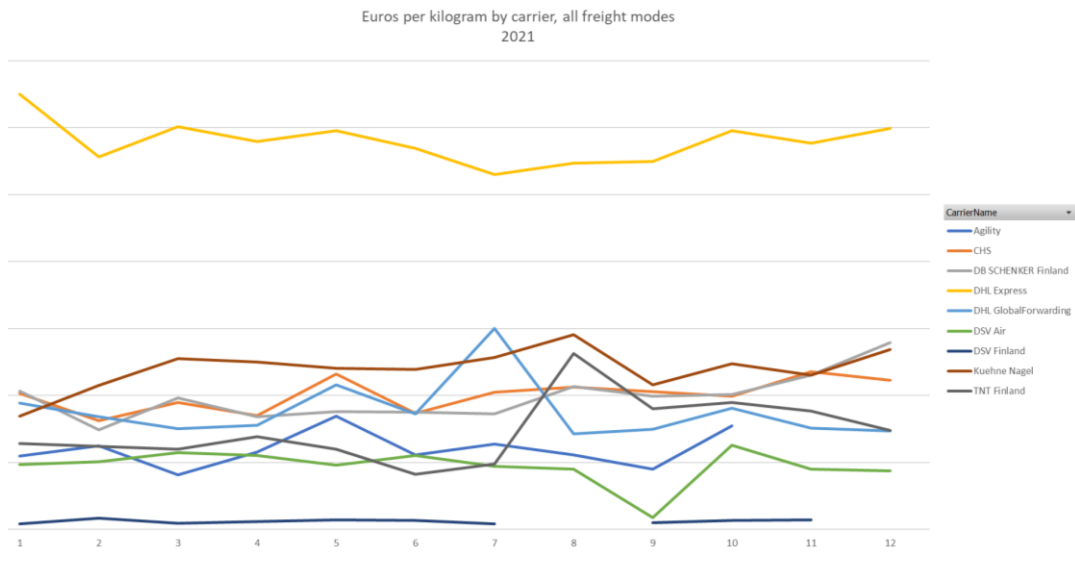
The difference in the stability of courier services, particularly DHL Express, compared to freight modes is most probably due to the high price level typical to courier services, which gives the carrier more flexibility when the world situation so requires. DHL Express also has its own dedicated aircraft and logistics network, which helps maintain a high-speed and highly prompt delivery time.

Courier services are not immune to, for example, fluctuations in fuel prices, customs duties, exchange rates or various pandemic or political restrictions. ABB Logistics Update states that, regarding Express shipments, DHL Express has lifted the weight restrictions to Origin China -shipments. Also, Fedex has announced delays to Europe-US deliveries. (Valsbrot, Jonathan 2022. "Status Update ABB Logistics"). Below pictures 13 and 14 clearly show the price volatility of years 2020 and 2021.



Picture 13. Monthly average freight prices by carrier in 2020, all freight modes included.

Among other things, the onset of the corona pandemic caused large fluctuations in freight rates, as shown in Picture 13.



Picture 14. Monthly average freight prices by carrier in 2021, all freight modes included.

In 2021, there were some signs of stabilization, but price uncertainty was still high as seen in Picture 14.

6.3 Share of Freight Costs in Sales Profit

The total freight costs of Drives Service standard and repair orders ate up 16,43% of the sales profit in 2020-2021 in average. In 2020, the average was 16,09%, in 2021 it was 16,74%.

A total of 12,940 warranty shipments were delivered during the period under review. Warranty orders are usually shipped via courier and do not generate revenue for Drives Service, meaning that the share of freight cost in sales profit cannot be calculated for these orders.

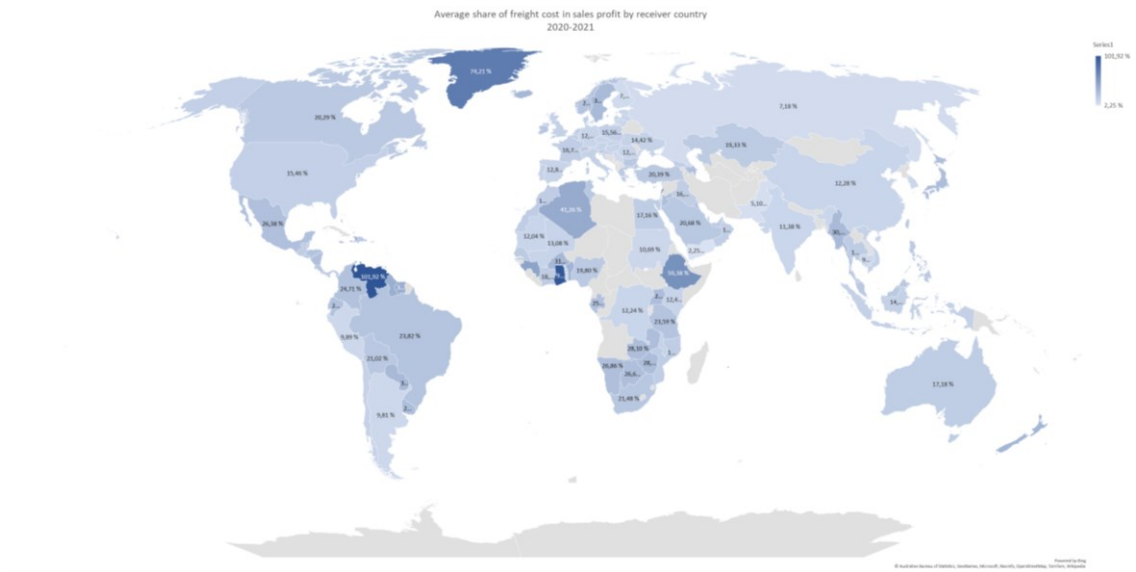
The numbers in the following sub-sections apply specifically to standard and repair orders, unless otherwise noted.

These numbers also include courier deliveries paid by customers themselves. These deliveries totalled approximately 3,0% of total courier costs in 2020 and approximately 4,2% of total courier costs in 2021.

It is also important to note that the overall gross margin used in the research calculations also applies to the small order fees, which do not actually generate any costs for Drives Service and are therefore pure profit. It is estimated that the overall gross margin used equalizes the pure net profit from small order fees in the overall average calculations.

6.3.1 By Receiving Country

For this part of the research, the receiving countries were sorted using a special coefficient obtained by multiplying the receiver country's average share of freight costs in sales profit by the number of delivered shipments. The countries sorted by the coefficient, from largest to smallest, show which receiving countries have eaten the most profit of Drives Service sales. The percentages presented in this section refer to the share of freight costs in sales profit. Freight cost in sales profit by country of destination is visualized in Picture 15 below.



Picture 15. The country-specific averages for the two-year reference period on a map diagram.

It is important to note that in the map chart above, the darkest countries do not cause much loss to Drives Service in terms of volume, but the profit margin of these countries remains small to zero. The only country to exceed 100% average was Venezuela with only two deliveries. Ghana ended up to 99% average with 11 deliveries.

It should be noted that Drives Service has had a special agreement with US ABB during 2020-2021 regarding freight costs during pandemic, which obliges US ABB to pay 50% of the freight costs that exceed the normal freight cost and that would under normal conditions be borne entirely by Drives Service. (Interview 2. Heidi Pyykkö, ABB Drives Service). This agreement has not been considered in the statistics and calculations of this study, other than what has just been mentioned.

Drives Service also has had a special agreement with Sweden during 2020-2021, under which no small order fees have been charged from Sweden. This agreement is clearly reflected in the statistics, as Sweden places an exceptional

number of small orders monthly, most of which are delivered by courier due to their small weight. (Interview 2. Heidi Pyykkö, ABB Drives Service.)

In both years, the top ten was the same but in a slightly different order. However, the top two remained the same: Sweden, which averaged 30,01% in 2020 (2278 shipments) and 30,97% in 2021 (2710 shipments), and Germany, which averaged 11,92% in 2020 (3408 shipments) and 12,39% in 2021 (3707 shipments). The figures of Norway are also noteworthy: in 2020, the average of Norwegian shipments was 18,66% (1214 deliveries) and in 2021 up to 27,13% (1522 deliveries). The other eight top ten countries in the matter of freight costs were Spain, the Netherlands, US, UK, Norway, France, Italy and South Africa. All these countries are also large in terms of sales, which helps to explain the high freight costs. However, all Asian countries, which are large in terms of sales as well, are missing from the top list, which confirms the functionality of the special coefficient used for this section.

Particular attention is drawn to Sweden, whose two-year average of 30,53% is very high in relation to transport distance from Finland. During the two-year period under review, 87% of orders destined to Sweden were sent by courier and only 13% by road. The average cost of courier deliveries to Sweden was around 10 times higher than the cost of road deliveries.

6.3.2 By Service Product

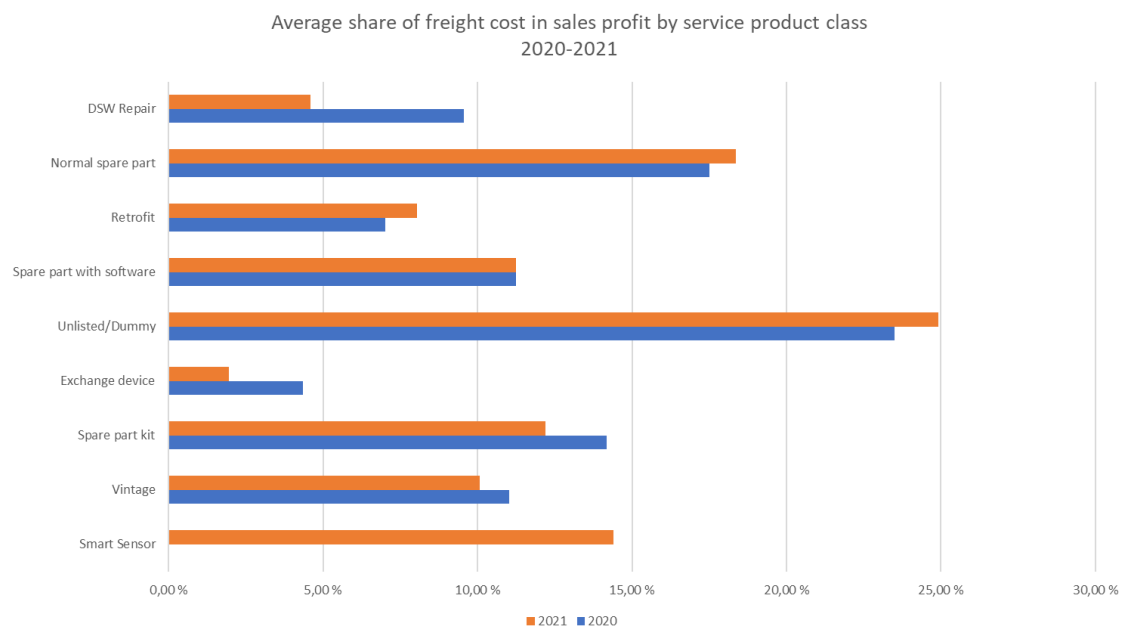
Drives Service's service products can be divided into nine different product groups: Smart Sensor, Vintage, Spare part kit, Exchange device, Unlisted/Dummy, Spare part with software, Retrofit, Normal spare part and DSW Repair. The types of these product groups differ significantly. For example, the Vintage group includes drives of all sizes, while Unlisted/Dummy products can be small screws or nuts.

Unlisted/Dummy clearly consumes more total sales margin than any other group, due to the minimal margin of unlisted items. Unlisted items are mostly small spare

parts used primarily in Drives Service production which cannot be ordered directly through BOL and a purchase always requires a quotation from the sales team. Unlisted products may also not have their own individually designed packaging procedures at the warehouse, which may result in higher freight costs when the package dimensions might needlessly large compared to the dimensions of the content.

Exchange devices, in turn, eat the smallest share of total sales margin due to the high product-level margin. Exchange devices is a special service product group that consists of replacement frequency converters of different power classes and sizes. The difference between an exchange device order and a standard device order (Vintage) is that in the exchange device order, the customer returns their old frequency converter to Drives Service, where it is either re-used or scrapped after inspection.

The differences in freight costs by service product can be seen in the chart below.



Picture 16. Share of freight cost in sales profit by service product, average.

As seen in Picture 16, in average, the delivery of Drives Service's unlisted products eats up more sales profit than any other service product class. The high margin of exchange devices guarantees a bigger share of sales profit. Drives Service added Smart Sensor to product catalogue in 2021, which is why the data isn't available for 2020.

7 Conclusions

This section presents the conclusions drawn from the research findings. First, a summary of the research is reviewed, followed by development proposals. Finally, the self-evaluation of the study is presented.

7.1 Summary

The purpose of this thesis was to present and analyse the current state of freight costs of the case company, ABB Drives Service, from the perspective of profitability and to provide development proposals to support future logistical decision-making. The need to research this topic became apparent when discussing different possibilities as the topic for the thesis with the case company. It became clear that the freight costs of the case company had not previously been studied from the perspective of the receiving country or service product. The soaring freight costs during the pandemic had already provoked a general debate in the work environment before the kick-off of this research, which influenced the decision of topic for this thesis.

The aim of the research was to support decision-making in matters related to the selection of logistical solutions so that the case company would be able to reduce future freight costs. The research was necessary because the case company had not considered the issues addressed in the research in its present decision-making in the absence of existing research data. The calculations, formulas and conclusions presented in this thesis can be used directly to support future decision-making.

At the beginning of the study, a few meetings were held with the key personnel of the case company and the supervising teacher, during which the objectives of the study and the appropriate scoping were reviewed. Once a suitable scope was found, four main objectives were identified:

- To analyse the current state of the case company's freight costs.

- To calculate the case company's share of freight costs from sales profit.
- To identify the factors that affect the formation of the case company's freight costs.
- To find out what LSU and Drives Service can do to help reduce freight costs.

Once the scope and objectives of the work were clarified, a search for suitable source data began. The data would need to include all relevant information on freight costs and retail prices. After a suitable report was found from the case company's internal system, data analysis and calculation began. The research phase of the work progressed with the analysis of the data, which began to form a better insight in the freight cost structure of the case company.

The next step was to analyse the current state of the company in terms of logistics operations and freight costs. The current state analysis started with processing the information contained in the Excel data source to meet the agreed limits. Once the data was edited, visualization and calculations were made. Based on the created diagrams and results of the calculations, the formation of research results began. The research results were finally used to draw conclusions and development proposals introduced in the next subsections.

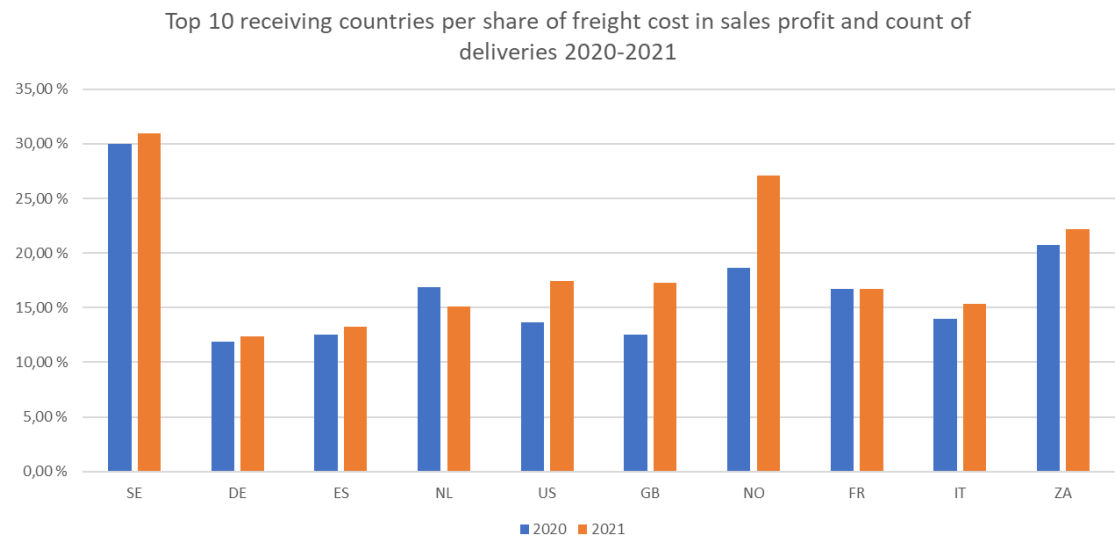
7.2 Development Proposals

The aim of the research was to support decision-making in matters related to the selection of logistical solutions so that the case company would be able to reduce future freight costs. Research revealed several points of improvement. These areas and key points are presented in the following subsections from both the LSU perspective and the Drives Service perspective.

7.2.1 LSU Perspective

According to statistics, Sweden's courier deliveries has the greatest potential for savings, as seen in Picture 17. As stated in section 6.3.1, almost 90% of shipments to Sweden are shipped by courier. As courier is the most expensive of the three modes of transport, it should be used as little as possible if any other mode of transport could be used for the order-specific purpose. This does not only apply to Sweden, but in general among all LSUs, courier services should only be used for urgent orders. LSUs therefore need to be motivated to use more standard air and road freight, the solution to which is presented in the next section.

Another point of development for LSUs is that orders should increasingly be allowed to be delivered as complete deliveries, meaning that all order rows would be dispatched at the same time. Complete deliveries save a large amount of money spent on freight costs as well as forwarder's working time because each row doesn't have to be tendered, packed and booked to carrier individually. On the other hand, global availability challenges cause increasing need for partial deliveries. In 2020, 38% of Drives Service's standard order deliveries were complete deliveries, in 2021 the figure was 41%. It is worth noticing that these numbers also include those complete delivery orders that have only one item row.



Picture 17. Top 10 receiving countries, all freight modes included. The greatest saving potential lies in courier deliveries to Sweden.

All in all, it can be summarized that the LSUs should be obliged to operate in the most cost-effective way possible for Drives Service whenever savings are possible in each sales case without sacrificing customer satisfaction or promised delivery times. It is essential that the LSU creates a BOL order without delay after receiving a purchase order from the end customer and encourages the end customer to anticipate their service product needs well in advance whenever possible. If the situation allows, LSU should consolidate orders by combining several different purchase orders into one BOL order and minimize the use of partial delivery in less urgent orders where all items are available in Drives Service sales stock.

7.2.2 Drives Service Perspective

If it is possible for LSU to reduce total freight costs through its own actions, such as reducing the use of the Courier or increasing the number of consolidated shipments, Drives Service should reward LSU by considering reduced freight costs in country-specific product pricing. In practice, such pricing could be implemented, for example, by monitoring the distribution of freight costs by country in a continent on a monthly or quarterly basis. For monitoring purposes,

continent-specific thresholds (for example, continent average) should be set below which the LSU would have to stay to receive a discount in pricing (price category 1). If freight costs are affected by factors beyond the control of the LSU or the continent, they should be considered when assessing the discount entitlement of an individual LSU. These beyond-control factors include, for example, natural disasters and political crises such as wars.

A fictional example: The average share of freight cost in sales profit for European countries in January was 22%, so the European limit for February is set to 22%. LSU Spain receives a monthly average of 18% in February and is set to price category 1. LSU Denmark receives a monthly average of 23% and remains in price category 2. European total monthly sales amount reached 20 million euros. Spain's share of this was 4 million euros. Price category 1 monthly discount percent is calculated by the following formula (where MST stands for Monthly Sales Total and MFSp stands for Monthly Freight cost in Sales profit:

$$\text{Price category 1} = \frac{\text{LSU MST}}{\text{Continent MST}} \cdot (\text{Continent MFSp} - \text{LSU MFSp})$$

and with the fictional sales figures for LSU Spain:

$$\text{Price category 1} = \frac{4}{20} \cdot (0,22 - 0,18) = 0,008 = 0,8\%$$

Quarters can also be used instead of months in the formula. The percentage obtained from the calculation would be used as an additional discount in service product pricing for the next month or quarter, after which a new discount rate and country-specific discount entitlement would be decided based on the most recent continent average. Such special pricing practice would encourage LSUs not only to reduce their freight costs but also to increase their turnover, as both factors affect the total discount earned.

Another point of development is the minimal margin of Unlisted/Dummy product group. Drives Service sells unlisted spare parts to meet the need and demand of

end customers, which is important for overall customer satisfaction. Still, the margin of unlisted products should be heavily increased to make it also economically viable to sell them. The new pricing should consider all stages of the order-supply chain for Unlisted/Dummy products, especially the resources required for quotation process and order handling, not forgetting the freight costs.

7.3 Research Evaluation

The goal of the research was to support case company's decision-making in matters related to the selection of logistical solutions so that the case company would be able to reduce future freight costs. With the research results, it was possible to answer all the research questions posed at the beginning of the thesis. Freight costs have now been calculated, and the development proposals made based on them are ready for use by the case company as a guiding factor in decision-making.

Several different visualizations were developed regarding the distribution of freight costs, which clarify the actual current state of the case company and indicate areas for future development. The discount calculation formula presented in section 7.2.2 is also ready to be used as such or as a modified quarterly version.

The findings of this research were, in part, very surprising. Some of the results were completely new and some confirmed already existing data. The case company has not previously considered the formation of freight costs from the customer country and service product perspective examined in this study in its logistical decision-making, making the results of this thesis well expected to support future decision-making. It is desirable that this research will be used to train the staff of both the case company and the local sales units to take freight costs into account in their own decisions regarding each sales case. It is important that, in addition to decision makers, also the employees understand the role of freight costs in the overall cost structure.

Deviations in the research data were analysed and solutions were created for related problems. The country-specific discount calculation formula based on freight costs is a concrete change proposal that has the potential to act as a motivator to reduce overall freight costs. The summary of measures that a local sales unit can use to reduce freight costs, presented in section 7.2.1, can be used as a general guideline, and should be considered for inclusion in the case company's Terms & Conditions.

In view of the above points, the results and findings of the research were in line with the expectations and objectives set. The research results can be considered significantly useful for the case company, as they will allow the case company to include the share of freight cost in sales profit in future decisions on issues related to logistics solutions. The discount motivator presented in this research might act as a buffer, if functional, extending the new price categories created in this study to other cost reduction themes as well.

The shortcomings in the current freight practices of the case company, as revealed by the research material, provide an opportunity for the company to take the research results into account and improve its practices in a better direction. Therefore, the benefit to the case company from this thesis can be considered good.

The topic of the research, such as logistics in general, was interesting to me and I hope to be able to help the case company to improve its current practices and create new operating models even after this thesis. Finally, I would like to thank ABB for their cooperation on this project – hopefully the results will be useful in future decision-making!

References

Talousverkko. "Mikä on myyntikate ja mitä se kertoo?". 2017.

<https://www.talousverkko.fi/post/myyntikate>. Online article. Read 19.2.2022.

DSV. "Koronaviruksen vaikutukset lento- ja merirahtiin". 2020.

<https://www.dsv.com/fi-fi/tietoa-dsvsta/lehdisto/uutiset/fi/2020/01/corona-virus-affects-transportation>. Online article. Read 20.2.2022.

Autoalan tiedotuskeskus. "Bensiinin ja dieselin hintakehitys".

https://www.aut.fi/tilastot/verotus_hintakehitys_ja_liikennemenot/bensiinin_ja_dieselin_hintakehitys. Online article. Read 20.2.2022.

Valsbrot, Jonathan. "Status Update ABB Logistics". 23.2.2022. ABB internal newsletter. Read 25.2.2022.

Grimsley, Shawn. "What Is Profitability? – Definition & Analysis". Updated 10.12.2021. <https://study.com/academy/lesson/what-is-profitability-definition-analysis-quiz.html>. Online article. Read 28.2.2022.

Logistiikan maailma. "Lentokuljetus".

<https://www.logistiikanmaailma.fi/kuljetus/lentokuljetus/>. Online article. Read 1.3.2022.

Investopedia. "What Is the Formula for Calculating Profit Margins?". Updated 17.1.2022. <https://www.investopedia.com/ask/answers/031815/what-formula-calculating-profit-margins.asp>. Online article. Read 5.3.2022.

Tanskanen, Jari. Yle Uutiset. "Lentorahdin hinta on rajussa nousussa – se nostaa Aasiasta tuotavan elektroniikan hintaa Suomessakin". 15.5.2021. News article. <https://yle.fi/uutiset/3-11925987>. Read 5.3.2022.

The Economic Times. "Definition of Road Transport".

<https://economictimes.indiatimes.com/definition/road-transport>. Online article.

Read 5.3.2022.

Logistiikan maailma. "Maantiekuljetus".

<https://www.logistiikanmaailma.fi/kuljetus/maantiekuljetus/>. Online article. Read

5.3.2022.

Huolintaliitto. "Koronaviruksen vaikutukset huolinta- ja logistiikka-alaan".

Updated 17.6.2020.

<https://www.huolintaliitto.fi/ajankohtaista/uutiset/uutisarkisto/2020/koronaviruksen-vaikutukset-huolinta-ja-logistiikka-alaan-paivitetty-17.6.2020.html>. Online

article. Read 5.3.2022.

Huolintaliitto. "Huolinnan toimialakatsaus 2021". 28.10.2021. Online industry

review. Read 5.3.2022.

Steer, George; Romei, Valentina. Financial Times. "Shipping costs quadruple to record highs on China-Europe 'bottleneck'". 19.1.2021.

<https://www.ft.com/content/ad5e1a80-cecf-4b18-9035-ee50be9adfc6>. Online

article. Read 5.3.2022.

Kilpelainen, Janna. "Covid-19-pandemian vaikutukset projektilogistiikkaan".

10.12.2021. Scientific research. Read 5.3.2022.

Neste. "Raakaöljyn hinta".

<https://www.neste.fi/konserni/sijoittajat/markkinatieto/raakaoljyn-hinta>. Online

article. Read 5.3.2022.

Ambrose, Jillian. The Guardian. "UK motorists face record fuel prices as global oil costs rise". 11.2.2022. <https://www.theguardian.com/money/2022/feb/11/uk-motorists-face-record-pump-prices-as-global-oil-costs-rise>.

Online article. Read 5.3.2022.

ABB. "ABB Suomessa". <https://new.abb.com/fi/abb-lyhyesti/suomessa>. Online article. Read 14.2.2022.

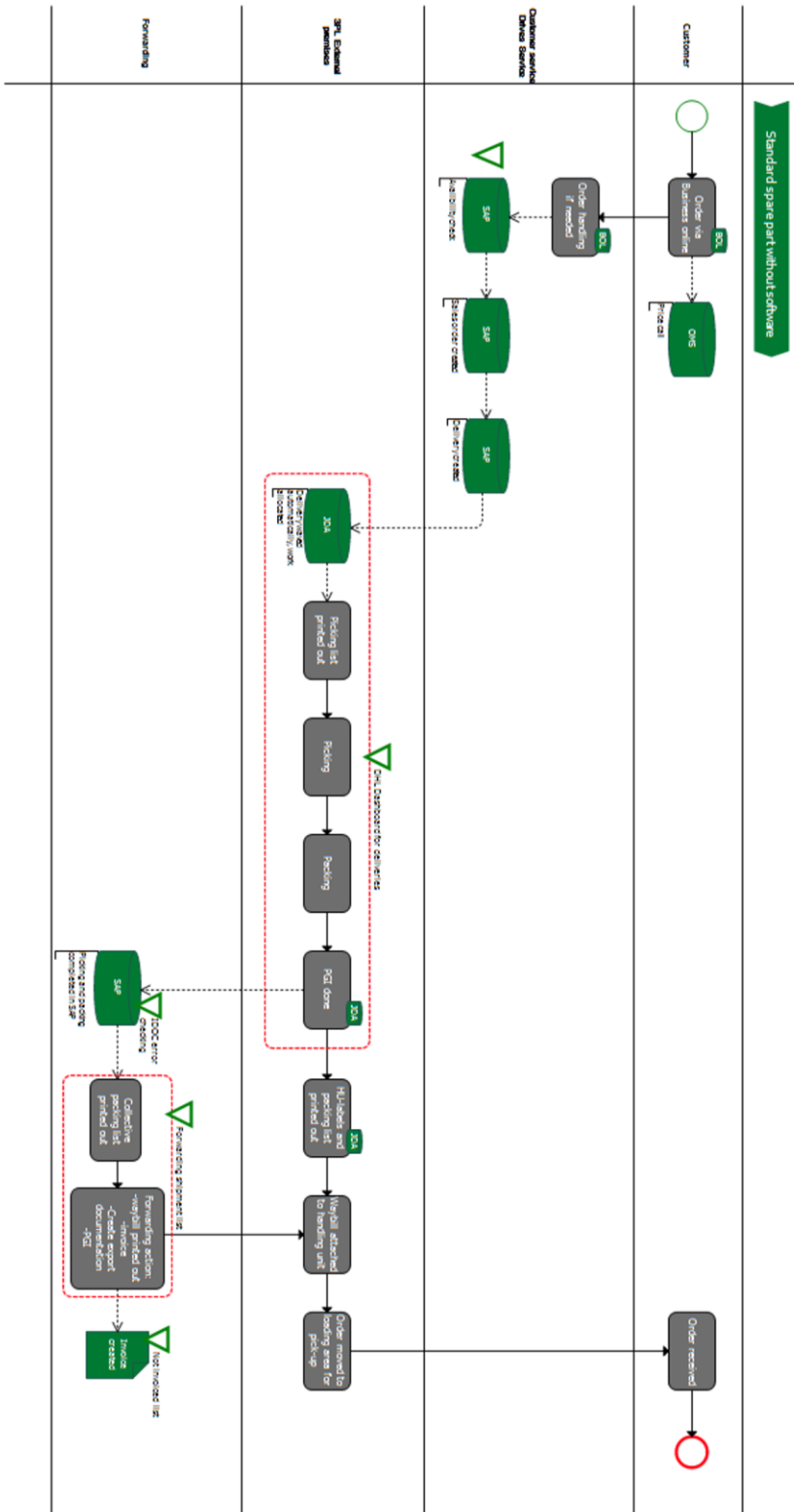
Interview 1. Petra Potinkara, DHL Supply Chain. Differences between standard air freight and courier air freight. Interviewed 10.2.2022.

Interview 2. Heidi Pyykkö, ABB Drives Service. Overall logistics operations. Interviewed 15.3.2022.

Interview 3. Kati Ikonen, ABB Drives Service. How are freight costs noticed in product pricing? Interviewed 15.3.2022.

ABB. "Historia". <https://new.abb.com/fi/abb-lyhyesti/historia>. Online article. Read 16.3.2022.

ABB. "ABB Oy, Drives". <https://new.abb.com/fi/abb-lyhyesti/suomessa/liiketoiminnat/drives>. Online article. Read 16.3.2022.



Appendix 1. Picture 4. Swim lane diagram of the Drives Service supply chain.