Tampere University

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EVALUATION OF LOGISTICS SERVICE LEVEL IN MULTIPLE MODES OF TRANSPORTATION

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ABSTRACT

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The project has been initiated in the aftersales department of an automotive company. Since the company has had recently record years in gaining market share and further efforts are being done to gain a competitive edge over the competitive brand by selling more aftersales parts. Which in turn makes it challenging for logistics to manage the increasing inflow and outflow of parts. For the case company, logistics processes form the critical loop involving both the company performance in logistics and customer experience. The company realizes that logistics costs can vastly impact overall business performance. Hence, an opportunity is presented at the case company to expedite regular stock-orders by utilizing available space inside emergency-order trucks instead of using shipping containers. The idea behind this proposed modification is that it will reduce lead time and increase logistics service quality. But the actual problem in this situation is the lack of knowledge to understand company-specific logistics service quality and then the evaluation framework which can help the management to decide whether to proceed or oppose the business idea.

Literature was reviewed to define the objectives of service levels and how to measure service quality. Based on the previous literature, a theoretical framework was developed which served as a guiding principle for the latter empirical analysis. The data collection was conducted through semi-structured interviews and information was acquired from a logistics management software. The results from both the quantitative and qualitative analysis uncovered that the case company has substantial profit margins to proceed with the proposed logistics activity leaving enough room for overhead costs. The logistics process does involve multiple challenges, but after performing sensitivity analysis, it was found that the process is flexible enough to handle challenges. Thus, the study provides a positive indication to proceed with this opportunity for a pilot test-run project.

PREFACE

I was lucky to receive the thesis topic when I was working as a logistics trainee in the aftersales department of the case company. Even though my master's specialization was related to sales and sourcing, having a similar background, but the learning curve in the overall thesis process has embarked on its importance in my life.

First, I would like to thank Associate Professor Teemu Laine for taking on the supervision of this research project. His contribution towards developing a framework and insightful comments about thesis writing have contributed to a great extent. Also, I would like to express my gratitude for the case company representatives for their interest and useful discussion on the topic in general. Most of all, I would like to thank my colleagues in the logistics team, we have had many brainstorming sessions both formal and informal where I have received support and encouragement for thesis and general life matters during the tenure of six months.

Finally, I would like to extend my humble appreciation towards my friends that I have made while studying in Tampere and relatively short stay whilst working in Espoo. Even more, a very warmhearted thanks to my parents; without their prayers and guidance in the right direction, I would not have made it this far.

Tampere, November 2019

Syed Hamad Shah

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LIST OF SYMBOLS AND ABBREVIATIONS

CCX	Case Company X
LSL	Logistics Service Level
LSQ	Logistics Service Quality
LMS	Logistics Management Software
VOR	Vehicle Off-Road
SOs	Stock Orders
EOs	Emergency Orders
ETD	Estimated Time of Delivery
PMS	Performance Measurement System

.

1. INTRODUCTION

1.1 Research Motivation

The term logistics relates to the management of supplies and transport required for operation. In today's emerging global economy, the business sector uses this term to describe the material and information flow from the point it is originated to the point it's utilized. Since, the concept of logistics is evolved from the supply chain, which is a key element of business performance measurement which deals with transportation, inventory management, shipping and plays a vital role in evaluating service levels.

In case of the automotive industry, which contains multiple products, new technological innovations, and processes that make the logistics more complex (Sabadka, 2015). An automobile usually consists of thousands of different parts being manufactured by multiple tiers of suppliers and makes the supply network much more complex. No matter the size of business and brand worth, every automotive company wants to expand its business and grow its customer base. Therefore, businesses focus on selling their products to customers by product positioning and brand image. Whenever a business witnesses an increase in car sales it greatly influences overall parts movement and logistics, especially the aftersales parts which are generally sold after a car is sold to the customer. For some companies, managing the inflow and outflow of the parts becomes difficult to manage because of a lack of specialized knowledge. In that case, the companies turn to the option of using third-party logistics service (3PL). A 3PL organization generally specializes in managing logistics and warehouse operations because the organization possesses the necessary experience and connections to perform integrated warehousing and transportation service using either its internal or external resources. Hence, numerous automotive industries are utilizing 3PL services to outsource its distribution logistics and warehouse responsibilities.

Thus, the quest for gaining higher market share has intensified the competition among the automobile manufacturers. The logistics process forms the critical loop and has great implications over the flows of materials, information, and the cash flow, which are the key elements that define logistics service levels (Zeng & Rossetti, 2003). In today's world, the business sector has realized that logistics plays the heart of supply chains and therefore, the reduction of logistics costs can certainly improve business performance efficiency and increase organizational service levels. As argued by Everaert (Everaert, et al., 2008), in today's streamlined world and global economy, cost-effectiveness in logistics is a requirement. The increased pressure to reduce the logistics in the automobile industry has certainly changed its dynamics, the costs are getting higher and usually, 14% of companies cannot estimate their costs properly (Sabadka, 2015). Therefore, many companies try to look for alternative logistics and modes of transportation, but the important question remains, what impact it can have on the company's logistics service levels.

From the company's perspective, the relationship with the end-customer is highly dependent on the logistics service quality being offered. Timeliness in order-delivery, information and order quality has a significant positive or negative impact on end-customers satisfaction (Saura , et al., 2008). With regard to improving the service quality and causal relationship, the companies are investigating possible ways to deliver products more efficiently and in a timely manner. Hence, companies continuously try to investigate different modes of transportation, economic order quantities, and delivery service packages. These efforts are being made not only to reduce the internal logistics costs but also to understand the complexity of the global logistic process and what can be done to improve the overall service quality. In this research, the focus is put more on understanding the complexity of logistic processes and modes of transportation from a real-world case study problem. Possibility to increase the efficiency of logistic service level and cost reduction is analyzed.

1.2 Research Context and Case Company

This thesis is done by collaborating with Case Company X, which acts as an importer and marketer for an automobile manufacturer. The company operates in seven different Nordic and Baltics market and this study is focused on Finland's market. The company has seven different vehicle models in its portfolio being offered in seven markets. The main departments of the case company which generate direct revenue are corporate sales and aftersales by selling tangible products. The corporate sales department is roughly selling 40,000 vehicles in seven markets in a fiscal year. The aftersales department roughly generates a revenue of 40 million euros. The aftersales department offers several products and services which include genuine accessory, local accessories, genuine parts, and associated business products. The department consists of different teams managing products and services including logistics, marketing, parts and tires, warranty and technical team. The logistics team handles moving the parts from a central warehouse to a local warehouse in each territory.

Presently, the logistics department deals with 124,000 active part numbers which are being delivered to local warehouses. The stock orders are delivered by shipping containers and emergency orders are being shipped by trucks from a central warehouse in Amsterdam to a local warehouse of each territory. The topic of the thesis has been developed due to the real need of the company to look for alternative ways of modifying transportation that can improve the efficiency of logistics service levels but the implications over costs are yet to be understood.

1.3 Research Objectives and Key Questions

In the current state, the scheduled delivery of regular stock orders is transported through shipping containers from the Rotterdam port to the port in Vuosaari. A local Finnish logistics service corporation provides third-party logistics (3PL) services in Finland and deals with transporting the goods to Finnish warehouse and storage activities in the local warehouse located in Vantaa. However, in case of emergency orders, which are first sent once-daily from Amsterdam to Denmark via trucks and then goods are distributed to other Nordic countries through trucks, either full-load or a half-load truck.

The regular stock orders being sent through full-load shipping containers provide very little visibility about the estimated time of arrival and have an average lead time ranging from 3 weeks to 5 weeks. Therefore, to cater to this issue, the required safety stock is higher than the average and, in a few cases, parts delay received negative responses on logistics service level from the local dealers in Finland. The responsible managers and stakeholders of the logistic process proposed an idea to create a tailor-made mode of transportation and more specifically the delivery service package including order types and quantity. However, despite having the defined logistic key performance indicators, the case company is missing logistic-service-level assessment from a customer and case company's point of view. If any development is to be made in the mode of transportation, it requires the information on how to measure the logistic service level and assess the impact and risk, thus the situation above formed the basis of this thesis with the following objectives.

- How can the logistics service levels be evaluated in the proposed logistics activity?
- What metrics are needed to increase the efficiency of logistic service quality?

- What challenges and risks are associated with the proposed mode of transportation?

This thesis aims to answer these questions for Case Company X as accurately as possible. First, the research is conducted by analyzing the relevant literature in detail and defining the logistics service levels from the case company's perspective. Secondly, the financial information about the products of the company is acquired to analyze the behavior of logistics costs for different modes of transportation. For the case company, the primary customers are the local dealers, thus, the study strives to answer the impact on customers from their perspective. Logistics service level is a broad concept and deals with various background factors but for this study, the aim is to investigate the narrow and relevant issues of service levels such as lead time, logistics visibility, communication, and customer satisfaction.

In this study the costs analyzed are based on the volume of the product being transport by 3PL (euro/volume), thus, the other costs of logistics are not taken into consideration. Furthermore, there are over 80,000 aftersales parts in the case company's system but for this study, the latest inventory stock analysis report is examined and only a few parts were considered to perform this study. The reasoning behind selecting these parts is explained in chapter 4. This case study is only focused on drafting a business case in a limited capacity, analyze its current vs planned logistics service levels, understand the behavior of logistics costs in both the cases, finally present overall challenges and possible solutions.

1.4 Structure of the Study

The thesis consists of several chapters which are divided categorically. After the introduction, chapter 2 discusses the literature and reviews the theoretical background in detail. First, managing logistics operations is discussed. The involved operational activities and challenges are examined especially in the case of the automotive industry. Secondly, service levels are defined from the case company's perspective. The emphasis of this subchapter is on understanding the role of logistics service levels in business performance and customer satisfaction. The third subchapter deepens the involved cost implications in logistics service levels and its behavior in different modes of transportation.

After the theoretical background, in the third chapter, a theoretical framework is developed which reflects theory concepts and provides guidance for empirical analysis. Furthermore, the fourth chapter explains how this study was carried out and the practicalities involved in the collection of data. The main research methods of this study were done by action research conducted by doing several interviews and brainstorming sessions with the case company's section managers. The data for cost analysis is gathered from the case company's internal information management system and with their consent. After discussing the research methodology, chapter five performs the empirical analysis of the case study and presents its conclusive results too. The first subchapter discusses the case company's aftersales department and its performance standings from the inventory control point of view. Then the current situation is further analyzed in the view of defined logistics service levels that include lead time, cost of operations and order delivery quality. The suggested mode of transportation and the case study's key question is analyzed in this subchapter. After this, logistics cost analysis's result is presented, and other involved challenges and risks are discussed as well.

The last chapter of the thesis presents several viewpoints and concludes the thesis based on quantitative and qualitative analysis. Another subchapter also summarizes the discussion and findings effectively and presents a solution to this business case. The limitations of this study are also explained at the end of this chapter and finally, to further develop this study other possible topics and ideas are also covered at the end of this chapter.

2. THEORETICAL BACKGROUND

2.1 Managing Logistics Operations

Logistics is generally defined as management of all the operations and activities that support movement or transportation in order to coordinate supply and demand in the creation of time and location utility (Heskett, et al., 1973, p. 17). Typically, logistics involves several phases including planning, implementation, and control of goods and information in order to effectively manage forward and reverse flow from the point of origin to point of consumption (Riopel, et al., 2005, p. 3). The logistics play a key role in the whole supply chain value stream which not only handles the forward flow of goods and information but also controls the reverse flow to satisfy the customer requirements. The physical flow of goods in logistics may include various types of tangible goods such as materials, equipment, supplies or other consumable items. From the company's point of view, the logistics system is seen as a collection of functional activities that determines the infrastructure and resources required to maintain the flow of materials and information required by the end-customers.

The structure of the logistics network is comprised of three main factors including the flow of materials, flow of information and time taken to fulfill customer demand (Harrison, 2014, p. 1). The overall scope of the logistics network depends on organizational business nature, organizational functions, products, and services. A typical example of logistics flow is shown in figure 1 below.

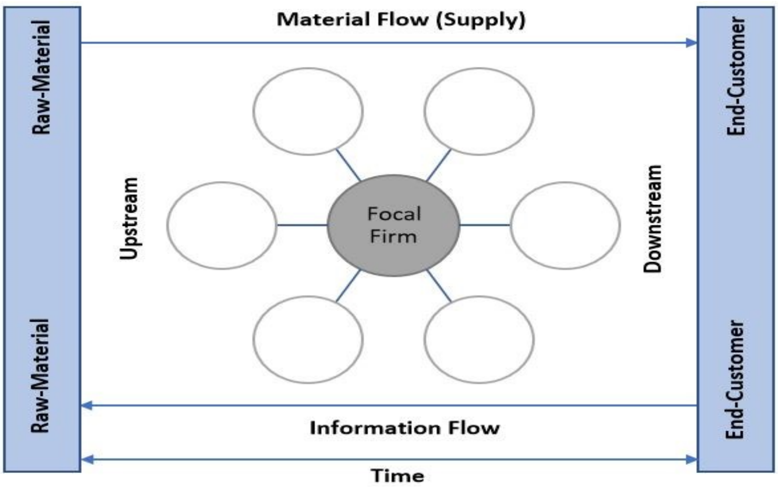


Figure 1. Logistics Flow (Adopted from Harrison, 2014, p. 1).

The figure above presents a visual image of the overall logistics flow. The material flow relates to the transportation of physical goods from the suppliers to the end-customers, but the information flow is given from the end-customers in the form of demand data to the suppliers. However, the time dimension is also critical in the logistics flow because it reflects the network speed that responds to the demand originating from the end-customer (Harrison, 2014, p. 13). That is why in the field of logistics management, it is important to control the reverse and forward flow of goods and information because of the complexity involved. As argued by (Everaert, et al., 2008) in today's simplified globe, cost-effectiveness in logistics has become a requirement, so logistics management not only integrates the supply and demand but also required to improve business efficiency.

2.1.1 Logistics Activities, Functions, and Networks

The logistics functions are dependent on the nature of the organization's business, its production process, location and distribution centers (Ghiani, et al., 2013, p. 5). In general, the logistics functions are comprised of order processing, inventory control, transportation, warehousing, material handling, and packaging. The table 1 below summarizes the activities involved in logistics management.

Table 1. Logistic Functions (Adopted and modified from Farahani, et al., 2011, p. 45)

Activities	Description
Order Processing	The process starts when the order is received from a customer and submitted to the central warehouse, if out of stock, request for new materials sent to the suppliers.
Inventory Control	It involves the supervision of supply and storage and ensuring that adequate goods and materials are available without over-supply.
Transportation	The physical movement of goods from warehouse to customer location (finished goods) or from supplier to the warehouse (raw-materials), different modes of transportation exist including by road, railways, shipping container lines and by air-freight.
Warehousing	Purpose of warehousing to facilitate the storage and easy delivery for incoming and outgoing goods, location of warehouse plays a vital role and operating a warehouse requires special knowledge.
Material Handling	It involves handling the materials at the warehouse, incoming goods are stored in relevant location and outgoing goods are inspected and prepared for shipping
Packaging	It involves packing the finished goods and arranging them in shipment pallets in a way to avoid transport damages and utilizing maximum available capacity

Table 1 above provides a short overview of the main functions involved in logistics management (Farahani, et al., 2011, p. 45). In recent years, the customer supply chain has been acting dynamically and restructured the operating environment of logistics. The functions of logistics from Table 1 mainly includes the allocation of resources, utilizing technology and labor to meet certain goals, but this strategy is highly dependent on the links within the supply chain network.

According to (Ghiani, et al., 2013, p. 5), there are also some aspects of logistics and involved activities depending on the location of organizational business units. Some of these logistics aspects include supply logistics, internal logistics, distribution logistics, and external logistics which are explained below.

- *Supply logistics* refers to managing upstream suppliers and incoming raw materials.

- *Internal logistics* relates to picking, storing and handling parts within factory or warehouse premises (Ghiani, et al., 2013).
- *Distribution logistics* includes the task of distributing the finished goods to the downstream tier 1 customers (Harrison, 2014).
- *External logistics* is the concept consisting of activities collectively from supply logistics and distribution logistics.

As per the viewpoints, it is realized that the scope of this research lies within the boundaries of supply logistics. In order to proceed efficiently with the supply logistics, key players in today's business environment have realized the importance of supply network planning, partnering distribution activities with expert organizations (Peng, et al., 2011). A supply network typically consists of a focal firm being connected to other entities of supply chain involving a series of activities which is extended beyond the organizational boundaries. As the flow of material typically moves from downstream and simultaneously the information is sent upstream to maintain coordination. In the logistics system, MTO (Make to Order) phenomenon is also used when a certain is directly received from customers which triggers the production activities at the manufacturer to meet that demand. On the contrary, the concept of MTS (Make to Stock) refers to forecasting and recording demand in advance to produce according to which therefore affects distribution logistics (Ghiani, et al., 2013, p. 6). A typical example of a logistics network is shown in figure 2 below.

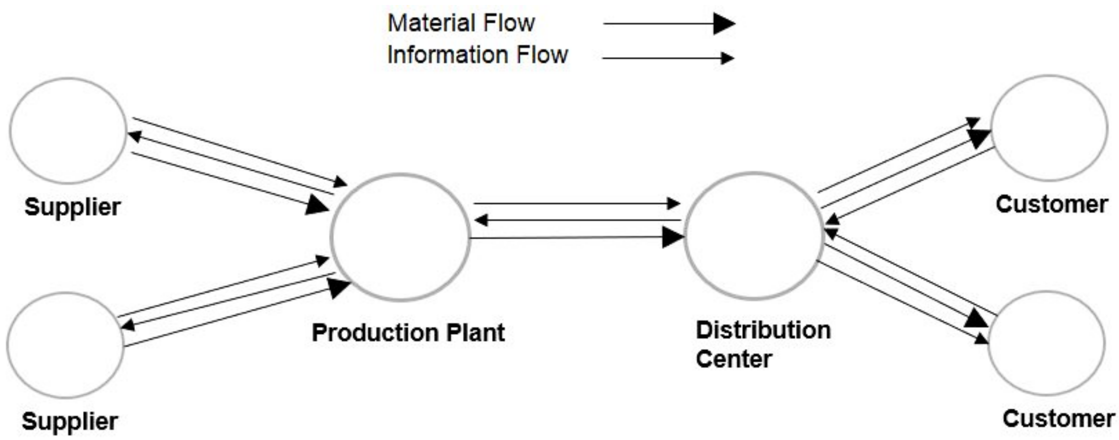


Figure 2. Supply Network (Adapted from Ghiani, et al., 2013, p. 7).

Figure 2 visualizes a rather simplified version of the supply network, it is worth noticing here that the flow of material is mostly unidirectional starting from suppliers until the end customer. In case, if the material is sent back from the end-customer, it is known as reverse logistics. However, the information flow in this process is rather a to-and-fro. In addition to this, a network becomes more complex when there are several products.

Companies, in that case, utilize ABC product classification (Ghiani, et al., 2013, p. 7) to subdivide the product into several categories. Since the case company in question has thousands of products, therefore, it is widely using ABC classification to manage inventory. The main reason behind classifying inventory is to set service levels (Teunter, et al., 2010) by assigning service levels for each class which typically is measured by revenue generated by each class in a referent time span (Ghiani, et al., 2013, p. 7). Class A usually consists of goods that account for 80% of the income generated and Class B constitutes 15% while Class C products contribute to the rest of the 5% revenue. From these concepts, it can be said that different modes of logistics and inventory control measures should be taken for each inventory class (Ghiani, et al., 2013, p. 8). Hence, the infrastructure of logistics becomes an important factor for success (Chow, et al., 2006).

When it comes to designing logistics infrastructures, many researchers have tried to optimize the communication process, distribution problems and supply network efficiency (Hokey & Sean, 1994) and transportation multiple mode evaluation and selection (Vannieuwenhuyse & Pintelon , 2003). Another contribution to this was made by Srinivasa in 2001 (Chow, et al., 2006) who introduced a business intelligence tool to improve the efficiency of warehousing database management especially for larger companies dealing with bigger volumes. The tool helps to visualize analytics involved in logistics, deeply examine the logistics function and converts this information into actionable knowledge which can help to improve the functioning of warehousing and transportation management.

Despite the technological improvements, operating a facility or warehouse not only requires specialized skills but also poses threats and risks of property losses, causalities, and natural disasters. Other contingencies such as equipment breakdown, power outages and strikes can also lead to facility disruptions. Hence, the infrastructure of logistics becomes an important factor for success (Chow, et al., 2006) and once a supply chain network is designed and infrastructure is built, it is costly to modify it afterward (Peng, et al., 2011). Therefore, to cope with the daily operational decision making for warehouse efficiently, many organizations turn to experienced third-party logistics service providers (3PL) to handle warehousing and decision making related to transportation and material handling (Chow, et al., 2006). A 3PL service provider acts as an external supplier that manages, delivers and coordinates logistics activities with the customer on behalf of the shipper (Hertz & Alfredsson, 2003).

There are typically two types of 3PL service providers namely asset-based and non-asset-based service providers. Asset-based service providers own the property that runs the logistics activities including logistics hub or warehouse. non-asset based is generally medium-sized companies that generally sub-contract part of the important activity with other partners to provide transportation, freight forwarding, and logistics services. (Choy, et al., 2007) The strategic position of 3PL is illustrated in figure 3 below.

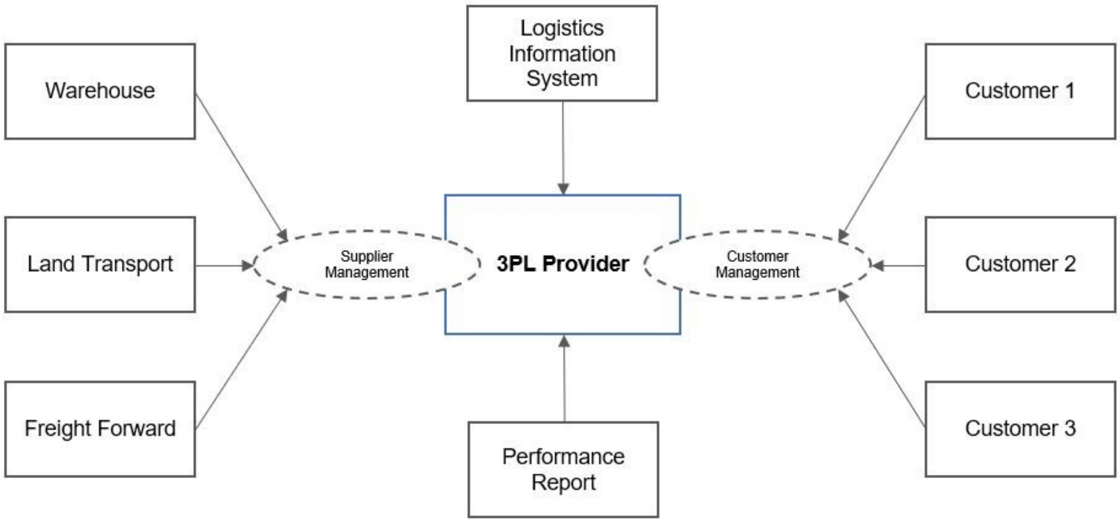


Figure 3. 3PL Provider Strategic Position (Adapted from Choy, et al., 2007).

Figure 3 illustrates the importance of 3PL in today's competitive business environment. This framework conceptualizes the process of working with 3PL. Since the case company is working directly with a third-party warehousing team so, in theory, it takes care of supplier and customer management. The reason businesses collaborate with 3PL having warehousing expertise and manpower to support product transportation and logistics activities. The 3PL is also responsible for the exchange of information flow with downstream customers and sharing logistics data, therefore, the companies share the operation's data electronically and communicate in real-time throughout the supply chain process (Grossman, 2004).

2.1.2 Parts Logistics in the Automotive Industry

As argued by Sabadka (2015), when both the inbound and outbound logistics are organized efficiently and support each other, then synergy is created that helps to meet the customer demand on time (Sabadka, 2015). However, increased product variety and newer technological processes can enhance the complexity of the overall logistics process especially in the case of the automotive industry. The automotive logistics, in general, include managing the inbound logistics, which deals with incoming goods in the form of raw materials, then converts these raw materials into finished goods through production and assembly lines. After the product is ready to be shipped, it is transported to the distribution center and shipped to local and international car dealers. In today's competitive business environment, the market pressure is intense which leads to changing customer needs and increased product individualization. This market behavior is noticed more in the automotive industry and is expected to grow more in the near future (Dörnhöfer & Günthner , 2017). An overall logistics process is illustrated in figure 4 below.

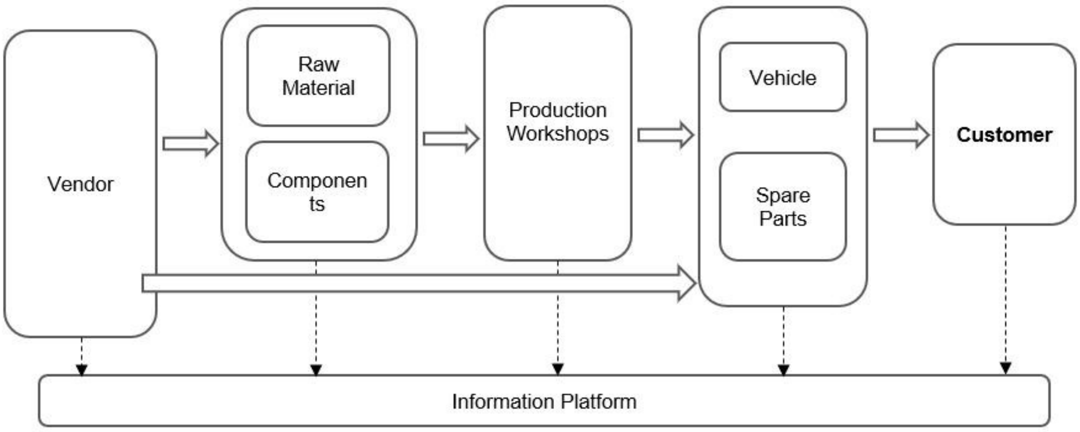


Figure 4. Automotive Logistics Flow (Adapted from Sabadka, 2015).

As figure 4 illustrates the flow of the automotive industry, it is evident that the logistics flow is highly dependent on a competent supply network. An automobile consists of thousands of parts which is acquired from multiple tiers of complex supplier network, therefore, the vehicle manufacturers outsource non-core processes to the expert organization in order to become more responsive to market competition (Bennett & Klug, 2012).

In the automotive business, the additional bigger chunk of sales revenues is being contributed by aftersales products. Aftersales parts include all the general vehicle parts, accessory products, chemicals, and other equipment and service parts that are sold and installed on vehicles. When the spare parts logistics is strategically aligned, it not only supports the business with additional revenues but also provides value to the customers and reduce overall costs (Wagner, et al., 2012). The companies offering aftersales services adopt a demand-driven model to ensure that the spare parts are available to deliver when required during a vehicle's service visit at an authorized dealer workshop. However, the aftersales market is greatly influenced by fluctuations in demand and market price volatility (Wagner, et al., 2012). Hence, companies try to understand market behavior by deeply analyzing the stochastics factors. According to Sabaka (2015), the logistics ecosystem is being affected by the new evolving trends in the automotive business which demonstrate the major challenges arising in the market, which are explained below.

- **Customer Expectation:** One of the most important logistics objectives is to satisfy customer needs, however, customer expectations are increasing and to improve logistics service is becoming even more challenging.
- **Networked Economy:** Nowadays the increased vertical supply chain collaboration is certainly offering greater benefits but it also challenging to integrate an organization's processes and systems.
- **Cost Pressure:** Total logistics cost has become a performance indicator of supply chain efficiency (Zeng & Rossetti, 2003). Hence, companies must put effort into decreasing their logistics costs.
- **Globalization:** If the logistics infrastructure is not efficient in this globalization era, then the resulting logistics' costs and service level will be negatively influenced especially in the emerging markets.
- **Demand Volatility:** The volatility in demand is a crucial element for the aftersales business, that's why most of the companies try to forecast demand to reduce risk. However, the volatility is also triggered by the economic or political crises in one part of the world and affects globally.
- **New Technology:** Companies have realized the importance of analyzing and utilizing data to plan better and control outcomes. Therefore, investments must be made to acquire newer technologies and analytical tools.
- **Risk and Disruption:** In a business environment, external and internal risks are always present. Organizations are trying to seek effective proactive and reactive approaches for risk mitigation.

Trends of the automotive industry highlighted by Sabadka (2015) speaks about the future logistics landscape. The organizations are also trying to research and develop mitigation strategies to cope up with these challenges. Many manufacturers are trying to centralize inventories and warehouses to benefit from the economies of scale. Other companies are trying to strategically align their spare parts logistics with organizational structure, systems, and supply network (Wagner, et al., 2012). To counter challenges, organizations are refining their transportation modes enhanced use of technology to product flow and communication in the logistics (Sabadka, 2015).

Another important area in the aftersales automotive business is reverse logistics. It is defined as the reverse flow of goods to the upstream suppliers for various reasons including transport damages, warranty parts, repairs and mis-shipments (Harrison, 2014, p. 163). Managing reverse logistics efficiently is one of the performance indicators of logistics service levels. Despite the challenges in managing reverse logistics including difficult forecasting, additional transport costs, less visibility, and other issues, it is important to incorporate reverse flow policy into the logistics system. Harrison (2014, p. 164) suggests approaching reverse logistics as a business opportunity by designing for recycling and commercial returns which will reduce negative market impact and may add up additional revenues. The case company x is also utilizing the option of taking a commercial return from customers for the aftersales parts, the buying-back price is reduced by 10% which adds additional profit for the company and return service for the customers.

In conclusion, the logistics involve both the movement of parts and information from the point it originated to the point it is consumed. From the case company's perspective, which is the automotive industry, it is important to prepare for the upcoming challenges and future trends which include meeting customer expectations, opportunities to explore logistics cost and preparation of demand volatility. This section of the chapter provided adapt knowledge regarding the management of logistics and its functions.

2.2 Service levels in logistics

A service level acts like a mutual agreement between two parties to deliver certain service which is usually measurable. A logistics service level (LSL) covers a wide range of logistics performance in order to satisfy customers (Ghiani, et al., 2013, p. 13). The service levels are connected to various factors including the on-time-delivery, promotional offers and pricing, communication and other collective marketing mix characteristics. In a competitive business environment, the efficiency of logistics activity will impact the customer service offered. In these circumstances, the logistics service level becomes a vital instrument to gain customer satisfaction and then ultimately their loyalty (Miricesu, 2013). A product is generally a combination of physical items combined with its service offered. Typically, the physical product is influenced by R&D and marketing. On the contrary, the service of the product refers to the logistics service level (Harrison, 2014, p. 18).

2.2.1 Objectives of Logistics Service Levels and Customer Service Quality

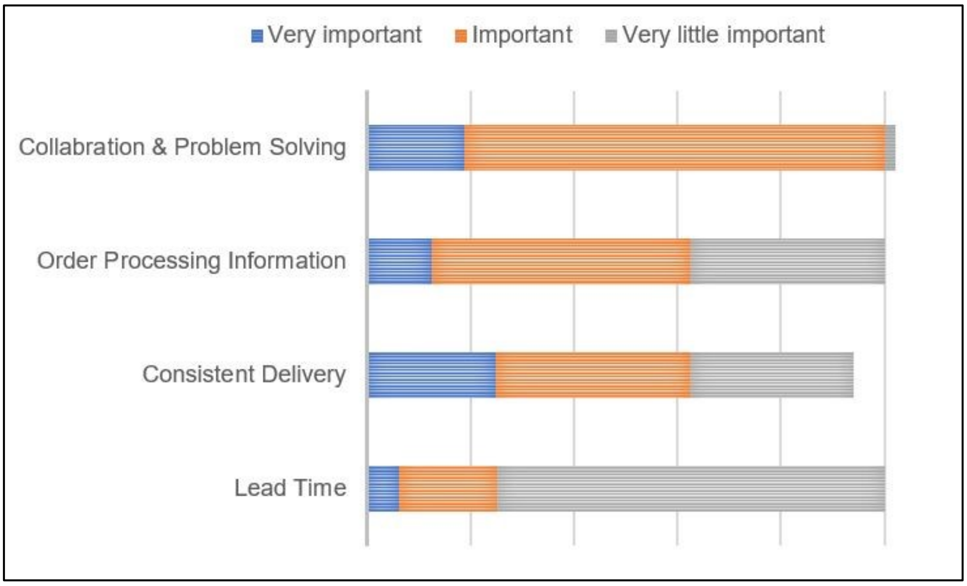
The customer service in logistics is reviewed from multiple pieces of literature to truly understand its meaning and objectives that define the overall logistics service levels. The first viewpoint regarding logistics customer refers to it as a powerful competitive tool

(Miricesu, 2013). If there is fierce market competition, then product mix, pricing policies, and marketing campaigns can be imitated by competitors. However, companies can turn this customer service tool into gaining a competitive advantage because offering reliable logistics service levels are more durable. Another viewpoint adds that the customer service in logistics refers to a set of sales chain activities which are executed to meet customer needs (Miricesu, 2013). Another perspective demonstrates the logistics service level about ensuring that the products are available for the customer at the right time in the right quantity (Gattorna & Martin, 1990). Therefore, the logistics service can be defined as...

"providing customer service to satisfy end-user demand through supplying the right product, in the right form and at the right time" (Harrison, 2014, p. 18).

To understand the contextual factors and specifics regarding logistics service quality (LSQ), let's look at a survey was performed by Miricesu (2013) to collect data from multiple respondents about interpreting logistics service levels and customer satisfaction as shown in figure 5 below.

Figure 5. Opinion on Logistics Service Levels and Customer Satisfaction (Adapted from Miricesu, 2013).



In this survey, the respondents were asked a series of questions related to the logistics service level, in order to identify the important elements of service according to the minds of the customer. From the results, it is evident that the main elements include order fulfillment rate (lead time), availability of stock, communication about order processing and cooperation related to ad-hoc problem solving (Miricesu, 2013). Thus, the criterion "very important and very little important" reflected the opinions of the participants. A sizable population believed to be quicker delivery and collaboration as the most essential elements in the service level.

The literature discussed in the above section explained the concept of logistics service levels. Interesting to note here is that, the elements defined in the logistics service levels such as lead time, consistent delivery, order processing information and customer collaboration is realized by the case company's logistics unit in theory as well, but before there was no specific definition of logistics service levels so the concept has been vaguely understood by the logistics unit in past.

Furthermore, a concept of logistics service quality (LSQ) is widely used in logistics, it is a measure of the extent to which the customer is experiencing the logistics service levels against their expectations In terms of modeling, service quality has been identified as having five characteristics from a global perspective (Parasuraman, et al., 1988).

1. Reliability
2. Reactivity
3. Safety
4. Empathy
5. Tangible elements

This model explains that perceived is the difference between two scales including perception versus received results. Different researchers have tried to explain the concept of logistics service quality; however, recent studies show that the most important component in logistics service quality is on-time delivery, accuracy, and quality of order (Saura , et al., 2008). Finally, information and communication technology (ICT) plays a great role especially in the context of logistics service quality. Nowadays, enterprises are using multiple resource planning software and advance electronic data interchange which enables companies to share real-time accurate data within the supply network.

The quest to becoming competitive in the market is achieved by creating inter-organizational information systems to share updated information (Saura , et al., 2008). An overall model logistics service quality is illustrated in figure 6 below.

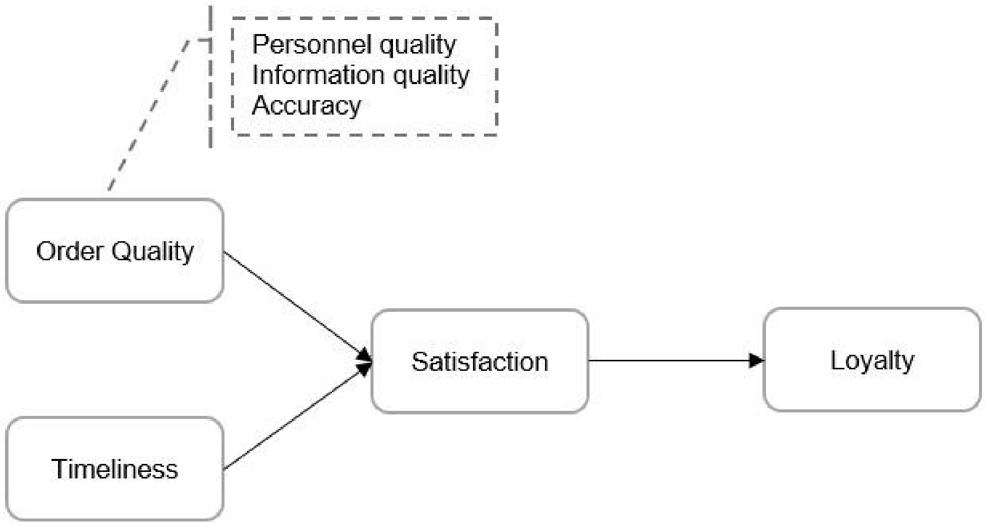


Figure 6. Service Quality Model (adapted and modified from Saura, et al., 2008).

Figure 6 illustrates a model developed by Saura et al. (2008), as per this model the researchers have proved a hypothesis for LSQ which is defined as following…

> *"LSQ has a direct and positive impact on customer satisfaction, then from customer's satisfaction comes the loyalty. The impact of LSQ is significantly higher when ICT is widely used and builds a strong relationship within the supply network".*

Considering the hypothesis and service quality model provided in the above section, it typifies the idea for the research question *"what developments are needed to improve logistics service quality"?* It is now more evident from the above discussion that the logistics service quality can be increased from improving the order delivery quality and timeliness. The overall order quality includes the personnel quality, to receive adequate support from competent personnel; information quality, communication about order arrival date and visibility. Thus, from a conceptual point of view, we can draft the objectives of LSL as elements needed to provide excellent logistics service to its customers. These elements mainly consist of timely delivery and order quality and moreover, with the use of the right ICTs the resulting relationship with a customer will be much stronger.

2.2.2 Evaluation of Service Levels

The logistics team usually strive to provide the highest service level possible to the customer at the lowest cost. A type of adequate service is usually dependent on organizational setup and customer environment. Hence, organizations contemplate the level of service to be offered and for all customers, it doesn't have to be at the same level. It is generally a considered notion that improving the level of service increases the cost, for example, increasing the possibility to deliver goods through multiple modes of transportation might increase the company's flexibility but also can potentially increase the costs. Therefore, to reach an optimum level where quality is good enough but cost as low as possible at the same time is important.

In order to find optimum service levels and improve quality, it is important to answer the research question *"how to evaluate the logistics service levels"?* Generally, before taking any decision it is important to assess the levels of logistics service in the current versus proposed scenario. Based on the literature reviewed in the section above, this section will further deepen the concept of LSQ and how companies are leveraging their LSQ to gain competitive advantage.

At first, when organizations try to push a new product into the market, it focuses on its R&D and marketing efforts. Later logistics comes into picture from ensuring the availability of parts to other customer services. These logistics services are not only advantageous to the parent organization and its customers, but it also benefits the supply value chain stream. When it comes to defining logistics advantages, it means that the organization needs to set clear goals, which are measurable and quantifiable (Harrison, 2014, p. 18). According to Harrison (2004), these advantages are usually hard objectives and it includes time, cost and quality.

The Time Advantage

The time measure refers to "lead time" which is defined as the time a customer needs to wait until the order is delivered. Generally, a lead time is considered from the moment an order is placed to the moment it is received by the customer (Harrison, 2014, p. 19). However, important to note here is that these lead times can vary from zero to several months. In case of the automotive industry, regular running stock-orders are usually available in inventories to immediately deliver it to the customers. On the other hand, if there is a new product model introduced or innovated, then it might take several weeks or even months to make the product available for the market. As argued by Miricesu (2013), the order fulfillment time (lead time) ranks second among the important elements to provide higher LSL. Therefore, competing on time is like the survival of the fittest (Harrison, 2014, p. 19).

Since lead time is an absolute figure which is also measurable, the shortening product lifecycle and requirement of shorter-delivery times have pushed the company's managers and leaders to develop new strategies and solutions to overcome this challenge. Hence, managers have realized the importance of efficient supply networks and new logistics approaches as a solution to this problem. One of the significant drivers to ensure competitive benefits in meeting customer demand is to establish a network of business relationships throughout the supply chain (Bianchini, et al., 2019). Therefore, once a company manages to reduce time-to-market a product or service, it not only provides excellent LSL to its customers but also generates positive and quicker cash flow for itself.

The Quality Advantage

The basic principle of managing logistics is to ensure that the end-product reaches its destination and does its jobs what it was supposed to do. Since quality is an easily interpretable and highly visible aspect of logistics. Therefore, any misadventure in the logistics that can cause defects, inaccurate or late delivery are quite easily identifiable. These problems affect negatively to the end-users and hurt the LSL (Harrison, 2014, p. 18). Based on the literature reviewed in the previous sections, it is fair to say that the quality of service is concerned with delivering the right product in the right quantity while sharing the order information with the customers. Also, it was concluded by Miricesu (2013) in the logistics survey, that cooperation in solving problems and offering a variety of delivery services for the customers proved to be a "really important" criterion to assess the LSL from a customer perspective.

A study done on the LSQ by Saura et al. (2008) has reviewed previous works of literature to explore different dimensions of the quality and benefits it can offer to its customers and the company itself. The aspects of service quality include timeliness, order condition and accuracy, information quality about order processing, availability, and quality of contact person to receive adequate support (Saura , et al., 2008). In the case of Toyota, when quality was positioned after the sales and revenue efforts, the brand suffered a huge loss because of the safety concerns and negative brand image (Harrison, 2014, p. 18). The purchasing decision is made by the end-user and that's what drives the supply value chain. Therefore, the logistics service quality has a much bigger impact on overall business performance and brand image. Logistics service providers who aim to maintain the highest standard of service quality put themselves at an advantage over the rivals (Harrison, 2014, p. 19).

The Cost Advantage

The logistics process superintends the flow of material, information, and cash. The dependency on the supplier's and manufacturer's location, exchange currency and market situation make logistics as a key element to fulfill customer orders. As argued by Gilmore (2002), transportation costs are a significant component of corporate expenditures and the role of logistics is evident when achieving a supply chain excellency (Gilmore, 2002). The logistics costs are subdivided into fixed and variable costs. The main categories of logistics costs are explained in table 2 below. (Ghiani, et al., 2013)

Table 2. Main Logistics Costs (Adapted from Ghiani, et al., 2003).

Main Cost Categories	Fixed costs	Variable costs
Storage costs	Administrative and running costs	Insurance policies
Operational management costs	Administrative costs of issuing computer orders	Loading/unloading, movement costs, packaging
Transport costs	Rental transport, devaluation	Variable transport costs, Insurance, reverse logistics
Stockout costs		Lost sale, Loss of image
Plant and equipment costs	Plant devaluation	Rental fees according to space

As argued by Ghiani et al. (2003), one possible objective of logistics is to reduce costs in reference time horizon while not comprising on the LSL. Since the company's profit margins are proportional to the service offered to its customers. Hence practically, the higher profits margins are achieved by keeping the LSLs high. As organizations are outsourcing a major or even a part of its logistics operations, it becomes highly important and critical to understanding the logistics costs to ascertain good profit margins (Zeng & Rossetti, 2003). In case of the automotive industry, the pressure to reduce costs is intensified and for many years the assemblers have been trying to reduce inbound supply chain costs. Especially the automotive aftersales market usually follow market-based pricing and if the competitors are reducing the price, then subsequently it will push all the companies to go for lower prices; but unless a company matches reduced costs with lower transportation costs, that company will eventually go out of business because of financial crisis (Harrison, 2014, p. 20). To cope with this scenario, companies try to investigate alternative modes of transportation in order to evaluate its LSL and the behavior of logistics costs in different modes to determine best profit margin possibilities

In conclusion, the logistics service levels are evaluated based on three hard objectives. First, the time objective, which refers to delivering the product on time. Second, quality objective means delivering the right product, in the right condition while sharing accurate order processing information with the customer. Third, the cost objective signifies the idea to bring the logistics costs down to achieve supply chain excellence. The time and quality objective are meant to improve the service quality for the customers to affect their satisfaction positively. The cost objective serves the purpose to reduce the logistics costs benefiting the internal transportation cost of the case company. From the main cost categories provided in table 2, only the transportation costs will be analyzed throughout this research.

2.3 Competing Through Logistics

2.3.1 Logistics Performance Measurement

Market competition always pushes the companies to seek for a differentiation strategy that can set apart an organization and its offered advantages. No matter how the organization positions itself in the market with products, it needs to sustain its differentiation and logistics is a big part of that strategy. It has been on numerous points that "how does logistics contribute towards gaining competitive advantage"?

Globalization of operations and marketing has given new perspectives to the managers of today. These new perspectives involve analyzing and investigating the functions of an organization to assess its performance measure in order to enhance organizational competitiveness (Gunasekaran & Kobu, 2007). When it comes to analyzing the system performance, a combination of qualitative and quantitative tools is used to measure performance adequately. Developing an adequate performance measurement system (PMS) becomes more difficult when it includes the overall scope, product variety, and involved entities. In case of supply chain logistics, the network usually consists of four levels (supply, manufacturing, distribution, end-user). However, the complexity of performance measurement is intense because each level's system of interest and physical facilities are different (Beamon, 1999). Hence, selecting supply chain logistics performance measures are critical to avoid vagueness.

The performance measurement as defined by Gunasekaran & Kobu (2007), is the process of taking regular measurements in order to quantify the effectiveness and efficiency of any program or action. However, the term 'metric' relates to the definition of measure. As for as the calculation of metric is concerned, it depends on who is calculating and how information is acquired (Neely, et al., 1995). The metric of supply chain logistics can also be subdivided into four categories including cost, quality, time and diagnostic measure (Bagchi, 1996). According to Bagchi (1996), the four categories of the framework is a useful tool for different decision-makers of any organization such as operational, tactical and strategic. Despite the research done on supply chain performance measurement, it still does not provide a clearer idea of what metrics to choose for an organization's supply chain.

As argued by Gunasekaran & Kobu (2007), it is of utmost importance to choose supply chain metrics that are practical, measurable, reliable and comparable to other competitors in the same industry. The viewpoint of Beamon (1999) which identified metrics for SC which naming resource, output, and flexibility, the viewpoint is, that a set of reliable metrics are required which can avoid repetition in the calculation and provide effective feedback on performance areas.

A good performance measurement tools in supply chains play an important role for the management to make decisions and take actions. Also, it improves the collaboration between the involved entities and involves transparent communication which increases the overall business efficiency (Gunasekaran & Kobu, 2007). Although the availability of logistics performance metrics is limited, few researchers have tried to explain the purpose and ways to deal with supply chain performance measurement and metrics. Beamon (1999) after analyzing multiple kinds of literature, developed a framework that consists of three most important parameters in supply chain performance measurement. Each of these three parameters including resource, output, and flexibility has different goals and covers the overall scope, as presented in Table 3 below.

Table 3. Supply Chain Performance Measurement (Adapted from Beamon, 1999).

Performance Measure Type	Goal	Purpose
Resource	Increase efficiency	Better resource utilization to increase profitability
Output	High level of customer service	Without standard output, customers will turn to other supply chains
Flexibility	Responsiveness to changing environment	In an uncertain environment and risks the logistics ability to respond

Table 3 presents the supply chain performance metrics which includes three parameters. First, the resource refers to inventory levels (including safety stock), qualified personnel, equipment usage, and cost. The efficiency measures the utilization of the resources involved in the logistical process. Therefore, one goal of performance measures is to check if any of the resources are under-utilized (Beamon, 1999). Examples include transportation costs, safety stock value, return on investment, space utilization. Second, Output refers to the quality of service received by the customers. Comparing to previously discussed literature from Saura, et al. (2008) the service quality closely relates with elements identified in the category "Output" by Beamon (1999) which includes customer satisfaction, information about order processing and on-time delivery. Examples include total sales revenue, fill rate, on-time delivery, estimated order arrival time. Third, flexibility is the measure of a system's ability to handle fluctuations in demand and supply. An example includes the ability to reduce backorders, handling emergency orders and others. These three parameters have a different set of goals but each of them is vital to overall performance improvement. The interrelationship between these three parameters is illustrated in figure 7 below.

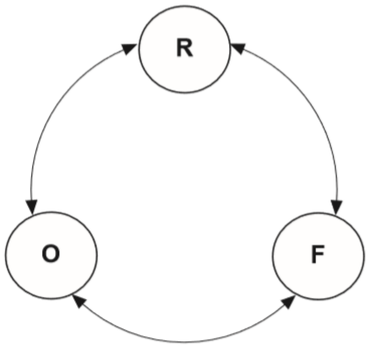


Figure 7 Interrelationship of supply chain performance metrics (Adapted from Beamon, 1999).

As illustrated in figure 7, at least one of the performance measurement parameters should be adopted by the organization when aiming for supply chain performance improvement. Furthermore, Beamon (1999) argues that the measure of flexibility is more complex and depends on the context and scope of supply chains. Since the operational objectives are demonstrated by the resource and output, but the flexibility refers to the potential of logistics. Flexibility has multiple dimensions and can be used to measure other objectives such as volume and delivery (Slack, 1983) and the same can be applied to the ability to deliver via multiple modes of transportation.

The delivery and volume flexibility can also be fulfilled if the supplier can ship the materials through different modes of transportation. In case when there is increased demand emerging from the customers, then the ability to deliver the emergency orders forward, the ability to handle fluctuations in volume, can be satisfied by offering transportation through different modes. Whether or not, offering multiple modes of transportation is beneficial for the organization's LSLs, it certainly can be described as an ability to handle volume and delivery flexibility.

2.3.2 Managing Freight Transportation

Freight transport structures and activities have become crucial steps in logistics planning. The effect of globalization, lowest-cost purchasing and changing market behavior had an adverse effect on the rate of information and material flows across the supply chains. The importance of freight transport planning is mainly based on two important reasons. First, freight is comprised of the key part of the total logistics costs (usually between one-third to two-thirds). Second, chosen freight service has a direct impact on delivery time and LSQ (Ghiani, et al., 2013, p. 318). The quest for efficient and reduced-cost transportation is more evident on long-distance through international routes where economies of scale are important to remain profitable (Beresford & Pettit, 2017, p. 1).

Freight transport includes multiple entities such as the suppliers, who either manufacture the good or acquire from someplace else; the carriers, which provides the logistics service to transport the material at the customer's location, and government is also involved, which create the policies and logistics infrastructures at the regional and international level (Ghiani, et al., 2013, p. 318).

Modes of Transportation

The freight transportation consists of multiple modes of transport including train, road, aircraft, and ship (long and short-sea travel, rivers). Most of the companies are using intermodal transport, which involves using different modes of transportation simultaneously to deliver goods from point of origin to point of consumption. The selection of different modes is based on the criteria of logistics cost and delivery times. The modes of transportation are further explained as follows: (Ghiani, et al., 2013, p. 319)

- **Rail Transport:** Goods are transported through in cars of railways. This mode of transportation is good for long-distances which makes it inexpensive, but it is an unreliable way of transportation which also limits door-to-door transportation.
- **Road Transport:** It the most used regional transport means adopted by a wide variety of companies. Trucks are mostly used as transportation vehicle which carries goods called "truckload" from origin to destination. It can either full truckload (FTL) or less-than-truckload (LTL). It offers a better delivery time but is generally a more expensive option than sea transport and limits the shipment pallets because of limited truck capacity.
- **Air Transport:** Air transport is the most expensive shipping route but offers great flexibility to the organization in terms of delivering special or emergency orders because of its ability to transport goods faster.
- **Water Transport:** Today companies are outsourcing part of its operation from lower-cost economies. Hence, container shipping is known as the 'workhorse' in the international shipping routes (Beresford & Pettit, 2017, p. 123) because of its ability to carry more volume at less price but takes longer delivery time.

Furthermore, the possibility to offer hybrid services by the firm to deliver the goods by more than one mode of transportation increases the flexibility and enables the firm to deal with the fluctuations of demand and supply. Therefore, many organizations worldwide and especially in Europe are adapting to intermodal transportation. The intermodal transportation is comprised of a single transport chain involving multiple modes of transportation through various terminals and channels. Intermodal transportation received good support and initiative programs launched by the European Commission's Directorate. Within this transportation model, the freight is not handled directly but instead, the loading units are only transferred from one mode to another via specified terminals (Nossack & Pesch, 2013). The CCX is also using intermodal transportation which is known as 'fishyback and birdyback' transport options because it involves ship-truck and air-truck movement respectively (Ghiani, et al., 2013, p. 323). Intermodal transportation including LT and LTL is illustrated in figure 8 below.

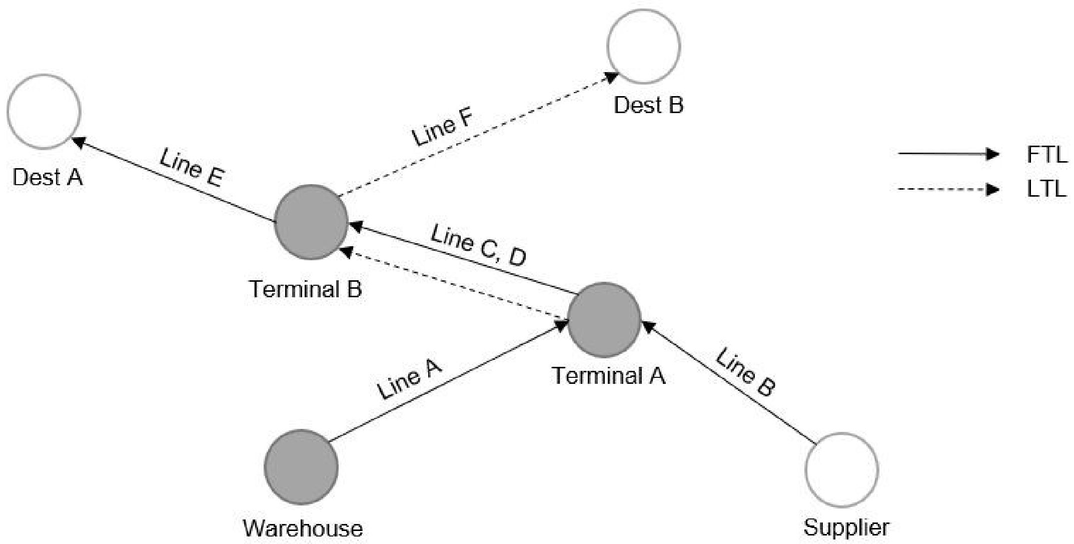


Figure 8. Intermodal LT and LTL Transport (Adopted from Ghiani, et al., 2013, p.322).

As illustrated in figure 8, the dotted line represents Less-than-truckload which means that in intermodal transportation some deliveries are combined to deliver full-truckload (Terminals A and B), but some deliveries are still transported as less-than-truckload (Line F). As argued by Ghiani et al. (2013), the goal of involving modes of transportation is to increase the flexibility of suppliers but keeping the costs low.

In case of the automotive industry, the mode of transportation is subject to a lot of external pressure. Depending on the location of suppliers, manufacturing plants, warehouses, and customer locations, the traditional flow of vehicles and aftersales products from East Asia to Europe are no longer dominating. Instead, a complex approach, diversified fleet, and agility are required from the automotive companies to meet the demand especially in the emerging markets (Beresford & Pettit, 2017, p. 171). Therefore, the logistics managers of automotive companies are always questioning the modes of transportation, whether the selected delivery routes are optimal or the mode of transportation via road and air are being handled efficiently? To answer these questions, managers must evaluate the LSL in the preferred mode of delivery in order to understand the impact on customer satisfaction and logistics costs.

3. THEORETICAL FRAMEWORK OF LOGISTICS PERFORMANCE MEASUREMENT AND SERVICE LEVELS

In case of the automotive industry, the latest trends and challenges have pushed the companies to rethink logistics and adopt a holistic performance measurement metrics (Dörnhöfer, et al., 2016) (Neto & Pires, 2012). The main elements of success in automotive logistics are by enhancing logistics productivity and customer satisfaction. Productivity is related to the factors of reduced time-to-market product, operational transportation, and warehouse expenses and increased communication (Dörnhöfer, et al., 2016). In addition to this, inventory levels including the safety stock are the key within the company and across supply chains (Wang & Zhang, 2010). However, to highlight the potential for improvement, a correctly designed PMS is needed. This PMS should be based on actionable Key Performance Indicators (KPIs) covering the whole process (Dörnhöfer, et al., 2016). As argued by Dörnhofer et al. (2017), the research on PMS of automotive logistics is not thoroughly done yet, but despite the research gap, a suitable PMS can still be developed according to the individual organizational needs and present literature.

As discussed in the previous chapter, the logistics service level is a mutual agreement between two parties to deliver service while meeting the criteria of certain factors. The number of these factors can be large according to organization setup, but according to previously discussed literature, the most important criteria are lead time, consistent delivery, order delivery quality, and customer collaboration. Working with these factors might be the requirement of the logistics service levels but to improve the efficiency of these factors comes under the umbrella of logistics service quality. The logistics service quality has a direct impact on the customer's satisfaction. Once the satisfaction improves, the loyalty of the customer stays intact.

Considering the above arguments, a theoretical framework is developed in the figure below that which includes a performance management system incorporated with discussed service quality objective to evaluate service level. Figure 9 presents the theoretical framework of performance measurement.

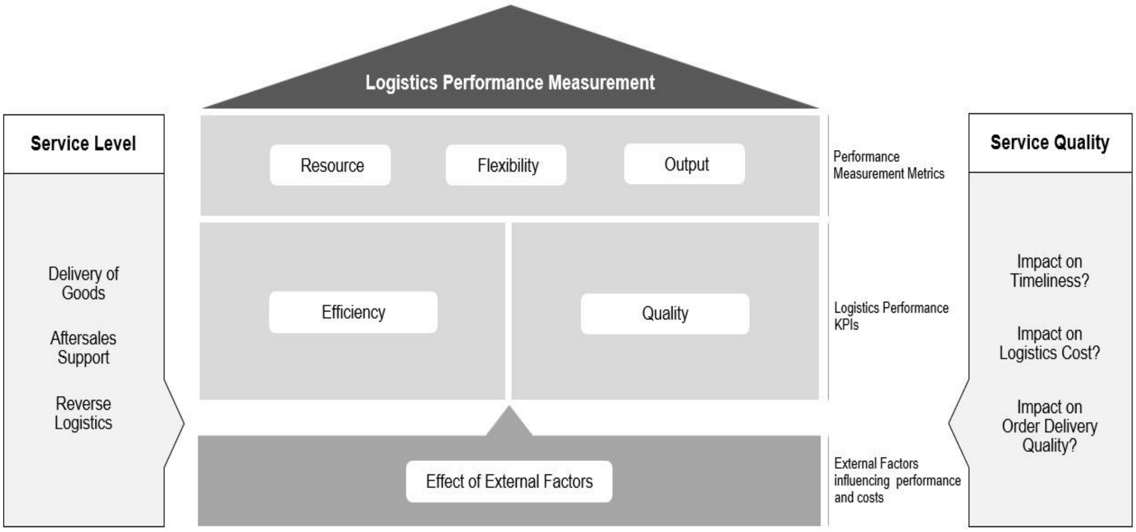


Figure 9. Theoretical Framework for Performance Measurement and Service Quality Objectives.

As shown in the figure above, the case company is offering service to its customers which include delivering the goods and providing aftersales support. There are several factors and megatrends which can initiate altering the current service level in order to handle demand volatility and increase logistics flexibility. In this case, whenever responsible managers have determined the modification needed in the service levels and before taking actions, the evaluation of logistics service levels is required which is followed by considering the performance measurement of current versus future state. The performance measurement is based on the measurable metrics which include exploring the logistics performance both from a quantitative and qualitative perspective to understand the measures correctly. These measures involve digging-deep into three areas of resource, flexibility, and quality. Once the metrics are all set and a possibility to measure them is understood, then the framework suggests looking into logistics key performance indicators from increasing efficiency and maintains the highest quality point-of-view.

First, in order to investigate the proposed service level properly, it needs to analyze its effect on process efficiency. The dimensions of logistics efficiency may include cost KPIs, supervising the logistics works or identifying opportunities for improvement. Second, parallel to investigating efficiency, this model suggests examining the effect on quality. Quality can be subjective and depends on the context and scope of a business case, but this research focuses on the case company’s perspective which relates to end-products and process quality. (Dörnhöfer, et al., 2016)

Furthermore, the model also deals with probing into external factors that might or might not affect the proposed service level in the future. These factors generally pose the risk on the process such as distance between the suppliers and customer, political situation of the region, changing customer demand, price fluctuation, and economic risks. Examining such factors can provide a bird-eye view about the inbound or outbound logistics costs and its effect on the overall productivity of the process as well. Finally, the model provides a development phase that investigates the customer's perspective and tries to measure its impact on modifying service level on its customers. Whether quantitatively or qualitatively, probing into understanding customer satisfaction level is important to sustain their loyalty with the company's product and services.

In conclusion, the theoretical framework provides a performance measurement system in order to evaluate LSL. The framework is useful for automotive logistics, which is broken down into a process module level from the logistics objectives. The concept of evaluating service levels incorporates measuring the service quality of the proposed idea with the conventional logistics target to maintain its highest efficiency and output quality. In today's distinct logistical process landscape and complexity of operations, this modular approach can not only handle process complexities but also facilitate standardization of service level processes.

4. RESEARCH METHODOLOGY AND DATA

4.1 Research Strategy

To understand the complexity and challenges of the real-world problem from the perspective of business management, case study research is a widely used research methodology. This research is also related to analyzing the case company's logistics process and service levels, thus it qualifies for traditionally naming it as "case study research". Case studies are employed to develop a better understanding of complex research and are generally known as the empirical inquiry that examines a phenomenon or concept within its real-life context. One of the most common and critical decisions in case study research is the selection of methods used for research and data collection. Two well-known methods have existed for years which include qualitative and quantitative research methods.

As said by Matta (2019), qualitative research is good for building the theoretical background and set grounds for further reasoning and investigation. On the contrary, the quantitative research method supports the claims made within the research either as conforming or disconfirming (Matta, 2019). The author further explains that qualitative research greatly defers from the quantitative research method. The qualitative research method involves forming a detailed theoretical overview and background related events which is used to understand the target phenomenon and based on this understanding, a logical argument and claims are made. On the contrary, quantitative research allows constructing a model backed by mathematical or statistical analysis. This allows the user to manipulate data according to the relevant context, but the challenge is to decode the statistics into local inferences properly. This viewpoint provided by the author deepens the knowledge related to the qualitative and quantitative research methods why it was widely used in this research.

Adding to these research methods, another viewpoint is argued by Gummesson (2017) in the context of case studies, there are five methods to generate data for management research. These common data gathering methods in management research are existing material, interviews, questionnaire surveys, and observation and action science (Gummesson, 2017, p. 215). Table 4 below describes the characteristics of each research method.

Table 4. Research methods (Adapted from Gummesson 2017, p. 215-233).

Method	Description
Existing material	This method refers to all types of data sources. Existing material comprises of everything that is available in formats such as books, databases, brochures or any other publication.
Questionnaires and surveys	This method is used to generate quantitative data for case studies research through formalized and standardized questionnaires and surveys.
Qualitative interviews	The qualitative interview is the most common method to generate data. Case study interviews could be formal or informal. Formal interviews can be done by questionnaires while informal or qualitative interviews are more like to a conversation
Observation	Observation includes several ways such as direct observation and participant observation
Action research	This method involves active participation and involvement of the researcher in the case study process by observing, studying from others and working with the process itself

However, besides these obvious research methods, another viable third approach exists, which is mixed-method research and involves blending the qualitative and quantitative analysis together to form logical reasoning. All these research methods have their pros and cons and depending on the nature of the matter under study. For the scope of this research project, a blended approach to perform action research coupled with qualitative interviews and quantitative analysis was adopted. These mixed-method studies are adopted to seek answers and perspectives which one paradigm cannot do alone properly (Leech & Onwuegbuzie, 2009). According to Leech & Onwuegbuzie, if the research standard has adopted both the quantitative and qualitative methods in the different phases of the research cycle, it is no longer viewed as mono-method design. That's why the mixing method involves collecting, analyzing and interpreting both the quantitative and qualitative data sets to research the target phenomenon (Leech & Onwuegbuzie, 2009).

Furthermore, the interviews are part of a qualitative research method in order to acquire data and insights from personnel who are involved in working or possess knowledge about the target phenomena. There are generally three types of interview methods which include structured, semi-structured and unstructured interviews. A structured interview involves asking a standard set of questions according to the set theme to each interviewee. The semi-structured interview gives more flexibility to the interviewee by allowing them to set the tone of an interview according to their likeness and discuss a topic of interest as well. On the other hand, unstructured interviews are quite unrestricted and informal. Getting the ideas and areas the interviewer wants to investigate is usually done through a conversation. (Wilson, 2016)

Wilson (2016) argues that the interviews can be done through any medium whether electronically or face to face. However, the advantage of conducting face to face interviews is to understand body language and enthusiasm of interviewees as well. To explore more on how interviews should be done, Beck and Manuel (2008) break down the interviewing process into steps which include identifying the relevant entities, deciding the interview medium and schedule, decide the type of interview such as semi-structured and draft set of questions and pace of the interview. Most importantly interviewer should have thought ahead of tactics to get useful and critical information out of the interviewee especially the shy ones (Beck & Manuel, 2008).

Based on the aforementioned literature regarding research methods and qualitative interviews, the research strategy of this study revolves around the concepts and procedures that are under-discussed in the current section. Considering the scope of this project, action research was used for the user to fully participate in the research strategy and data gathering workshops. To analyze the non-numeric side of this research, qualitative interviews were arranged with several participants to collect detailed insights regarding the research topic and case company's challenges. In addition to this, quantitative analysis was also performed to verify whether the claims or ideas generated through the interviews complied with the reality or is the situation is different in general. In conclusion, the research adopted a multi-method data gathering approach to mix quantitative and qualitative analyses to generate useful results.

4.2 Research Process

The research process lasted approximately five months which kickstarted from the case company's motivation to invest the first month in brainstorming and understanding the objectives of the study and last month of finishing the reporting. The overall process briefly comprised of 8-steps, which commenced in the time-span between June till November of 2019. The steps involved are illustrated in figure 10 below.

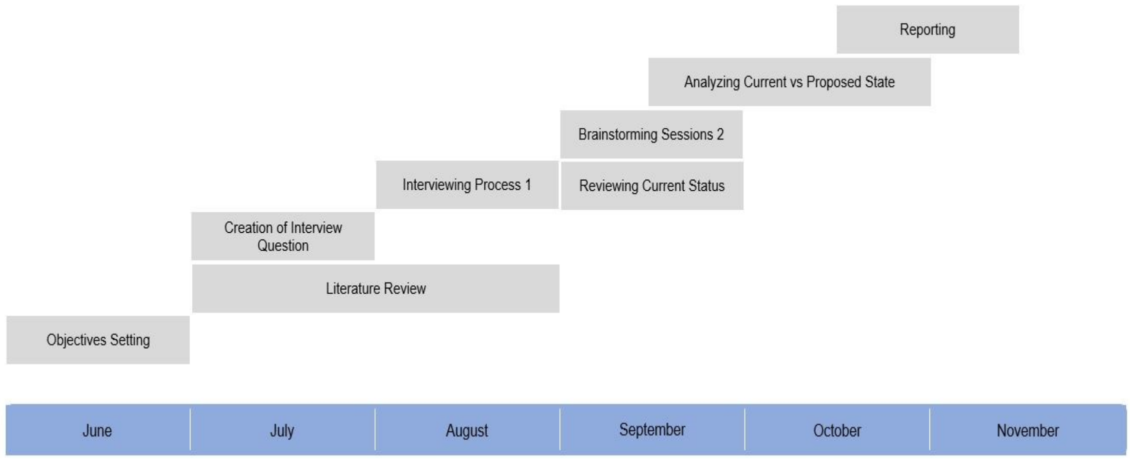


Figure 10. The research process of the project.

The research process started with an objective setting and a breakdown of the problem statement. Since the topic of the research was initiated by the request of the case company and to keep overall scope relevant, the objectives have been formulated and modified a bit over time. Based on the objectives and involved process concepts, the relevant literature was discovered and studied in detail. Different articles and books were summarized and analyzed according to the current situation. From the theoretical background, a final evaluation framework was formed which was used in an empirical analysis of this research. The next phase of this research was to conduct interviews and explore the current state in depth. The interview questions were drafted based on the literature and objectives of the research. The interview also involved extensive brainstorming sessions with the involved stakeholders to review the current processes and challenges in detail. The latter part of the research was developing a cost matrix after analyzing the current status, the idea was to perform a qualitative assessment of the solution concept coupled with quantitative analysis. The writing process of the research begun already from the start of August and final research outcomes were reported in the last month.

4.3 Data Collection and Analysis

The data collection started with action research that involved participating in daily operational tasks to understand the process flow. Once the process was understanding and critical areas has been identified, then the semi-structured interviewing process began. The interview questions were designed as open-ended questions and interviewees were given the flexibility to discuss other related issues as well if needed. The literature study had an influence in setting the structure of the interview and asking critical questions to get the most information. The interviewees were grouped into two categories. The first group of respondents included the case company's internal personnel. The second category considers the interviewing session that took place with the 3PL local warehousing team in Finland. The interviewees were selected based on their ownership and stake in the logistics process with the CCX. The list of interviewees is shown in table 5 below.

Table 5. List of interview participants.

	Role	Base Office	Duration in First Round (min)	Duration in Second Round (min)
Interviewee 1	Inventory Controller	Espoo	50	45
Interviewee 2	Logistics Helpdesk	Espoo	45	30
Interviewee 3	Logistics Manager	Espoo	35	15
Interviewee 4	Logistics Officer	Espoo	45	30
Interviewee 5	Warehousing Strategy Section Manager	Amsterdam	50	
Interviewee 6	3PL Warehousing Supervisor	Vantaa	60	20
Interviewee 7	3PL Warehousing Operation Incharge	Vantaa	60	20

As it is shown in table 5 above, the only exception in these interviews was with the warehousing strategy section manager which was conducted through skype audio call and the rest of the information was shared through emails. However, the other interviews were conducted face-to-face with open-ended questions, open discussion and opinion sharing which lasted on average 30-45 minutes. There were also day-to-day conversations and brainstorming sessions with the logistics team member in Espoo regarding the research topic. The data gathered through the interviews were later undergone through qualitative analysis.

After the first round of interviews, the current state of case company logistics processes was drafted, and critical areas were analyzed including the lead time, costs and order delivery quality. The first-hand experience gained from action research coupled with qualitative interviews helped to understand the target phenomenon accurately. The second batch of interviews involved brainstorming with the process entities regarding current versus future state. Discussion involving product type, mode of transportation, costs, and challenges on product selection happened in these rounds of interviews to further broaden the concept and to find optimal solutions. Once, the theoretical and conceptual background of the logistics process, terminologies and objectives were clear, then the quantitative analysis commenced parallel to the second batch of interviews. Results from a draft version of mathematical observations were discussed with the inventory controller and logistics manager to hear further opinions based on their expertise to figure out what aspects were covered by the quantitative analysis, what further perspectives are left behind and how to solve them.

In addition to this, the use of existing material and research articles provided extensive knowledge and hypothetical background related to research's context. The multi-method qualitative research method was utilized, so different sources and articles were explored to gain a solid background and understanding of the involved concepts. To ensure consistency in the theoretical background, the sources were chosen based on its relevancy and ability to maintain conformance with the research objectives. Furthermore, the empirical data were analyzed systematically with respect to the case company's context. Due to the limited availability of existing material on the evaluation of logistics mode of transportation, only a limited number of articles were discovered especially related to cost implications in the current scenario. Hence, the empirical analysis was done based on the limited available sources, the case company's internal KPIs and stakeholder's viewpoints.

5. EMPIRICAL ANALYSIS AND RESULTS

5.1 Case Company X

5.1.1 Aftersales Department

This research is focused mainly on the case company's aftersales department and particularly the logistics unit. This section presents briefly about the aftersales business of the case company, its functionalities, and challenges.

The case company's aftersales department is shared into main products, services, and support functions. Its main products and services consist of accessories, genuine parts, and associated-business products. In the automotive industry, to perform always at the highest possible level, vehicles and services require proper maintenance and support; therefore, it is important to recognize case company's aftersales supporting functions such as logistics, aftersales marketing, warranty, and technical support. These functions make it possible for accessories, genuine parts, and associated-business products to work smoothly around the clock.

The topic of research relates more to the aftersales logistics and marketing team of the company; hence, the work procedures are presented only from these areas. First, the aftersales marketing team is dealing with all the activities related to the promotion, discount, and sales of aftersales parts and accessories. The team is also responsible for managing spend-funds for product promotions adequately. The spare parts and accessories section manager work closely with the logistics team to harmonize new product promotions and ensuring stock availability. Second, the associated-business contract team prepares, evaluate and coordinates all the activities related to the CCX's service contracts, warranties, and insurance both with the end-customers and insurers in all the seven customer markets. CCX is utilizing third-party insurance companies to handle claims and offer different services for the customer's ease and safety. Genuine parts and accessory team are forecasting the parts, organizing promotions and managing the pricing of the parts for dealers and end-customer according to the recommended European pricing and market competitors. The structure of the aftersales department is shown in figure 11 below.

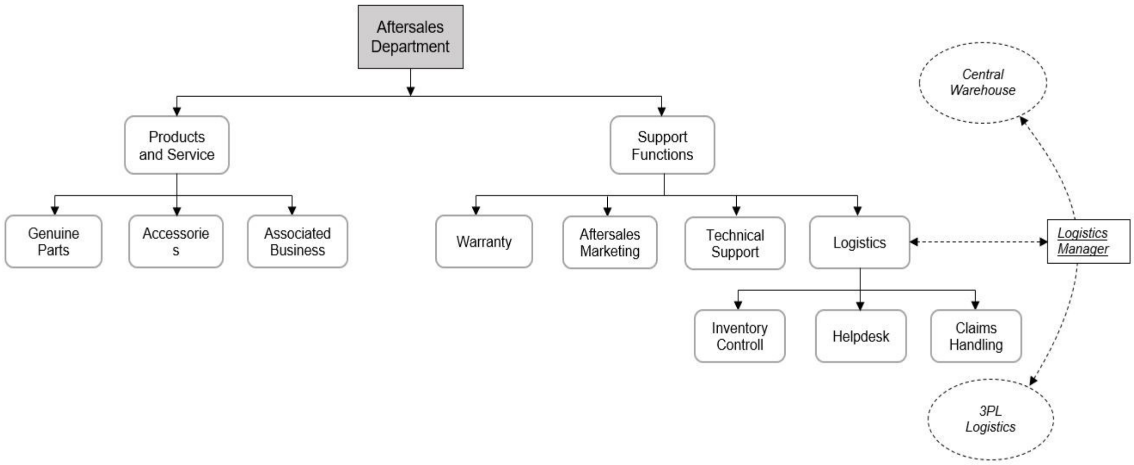


Figure 11. Aftersales Department of CCX.

As shown in the figure above, the CCX has several teams working parallel to each other to deliver superior customer value. The technical team is providing support dealing with local dealers to solve a problem related to vehicle maintenance and spare-parts installation. The logistic unit is being headed by a logistics manager who implements the supply chain process, coordinates the daily logistics activities with the 3PL and the central warehouse, manages the team of the logistic unit to ensure effective communication with local dealers. The responsibilities and involved activities of a logistics team are explained in the following section.

5.1.2 Logistics Unit and Inventory Control

The logistics team organizes and controls the parts and accessory supply chain for all Nordic and Baltic countries. The case company uses multiple external logistics service providers to utilize their warehouses both in Helsinki to serve customers in Finland and Baltics, and another warehouse in Borås to serve customers in Norway and Sweden. Denmark is supplied directly from the case company's main European warehouse in Amsterdam. Logistic unit is also a provider of parts logistics helpdesk to support dealers in all seven countries and controls the parts ordering systems through LMS.

The local dealers place the stock order through the established B2B software, then the orders are processed through the system and sent directly to the 3pl warehouse. The warehousing team picks the required stock according to the order information and ships the part early next morning. Meanwhile, the inventory controller regularly checks all the stock items, the inventories which are reaching the re-order point, and maintains the safety stock. Whenever the parts that reach the re-order point, are ordered directly from the central warehouse. Given the time frame of 3 to 5 weeks to deliver SO, the inventory controller is responsible for maintaining the safety stock until the stock is replenished.

The parts, that are not found in the store of the central warehouse, are called backorders since they will be back-ordered to the suppliers. Typical KPIs of the logistic team include the inventory fill-rate, timely delivery of backorders and emergency orders.

Moreover, three main types of orders are processed through logistics cell which includes the regular stock orders (SO), vehicle off-road orders (VOR) and emergency orders (EO). First, the stock orders are placed regularly and include all the classification of inventory A, B, C and D. The seasonal stock is also ordered in advance and delivered via SO delivery method. For example, painted bumpers are generally more sold in winter season because it is prone to get damaged in the cold season and therefore, increases the demand for a product, especially in the Nordic market. The team analyses the historical car-colors sold and then forecast the required bumpers amount needed to be ordered in advance.

Second, the vehicle off-road cases are defined as, when the vehicle is not functional or missing any part, without which, the vehicle cannot be driven. VOR cases are handled as the priority by all the parties involved to provide quick service to the end-customer. If the part is not available in a local warehouse, then it is shipped immediately via air from the central warehouse

Third, the EOs are offered as a service to the local dealers. It involves all the cases where the vehicle might be functional, but the safety and satisfaction of end-customers are concerned especially in case of vehicle damage maintenance after an accident. In such cases, a dealer places an emergency and if the parts are available in a local warehouse, it is shipped the same day or the early next morning. Otherwise, the order is transmitted to the central warehouse, whose target is to ensure that the required parts are prepared and shipped within the next business day. The orders are collected by a third-party trucking company whose target is to ensure safe and quick delivery of EO to the local warehouse within 2 days when the order was received. The overall route of both the EO and SO is shown in figure 12 below.

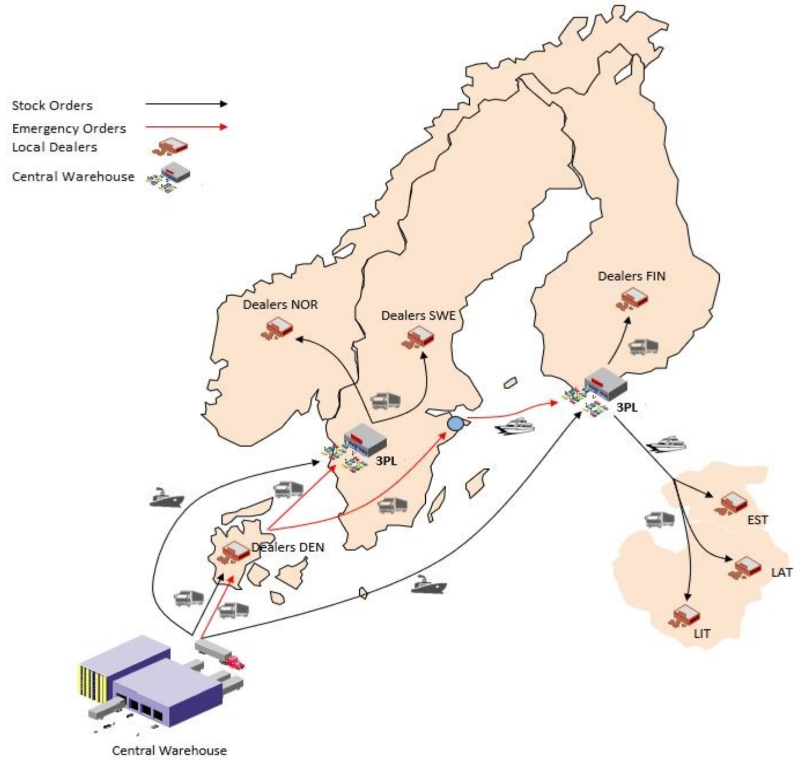


Figure 12. Physical forward flow of aftersales products.

As shown in the figure above, the EOs are packed and shipped from a central warehouse. The orders are delivered by 40ft trucks and the first destination is Denmark. After arrival, the EOs are dispatched to each territory during the same day. The whole logistic process involves multiple modes of transportation including ferry and truck.

Furthermore, the 3PL warehousing company receives the notification both from the trucking company who is transporting EO goods and the container-shipping company which is transporting SO, sends the expected arrival time notification to the warehouse personnel and arranges the delivery at the warehouse. The warehousing company first, inspect the parts and shipment pallets. Then, the responsible inventory handler stores the part into the right location and accessible location depending on the order type i-e SO or EO. This process is called in-binning which also includes updating the current inventory levels in the system after new parts arrive and have been inspected.

Furthermore, Company X also offers a reserve logistic service for its customers. The process deals with transporting the goods from its customers back to the company's warehouse of that market. Typically, customers create a claim in LMS if the parts are damaged or any other reason. The logistic unit investigates customer claims and data, approves the claim and report to the insurance and transportation companies. There are various types of claims being handled by the CCX which include commercial return, transportation damage, mispicked order, wrong content, product catalog error, oversupplied or shortages. In case if the mistake or damage is done by the transportation company or CCX's warehouse, the transportation is chargeable and paid by the CCX. End-customers only pay the transportation cost if they wish to return any product as a commercial return with a 10% discount. The overall reverse logistics costs if left unchecked, can possess a significant impact on business profitability. When asked for a type of repeating damage claims, the logistics officer responded:

"Usually the vehicle bumpers, lamps, windshields, and fenders are products that are more prone to getting damage"

It is mainly because these products require extra care during the packaging and material handling process. Nevertheless, these products remain on top of the list with the highest amount of damage and repair claims by the customers. This also indicates the criticality of choosing the right product to ship inside the EO truck.

5.2 Current State of Logistics Service Levels

This sub-chapter will provide a review of the case company's logistics service levels and opinions of the colleagues facing different challenges related to it. The automotive aftersales parts supply chain is the exponent of global competition. Since then the case company being related to a similar industry has been trying to improve its logistics and supply chain operations and seeking better ways to meet customer satisfaction. The case company has the right technological resources and established distribution network, but for customers, building a reliable and flexible logistic is the key to success.

Case company's managers brainstormed about the future upcoming challenges and among those included were the changing product demand, less order delivery information and longer lead times. In a qualitative interview session with the department's inventory controller, he said the following.

"Many times, I receive an email from local dealers asking about the availability of certain products, and I can't even properly reply with a reliable expected arrival time"

Not only the regular stock order delivery time is huge, but that is the only delivery method company is using to ship stock orders. Thus, not being flexible enough is also one of the potential areas for the case company to improve. The inventory controller came up with the idea of shipping stock orders inside the emergency trucks provided that the truck allows space for the SO cargo, but most important the logistics service levels are not negatively affected by that.

5.2.1 Review of Lead Time

The logistics unit of CCX is responsible for ordering, maintaining inventory and expediting deliveries of the automotive aftersales spare parts and accessories. As the process flow is concerned, the parts are expedited and ordered from the central warehouse which is in Amsterdam. The local inventory controller in each market is in charge of maintaining the local stocks. Therefore, the inventory controllers can check both the availability of existing parts and the introduction of new parts at a central warehouse through the established information management system and warehouse management software. Usually, inventory controllers forecast the demand of each product group by analyzing the last 12-months sales data and using logistics experience related to seasonal and market trends, then the controller places the product orders to the central warehouse.

The actual inbound logistics process starts when the inventory controller places the spare-parts order through the logistics management software (LMS), the software simplifies the order data and transmits the information to the central warehouse. The regular SO are delivered by shipping routes to both the local 3PL warehouse in each market. The lead time of SO varies between 3 to 5 weeks, as tracked by the CCX in 2018, the lead time of shipping containers averaged 7 to 10 days as shown in table 6 below.

Table 6. EO truck lead time follow-up.

Container	Departure Amsterdam	Arrival to HKI Harbor	Inbinning Starter	Inbinning Finished
TX520	24.10.	30.10.	30.10.	31.11.
TX615	25.10.	30.10.	1.11.	2.11.
TX679	25.10.	30.10.	1.11.	2.11.
TX639	25.10.	2.11.	2.11.	5.11.
TX643	25.10.	5.11.	5.11.	7.11.
TX597	26.10.	5.11.	6.11.	9.11.
TX942	01.11.	6.11.	12.11.	12.11.

As evident in table 6 above, the average lead time of container was moderate, however, the globalization and change in demand have an adverse effect on the lead time. Since automotive logistics parts also include fast-moving products and main decision problem arises when an emergency part is required. Therefore, CCX has adopted the milk-run system, which involves transporting the required parts to the dealers located very close to the local warehouse. The milk-run system allows multiple deliveries to the dealers and even allows the possibility to pick the product by themselves at their convenience. However, not all the dealers are in a nearby geographic region so the idea of supplying the parts urgently is only limited to few dealers. For the rest of the dealers, the transport time is a bit longer. In case of EO, one of the key performance indicators of the CCX is to coordinate with involved logistics parties and deliver the EO within 2-3 days after the order is placed. The CCX tracked the EO order incoming/arrival time to analyze the current situation of EO delivery time as shown in table 7 below.

Table 7. EO truck delivery times.

Invoice	D.o.D	Day	D.o.A	Day	T.o.A	In-time (Y/N)	Note
TC544	29.07	Mon	01.08	Thu	10:15	N	Same day shipped
TC620	30.07	Tue	01.08	Thu	10:15	Y	Same day shipped
TC728	31.07	Wed	02.08	Fri	10:05	Y	Same day shipped
TC815	01.08	Thu	05.08	Mon	6:45	Y	Same day shipped
TC782	02.08	Fri	05.08	Mon	6:45	Y	Same day shipped
TC986	05.08	Mon	07.08	Wed	10:45	Y	Same day shipped
TD239	0608	Tue	0808	Thu	10:20	Y	Same day shipped
TD120	0708	Wed	0908	Fri	10:00	Y	Same day shipped
TD159	0808	Thu	1208	Mon	7:00	Y	Same day shipped
TD279	0908	Fri	1208	Mon	7:00	Y	Same day shipped
TD331	1208	Mon	1408	Wed	10:30	Y	Same day shipped

As the EO situation is evident in table 4 above, the average lead time of EO is 2-3 days for the trucks that leave the central warehouse from Monday till Wednesday. For trucks, that leaves on Thursday and Friday reach the local warehouse in Helsinki on next Monday. To answer the question of the manager, that can we transport SO inside the EO order trucks in order to bring some prioritized parts faster; the truck container size needs to be determined and historical truck filled-data is required before further cost analysis is done. As argued by (Hakim, et al., 2018), the information about the type of container and capacity of containers used in logistics inbound operation is a very significant choice to be determined, so that the logistics costs and possibility to ship SO can be examined.

If any part is not available in the central warehouse it is declared as a backorder and the central warehouse places the order the required part to the supplier. The situation becomes critical when the backorders are delayed for more than 30 days because it affects the dealer negatively who has been waiting for the part to arrive. If in some cases, if the required part is covered by warranty, then as a courtesy, a car is issued to the end-customer to drive until the backorder is delivered by the CCX. This situation incurs additional costs; therefore, the lead time is an important factor for the CCX. However, when the central warehousing strategy section manager was interviewed regarding this scenario, the following viewpoint was discussed:

"The situation with backorder is really tricky if the old supplier does not exist or if they do not supply that part anymore. In that case, delivering aged backorder is our priority from other suppliers or taking part from production/assembling plant during the manufacturing of new vehicle"

This highlights the fact that the factor of lead time is also dependent on a variety of external factors including supplier's capability, geographical political situation, and others. Delivering the backorders quickly is a crucial issue for some dealers in order to provide excellent service quality to the end-customer. This issue is being discussed between the regional business units i-e CCX and the central warehousing team to find other reliable solutions. On the contrary, even when the part is acquired by the central warehouse, it is still treated as regular SO and delivered by shipping routes. Another inventory controller said:

"Dependency on the singular delivery route of SO is also causing us to be less flexible and adaptive to alternative options"

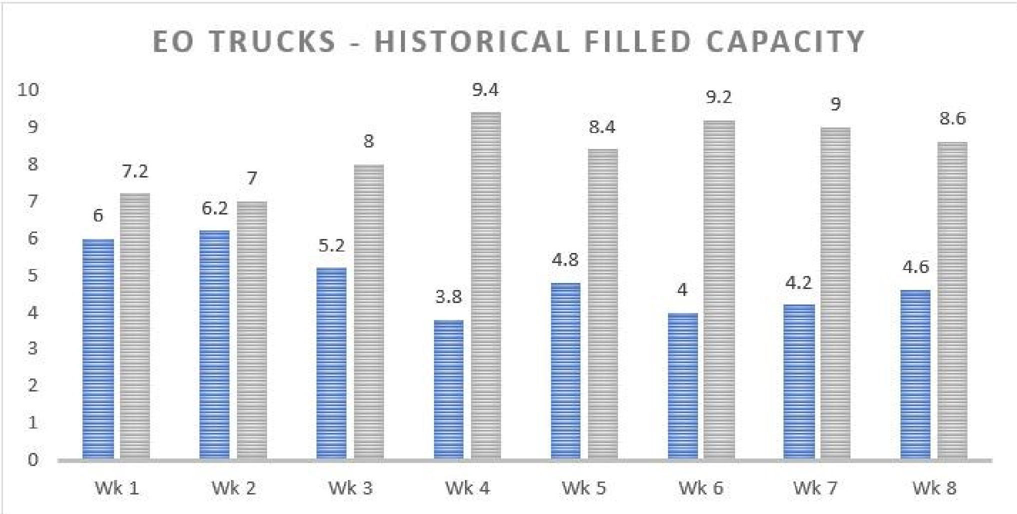
Moreover, when a dealer suddenly calls or email to ask for expected delivery times the inventory controller or helpdesk personnel are left with non-convincing answers to justify the late delivery timing because of less available information. Hence, negatively affecting the logistic service levels.

5.2.2 Review of Logistic Costs

The lack of delivery information and longer lead times are real-time troublesome issues for the case company which is causing the company's logistic to be less predictable. The less predictability of the logistic delivery times is influencing the safety stock levels, because the longer the lead times the more inventory and safety stock is needed, which in turn causing the monetary value to be tied-up. The inventory controller highlighted:

"If the SOs are to be shipped in EO trucks as much as space is allowed, this way we could have been able to decrease our local inventory value and labor on fast-moving items"

Interestingly, the CCX has many regular fast-moving parts which are classified as inventory classification. This argument highlights the fact that the logistic cost does not only include the cost of delivery but also the local inventory value especially for the fast-moving product type A. However, as far as the incurred logistic costs are concerned in EO delivery, it is important to recognize the type of delivery container is being used. The 3PL warehousing personnel was tasked to track the EO truck filled versus the available capacity in order to understand the historical pattern of the volume filled. An average of recent data from the 40 ft truck container, each week filled volume, is presented in figure 13.



	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5	Wk 6	Wk 7	Wk 8
Filled	6	6.2	5.2	3.8	4.8	4	4.2	4.6
Vacant	7.2	7	8	9.4	8.4	9.2	9	8.6

Figure 13. EO - Filled vs vacant capacity.

As shown in the figure above, the 40 ft container has a total of 13.20 sqm available capacity. Historically the truck has been filled with EO averaging to 4.85 sqm of space utilization in the period of 8 weeks and leaving behind approximately 8.35 sqm space inside the EO truck. Despite the varying volume of shipped goods each week, this follow-up of container's space utilization indicates a positive sign that there is enough space to also ship SO orders. When presented this data to the inventory controller, a few important key questions were raised…

"Space utilization's data shows that there is enough space inside EO truck for SO but nevertheless the question still remains that what product category can be chosen from the SO to achieve the optimal cost and productivity from this situation"

This key question holds a significant value from the logistics point of view because the CCX has 1,24000 active product numbers and hundreds of product categories. Therefore, defining a criterion for product selection and categorization is necessary to proceed with this situation. Also, the incurred logistic costs can be higher or lower depending upon the products chosen and the space it takes.

Furthermore, the logistics cost related to the delivery of EO truck is generally complex but is made simple for the CCX because the 3PL handles all the customs clearance, invoice billing to other parties involved and managing the delivery. The CCX is aware of the chunk of transactions that the company must pay in each logistics transaction of SO delivery. Roughly, when calculating the gross margins, the company adds 34% of the logistics cost as contribution margin in each logistic transaction emerging from SO delivery; this 34% is added on top of the actual product's standard cost. However, in case of EO, an amount under 100€ per meter-cube is the cost that the company pays to the 3PL trucking company for handling and delivering the items. If there are dangerous category goods such as batteries, compressed oxygen, engine oils or other, add an additional 30€ which is being paid twice a week on average. The exact delivery costs are manipulated to maintain case company's secrecy.

In conclusion, the transportation cost to deliver emergency orders by a trucking company is rather simplistic but what's more important for the case company is the prioritization of the regular stock orders and product categories. Historical averages indicate that the Company X can ship SO inside the EO trucks, however, considering the quoted transportation costs which products can be optimal to keep the costs minimum is still uncertain.

5.2.3 Review of Order Delivery Quality

In addition to being flexible or trying to reduce the lead time, another challenge that the case company was facing is the quality of order delivery. As argued in the literature study, quality is the key to takeout and delivery. Company X defines quality as on-time delivery, in the right quantity and right condition of the product. That is why the company is also offering the reverse logistic claim service for its customers to raise a claim about any incident. When asked the logistic offer about claim handling, he said:

"If customers have a big order but receive one important part damaged, it affects very negatively about overall order quality"

This could be partly explained by the company having longer lead times and not all the parts are available in local warehouses due to pipeline shipments coming from a central warehouse. That is why, it is utterly important that whether Company X proceeds with the proposed model of transportation or not, the quality of order cannot be compromised. However, receiving a damaged product is entirely the Company X fault or mistake, it is mainly contributed due to mishandling from the external transportation companies. A noteworthy point was made by a logistic officer:

"Customers sometimes do complain us having bad packaging of some of the products but most of the time it is mishandling from transporters that damages the product"

Hence, it is important for the case company to realize that both the reliable packaging and proper material handling is required to ensure that customers receive the product in form and shape. Furthermore, it was also noticed through the interviews that the communication between the logistics team and customers regarding the order expected time of arrival is very minimal. When customers place either SO or EO through the B2B portal, they can only see the expected time of delivery (ETD) for only a few parts, which in some cases is not reliable. As said by Saura et al. (2008), the importance of sharing accurate information on time has a direct positive or negative impact on customer perceived service quality. In the current scenario, the logistics team receives the first notification in the form of an invoice from a central warehouse when the parts are shipped from the warehouse. The next notification is received by the local 3pl warehouse a few days before the parts are about to arrive at Helsinki harbor. If there is any local dealer contacting about the expected arrival time in between these 3 to 5 weeks regular shipping, the logistics team does not usually have a reliable answer.

Less availability of information related to expected arrival time can also be partly explained by the fact that the logistics team is still using an old-fashioned and limited version of the LMS. Currently, the team uses two separate LMS for inventory control purposes and an ERP (Enterprise Resource Planning) to check logistic claims, dealer historical orders, credit and invoicing. The issue is that the two versions of LMS have very limited and scattered tools. There are no reliable and efficient ways to communicate the logistics team by the central warehouse, in case, if the parts delivery has been delayed or has been back-ordered from the supplier. At this moment, it's a combination of a little bit of assumption and emailing the central warehouse to ask for an expected arrival date. Hence, the central warehousing team is developing a renewed LMS called Alias, which will not only replace older versions of LMS but will allow Company X and local inventory controllers from each country to track their order processing. The software will be able to synchronize all the orders in its respective markets and in some cases if a backorder is delayed more than 30 days, then the possibility to obtain apart from other EU warehouses, vehicle production and assembling plant will be made visible through the renewed LMS.

In conclusion, the logistics unit is currently meeting its most of the KPIs including fill-rate and order dispatch time. However, there are no ways to asses properly regarding the overall order delivery quality which includes important elements such as accurate information sharing, avoiding transport damages and reliable ERP. The logistics unit realizes the fact that these three areas also need avenues of development to enhance service quality. If the renewed Alias begins working soon, then it will not only enhance collaboration between warehouses and other regional business units but can also communicate accurate information with the local dealers about the expected time of arrival.

5.3 Analysis of the Proposed Mode of Transportation

In the automotive industry, the involved global megatrends and risks such as Brexit deal and others are continuously pushing Company X to build a robust aftersales logistic design which is more resilient to risks and disruptions. The managers of the case company have been brainstorming on how to mitigate the risks of disruption, increase logistics flexibility and reduce lead times. The idea of using EO trucks to fill-up with SO which was pitched initially by the inventory controller does seem like a possibility that will enable the supply chain to function smoothly and reduce the lead times. However, what impact it might have on logistics flexibility, communication, and overall cost structure. This section of the research aims to answer these questions in detail.

5.3.1 Product Selection

The associated costs of logistics in a delivery method by trucks are substantial, not surprisingly, it still is just a portion of total logistics costs which also involve warehouse operating costs. The focus of this research relies only on the costs of delivery by trucks. The cost of delivering a one-meter cube of the product by truck is known to the CCX, which is of course heavily dependent on the type, weight, and volume of the product being delivered. In a brainstorming session with an inventory controller, an interesting viewpoint was raised:

“The cost of per meter cube of products does not allow enough room to maneuver, therefore, choosing the right products is not only important from a cost perspective but also from inventory controlling point of view to improve overall efficiency”.

The complexity of the situation becomes obvious because the case company has thousands of active aftersales products being delivered. The products are categorized and vary greatly in demand; therefore, ABC inventory classification is being used to understand the impact of different product categories on overall turnover. In order to find an optimal type of product to be able to deliver as a SO inside the EO trucks, each product category needs to be critically analyzed according to the criteria in the previous section. Logistic manager of the case company highlighted the following fact:

“If the size and packaging of the product are huge, it will incur higher costs. If the size of the product is too small, it might be feasible to ship it by EO truck due to lower dealer net price”.

Keeping this in mind, it is utterly important that the products should not only be optimal in size, but the dealer net price should be substantial that can make this effort worth it financially and productivity-wise. Given the number of products available, it was still possible to make quick adjustments and prioritize items for this study. Since the inventory is classified into various categories, when asked about which category should be prioritized, the inventory controller said:

“If we chose a few fast-moving products among the available, that will probably be the safest option to start with”

In order to proceed forward in terms of analyzing the parts which can be ideal to ship inside EO trucks, a stock analysis report was utilized. The report was acquired from the LMS which included all the figures related to parts sales, demand, quantity on hand and other information. After analyzing the available data from LMS, few parts were prioritized based on the set criterion which is displayed in table 8 below, the part names and annual demand figures were manipulated to maintain the privacy of the case company’s business.

Table 8. Product Selection.

Product	Annual Demand (units)	Inventory Classification	Dangerous Goods	Weight (g)	Volume	Volume Unit
Item 1	25122	A	N	35	77* 48* 48	Mm
Item B	22757	A	N	80	100* 100* 70	Mm
Item C	20587	A	N	100	255* 185* 40	Mm
Item D	14966	A	N	175	380* 140* 85	Mm
Item E	11273	A	Y	280	270* 185* 55	Mm
Item F	8531	A	Y	19,100	278* 190* 175	Mm
Item G	6925	A	N	4	720* 520* 30	Mm
Item H	6936	A	N	190	245* 190* 35	Mm
Item I	3399	A	N	680	158* 120* 98	Mm
Item J	1642	A	N	1,000	255* 255* 50	Mm
Item K	1641	A	N	1,250	100* 100* 95	Mm
Item L	384	B	N	22,956	1190* 320* 150	Mm
Item M	199	B	N	12,500	1026* 810* 170	Mm
Item N	185	B	N	100,000	860* 860* 560	Mm
Item O	168	B	N	5,910	400* 240* 160	Mm

The empirical investigation as showcased in the table above is based on real-life datasets. In order to evaluate these products, the study also needed information about the product's weight and volume. The data related to inventory holding cost of each is not available and therefore, is not considered in the scope of this study. However, the main elements to figure out at this point is, which products are more optimal to ship in terms of cost, potential sales (cash flow in euros) and easier to handle by the 3PL. The empirical investigation was discussed with the logistics helpdesk and 3PL warehousing manager, the idea behind brainstorming sessions was to get a critical review on the fast-moving products, annual demand and to understand the importance of product weight and volume. The 3PL warehousing supervisor said:

"These type of inventory parts especially sensor units, oil filters, and timing chain might be optimal to ship inside EO truck because it occupies less space and easy to handle"

It is interesting to note that, there are still many other parts that have high demand and included in the list of fast-moving products, for instance, bumpers and lamps; but the reason those product types are not chosen because those products are prone to get damaged and require extra efforts by the warehousing team to inspect and store.

5.3.2 Cost Implications

In this research, the objective function is to understand the cost behavior and how it can change when the logistics activity is altered. For the CCX, it is utterly important to be aware of cost changes while constructing or proposing an alternate mode of logistics. Generally, the logistic cost is comprised of fixed and variable costs. Both elements include multiple sub-components contributing financial liability and constituting a full cost element. The fixed cost in this study is mainly consists of first, the standard cost of the product, which is the direct material cost that company pays to buy the goods from its supplier, and secondly, the direct delivery cost, which is the amount that company pays to its 3pl trucking company that delivers the goods from central warehouse to Helsinki warehouse. In any logistic circumstances, these costs will remain the same. On the contrary, variable cost is the cost behavior which varies directly with changes to a logistics activity. For CCX, the direct-variable cost is out of scope for this study, however, a mixed cost element shall be introduced in order to cope with the objective function of this study.

The idea of this study is not to reduce the cost but rather evaluate the costs in both the business scenarios. The overview of evaluating logistics costs is presented in figure 14 below.

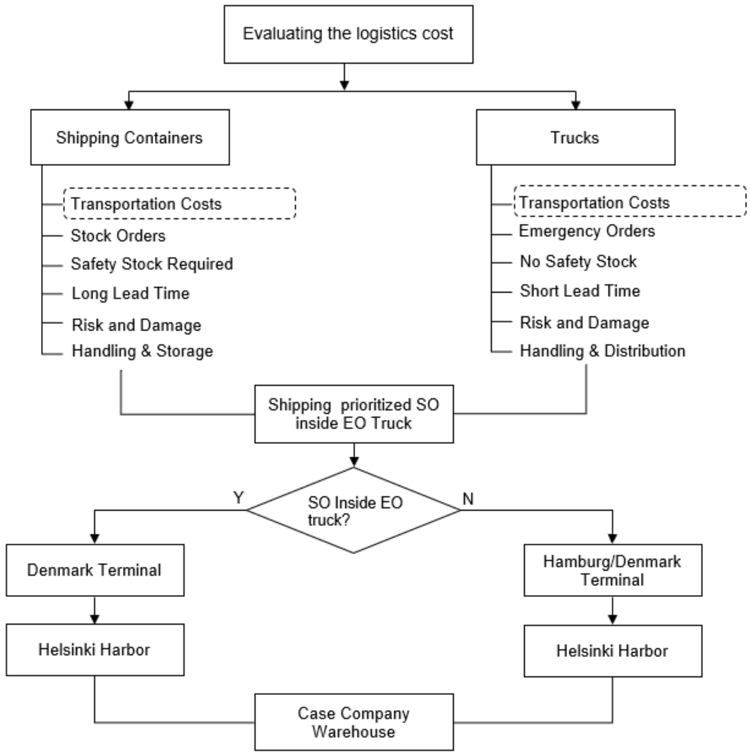


Figure 14. The overview of logistic facts and cost elements (adapted and modified from Zeng & Rossetti, 2003).

As illustrated in the figure above, the fact is that the logistic cost is comprised of different multiple fixed and variable cost elements, but the scope of this study is focused on the fixed transportation cost and its behavior in both the scenarios including direct trucking route to Finland and shipping SO inside EO truck. The illustration in the figure shows general facts in the first potion. In both the cases of shipping containers and EO trucks, the transportation cost, nature of order type and safety stock are variable. So, the overall logistic service level is dependent on the type of transportation mode chosen as well as the associated risk of transport damages and material handling. The decision-making process for the CCX includes two different sets of routes, depending on which path should be chosen, cost implication plays a huge role in that process.

Evaluation Framework

The cost per sqm is already determined by the CCX both, however, to what extent the logistic costs arising from the prioritized parts delivery can impact the overall process. In order to find the lengths and cost behavior in this business situation, it is utterly important to set relevant cost categories and define the evaluation framework. As discussed briefly in the literature review from Zeng & Rossetti (2003), since the CCX does not have centralized datasets and information to retrieve related to the costs involved in the overall logistics process. Therefore, considering the scope of this study, the focus is on only one cost category which involves the transportation costs, being paid to 3pl trucking company for handling and delivering the EO orders. As said by the logistics manager:

“The delivery cost information is available, but we are still missing the cost factors considering the scope of this study which can determine the proposed logistic setting’s feasibility”

Hence, to cope with this issue, literature from Zeng & Rossetti (2003) has been adopted and modified according to the case company’s logistic setting. Since the main cost category for the CCX is the logistic delivery cost, hence, total logistic cost needs to be determined based on the proposed model. A cost-matrix is constructed on a spreadsheet in order to estimate the total logistic costs and to understand overall cost behavior. As pinpointed by the logistic manager above, the evaluation criteria need to be determined in this case. Since the combination of transportation and delivery modes have been determined, which needs to be evaluated form cost perspective. Therefore, the number of input parameters needs to be developed which will undergo cost analysis. Since this study is only concerned with only one cost-category, transportation cost, so a total of parameters will be used to ascertain logistic cost behavior, as explained below.

1. Product description
2. Net weight (KG)
3. Volume (cbm)
4. Dangerous good (Y/N)
5. Standard cost (€/unit)
6. Dealer net price (€/unit)
7. Logistic cost (€/cbm)
8. Dangerous good cost (€/cbm)
9. Avg. truck available capacity (cbm)

These input parameters have been finalized after verifying with the CCX stakeholders, net weight, volume, cost, and price of the product plays a significant role to understand the cost and benefit of both the problem scenarios. These parameters will be used to construct the cost matrix and the input data has been obtained from LMS.

In addition to developing a cost matrix, evaluation of the effectiveness of shipping alternatives and logistics cost awareness needs to be concluded with the help of evaluation percentages. As argued by Zeng & Rossetti (2003), a computational figure can be obtained in the proposed model by creating different sets of percentages. These percentages can be determined in the following way:

$$TC_F: \quad [\text{Annual Demand(units)*Transportation Cost}\left(\frac{€}{\text{unit}}\right)] + [\text{Annual Demand(units)* Std. Cost}\left(\frac{€}{\text{unit}}\right)]$$

TC$_S$: $\text{Transportation Cost} \left(\frac{€}{\text{unit}}\right) * \text{Maximum Available Capacity} \left(\frac{units}{\text{cbm}}\right)$

TC$_{VA}$: $\frac{\text{TCF}}{\text{Customer Net Price} \left(\frac{€}{\text{unit}}\right) * \text{Annual Demand (units)}}$

These percentages are extremely useful in order to understand the behavior of logistics costs. However, for the purpose of illustration, a quantitative analysis has been shown below. The related data has been obtained from LMS and ERP but has been modified to protect data privacy. Two important parameters for the data include, first, the transportation costs which are quoted under 100 euros per cubic meter. Secondly, the average available capacity inside EO truck 4.85 square meters, which was determined in while tracking EO truck's historical data. The first part of the cost matrix is shown in table 9 below which includes the unit cost per product.

Table 9. Product cost analysis.

Product Description	*Net Weight (g)*	*Dimensions, LxWxH (mm)*	*Volume / Unit (cbm)*	*Transport Cost / Unit (€/unit.vol)*	*Available Capacity 40 ft Container incl. Packaging (units)*	*Total Transport Costs per Available Capacity (€/units)*
Item A	35	77* 48* 48	0.00017	0.020	40,721	2,213
Item B	80	100* 100* 70	0.00070	0.084	10,157	2,213
Item C	100	255* 185* 40	0.00189	0.226	3,688	2,213
Item D	175	380* 140* 85	0.00452	0.542	1,539	2,213
Item E	280	270* 185* 55	0.00275	0.329	2,405	2,213
Item F	19,100	278* 190* 175	0.00924	1.535	729	2,767
Item G	4	720* 520* 30	0.01123	1.347	566	2,213
Item H	190	245* 190* 35	0.00163	0.195	4,245	2,213
Item I	680	158* 120* 98	0.00186	0.223	3,705	2,213
Item J	1,000	255* 255* 50	0.00325	0.390	2,167	2,213
Item K	1,250	100* 100* 95	0.00095	0.114	7,453	2,213
Item L	22,956	1190* 320* 150	0.05712	6.850	92	2,213
Item M	12,500	1026* 810* 170	0.14128	16.944	37	2,213
Item N	100,000	860* 860* 560	0.41418	49.672	10	2,213
Item O	5,910	400* 240* 160	0.01536	1.842	394	2,213

As shown in the figure above, a few products such as Item A and Item B have the highest number of annual demand and low volume. Hence, the product can be shipped in a large number of quantities inside the EO truck. On the contrary, Item N has low demand and because of large unit volume, the maximum number of units possible to ship is also less comparatively. It is also noticeable that the transportation costs for these products do not vary in greater quantity especially in the top 80% of the parts. Nonetheless, the parts which are optimal to ship shall be founded on the evaluation percentages as shown in Table 10 below.

Table 10. Cost Matrix.

PRODUCT DESCRIPTION	TRANSPORT COST (€/UNIT)	STD. COST (€/UNIT)	C.N.P W/O VAT (€/UNIT)	ANNUAL DEMAND (UNITS)	TC_F	TC_S	TC_{VA}
Item A	0.020	4.31	13.28	25122	108,837 €	67.39%	512 €
Item B	0.084	1.58	6.48	22757	37,780 €	74.38%	1,911 €
Item C	0.226	1.86	10.93	20587	42,934 €	80.92%	4,659 €
Item D	0.542	6.51	42.04	14966	105,525 €	83.23%	8,116 €
Item E	0.329	5.62	11.37	11273	67,073 €	47.69%	3,714 €
Item F	1.535	45.30	60.39	8531	399,522 €	22.45%	13,094 €
Item G	1.347	13.12	28.03	6925	100,160 €	48.40%	9,329 €
Item H	0.195	6.26	17.48	6936	44,743 €	63.10%	1,355 €
Item I	0.223	20.13	24.93	3399	69,178 €	18.35%	757 €
Item J	0.390	27.34	88.82	1642	45,539 €	68.78%	640 €
Item K	0.114	25.66	66.42	1641	42,275 €	61.20%	187 €
Item L	6.850	203.89	273.44	384	80,871 €	22.93%	2,629 €
Item M	16.944	168.76	287.25	199	36,971 €	35.35%	3,373 €
Item N	49.672	1,337.89	4,448.04	185	257,283 €	68.81%	9,210 €
Item O	1.842	366.63	886.98	168	61,792 €	58.46%	309 €

As shown in the table above, the percentages can determine the expenses and overall behavior of logistics cost. The TC_F represents the total fixed costs including the transportation and standard product cost. It is noticeable that the parts including Item F and Item N can possibly contribute to the highest total costs if transported by trucks. Similarly, followed by the lowest total cost contribution from Item B and Item M considering the annual demand and transportation costs per unit volume. Moreover, the logistics cost per shipment is reflected from the TCs percentage, which makes it obvious for the inventory controller to evaluate transportation costs per shipment of any part. However, from the cost's standpoint, the most favorable product is presumably the one offering higher gross profit margins. Hence, TC_{VA} represents the overall value that the product can offer considering the current situation. It presents the ratio of total costs by revenue which is generated from the customer's net purchasing price. It is evident that most of the products are offering significant gross margins for the case company nonetheless, some parts including Item F, Item I and Item L are donating handful profit margins which can reach breakeven easily if offered as a campaign or kit discount. So, the CCX must proceed prudently with these types of parts to leave enough room in the gross margins in order to maneuver with campaign or price changes.

5.3.3 Impact on Lead Time and Delivery Quality

The lead time is a crucial element when analyzing an optimized mode of transportation. With this research, the case company got to understand the several factors involved in determining the lead times of truck delivery routes. First, there are two truck delivery routes that have been deliberately analyzed in previous sections. The present route follows the Denmark terminal to navigate through Sweden while reaching the Helsinki harbor. The route involves multiple offloading and unloading of goods from trucks to transport ferry. Now, the current routes on average take 2-3 days to deliver goods from Amsterdam's central warehouse to the Helsinki warehouse. On the contrary, when asked for lead time from a third-party trucking company that follows the logistics course via Hamburg. This company quoted the delivery time to be 10 days starting from point of picking (Amsterdam) to the point of delivery (Helsinki). It is obvious that the new 3PL trucking company's quoted time is higher than the current delivery company. Regarding lead time, the logistics manager said:

"It is questionable as to why the lead time is quoted as 5 days whereas many companies can delivery within 3 days. Nevertheless, the routes need to be investigated more or get the current company onboard"

In addition to the manager's comments regarding getting the current company onboard, previous negotiations have been done regarding the possibility to launch another truck to deliver only SO. However, the trucking company agreed to deliver if and only there will be regularly running orders each day. For the CCX, it might not be the most optimal solution because the demand volume, product variety, and seasonal products were stumbling blocks in the past. Either way, the possibility to optimize route together with the trucking company or starting a dialogue with the current company can be a good starting point.

Order Delivery Quality

The proposed model of transportation and deliveries by trucks does shorten the lead time from the regular stock order delivery method comparatively. Whether the proposed logistics model can provide good overall order delivery quality is still uncertain and needs more process investigation which required more digging and dialogue with the trucking companies but unfortunately became out of scope for this research. Nonetheless, the order delivery quality discussed in the current scenario referred mainly to transport damages and expected arrival date information shared with the customers.

The ability to deliver quality information before and during when customers order is dependent on the information system as well as the logistics helpdesk personnel. When it comes to displaying ETD in the LMS, the central warehouse plays a vital role in input updated information in the system. Surprisingly, the complexity and variety of products make it difficult for the central warehousing team to give out reliable ETD. Still, the LMS shows ETD for approximately 80% of the parts, but the issue is the reliability. Whether the proposed mode of transportation can perform outstandingly in sharing ETD is still highly dependent on a central warehouse which is still unknown because of uncertain volumes and final types of products. As far as the logistics personnel are concerned, inventory controller mentioned:

“With this idea, we could modify customers order intake, and we will be able to know what is being shipped and ETD will be more reliable to present to the customers”

The helpdesk tried its best to push for ETD and other accurate information but sometimes the response is not given back because of the notion that it’s the same repetitive complex issue. This mode of transportation brings more transparency in the ETD because of shorter lead times and well-established information flow process not only with the CCX logistics team but also with the 3PL local warehouse.

5.4 Sensitivity Analysis

Typically, in a practical business environment, the set of variables or elements which are part of a system might change due to internal or external factors. Changes in important parameters might have an adverse effect on the final decision regarding any mode selection and impact on transportation costs (Zeng & Rossetti, 2003). A sensitivity analysis is a tool, which is further utilized in the current context to check how changes in certain cost and demand elements will affect the projected logistics cost structure. The cost elements selected for assessment include transportation cost (€/unit), standard cost(€/unit), customer net price (€/unit) and annual product demand(units). The results analyzed from sensitivity analysis are based on four assumed situations that might happen in a business environment. In the first, analysis of the annual demand of the product is assumed to be reduced by 20% due to any external reasons and the rest of the variables are kept constant. Three columns are created to determine the variance percentage after the current changes in factors versus the previously determined cost figures. The first situation is presented in figure 15 below.

Product Description	Transport Cost / Unit (€/unit)	Standard Cost (€/unit)	Customer Net Price excl. VAT (€/unit)	Yearly demand (units)	***Variance TC_F***	***Variance TC_{VA}***	***Variance TC_S***
Item A	0.020	4.31	13.28	20097			
Item B	0.084	1.58	6.48	18206			
Item C	0.226	1.86	10.93	16469			
Item D	0.542	6.51	42.04	11973			
Item E	0.329	5.62	11.37	9019			
Item F	1.535	45.30	60.39	6825			
Item G	1.347	13.12	28.03	5540			
Item H	0.195	6.26	17.48	5549	-25.00%	0.00%	-25.00%
Item I	0.223	20.13	24.93	2719			
Item J	0.390	27.34	88.82	1314			
Item K	0.114	25.66	66.42	1312			
Item L	6.850	203.89	273.44	307			
Item M	16.944	168.76	287.25	159			
Item N	49.672	1,337.89	4,448.04	148			
Item O	1.842	366.63	886.98	134			

Figure 15. Sensitivity Analysis (Situation 1).

As it's visible in the figure above, the annual demand has a direct impact on the total costs of the product and the total cost of shipment. The variance dropped to an equal 25% in both the percentages. However, the situation is justifiable especially in case of no variance change in the TC_{VA} because reduced demand will ultimately reduce the creation of the product; thus, balancing the situation. So, besides the reduction in revenue generated by the CCX, the demand has no threatening impact on this mode of transportation and these parts specifically. The second situation with a 30% increase in delivery cost is presented in figure 16 below.

Product Description	Transport Cost / Unit (€/unit)	Standard Cost (€/unit)	Customer Net Price excl. VAT (€/unit)	Yearly demand (units)	***Variance TC_F***	***Variance TC_{VA}***	***Variance TC_S***
Item A	0.027	4.31	13.28	25122	0.14%	-0.07%	
Item B	0.109	1.58	6.48	22757	1.49%	-0.53%	
Item C	0.294	1.86	10.93	20587	3.15%	-0.77%	
Item D	0.705	6.51	42.04	14966	2.26%	-0.47%	
Item E	0.428	5.62	11.37	11273	1.63%	-1.86%	
Item F	1.995	45.30	60.39	8531	0.97%	-3.52%	
Item G	1.751	13.12	28.03	6925	2.72%	-3.07%	
Item H	0.254	6.26	17.48	6936	0.90%	-0.53%	23.08%
Item I	0.290	20.13	24.93	3399	0.33%	-1.48%	
Item J	0.507	27.34	88.82	1642	0.42%	-0.19%	
Item K	0.148	25.66	66.42	1641	0.13%	-0.08%	
Item L	8.906	203.89	273.44	384	0.97%	-3.39%	
Item M	22.027	168.76	287.25	199	2.66%	-5.27%	
Item N	64.574	1,337.89	4,448.04	185	1.06%	-0.49%	
Item O	2.395	366.63	886.98	168	0.15%	-0.11%	

Figure 16. Sensitivity Analysis (Situation 2).

Situation 2 showcases the variance in all these three percentages. TCs undergo the same variation of +23.08% in all the products due to a flat increase of 30% in transportation costs. As would be expected, the variance in TC_{VA} and TC_F is distinctive for each product due to different annual demand and unit volume. Looking at the current situation, even a flat increase in transportation cost does not seem to bring any alarming variation versus the previous cost figures, it is mainly supported by the fact that the CCX has huge gross margins in these products to support offset price changes. Situation 3 with a flat increase in standard cost of up to 20% is shown in figure 17 below.

Product Description	Transport Cost / Unit (€/unit)	Standard Cost (€/unit)	Customer Net Price excl. VAT (€/unit)	Yearly demand (units)	***Variance TC_F***	***Variance TC_{VA}***	***Variance TC_S***
Item A	0.020	5.17	13.28	25122	16.60%	-10.66%	
Item B	0.084	1.89	6.48	22757	15.96%	-7.00%	
Item C	0.226	2.23	10.93	20587	15.13%	-4.39%	
Item D	0.542	7.81	42.04	14966	15.58%	-3.86%	
Item E	0.329	6.74	11.37	11273	15.89%	-26.14%	
Item F	1.535	54.36	60.39	8531	16.21%	-201.43%	
Item G	1.347	15.74	28.03	6925	15.35%	-23.97%	
Item H	0.195	7.51	17.48	6936	16.24%	-12.79%	0.00%
Item I	0.223	24.16	24.93	3399	16.51%	-733.12%	
Item J	0.390	32.81	88.82	1642	16.47%	-9.83%	
Item K	0.114	30.79	66.42	1641	16.61%	-14.45%	
Item L	6.850	244.67	273.44	384	16.21%	-185.96%	
Item M	16.944	202.52	287.25	199	15.38%	-49.79%	
Item N	49.672	1,605.47	4,448.04	185	16.17%	-9.58%	
Item O	1.842	439.95	886.98	168	16.60%	-16.47%	

Figure 17. Sensitivity Analysis (Situation 3).

As illustrated in the figure above, the flat increase in standard costs of the product has impacted negatively in many products. Although the CCX has a fixed standard cost agreement with the suppliers for one year it is interesting to be aware of the products reaching an alarming situation. As highlighted, the products including Item F, Item I and Item L have suffered huge negative variations due to standard costs increase. In the automotive industry, for certain products, an increase in standard costs between 5% and 8% after a year is a known fact. This is also thought-provoking for the CCX to only publish the products for this mode of transportation that has enough room in gross margin, and it can withstand some uncertain increase in standard costs. Finally, a reduction of 25% in customer net price is presented in figure 18 below.

Product Description	Transport Cost / Unit (€/unit)	Standard Cost (€/unit)	Customer Net Price excl. VAT (€/unit)	Yearly demand (units)	***Variance TC_F***	***Variance TC_{VA}***	***Variance TC_S***
Item A	0.020	4.31	9.96	25122		-19.23%	
Item B	0.084	1.58	4.86	22757		-12.97%	
Item C	0.226	1.86	8.20	20587		-8.53%	
Item D	0.542	6.51	31.53	14966		-7.20%	
Item E	0.329	5.62	8.53	11273		-57.64%	
Item F	1.535	45.30	45.29	8531		-760.11%	
Item G	1.347	13.12	21.02	6925		-55.12%	
Item H	0.195	6.26	13.11	6936	0.00%	-24.21%	0.00%
Item I	0.223	20.13	18.70	3399		-307.10%	
Item J	0.390	27.34	66.62	1642		-17.83%	
Item K	0.114	25.66	49.81	1641		-26.79%	
Item L	6.850	203.89	205.08	384		-931.65%	
Item M	16.944	168.76	215.44	199		-156.17%	
Item N	49.672	1,337.89	3,336.03	185		-17.80%	
Item O	1.842	366.63	665.23	168		-31.04%	

Figure 18. Sensitivity Analysis (Situation 4).

With a flat reduction of 25% in customer purchasing price, it was anticipated that it will only impact TC_{VA} and other variance percentages remain unaffected. However, the products including Item F, Item I, and Item L seem to fall into the worrisome category. All these three products after reducing 25% net price are landing into negative gross profit margins. If there are a further campaign or virtual kit discounts set up in the case company, then these products might not be generating any positive cash flow. Hence, it is important for a case company to realize the sensitivity of discount percentages in items like these.

In conclusion, changing the cost of variables involved in this study has a direct impact on evaluation percentages especially TC_{VA} which reflects how much value a part can generate in the given scenario. Despite showing some negative trends in percentage TC_{VA} in the above four situations, there is still a substantial number of products offering higher gross margins. The effects of varying elements can be examined thoroughly in the sensitivity analysis spreadsheet which can be used as a guideline while decision-making of product selection and logistics cost sensitivity in the future.

6. CONCLUSION

This thesis work was done based on the automotive case company's context and the main purpose was to evaluate the logistics service levels in current versus proposed mode of transportation from shipping containers to trucks. Based on service level argumentation, then identify opportunities and challenges related to this idea. This chapter summarizes the main results obtained from the empirical analysis of the case study. Furthermore, a draft action plan has been constructed for the CCX based on the results and data analysis, the opportunities and risks associated with changing the mode of transportation are presented as well.

During the execution of this thesis project, research questions remain intact but the scope of the study, research methods have been modified and adapted to the context of the case company. Highlighting the facts and figures, opportunities and risks for the case company related to the study's objectives have been successful from the case company's perspective. Since this study was to examine the pre-launch scenario and associated challenges, hence, the validation and endorsement of the idea during the post-launch stage cannot be authenticated at this point. The decision to go with the launch of the modifying mode of transportation lies in the case company's management and the need for further investigation. The nature of results and proposed recommendations are not generally valid in every scenario rather it is intended to accomplish research objectives according to the case company's business environment.

6.1 Summary of Empirical Findings

The thesis work concentrated on the areas of evaluation of logistics service levels and impact on the service quality for the case company. The aim was to define the logistics service levels, determine the parameter and impact factors that will be affected by modifying the service level. Measure the level impact in order to examine the logistics service quality. Moreover, all the stakeholders involved in the logistics process were expecting specific factors to be measured that fall under the umbrella of logistics service quality. This section tries to summarize the findings from the research and discuss them based on formulated research objectives.

To start with the recap, the logistics service levels were defined in the sub-chapter 2.2. According to the literature, a logistics service is a mutual agreement between two parties to deliver something tangible or intangible and is measurable. In this case, the service level denotes the delivery of goods being made by the 3PL trucking on behalf of CCX. Since the case company is seeking to modify service levels in order to utilize available resources such as a truck's capacity. For CCX, to utilize the resource's capacity properly will generate more output in the form of revenues by delivering a greater number of products. Also, utilizing the existing resource to its potential will increase the logistics flexibility to handle volume and demand fluctuations. To be able to move forward with this modification, it requires to analyze the proposed mode of transportation and measure its impact on most of the prioritized factors surrounding logistics costs. In the next section, the discussion takes place considering this background and tries to justify the arguments according to research objectives.

6.1.1 Business Objectives and Key Questions

At the beginning of the research, considering the scope of topic and research objective, the following three research key questions formulated:

How can the logistics service levels be evaluated in the proposed logistics activity?

What developments are needed to increase the logistic service quality?

What challenges and risks are associated with the proposed mode of transportation?

The first research question asks the process of evaluating the logistics service level. Since the phenomena of logistic service level is known at the CCX but the procedure and metrics to measure the LSL was unknown. In the literature, there were underlined aspects of evaluating LSL based on the hard objectives of LSL including time, cost and quality (Harrison, 2014, p. 19). In the proposed logistics activity, the LSL was evaluated by measuring the quality of service being offered. LSQ Since, quality of service in the context of CCX is comprised of prioritized factors that include lead time, transportation costs and order delivery quality. This modular approach helped to conceive the idea of evaluating the service level with the aspect of service quality by measuring the hard objectives. It can act like a standard process at least in the context of the aftersales department.

The second research question demands to explore the concept of logistics service quality from measuring the performance point of view. In the literature chapter 2.2, it has been established that logistics service quality is the customer service that the responsible entity provides. It has a direct impact on the end-customer satisfaction. Afterward, the features of service quality were discussed which included analyzing the influence of each feature on the customer's satisfaction including timeliness and order delivery quality (Saura , et al., 2008). For the CCX, the logistics service quality was analyzed for the proposed logistics activity. In the subchapter 5.2 and 5.3, the features of service quality are analyzed both quantitatively and qualitatively to identify the impact on the service quality because of the proposed mode of transportation. The proposed activity brings the fruitful result to increase the logistics flexibility, reduced lead time and resource utilization. However, the areas of development to improve service quality are also discussed which includes the order delivery quality. The order delivery quality has proven to be questionable in the proposed logistics activity because of high dependency on 3PL trucking company material handling and most importantly required input from the central warehouse is a big hurdle. The second research question has been countered effectively both in the literature and empirical analysis from the case company's perspective.

The third research question is more generic in nature, but the company-specific challenges and risks have been discussed throughout the study especially subchapter 5.3 dialogs more about different problem scenarios. Sensitivity analysis has been performed in the subchapter 5.3 to determine the uncertainty of contributing cost elements in the proposed logistics study. The outcome in the form of percentage TC_{VA} has been calculated by taking alternative assumptions about standard cost, transport cost, customer discounts, and demand fluctuation. From the results, it was evident that there is no external immediate threat to the proposed idea because the CCX has substantial profit margins to cover the gap. However, the same cannot be assumed for every product since each product has different dimensions and customer purchasing price.

6.1.2 Case Study Results

Within the project, a current state analysis for the case company has been performed by reviewing the company-specific service quality hard objectives which include lead time, logistics cost and order delivery quality. First, the existing lead time of emergency order was determined which is delivered by trucks. Furthermore, it was noticed that the EO trucks on average were meeting its delivery KPIs related to lead time which took between 2-3 days to delivery order from the central warehouse in Amsterdam to Vantaa warehouse. This review of lead time highlights its importance during the qualitative interviews especially if the order has been backordered to suppliers or the expected arrival date is uncertain. In this case, case company X faces a negative response to the logistics service levels. That is why the importance of early deliveries is huge not only for EO but also for SO. For the proposed logistics activity this was useful insight about lead time current situation.

Second, the logistics costs of EO trucks were analyzed in the current state. The case company pays the trucking company a fixed compensation under 100 € per cubic meter.

Therefore, the capacity of trucks being used, and its utilization were an important part to consider transportation costs. For this study, only fixed transportation costs of under 100 euros were considered and overhead costs such as inventory holding costs and customs clearance are being handled by the trucking company and were out of scope from this study. After the historical tracking of trucks, an average of 4.85 sqm were available daily in the EO truck. Although the CCX is not paying for the vacant space, this serves as an opportunity to ship SO. The ambiguity in the current state was obvious because of a big question, which products are optimal from cost and productivity factors to run a test-model of this idea. Hence, the review of logistics costs also pointed to looking for optimal products keeping in mind the transportation cost, but the specific cost elements and criteria were yet to be defined.

Third, the order delivery quality has been highlighted as one of the most important service quality objectives in the literature which has a direct impact on customer service being negative or positive. Hence, the order delivery quality has been reviewed in the subchapter 5.2.3 through the qualitative interviews. From the case company's point of view, the order delivery quality included shipping the right part, in the right condition at the right time. Transport damages and information sharing about expected delivery time play a major part in delivery quality. Even though the CCX provides a reverse logistics service in case of transport damages, but it plays an important role in affecting customer satisfaction regarding aftersales deliveries. Now, the dependency on the central warehousing team is becoming a big challenge for CCX to get the ETD. Even though the ETD is share for 80% of the parts but only 20% or less affect the customers psychologically especially in case of emergencies. A review of order delivery quality suggests that there are plenty of areas of development which are discussed in this section below.

Moving forward with the proposed logistics activity to ship SO inside the EO trucks which have on average 4.85 sqm space available. But what impact it might have on logistics flexibility, communication, and overall cost structure. The sub-chapter 5.3 discussed these questions in detail. The importance of product selection is vital to test-run this model and therefore, to be on the safe side further analysis was performed on few fast-moving products from inventory class A. Furthermore, the fixed cost of transporting goods inside EO trucks was simplistic to use in the quantitative analysis. However, the cost implications of each selected product were performed in section 5.3.2 in order to analyze the logistics costs. Few evaluation percentages namely $TC_{VA,}$ $TC_{F,}$ and TC_F were introduced and each of these percentages reflected an aspect of the logistics costs so that it can help in decision making and understanding the overall cost behavior.

From the cost analysis, it was noted that the case company had substantial profit margins on the majority of the products but only a few products were closer to break-even point due to the higher purchasing price of those products. This showcased the company the opportunity that lies in the proposed logistics activity that the gross margins on average are 55% after deducting standard costs and transportation costs. Even if overhead costs are assumed, the gross margin is fair enough to offset the additional cost while still making profits. Only three parts including Items F, I and L having gross margins below 25% reflected a fact that this might not be feasible for every product category. So, this product category is not the ideal for the proposed logistics activity in the long-run. The results from the empirical analysis are summarized in figure 19 below.

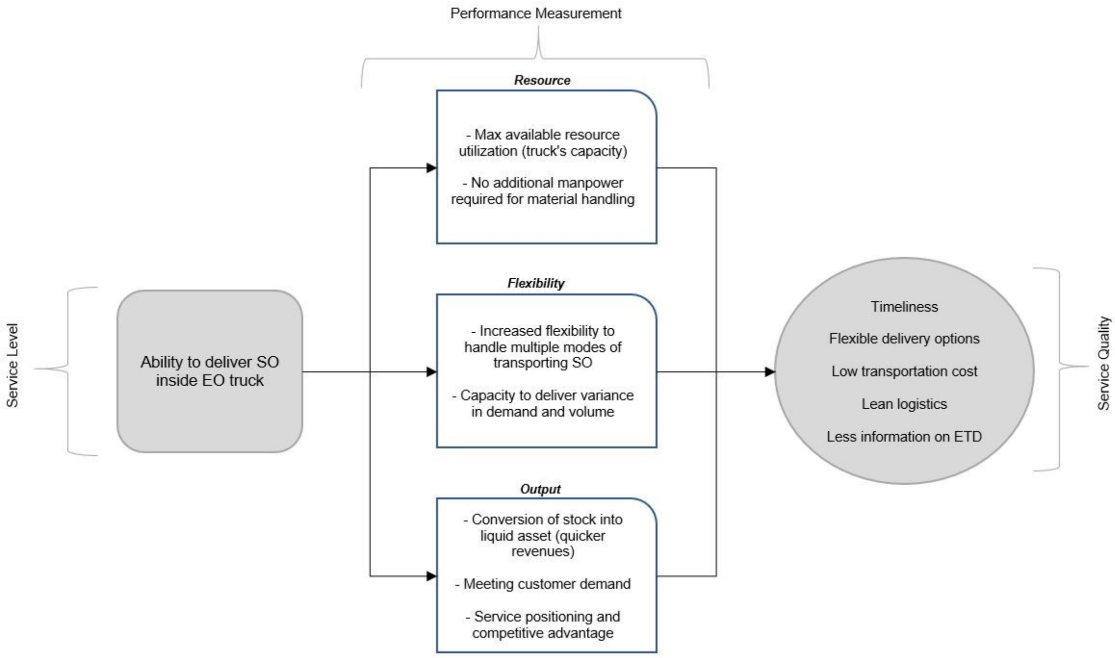


Figure 19. Summary of Evaluation of Service Level.

The figure above presents the assessment of the results from the empirical analysis based on the originally developed theoretical framework of the study. As this figure illustrates, the CCX wants to delivery SO inside EO trucks leading to service level modification. The evaluation of service includes logistics performance measurement using the company-specific metrics which cover three important aspects including resource, flexibility, and output. From the empirical analysis, it has been concluded that resource utilization will be increased by the proposed modification. This delivery change also provides flexibility to delivery higher volumes, several highest possible items per product are presented in table 9, section 5.3.2. The possibility to generate quicker revenues, branding of the CCX by offering additional delivery methods and gaining a competitive edge in the supply chain can be understood as attractive output from the proposed activity.

The results of the empirical analysis evidently point out the fact that the proposed has some potential opportunities to impressing customer satisfaction positively while some areas of the activity are still grey. First, this delivery method will take 2-3 days on average to delivery SO while the regular shipping method of SO takes 3-5 weeks. So, shorter lead times are attainment emerging from this idea. Secondly, Flexible delivery options will enable the CCX to gain a competitive edge in the fierce market while also allowing the inventory controller to release tied-up inventory in the form of safety stocks. An interesting idea can be to analyze the possible impact on safety stock, but this becomes out of scope for this study. The third takeaway from this study the possibility to make logistics operation as lean as possible because the lead times are shorter; therefore, in an ideal scenario there will no need to keep a large stock of inventories at least for the prioritized SO orders to be delivered by EO trucks. The right product in the right quantity can be delivered at the right time but the challenge will be to maintain adequate stock at the central warehouse as well. However, this is not the only challenge that CCX will have to face. The order delivery quality still needs more investigation and dialogue to take place between the trucking company, central warehousing team and CCX logistics units. The main idea is to improve the material handling issues on the trucking side to reduce transport damages. Furthermore, the situation regarding the launch of the Alias system at the central warehouse is to be understood. Otherwise, the products which usually do not have ETD should not be shipped by EO trucks.

6.2 The implication of Results in Literature

The focus of the study was to evaluate LSL in the proposed logistics model but the detection of LSL in the case company context was missing. Before the case company can evaluate LSL, the interrelation between LSL, service quality and customer impact needed to understand. The literature sources showed that the logistics service level is defined as the service offered to its customers. The level of that service assesses the performance of logistics based on essential factors which are also known as the logistics service quality. The success of the business lies in the quantification of service quality and its essential elements (Miricesu, 2013). Hence, multiple frameworks and perspectives have been discussed to determine the essential factors of service quality. One perspective from (Parasuraman, et al., 1988) states that service quality is like behavior and approach of an organization towards the superiority of its offered service. Furthermore, few researchers have presented specific elements of quality including timeliness, quality of information, condition of order as the most important set of dimensions to measure logistics performance (Rutner & Langley, 2000). Although the term quality is highly subjective, in the sphere of logistics some case company-specific elements of service quality needed to be understood out of many discussed elements.

Generally, the key performance indicators are also used by an organization to evaluate the success of any operation. In this scenario, the case company's existing KPIs were not telling the whole story needed to make a decision regarding the proposed activity. Hence, to find the impact and consequences of service quality, different surveys and literature work were studied. From the previous work, it was determined that the main consequences of service quality are satisfaction and loyalty (Saura , et al., 2008). Even though the satisfaction has been interpreted as customer retention but the interesting area to explore was how to assess the service quality to determine the satisfaction level. To answer this, a consequence chain model was presented in figure 6, according to the model there exists a causal relationship between elements of service quality and customer satisfaction. Among all the elements of service quality, timeliness and order delivery quality were found as the most significant dimension of service quality (Saura , et al., 2008).

Now that the concept of service quality has been established, but it still has to be deterred how to calculate it. Hence, a performance measurement system as a standard procedure for the case company by introducing metrics. A performance measurement system plays an important role because it offers the necessary information for decision making and behavior (Gunasekaran & Kobu, 2007). As further said in the literature that if there are no measurements in logistics, then there are no improvements (Kaplan, 1990). Having understood that, a performance measurement framework was developed in chapter 3, figure 9 which illustrated the fact that the management can act as a driver to control the outcome of proposed logistics activity. The PMS is based on three main elements of metrics, whose objectives are to satisfy different stakeholders. As said by (Beamon, 1999), resource, output, and flexibility are the most important metrics in logistics performance. That is why in CCX context, a resource was considered as a daily incoming EO truck, quicker delivery of SO as the main output and ability to offer multiple modes of transportation for the company and reduced logistics internal costs as flexibility emerging from the proposed model.

Furthermore, reviewing the literature suggested that the effectiveness of the proposed logistics activity can be summarized if it offers quality and meets customer satisfaction (Dörnhöfer, et al., 2016). As explained by the researchers, automotive logistics need hierarchical PMS that includes KPIs, and metrics that will affect the service quality and ultimately influence customer satisfaction. Thus, the two important components of the service quality which are also applicable in CCX context include timeliness and order delivery quality (Saura , et al., 2008). Customers that are sensitive to the response of an organization and adaptability to their requirements are the key competitive advantages that a company needs to gain (Miricesu, 2013). Hence, the aforementioned arguments were found to be true in the case company, where the company has received few negative responses on orders being delivered late and mostly the ability to not share ETD information with the customers.

6.3 Action Plan and Challenges

This research has contributed to the case company is paving the way to understand the complexity of the logistics and provided facts and data regarding the proposed mode of transportation. In CCX, logistics service quality was not measured in the way it is suggested in this research. However, after utilizing previous literature, important and relevant elements of service quality were determined, and measurement methods were understood and summarized by developing a framework. Using the framework as base work, the current state analysis of the case company was performed in terms of essential service quality dimensions including lead time, costs and order delivery quality. Since CCX has thousands of active part numbers, using qualitative interviews and action research, few fast-moving parts were prioritized to perform quantitative analysis. After developing the evaluation framework, a cost matrix was developed to perform analysis. The economic evaluation from the cost matrix showed that company X has enough margins to proceed with the proposed activity. To investigate the sustainability of the proposed activity, a sensitivity analysis was done which also indicated positive outcomes, but the key message is that; the proposed activity is not suitable for all the products due to the difference in margins. Even though this research provides a constructive conclusion towards the proposed logistics activity, but it only considers gross margins and the fast-moving product category. This means that it serves as a good starting point to deeply investigate if company X decides to start the delivery at a bigger scale.

Nevertheless, the generated action plan consists of concrete steps based on case study analysis and evaluation of logistics service levels for the proposed modification in the mode of transportation. Table 11 below presents the suggested action plan for the case company when starting a pilot project.

Table 11. Action plan and recommendations.

What	Who	How
Reviewing product groups based	Parts Manager and Logistics team	Categorization of products based on the proposed model, review product selection criteria
Analyze and record the safety stock and current stock	Inventory controller	Manually track-record the safety stock and random inventory checks through LMS
Dialogue with central warehousing team to revise order processing, ETD and shipping process	Central warehousing and CCX	Performing current state analysis, reducing process wastages. Vertically integrated information flow with suppliers for backorders and/or only choose products with available ETD
Review of a received delivery quotation from trucking company	Central warehousing team	Reviewing quoted transportation costs and trying to find room for negotiations on economies of scale or volume discounts
Negotiation and dialogue with trucking company on material handling, lead time and delivery costs	Central warehousing, CCX, and 3PL trucking company	Review and negotiations on economies of scale or volume discount. To impact delivery quality positively, improve material handling procedure to avoid damages
Review current order-take and scheduling process	Inventory controller and helpdesk	For selected products, the order-take process can be altered to receive the deliveries efficiently
Test a pilot-run project	CCX, central warehousing, 3PL provider	A pilot project should be run for 3 months, analyze overall costs including overhead, evaluate the process productivity and forecast future demand to extend the delivery option for other products
Continuous evaluation of logistics service quality	CCX logistics team	An update to existing logistics KPIs can be made to include timeliness and order delivery quality. Standardize best practices and sustain

The action plan provided in table 11 summarizes the action items that can be taken to jump-start the project because the initial evaluation of the proposed service level seems to be promising for the case company. However, with new opportunities comes new challenges and the challenges included in this pilot-project from the case-company context can be following.

- Right categorization and product selection are the first emerging challenge. Since CCX launches new products for the new vehicle models each year. So, updating the masterfiles and cost matrix for the new products will be required.
- Getting the ETD for the parts belonging to aging vehicle models is always a challenge because in some cases suppliers stop producing the parts. Even though the reliable delivery times, in this case, allow inventory controller or LMS to intelligently guesstimate the arriving time but more reliable way should be determined together with the central warehousing team.
- Dynamics in customer preferences regarding certain parts can beget demand fluctuations. In order to tackle this, either tentative forecasting can be done, or continuous monitoring of the part's demand will be required.
- In order to gain a competitive edge in the market, CCX offers certain seasonal products in campaigns and discounts. A background gross-margin check should be performed separately for the SO delivered by trucks. Especially in case of dangerous goods as it can easily reach the alarming gross margins.
- The proposed idea will require a restructuring of logistical processes, physical and information flow. A huge challenge will be to reform each process not only physically but also reorganization in the LMS will be required for proper and renewed invoicing and billing of the customers.

Despite possible challenges, the countermeasures exist to tackle the issues. In conclusion, the need for logistics activity is justifiable enough now to only start the pilot-project. After the test-run evaluation, it should be reviewed again only for the parts that generate most of the business revenues with fair demand.

6.4 Limitations and Criticism

While the study aims at presenting a framework for the case company to analyze proposed service levels, however, logistics service quality should not be compromised to an alarming situation. Despite supporting the study and conclusion with theoretical and empirical analysis, some observable limitations still exist. The first being case company-specific solution. Since the thesis was done for an automotive industry so the proposed action plan to the challenges are rather unique and cannot be generalized.

Second, even though the empirical analysis shows that CCX has substantial gross margins and products with high demand can be first-mover items to start with. However, the product selection is still questionable. Within the case company, there was a notion that “fast-moving products are rather shipped by sea than the roads”. This perspective needs more dialogue to define the product selection criteria accurately. Furthermore, as this case study only considered the fixed transportation costs of deliveries by trucks. Other overhead and warehousing costs are not analyzed, therefore, the net profit can dubious for certain products and it makes the case-study analysis rather shallow considering the actual net. The developed cost-matrix is accurate for a time-being because the case company goes through annual price changes once or sometimes twice. Hence, the accuracy of the cost matrix can be outdated and will need proper monitoring.

Third, a part of data collection has been done through qualitative interviews. It has been argued in the literature as well that the reliability of semi-structured interviews can be questionable due to some interviewee’s biasness and generalization of things (Saunders, et al., 2009, pp. 326-336). Even though the interviews were done in a professional environment and the interviewees have been working in the industry for more than 5 years. So, their experience does add value to understanding case study problems and possible countermeasures but still, it does not necessarily ensure the generalization and extrapolation of the results. More investigation and research due to changing business environment should be performed. Finally, the results of the case study analysis meant to help company managers in the pre-launch stage of the project. Therefore, the conclusions and the after-effects of the results can only be validated in a post-launch stage which was out of scope for this study.

6.5 Directions for Future Research

Although the literature regarding the evaluation of logistics service levels was limited to the service level concept and performance measurement of the supply chain from service quality point of view will enhance. But the results and constraints emerging from this research point out the following potential research topics.

One approach is to research the effect of logistics service levels onto the safety stock from monitory perspective. Since inventory and safety stocks are treated as operating assets which are required in daily logistics operations to generate revenue for the aftersales department. Whether it is related to changing the mode of transportation for all the SO from shipping containers to trucks or for only a few prioritized SO, the effect on the safety stock and tied-funds in the form of monetary value can be analyzed. Also, the correlation between safety stock and lean logistics is interesting to explore from theoretical concepts. The idea is to determine if the proposed logistics activity is leaner or is it investment intensive in the form of operating assets rather than being liquid assets.

Secondly, it would be interesting to validate the service level after it has been initiated by the CCX. The proposed framework in this study can be used and developed further to analyze the important factors of service quality including internal logistics costs but also considering the overhead costs, lead time and order delivery quality. Historical track record of customer complaints regarding transport damages and missing ETD information can be used to review and improve order delivery quality.

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