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Calculating cost of poor quality of transport services: A transport purchasing perspective

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Supply Chain Management

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Abstract

During the last decades, the margins in the automotive industry have decreased and a larger part of the profit comes from the aftermarket. At the same time, the customers require a higher service level in the aftermarket to always have their vehicles up and running, putting pressure on logistics to fulfil and exceed customer expectations. Therefore, it is more crucial than ever to have a good balance between a high service level and low costs. To find this appropriate level and maximise the company's performance, it is crucial to base the choice of transport provider on hard facts and not anyone's perception or feelings.

The purpose of this master thesis is to investigate the cost of poor quality caused by transport providers, so it can be included in sourcing projects. To reach the aim of the thesis, interviews were carried out to identify the aspects that are part of poor quality for Volvo's transport providers, and further identify the actors and activities that are affected by poor quality. To identify how Volvo's dealers are affected, a survey was sent out to get generalisable numbers.

The thesis has shown that it exists many aspects of poor quality for Volvo. But, due to constraints in measuring the size of the aspects and due to lack of performance measurements, only the cost of poor delivery precision can be added to the cost of poor quality at the time of writing. Still, including this cost of poor delivery precision can have a definite impact in the decision of transport provider. How large the impact is depends on the size of cost of poor quality relative the other factors in the Supplier selection model, which differ between sourcing projects.

Keywords: Cost of Poor Quality, Transport Purchasing, Logistics Purchasing, Delivery Precision, Late Deliveries, Total Cost

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1. Introduction

The first chapter starts with a background that introduces why the choice of transport provider of spare part deliveries is of interest and how Volvo is concerned by it. This is followed by a problem discussion that leads to the aim of the study which is decomposed into research questions. Thereafter, the chapter ends with an explanation of the system that presents the boundaries of the study.

1.1. Background

In a time where the aftermarket and service market are increasingly important, basing decisions regarding spare parts on actual costs is crucial. It is widely known, that because of shrinking profit margins within automotive, it is within the service market that many companies are actually earning money (Gaiardelli, Saccani & Songini, 2007). Furthermore, the logistics costs play an important role in the automotive industry, because of the tough competition the companies are under. Additionally, customers have increasing demands and requirements, putting pressure on logistics to fulfil and exceed customer expectations (Engel & Dombrowski, 2013). This is the case for Volvo but also all other companies in the industry. If companies do not take all costs arising from a supplier selection of transport providers in consideration, they risk sub-optimising their decision and activities (Becker, 2006). It is therefore important for Volvo to base their decisions on facts to make the best possible decision.

Previously, Volvo has estimated the effect of a transport provider's performance on the gut feelings from the involved stakeholders. A feeling can easily be influenced and differ significantly between people, and by translating the supplier's performance into concrete costs, the supplier selection can instead be based on hard facts. In that way, Volvo make sure that the best decision is made independent of people's feelings and impressions.

At Volvo Group, the department Logistics Purchasing is responsible for all logistics purchases, e.g. transports, for Volvo Group. Today, Logistics Purchasing has a sourcing process consisting of a number of pre-defined steps for how they source logistics services. One of these steps is to compare the bids from the potential suppliers to award the project to the most suitable supplier, and in this comparison a model named the Supplier selection model is used. The aim of using the model is to assess all costs that come with a supplier selection in sourcing projects, and therefore not only cost of rates. However, the Supplier selection model is not yet complete. Logistics Purchasing need to extend their work where costs are not set, which is within Transport Parts, e.g. transports of spare parts, and cost of poor quality. With the term cost of poor quality, Volvo is referring to all extra costs related to that a transport provider in some way fall short in their performance. The sourcing process and the Supplier selection model are further described in 4.2 The Sourcing Process and 4.3 The Supplier Selection Model.

Another problem in the automotive industry is that lower prices on non-original spare parts have led to more end-customers purchasing their parts from so called second sales channels (Meinig, 1998). Therefore, many automotive dealers feel that they cannot keep their high spare part prices. One way that companies could break this trend is to make sure that the service offered in the

aftermarket is much higher than the service from non-original manufacturers. This is especially important for truck, bus, and construction equipment companies since their customers do not necessarily pay for the goods itself, instead they pay for uptime.

The Supplier selection model and the cost of poor quality for Transport Parts, can help Volvo and other companies to make costs visible. Furthermore, this model and the findings can be valuable for transport providers as well. When using the Supplier selection model, it becomes transparent what Volvo value in their transport services and the transport providers can thereby focus on the appropriate improvement areas. That in turn can make the transport providers value and allocate their resources better which can lead to decreasing costs and improving service. Continuing work with the Supplier selection model is also a large opportunity to get ahead of competitors that might still base their decisions on suppliers' rates and gut feelings.

1.2. Problem Discussion

There are many ways to define (poor) quality, particularly within transport services (Yeo, Thai & Roh, 2015). What parameters that are included in the definition differ depending on what company you observe and their unique situation. Some companies may think that certain activities from a transport provider are associated with poor quality while some other think it is good quality. Therefore, it is important to adjust the definition of poor quality to the specific company to include all parameters that are poor quality for them.

Distribution networks often have complex structures that can take any form (Gustafsson & Rask, 2010). The distribution network consists of different actors that perform one or several activities. These actors are working together to a varying extent to perform in the best possible way to create a competitive advantage and satisfy the end-customer (Gustafsson & Rask, 2010). With the complex structure of the distribution and collaboration between the actors, it can be a challenge to find out which actors that are involved in the chain and what activities that are performed by whom.

1.3. Aim and Research Questions

The aim of this thesis is to identify the parameters of cost of poor quality for Transport Parts, so Volvo can include it in the Supplier selection model, used for choosing between transport providers. Further, the aim is to demonstrate the size of the cost of poor quality in comparison with other costs included in the Supplier selection model.

To reach the aim of the thesis, several research questions (RQ) have been identified that need to be answered. The questions are further linked to each other and RQ1 need to be answered before RQ2 is possible to investigate and RQ2 need to be answered before RQ3.

1. What does the distribution of Volvo's spare parts look like and who are the actors involved?

2. What actors and activities are affected by poor quality in the distribution of spare parts?

3. What costs does poor quality from transport providers lead to for the affected actors and activities?

1.4. System definition

The system studied in this study is pictured in Figure 1 and consists of the transport leg of spare parts from DCs (distribution centres) to dealers. Globally, the network consists of 44 DCs and over 4000 dealers. Within the system, there are three types of orders; day orders, stock orders and vehicle off road (VOR) orders, all described further in 4.4 Distribution of Spare Parts . Within the system, both physical flows and information flows are included. The physical flow is illustrated by the arrows in Figure 1 and the dotted arrows illustrate the reversed logistics. However, the VOR orders are not in the figure, even if they are a part of the system, since they are unpredictable and a result of a failure of any form in the system. The information flow is not pictured in Figure 1 but consists of all kind of communication that concern the physical flow between involved actors. Further, all actors within the system are not pictured in the figure. One actor that is a part of the system but is not pictured in Figure 1 is the Service centre, which is described further in 4.5.1 Operation. The other actors are all described in 4.5. Internal Stakeholders.

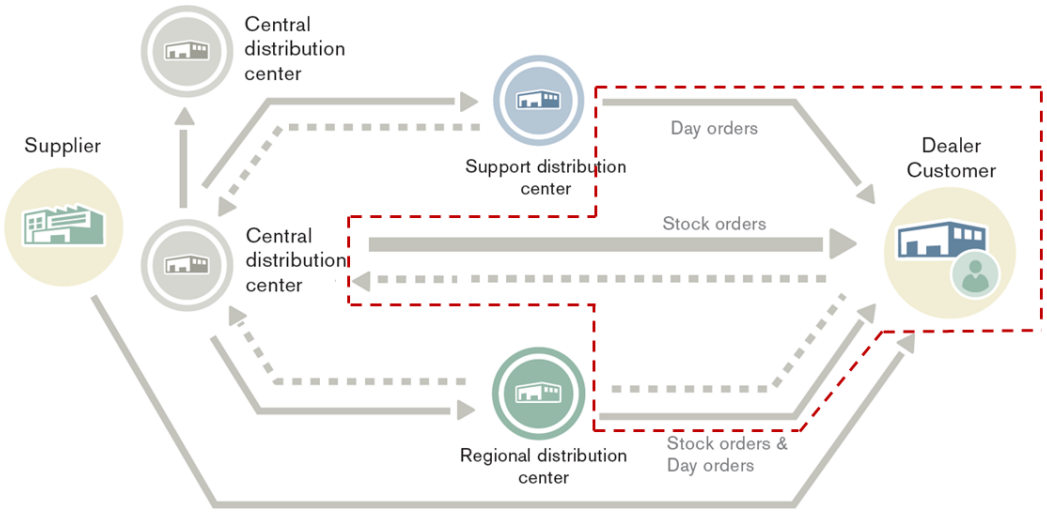

Figure 1: Illustration of the physical flow of the system that is in focus for the thesis

The area that is studied begins when the shipments have left the DC since it is only then that the transport provider can affect the activities, therefore no operations within the DC are included. For instance, costs that appear because of a pick and pack error in the DC and that delay a transport are not to be included. As mentioned earlier, the system is defined as the transport between DCs and dealers, which mean that transports between DCs are not included. The definition is made because the DCs have stock on hand acting as a buffer; meaning that a delay is not as severe compared with a delay within the distribution to a dealer.

The system ends when the dealers no longer are included in the communication or physical movement of the spare parts. Accordingly, the end-customer is included in the system as long as it also concerns the dealer. This mean that the possible effects on the end-customers' business due to poor quality in the transport are included in the system. Furthermore, the spare parts included in the system are the spare parts that Volvo have in stock in their DCs. A dealer can order spare parts from external suppliers, but these are not following Volvo's normal distribution structure and are therefore not part of the system.

1.5. Outline

To give the reader a broad picture of the report, the thesis structure is presented in this section. The thesis consists of seven chapters and the main points of each chapter is presented in Table 1.

Table 1: Outline of the thesis

2. Theoretical Framework	The chapter describes the former research and forms a frame of reference. Spare part distribution, different aspects of cost of poor quality and performance measurements, among others, are included.
3. Methodology	The methodology describes the research methods used in the thesis were the focus is on the interviews and the survey that have been carried through during the project.
4. Empirical Findings	The chapter includes findings from Volvo and its surroundings, from the distribution structure to the parameters of poor quality within Volvo.
5. Analysis of Empirical Findings	The previous research and findings from Volvo are linked and analysed. The results from the survey are presented and analysed to end up in an equation for how to calculate the cost of poor quality for Volvo.
6. Discussion	The chapter discusses the cost of poor quality and the findings and ends with suggestions regarding how the estimation of cost of poor quality can be improved and what is needed to keep it up to date.
7. Conclusion	Reflections are stated and conclusions are drawn in this chapter. A concluding statement is made regarding the research questions and aim of thesis.

2. Theoretical Framework

This chapter starts with an explanation of total cost of ownership and how it can be used in a purchasing situation. Further, the spare part distribution, particularly in the automotive industry, is presented. The costs that can arise in spare part distribution are explained and the cost aspects related to this study are discussed. Further, an explanation of the cost of poor quality is leading to a review of how performance measurements can be used to demonstrate how logistic costs impact the cost of poor quality.

2.1. Total Cost of Ownership

Total cost of ownership (TCO) is a method in purchasing with the aim of understanding the real cost of a purchase, and TCO can be used for all types of goods and services (Ellram & Siferd, 1993). This is done by taking more than just the purchase price in consideration; TCO should instead include all costs related to the acquisition, use and maintenance.

According to Ellram and Siferd (1993), the key benefit of using a TCO approach is that better supplier selections can be made by knowing the total cost. Further, an important benefit of a TCO model is that the information that is gained about where costs occur can provide important information which can be used for analysing and reducing the costs related to purchasing of goods or services.

If a purchasing company do not have hard data and only compare the direct purchasing price and the impression of how the supplier performs in other areas, the selection of a supplier may be based on gut feelings. A gut feeling is according to Ellram and Siferd (1993) strongly affected by recent events, which may not be relevant for the true historical or future performance of a supplier. To reduce the risk of making wrong decisions based on these gut feelings, perception need to be identified and quantified.

When analysing a company's TCO in a purchasing situation, the first step is to identify all activities that lead to costs and to classify these into different classification such as fixed, variable, direct, and indirect costs. This can be done by representing the activities in a flowchart (Ellram & Siferd, 1993). When the potential activities have been identified, Ellram and Siferd (1993) suggest four questions to be asked:

1. Which activities consume the most time?
2. What are the costs of these activities?
3. What drives the level of these costs?
4. For which costs is information readily available?

When these questions have been answered, the company can estimate the TCO and start working to reduce the TCO. If limited information is available about the costs of the activities, the focus in the beginning should be to select the costs that seem to be largest, relevant for decision making and most easily estimated. By doing so, it is possible to develop a TCO model that initially can be used and early gain the advantages of a TCO approach (Ellram & Siferd, 1993).

2.2. Spare Part Distribution

In order to investigate and analyse a spare part logistics network it is crucial to understand its general characteristics. The aftermarket, including spare part distribution, has become increasingly important for companies the past years. Focusing on the aftermarket and keeping customers has lower costs than finding new customers (Cohen, Agrawal & Agrawal, 2006). Spare parts are now a way to create long-term relationships and achieve greater customer loyalty for companies. Furthermore, Cohen et al. (2006) state that spare parts are a way to increase profits and revenues where they in many industries have been stagnating or declining. Wagner, Jönke and Eisingerich (2012) confirm this and state that in the machine and plant construction industry, spare parts make up to 25 percent of sales and 50 percent of profit for many companies.

The past decades, customers have increased their expectations of the delivery and long-time availability throughout the whole product life cycle (Wagner et al., 2012; Cohen et al., 2006). This has led to a tremendously increasing complexity of the spare part assortment, putting pressure on the spare part logistics. Furthermore, the spare parts market has high demand fluctuations and violability due to wear behaviour and failure rates, leading to a complex system requiring a lot of resources. Additionally, some spare parts have low or zero demand but are expensive and critical, which may require the companies to keep them in stock anyways (Martin et al., 2010). According to Rubin and Ehsanifar (2011), delivering value within service market logistics is much more complex than distribution of finished products leading to many companies struggling with it.

According to Cohen et al. (2006), customers do not expect products to be perfect, but they do expect manufacturers to quickly fix problems arising, hence why lead time is such a critical factor in spare part logistics. Furthermore, within the automotive industry there is a clear correlation between quality of after sales services from a brand and the customer's tendency to repurchase. The customers that Cohen et al. (2006) discuss can be end-customers, but they can also be the dealers who are customers for the manufacturing company. According to Meinig (1998), many manufacturers forget that dealers are a type of customer since they purchase the spare parts and products from the manufacturer. Meinig (1998) therefore states that the way a dealer is treated and how satisfied they are with the manufacturer has a large impact of the sales for the brand, since the dealer can choose to become an authorised dealer for a competitive brand.

In this complex environment of spare part distribution where the costs and service are crucial, the costs first need to be identified in order for them to be decreased. However, to identify the costs is seldom easy and requires a clear approach and strategy.

2.3. Logistics Costs

There are multiple ways of how logistics costs can be defined and what kind of cost components that it should include (Engblom, Solakivi, Töyli & Ojala, 2012). In general, four components are in some way included in the most definitions: transportation, warehousing, inventory carrying and administration. However, respective author defines the limits of the components in their unique way and includes different additional components. In this study, the definition of Jonsson (2008) has been used as a base and has been adjusted to be suitable for the purpose of the study.

According to Jonsson (2008) logistics costs are all costs that can be associated to logistics activities. Among these, a wide variety of costs are included, ranging from the transport and storage to administration. Jonsson (2008) has identified eight categories that logistics costs can be broken down to, these being:

- Transport and handling costs
- Packaging costs
- Inventory-carrying costs
- Administrative costs
- Ordering costs
- Capacity-related costs
- Shortage and delay costs
- Environmental costs

Six of the identified categories are not related to a transport provider's performance or are already covered in Volvo's Supplier selection model and these are transport and handling costs, packaging costs, inventory-carrying costs, ordering costs, capacity-related costs, and environmental costs. The other two categories, shortage and delay costs and administrative costs, can be related to the quality of a transport provider's performance. In comparison with many other, Jonsson (2008) have not included any cost parameter concerning the indirect costs, but has instead included it in the other cost parameters. However, to make it clearer in this study is indirect costs, here described as goodwill, given its own category. Further, Jonsson (2008) point out that a single cost can be attributed to more than one category and it is therefore of highest importance to make sure to not count a cost twice when consider the total logistics cost.

2.3.1. Shortage and Delay Costs

Shortage and delay costs consist of all costs related to that a delivery cannot take place at all or in another way than the customer wishes. Furthermore, Jonsson (2008) make a distinction between delivery precision and delivery reliability, where delivery precision measure the frequency of delays. Delivery reliability on the other hand refers the number of orders that arrive to the customer without complaints regardless if they are on time or not. Further, Stadtler, Kilger and Meyr (2015) state that the cost variables associated with delivery reliability are different from those associated with late deliveries.

2.3.1.1. Delivery Precision

Lead time is affecting the delivery precision and is measured as the time between the start and end of an activity (Jonsson, 2008). One type of lead time is delivery lead time which is measured as the time it takes for a part to get to the end location from the time a customer order is received. Lack in the performance of achieving the set lead time from a transport provider will lead to delays in the transports. The higher that the delivery precision is, the lower the frequency of errors in the lead time will be and vice versa. Delivery precision can be affected by deliveries that are late but also too early, depending on the agreement with the customer.

The costs associated with delays in the transport are according to Jonsson (2008) hard to estimate in advance since the activities that arise due to delays vary from case to case. Further, delays in the

transport can lead to various costs depending on who the receiver of the goods is. If the receiver is the end-customer, a delay may lead to loss of customer satisfaction and in the next step lead to that the customer may change supplier and choose another brand. If the receiver is a store that is supposed to sell the goods, delays may result in lost sales due to lack of goods, extra transport or loss of goodwill (Jonsson, 2008). This goes in line with Stadtler et al. (2015), who highlight the importance of having a high delivery precision to keep a strong and close relationship with the customer.

2.3.1.2. Delivery Reliability

Delivery reliability refers to whether the right product in the right quantity is delivered (Jonsson, 2008). The right product can often refer to the standard that the product is delivered in, in other words if the part is damaged at delivery. According to Jonsson (2008), a low delivery reliability leads to many unnecessary activities that would not been needed, and thereby also unnecessary costs. Quality errors, leading to damages on the goods, can occur both in the manufactures process and remind undefined until delivery or they can be caused during the transport.

Damages during transports are more frequent in some situations than others. Spare part deliveries are often sent in small quantities which mean that they cannot fill a full truck and thereby are sent in LTL shipments (Less than truckload). To reduce the total transport cost, these shipments are often consolidated which requires reloading between trucks and these reloading activities often causes damages on the goods (Lumsden, 2012). Accordingly, it is more common with damages for spare part deliveries since finished products and raw material are more often sent by FTL (Full truckload) shipments. Coyle, Langley and Bardi (2003) confirm that the risk of damages is higher with LTL shipments, but also emphasise other risks with the increased handling that comes with LTL shipments, such as that the goods can disappear during transport. On the other hand, emergency deliveries, commonly used for spare parts, are often sent in direct door-to-door deliveries using one truck for the delivery even if the goods do not fill the full truck (Lumsden, 2012). This means that the goods in these cases could be safer from damages during that transport than for FTL deliveries, since the risk of damages from other goods in the transport is reduced.

2.3.2. Administration Costs

According to Jonsson (2008), administration costs are all costs that can be related to planning and operative management of the goods flow. These are mainly costs for administration personnel but can also consist of costs for communication and IT systems. While implementation of IT systems could be a cost to take into account for Volvo's supplier selection, it more related to the change of a supplier rather than the performance of a supplier. Accordingly, communication related to administrational personnel makes up the larger part of administration costs related to the performance.

According to Aharonovitz, Vieira and Suyama (2018), communication includes solving logistics problems and contingencies. In other words, communication performance could be evaluated on how involved a supplier is in solving contingencies and other problems.

In a case study by Löfdahl and Sjödin (2013) regarding the importance of different aspects in supplier selections, communication openness had the relative weighting of 1 percent, which is by far lowest in the study. It could further be compared to product quality at approximately 30 percent and on time delivery at 14 percent. Furthermore, when using the weightings in the model, Löfdahl and Sjödin (2013) were not able to retrieve any answers from potential suppliers regarding their communication openness. This implies that using communication costs in a supplier selection is very difficult. According to Sarkis and Talluri (2002) (as cited in Löfdahl & Sjödin, 2013), one way to evaluate communication, and thereby use it supplier sections, can be by asking the question "How open is the communication with the supplier?". It is not clear how the answer to this question can be translated to hard facts, instead it is most likely so that the answers will be dependent on perception and gut feelings.

2.3.3. Goodwill

Many authors have mentioned the importance of a well-functioning logistics system to make sure that the end-customer is not negatively impacted and thereby get a negative impression of the company. For instance, Jonsson (2008) mentions problems of not being able to supply the customer due to problems with the logistics, which may lead to effects on the goodwill. Further, Cohen et al. (2006) state that the overall quality of the aftermarket logistics is highly important to not affect the customers' perception towards the company.

According to Cohen and Lee (1990), consumers' expectations for quality and performance in the most product segments have increased. But it is not only the products that are in focus for the customer, also the aftermarket is under pressure from the consumer who demands fast and reliably service. Cohen and Lee (1990) mention two types of costs related to having a high performing aftermarket: direct and indirect costs. The direct costs are the costs that are associated with solving the problem and are often relative easy to identify. The indirect costs consist of costs of having a product unavailable and unusable. These are in many aspects much more complex to quantify, but at the same time they are usually more important to quantify due to their large size. This is especially important if the customer is dependent on the product for his business or way of life (Cohen & Lee, 1990).

Cohen et al. (2006) state that one important figure that tells how likely it is that customer will stay with a specific brand and do repetitive buying is the satisfaction of the aftersales services. More specific, this has been proved for the automotive industry where it is possible to see a distinct correlation between customers intention to do repurchase and the quality of the aftersales services. Furthermore, Cohen et al. (2006) accentuate aftersales support as the most long-lasting source of revenue while it at the same time requiring small investments. Cohen et al. (2006) claim that it is a big problem that many executives do not realise this and thereby increase the risk of losing customers and decrease the revenue for their companies.

Liberopoulos, Tsikis and Delikouras (2010) state that the indirect costs, in the form of impact on the company's goodwill when not being able to satisfy the customers' demand, often are much harder to evaluate than the direct costs for transportation. According to Liberopoulos et al. (2010) the impact on goodwill is especially noticeable in a competitive market where the customer easily can change between suppliers.

2.4. Cost of Poor Quality

The definition of cost of poor quality is, according to Sörqvist (1997), "The cost which would be eliminated if a company's products and processes in its business were perfect". The cost of poor quality is approximately 25 percent of sales for many companies, but it can be tremendously higher if badwill and loss of customers would be included (Sörqvist, 1997). Even though this is known, many organisations do not measure costs of poor quality and takes actions to decrease these costs (Abramsson et al., 2006). One reason for this could be the disagreements regarding which costs are included in poor quality, as Sörqvist (1997) states that there are often discussions and disagreements regarding which costs that are associated with poor quality.

According to Gustafsson and Rask (2010), costs from a logistics perspective can be divided into the three categories; operative costs, costs for tied-up capital and logistics quality deficiency. Logistics deficiency cost covers all costs that can be associated with not being able to meet agreed service level. Accordingly, it can be compared with the term used by Volvo (i.e. cost of poor quality). However, few studies have been made in the area of logistics quality deficiency which mean that it does not exist any widely acknowledge way of how to use performance measurements to estimate the size of this cost (Forslund, 2007).

Another reason why companies do not work with cost of poor quality may be the difficulties that comes with it. Eldridge, Balubaid and Barber (2006) states that there are five obstacles for working with cost of poor quality; lack of understanding and awareness, company culture, lack of information, confusion between organisational hierarchy and inefficiencies of accounting information. These obstacles must therefore be removed for a company to successfully work with cost of poor quality. While many companies do not have all these obstacles, they still need to eliminate the ones they have or the work with cost of poor quality will not be best possible (Eldridge et al., 2006).

According to Sörqvist (1997), a good way of carry out the work with cost of poor quality is to start with a simple survey where the most basic parameters mainly are used to make it more tangible and create understanding on management level. By having support from the organisation, it is then possible to expand the scope of poor quality by improvements in the organisation, such as developing capable measuring methods for other key costs aspects.

2.5. Performance Measurements

The main purpose of logistics is to improve companies' efficiency and effectiveness and, in that way, create high performance and competitiveness (Jonsson, 2008). By measuring and follow-up performance variables, that express different aspects of performance, it is possible for companies to formulate a business strategy that support competitiveness. According to Brewer and Speh (2000) a generally accepted performance measurement framework does not exist within supply chain management. However, it does not mean that it is irrelevant to use performance measurements for supply chains. Caplice and Sheffi (1995) instead highlight the importance of using performance measurements for logistics. Performance measurements do not only have a direct impact of the logistics strategy, but also has a big impact on other selections, such as supplier selections.

Additionally, both Caplice and Sheffi (1995) and Ploos van Amstel and D'hert (1996) emphasise the importance of using performance measurements that are uniquely adjusted to each company.

One of the most important factors to take into consideration when working with logistics management is according to Caplice and Sheffi (1995) the impact on the customer. Performance indicators related to quality which are measuring customer service can be percentage of shipments that resulted in a complaint of a customer, mean correction time, maximal acceptable correction time, and number of damages/claims (Ploos van Amstel & D'hert, 1996).

Brewer and Speh (2000) argue that even though there are hundreds of metrics within logistics, the metrics do not usually measure chain-spanning activities and it is difficult to compare supply chains with each other through the metrics that are commonly used. According to Ploos van Amstel and D'hert (1996) performance measurements must satisfy seven conditions:

1. The performance indications must be realistic and representative, so that the gathered information reflects reality.
2. The measurements must be performed consistently, in order that they are defined and quantified in the same way throughout the entire distribution chain.
3. The performance indicators must relate to the commercial and distribution process between producer and customer.
4. The performance indicators should not only be expressible in physical units, but also in financial terms.
5. The performance indicators must be able to make costs transparent and to provide a basis for investment decisions.
6. The performance indicators must reflect the responsibilities of the managers involved in the distribution process.
7. The costs to collect and present the performance indicators should reflect the benefits of the information.

It is very likely that the hundreds of performance measurements that Brewer and Speh (2000) discuss do not all fulfil the conditions stated by Ploos van Amstel and D'hert (1996). Further, Rafele (2004) state that many companies add performance measurements continuously, but rarely remove any KPIs. Furthermore, Keegan, Eiler and Jones (1989) (as cited in Rafele, 2004) argue that the problem for many firms is that they have too many measurements and that many of the performance indicators are obsolete and inconsistent.

Sörqvist (1997) recommend a five-phase model of developing a measuring a system, that is a pre-requisite to be able to identify and use cost of poor quality. The first step is to prove a need of using performance measurements to get support from the company's management. The next step is to develop the measurements and carry through a pilot test. In the second step it is important to include as many employees as possible so they feel like a part of the development and are eager to use it. The third step is to teach everyone how to use the measurements in the right way. The two last steps are according to Sörqvist (1997) to implement the measuring system and to fully use and maintain it in the organisation.

2.6. Synopsis

By the literature review, it is clear that the spare part distribution in the automotive industry is a complex system where logistic costs can have a large impact. The cost of poor quality from the transport provider in this distribution can be affected by several possible logistic cost parameters. Further, in order to include these cost parameters in the cost of poor quality, one need to be able to measure them. Accordingly, performance measurements for these parameters need to be in place.

Consequently, to be able to identify the cost of poor quality and to be able to include it in the Supplier selection model for Volvo, the cost parameters that can be a result of poor quality from transport providers need to be identified. However, as every supply chain is unique, it can exist cost parameters that are not identified in the literature review.

A potential equation for the cost of poor quality in the transport of spare parts in Volvo's distribution can thereby be stated as Equation 1. Further, in line with TCO, the activities that can be an effect of poor quality in these cost parameters need to be estimated.

Equation 1: Potential aspects of cost of poor quality

$$Cost\ of\ poor\ quality = cost\ of\ poor\ communication + cost\ of\ poor\ delivery\ precision + cost\ of\ poor\ delivery\ reliability + potential\ cost\ aspect\ not\ identified\ yet$$

3. Methodology

In the following chapter, the ways that the data collection has been carried through will be presented and discussed. This data collection consists of a literature review, semi-unstructured interviews and a survey that was sent out to dealers to collect their opinions. Further, the quality of the research is discussion and the methods that have been used to analyse the gathered data are presented. The chapter end with a discussion about the limitations of the thesis.

3.1. Data Collection

A literature review was done throughout the project, with a more extensive focus in the early phase of the process. Former research was found through databases as Scopus and Google Scholar, previous relevant courses and master's theses. In an early stage of the project, the literature was used to get basic knowledge of what logistics aspects that could be a part of poor quality and to build a theoretical framework around it. Through this, it was possible to have a narrower focus in the next steps and have a faster progress in the process. Later, the theory was used for the analysis, when the literature was compared with the empirical findings and in that way find shortcoming and strengths. The empirical findings regarding Volvo's case were collected through interviews and a survey to Volvo dealers described further below. Furthermore, secondary data was also gathered from internal documents and presentations.

3.1.1. Interviews

Interviews were conducted in different stages of the project to collect information from employees at Volvo as well as from dealers. A list of the 31 persons who were interviewed can be seen in Appendix A - List of Interviewed Persons. The interviews had a length of 30 to 60 minutes. While the interviews did not have the same purpose or aim, they were all semi-structured. In the beginning of the project, interviews had a more general approach where the goal was to get an understanding of the current situation and the flows of goods and information. In this stage, employees with a broad knowledge of the whole flow, as purchasers and transports coordinators, were interviewed. Accordingly, the questions in these interviews were more generalisable without asking about details of specific activities.

Further on in the project, the interviews were more specific and detailed. The general goal of the interviews in this stage was to obtain information regarding specific actors and activities and how they are related to parameters causing poor quality. The specific subjects in the interviews were based on the expertise of the person who was interviewed. For instance, if the person work with reversed logistics, the questions were about what role the reversed logistics has in the performance of a transport provider. To fully understand what role that the interviewees had, the interviews started with questions regarding his or hers work tasks and what they do in their daily operation. In that way, the further questions regarding how his or her work is affect by the performance of transport providers could be adjusted to more fit the role of the interviewee.

3.1.1.1. Semi-structured Interviews

By using semi-structured interviews, it is possible to ask additional questions that arise during the interviews. Another large advantage with interviews is that questions could be explained further,

which was needed in some situations since some terms are not being used in the same way in the whole organisation. In addition, with interviews it is possible to consider other things as body language and intonation (Bryman & Bell, 2015). On the other hand, Volvo is acting globally and the study had a global focus, meaning that interviews also were conducted with people outside Gothenburg. This resulted in that many interviews were done through telephone and Skype, which reduced some of the described advantages of interviews.

The main disadvantage with interviews is that they are time consuming, since it takes a lot of time to form the questionnaire, carry through the interviews and analyse the result. Further, a risk with using interviews is that the questions can be suggestive, why it is important to take time to carefully write and evaluate the questions beforehand (Bryman & Bell, 2015). In an early stage of the process, when the factors included in poor quality were to be identified, the interviews had more open questions. The reason for this was to not affect the interviewees and keep an open mind to all possible aspects and paths that the project could take. The interview questions were in a later stage, when the effect of the identified factors was to be specified, shifted to more closed character.

3.1.1.2. Interviewed Actors

The selection regarding what people to interview was done in multiple ways. The supervisor at Volvo had suggestions for whom to interview, since she had a good insight in the organisation and thoughts regarding who would be of value for the project. The suggested interviewees did for example included the purchasers. The purchasers were all invited to interviews but not all responded and therefore, the interviews were held with the three persons who did answer. Since all purchasers had similar working tasks, it was concluded that interviews with those persons was sufficient. Furthermore, the purchasers were not the largest part of the study, and the interviews were of a more general approach and therefore it is assumed that the bias does not influence the results of the study. The questions to the purchasers regarded the actual way of working with the transport providers, their view of quality from transport providers, the transport contracts, and from literature identified quality aspects. The question areas were asked in an order that made the purchasers give their opinions regarding the quality and afterwards questions regarding specific quality aspects were asked. The purchasers provided knowledge regarding what the transport flow look like and which actors that are involved, and then interview invitations were sent out to those actors. In this way, the authors got in contact with service centre Nordics.

The procedure for the interviews with the service centres was similar to the interviews with the purchasers. Invitations was sent to all service centre managers within EMEA and 9 of 11 people answered and those were therefore interviews held with. A 10th service centre manager was not interviewed but an e-mail correspondence carried out. The interview with service centre Nordics was more comprehensive than the other eight interviews since it was held in the beginning of the project when more knowledge was needed. The interview with service centre Nordics spanned areas such as the organisational structure and scope of service centre and the communication held with dealers and transport providers. The other eight interviews had more specific questions in which the questions were approximately the same as for the three service centre coordinators in service centre Nordics. During all interviews with the service centres, the authors also asked if the interviewees had suggestions on who could help the authors progress in the project, and from this the transport coordinator and the supplier manager was contacted.

To get the dealers' view of how they are affected by poor quality from transport providers, the project started with visiting a dealer in Southwest Sweden to see how a workshop is built-up and how the work is carried through in the workshop. The dealer was chosen since it was located within reasonable distance, meaning that it would be easy for the authors to travel to the interview. Furthermore, to visit the dealer gave the possibility to have deep-interviews. These interviews were semi-structured, with the purpose of using previous knowledge to restrict the interviews to the scope of the project but at the same be open to that aspects that had not been considered before could be highlighted by the dealer.

During the next step, to get a picture of what more dealers thought about poor quality, four dealers were contacted for interviews over telephone. The dealers were randomly selected from dealers within Sweden. The purpose of these interviews was to investigate if there exist any differences between the Swedish dealer visited earlier and the other dealers. When the initial meetings and interviews with dealers were held, it was possible to identify the activities that are affecting the dealer because of poor quality from a transport provider. The authors concluded that there exists an uncertainty of the cost for these activities and that the costs possibly could vary from dealer to dealer. Therefore, it was decided that it would be inappropriate to estimate these costs by interviewing a few dealers. Instead, to retrieve information from a high number of dealers, a survey was considered to be more appropriate. Further, the interviews gave a deep understanding and context while the survey gave a more generalizability numbers for how the dealers are affected of late deliveries.

3.1.2. Survey to Dealers

There are multiple advantages with surveys, one being that they are time-efficient. This was a large advantage in this study since it most likely not would have been possible to use interviews to make this type of large scale data collection due to the time constraints. Further, some analyses are easier done by surveys instead of interviews since the answers will be in the same form. Furthermore, a web survey was used with the advantage that it is easier to collect the answers by automatically downloading and compiling the answers into a database (Bryman & Bell, 2015). However, a risk with using surveys is that you cannot explain a question further if it not is understood by the respondent meaning that the questions must be clear and carefully designed.

Additionally, a survey goes in line with what Sörqvist (1997) argue as a good starting point for using the cost of poor quality. According to Sörqvist (1997), it is possible to create an understanding on management level by using a survey with acknowledged parameters. From that, it is then possible to expand the scope by continue developing the poor-quality concept. To plan, construct and carry through the survey, a model consisting of 19 steps by Bryman and Bell (2015) was used and modified to the six steps seen in Figure 2.

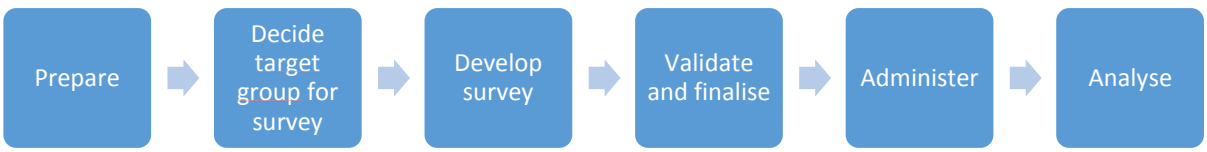

Figure 2: Steps of conducting the survey, inspired by Bryman and Bell (2015)

The prepare phase, consisting of reviewing the focus area and the related literature, had already been done when a survey was decided to be carried out. Accordingly, the next step was to consider what kind population that should be investigated and what sample design to employ.

3.1.2.1. Target Group for Survey

Since the project was limited to EMEA, the dealers within this region were relevant to study. Within EMEA there are 2130 different dealers and accordingly, these were also the total potential population of investigation. Due to some mistakes, the 24 dealers that are located in Turkey were not included in the list of dealers even though they are a part of EMEA, and these dealers did therefore not receive the survey and the possible sample size decreased to 2106 dealers. The potential implications on the result due to this are discussed further in 3.1.2.4 Response Analysis.

After further inspection, it was concluded that some of the dealers were part of the same corporate group and had the same contact person. To make sure that their answers were not counted multiple times and thereby lead to misleading results, those dealers were only giving the possible to answer the questionnaire once.

A confidence interval of 90 percent and a margin of error at 10 percent were decided to be a good trade-off between the works needed for the survey and to get accurate numbers out of the survey. With the formula in Equation 2, the number of dealers that was had to answer the survey, the sample size, was estimated to be 67 which the authors believe is an appropriate and feasible number.

Equation 2: Estimation of the sample size to survey

$$SS = \frac{Z^2}{c^2} * p * (1 - p)$$

SS = sample size
Z = 1,645 (given from the decided confidence interval)
c = confidence interval (10 percent = 0,1)
p = 0,5

According to Anseel, Lievens, Schollaert & Choragwicka (2010), the response rates of surveys has declined due to the increased popularity of using surveys. Further, Anseel et al. (2012) argue that the response rate varies a lot between different kind of surveys and that it is hard to predict in advance. Furthermore, as the majority of the dealers are not internal employees at Volvo, it can result in a lower response rate than for employees who may see it as a part of their work to answer surveys will in the end help Volvo improve. With this in mind, it was estimated that a response rate of around 15 to 20 percent would be reasonable to anticipate. Accordingly, the survey was needed to be sent out to around 400 dealers to reach the desired level of more than 67 answers.

The authors had been sent a list of all dealers that belonged to Volvo Group's brands. The dealers who were chosen to receive the survey was randomly selected among all the dealers that earlier have been described as possible to contact. The randomisation of dealers was done by each dealer was assigned a random number through the Excel's RAND function. The randomised numbers were then sorted in rising order, and in line with earlier estimation, the survey was sent out in that particular order until it had reached 398 dealers.

Worth to notice is that the dealer list from which the randomised selection was made did not include Volvo Penta dealers due to mistakes from Volvo's part. Globally there are 3500 Volvo Penta dealers but it is not at the time of writing known how many of these that is located in EMEA. Furthermore, it is not known how many of the dealers that are only Volvo Penta dealers and how many dealers that are also dealers for another Volvo brand that are already included in the dealer list, i.e. it is not known how many more dealers there would be in the dealer list and possible sample size if Volvo Penta would be included. It is therefore not possible to know how this affected the survey.

3.1.2.2. Development and Validation of Survey

A questionnaire was constructed by the authors with questions related to the identified activities and with the main purpose of identify the costs associated with these activities. The purpose was to have a short but concise survey, so that the dealers would not be overwhelmed by the number of answers. Furthermore, it would not be appropriate to use multiple choice or intervals regarding the time estimations, since it would most likely influence the respondents regarding their answers. Furthermore, if the authors needed to change the intervals during the analysis, this would not be possible. If the respondents themselves would type their answers, they would not be influenced by the intervals and the authors could then afterwards make intervals according to the answers.

The invitation and introduction text to the survey was carefully constructed in line with the recommendation stated by Kaplowitz, Lupi, Couper & Thorp (2012). The URL location was place to the end, an estimation of the effort was mentioned and an “authoritative’’ subject line was used. According to Kaplowitz et al. (2012), these things can increase the response rate of the survey. The questionnaire was discussed with purchasing analysts and external people who earlier had used surveys in their research to validate the survey's relevance and correctness. When the questionnaire had been constructed, a pilot study was carried through to make sure that the survey was understandable for the dealers and that they answered as intended. The pilot objects were dealers who the authors had not been in contact with earlier during the project, so that the dealers would have the same pre-conditions as the dealers who later would receive the survey.

The pilot lead to minor adjustments were made to the questionnaire before it reached its final appearance that can be seen in Appendix B – Survey Questionnaire. Among the randomised dealers, some of the e-mail addresses were invalid and the survey did therefore not reach those dealers. Instead, the survey was sent out in six rounds following each other until the survey had been successfully sent to the appropriate number of dealers. The survey was not sent out in one round since Outlook had restrictions in the number of recipients per e-mail. Further, since some e-mail addresses were invalid and could not be delivered, the authors had to continue sending out the survey to reach the determined number of recipients. The authors investigated whether dealers from specific regions or non-Volvo owned dealers had invalid e-mail addresses. Though, it was not possible to identify any common thread between the invalid e-mail addresses, meaning that it can be assumed that the errors were randomised. Therefore, this should not have any impact of what kind of dealers that received the survey, nor the result of it. The split between the countries that received the survey can be seen in Figure 3. Since the selection was randomised, the division of countries who received the survey is approximately equal to the division of countries where there are dealers.

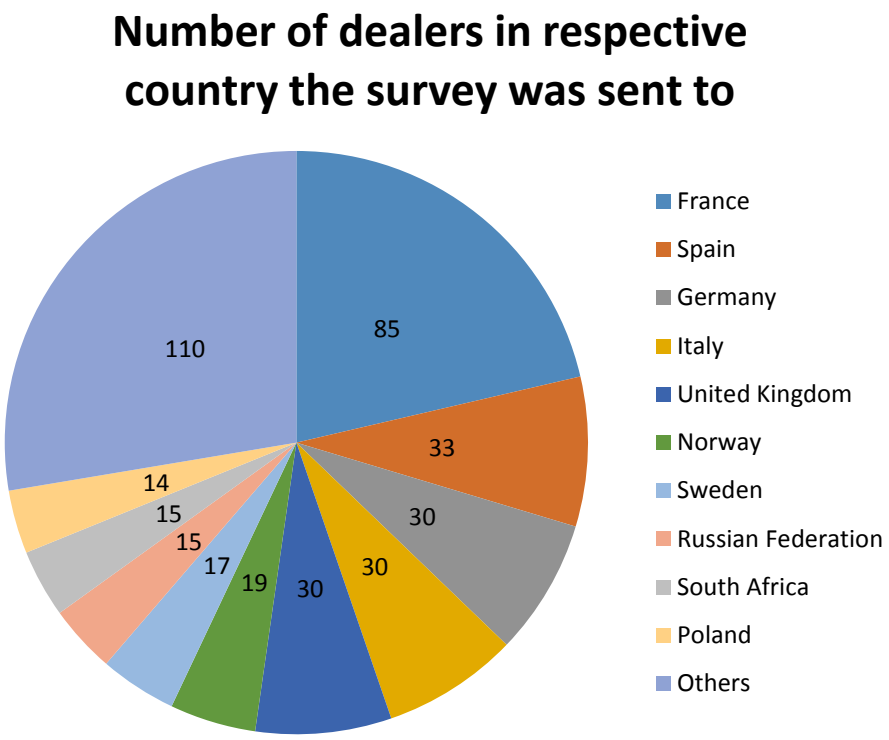

Figure 3: Number of dealers in respective country that the survey was sent out to

3.1.2.3. *Administer Survey*

When the survey was sent out, the authors administered the survey by answering e-mails and phone calls from three dealers who had further questions about the survey. Two of the dealers were from France and asked if it was possible to send the survey in French and one Bulgarian dealer asked if the survey was the same survey that Volvo's SML department sent out, discussed further in the next section 3.1.2.4 Response Analysis. Due to communication restriction that arose after the survey was sent out, it was not possible to send out any reminders to dealers who had not answered. This restriction also led to that it not was possible to send out the survey to more than the 398 dealers that it was sent out to from the beginning. A discussion regarding on how this may have affected the results is further discussed in the next section. Two weeks after the survey was sent out, it was taken down to compile and analyse the answers.

3.1.2.4. *Response Analysis*

All dealers in the dealer list did not have e-mail addresses connected, and in the cases with missing contact information, the e-mail addresses were looked up at the dealers' websites. This might have lowered the response rate from these dealers, since the e-mail might not have been sent to the appropriate person. On the other hand, excluding these dealers and only sending to dealers who's e-mail addresses were know would have skewed the result. Furthermore, the known e-mail addresses were in many cases a non-specific address, such as an info e-mailbox and not to a specific person. In the cases when the contact information was manually retrieved, the e-mail addresses were in nearly all cases to a specific person, such as the parts or service contact, which could mean that the

response rate is higher for those than for non-specific e-mail addresses. Though, this was not investigated by the authors due to time restrictions.

In total, the survey had a response rate of 8 percent, which represent an answer from 32 dealers. Among the answers, dealers from all across EMEA are represented, see Figure 4.

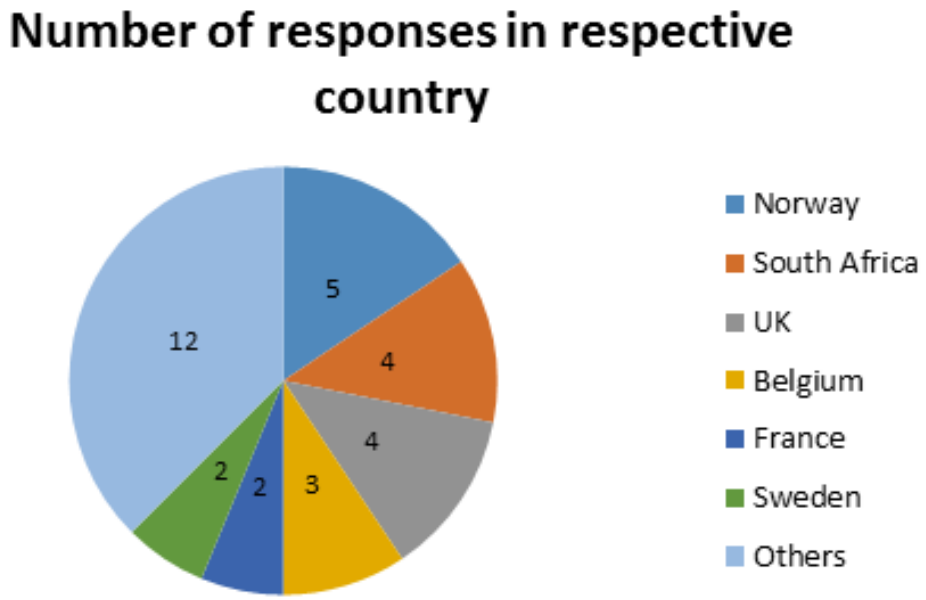

Figure 4: Number of responses on the survey from respective country

Figure 4 can be compared with Figure 3 where the number of dealers in respective country that the survey was sent out to is illustrated. By that, it is possible to conclude that France had very few respondents compared to how many dealers that received the survey. The reason for this is most likely language barriers, especially since two French dealers responded and asked if it was possible to receive the information and the survey in French instead of English. That language barriers exist among the dealers could also be seen by that four dealers responded in their mother tongue, instead of English. However, these answers were translated by Google translated and handled as the rest of the answers.

The communication restrictions that arose during the project most likely led to a lower response rate than what was previously aimed for. According to Bryman and Bell (2015), a low response rate means that it is more likely that it will be a great bias in the answers and that the answers may therefore not be representative for the sample. Further, a low number of respondents mean that one answer can have a larger impact on the average and median values. Accordingly, the low response rate could lead to that the result of the survey is misleading. To what extent this was the case for this study is further discussed in connection to the analysis of the survey in 5.1.3 Delivery Precision.

As mentioned in 3.1.2.1 Target Group for Survey, the 24 dealers located in Turkey where not included in the list of dealers from which the randomised selection was made. While this could have

have an impact on the results, the likelihood is small. Disregarding the Turkish dealers, 18.89 percent of all dealers were contacted for the survey. When including the Turkish dealers, this would mean that four dealers statistically would be contacted following the randomised sample. When also considering the response rate of eight percent, it is likely that none of the Turkish dealers would have answered. Though, it could not be investigated whether it would be likely that the Turkish dealers would have answered differently than the other dealers.

The respondents are located in all areas of EMEA; Europe, Middle East and Africa. However, there are fewer respondents from Middle East and Africa than there are respondents from Europe, which could be explained by that there are more dealers in Europe than the other areas of EMEA. Africa has the highest response per dealer rate which may skew the results a bit, but since the difference is minor it is thought to not influence the results significantly.

Once annually, Volvo's Service Market Logistics department sends out a survey to all Volvo's dealers to measure service, ease of doing business with, correct part, quantity, quality, timeliness as well as overall satisfaction. In 2018, this survey was available for the dealers to answer from the 26th of March to 13th of April, meaning that there was a small overlap with that survey and the survey sent out for this thesis. This could have created confusion for the dealers, since they had to answer to different surveys within a short time span. As mentioned earlier, this was also confirmed when a dealer asked if they should answer both surveys. On the other hand, this confusion is probably not widespread since it is clear that the other survey measures satisfaction on scales, while the survey for this thesis is only regarding late shipments and the dealer's estimation of time consumption for activities. Furthermore, when reading the e-mail sent along with the surveys, as well as when opening the two surveys it is clear that they are of two separate kinds. Accordingly, this has probably not affected the response rate or result of the survey a lot.

3.2. Method of Analysis

Two types of data analyses methods have been used in this study, a quantitively method of analysis and a qualitative method of analysis.

The quantitively data analysis mainly occurred in the end of the project but, in line Bryman and Bell (2015) who state that it is important to think about how the analysis should be made already before the collection of data has taken place, it was kept in mind during the whole project. This was also considered when construction the survey and its questions. The authors therefore wrote questions that were possible to analyse. Further, the raw data, which mainly was collected through the survey, was turned into information that could be used in the estimation of the cost of poor quality. In order to do so, the raw data needed to be organised in an explicit way which was done through usage an Excel sheet. However, before analysing the data, possible errors in the data needed to be identified and handled, which was the case when two dealers clearly misunderstood some questions. Further, the same type of raw data can be interpreted in different ways and thereby emphasise the result differently. Accordingly, a scientific thinking was needed to present the data in a fair and usable way.

The answers from the survey was compiled and graphs were made on the questions with numerical answers to get a visualisation of the responses. Correlation was calculated for the questions that

clearly were related (such as question 4a and 4b seen in Appendix A) but also for questions not clearly related.

The qualitative data analysis approach was used to analyse the interviews, documents and free text answers in the survey. According to Bryman and Bell (2015), qualitative analyses do not have any firmly set rules for how it should be carried out in contrast to the quantitative analysis. At the same time, qualitative data consists of soft data that need to be structured and analysed. Accordingly, a qualitative analysis put a lot pressure on the researcher, as the findings from the data depends on the judgement from the individual. In this study, the quantitative analysis was carried out by segmenting the information between the sources of information. Further, analyses were made within the segmented groups to find general opinions or facts, and afterwards it was possible to do analyses between the different groups. Through this, the scope of each analysis was smaller and more manageable. It also meant that it was possible to draw conclusions from these smaller groups even if the data was very scattered in the bigger picture.

3.3. Research Quality

There are more things than research method and design that affects how well a study is performed. During research it is very important to be critical and to evaluate if the methods used are appropriate. According to Bryman and Bell (2015) there are two main criterions for evaluating research: reliability and validity.

Reliability is concerning whether or not the study and its results are repeatable (Bryman & Bell, 2015). For a study to have high reliability, the results must be consistent. The consistency in this study could in some extent be questioned, mainly due to the survey. The dealers estimated their answers to the questions, which indicate that if another person in the same workshop would answer the survey, the results may be different. The answers could also differ even if it is the same person who answered the survey since the answers could depend on that person's current state of mind and the person may trust his or her gut feeling. However, with an appropriate response rate, the answers would represent the whole population and not be biased. Since the response rate to the survey in this study was fairly low, due to earlier described reasons, it would not necessarily have the same result if repeated.

Validity is in many ways the most important criterion and relates to if a concept or conclusion actually denotes reality (Bryman & Bell, 2015). In other words, validity is the degree to which a study measures what it is said to measure (Björklund & Paulsson, 2003). In order to increase validity of this study, triangulation was used. This is done through comparing interview answers from persons that had the same, or comparing, working tasks. For example through comparing answers from the service centre managers. But also, by comparing thoughts and opinions regarding the same topic from different people involved in the same activity, such as dealer and service centre. As it has not been any earlier extensive studies on cost of poor quality, it does not exist any widely accepted definition to compare the result with which means that it was not possible to compare interview findings with literature to a very large extent. However, the authors did answers the aim by identifying the parameters of poor quality for Volvo's transport providers of spare parts. Further, with this definition of poor quality, it was possible to compare the cost of poor quality with other costs in the supplier selection which mean that also the second part of the aim was possible to reach

by the used method. However, as the labour costs number used in this study are based on average numbers and not for the specific Volvo actors, these numbers need to be validated to surely represent the identified actors. Further, the low response rate in the survey also mean that the used numbers from this are not surely valid and representable for the whole populations.

3.4. Limitations

Because of time and monetary aspects, the authors were not able to travel outside Sweden, hence no dealers or other actors outside the borders were possible to visit. This means that it was not possible to talk face to face to people abroad, and therefore communication with these people were limited to Skype or other communication technology. Because of this, people in the Gothenburg office have been over-represented among the interviewees in comparison with the number of employees in the office. This could have led to things that are of particularly interest for people in Gothenburg are highlighted more than they should or vice versa. On the other hand, it is possible to argue that the affected persons are more located in Gothenburg, since the transportation sourcing has its base there. Accordingly, employees in the Gothenburg offices could have been a large part of the interviewees regardless of where the thesis had its base. Further, one of the more important methods of collecting data in this study, the survey, did not have this issue which limit the potential problems of this limitation.

From initial meetings, it could be concluded that the organisation works very differently in the different regions of Volvo. Furthermore, due to lack of opportunity to make contact and time constraints, it was together with responsible and affected people decided that the investigation should be limited to EMEA only. Accordingly, the result of the study will only be directly useable for EMEA. However, the purpose is that several parts of this study should be usable for the other regions, so that cost of poor quality can be included in sourcing projects in those regions as well. In order to include the cost of poor quality in the other regions, the same method of investigation and analysis can be made but it would be appropriate to see if the way of working is in the same in the other regions. Since the study has been carried out in interaction with stakeholders in EMEA, it could meet resistance if trying to apply the findings in other regions. Therefore, it would be important to have a close collaboration with, and to early include, stakeholders in the other regions when using findings from this study in those regions.

4. Empirical Findings

The following chapter contains the empirical data that have been found throughout the project. The beginning of the chapter contains a higher-level description of the organisation and projects for which this thesis is most relevant. In the later part, the findings for how poor quality affects different stakeholders are described. If not stated otherwise, the source of information is the described interviews in 3 Methodology.

4.1. Volvo Group and its Organisation

Volvo Group, founded in 1927, is one of the leading manufacturers of trucks, buses, construction equipment and marine engines. The total sales for Volvo Group in 2017 were 335 billion SEK (Volvo Group, 2018a). Volvo Group owns several brands, for example Volvo Trucks, Volvo Buses, UD Trucks and Renault Trucks, but also have three joint ventures in Asia; Dongfeng and SDLG in China and Eicher in India, all seen in Figure 5. Volvo has three truck divisions which are:

- Volvo Group Trucks Technology: Responsible for R&D for complete vehicles, components and service offerings.
- Volvo Group Trucks Purchasing: The division for purchasing of automotive products and parts, including aftermarket, for all truck brands within Volvo Group.
- Volvo Group Trucks Operations (Volvo GTO): The division for the manufacturing of cabs and trucks for Volvo, Renault Trucks, Mack and UD Trucks as well as the production of engines and transmissions.

The actual logistics and transport operations lie under Volvo GTO and Volvo believes that it is better if purchasing of logistics is closer to the operations instead of the other purchasing departments. Therefore, Volvo GTO is also responsible for purchasing of logistics solutions within Volvo Group (Volvo Group, 2018b).

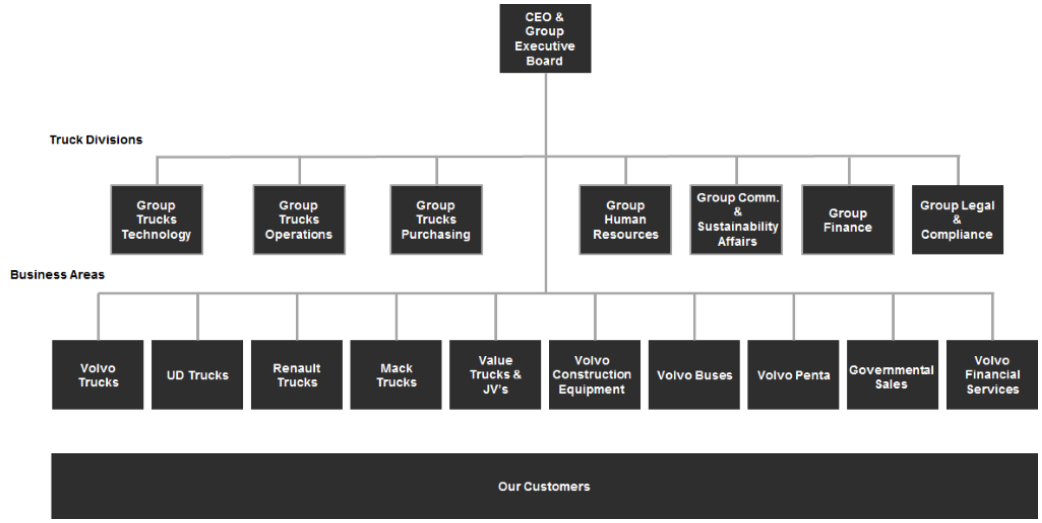

Figure 5: Volvo Group's organisational structure

Within Volvo GTO there are several subdivisions which are seen in Figure 6. Two of the subdivisions are Service Market Logistics and Production Logistics. Before July 2017, these departments were one but were split because of a new organisational structure. There may be confusion since this thesis is related to spare parts, which usually is handled by Service Market Logistics, but it lies under Production Logistics. Transport Parts was put under Production Logistics since it is closely related to Transport Material and Transport Products, which evidently should be positioned under Production Logistics, and there are thereby great synergies to be leveraged between the areas. This thesis was therefore under the department Production Logistics but within the service market area and therefore, multiple of the people contacted was under the Service Market Logistics department.

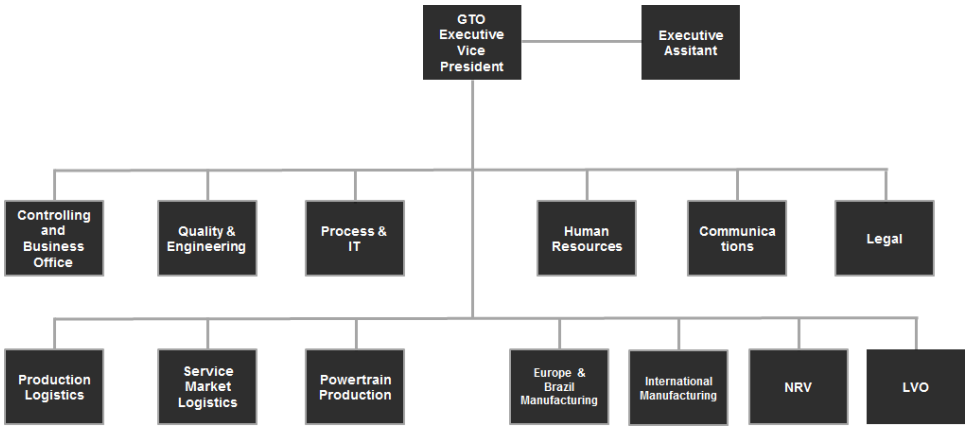

Figure 6: Volvo GTO's organisational structure

Logistics Purchasing is a sub-entity of Production Logistics responsible for the sourcing of transports globally. They initiate and manage the sourcing projects and do the selection of which transport providers to subcontract. With the responsibility of purchasing transport solutions for Volvo globally, the performance of Logistics Purchasing affects many other divisions and affects both the direct costs but also future revenue. Accordingly, Logistics Purchasing can have big impact on Volvo's bottom line.

4.2. The Sourcing Process

The procurement of logistics services at Volvo is done through sourcing projects. The sourcing projects are either for a completely new market or, more commonly, for an existing market where the contract with the transport provider has ended or soon will end. The frequency of these projects for an existing market and transport type is once every third year. The sourcing projects at Logistics Purchasing consist of a process that has five phases and five gates, see Figure 7. To pass one gate and continue into the next phase, pre-determined objectives need to be met and the stakeholders need to validate these. Important to note is that this sourcing process is only used for procurement of logistics services and therefore not applied on sourcing of other services or goods.

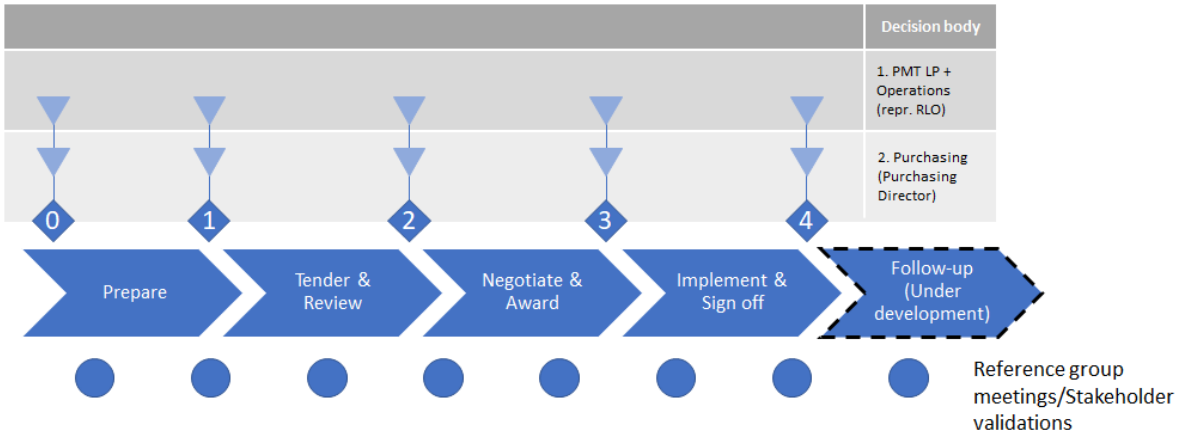

Figure 7: The sourcing process at Logistics Purchasing

The steps in the process that are mostly related to the Supplier selection model where the cost of poor quality is included, described further in 4.3 The Supplier Selection Model, are phase 2 and 3 as well as gate 2 and 3. During phase 2, a request for quotation is sent out to selected suppliers. The suppliers can then hand in their quotation according to the project's limitation. At gate 2, Volvo selects suppliers and thereby generates a shortlist with whom Volvo negotiates with. The Supplier selection model is then used in phase 3 to award the best supplier the project. By using the model, and considering all costs related to the choice of supplier, it is possible for the sourcing team to do rational decisions based on facts, i.e. reliable numbers, and not gut feelings. When the team has compared the costs and made a decision about which proposal to continue with, it is possible to carry through into phase 4 which is the implementation.

The sourcing projects belong to different sub-regions. Most of the projects within transport parts that is carried out in EMEA belong to one of three sub-regions, all located within Europe; Central East Europe, West Europe and North Europe, see Figure 8.

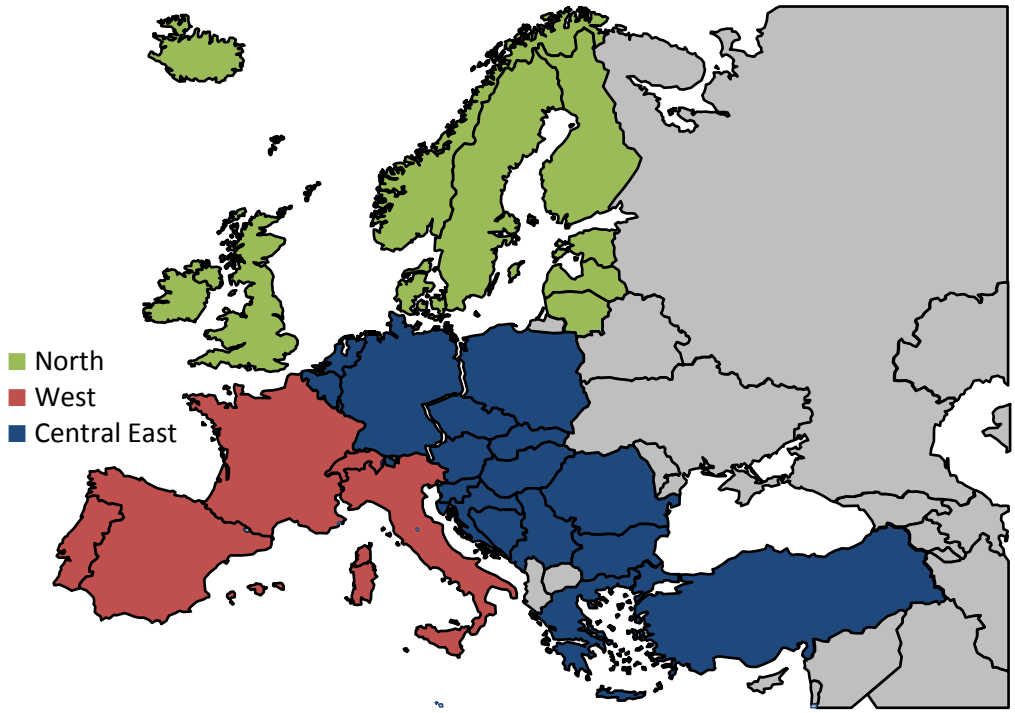

Figure 8: Volvo's sub-regions for purchasing projects in Europe

By dividing the projects into the different sub-regions, it is possible to get better control of the projects and to have a scope that is of reasonable size. Also, more specialisation can be achieved and employees can focus on their skills and knowledge within the sub-region.

4.3. The Supplier Selection Model

Earlier, Logistics Purchasing worked with what they call a soft supplier selection model. With the soft supplier selection, they compared the direct costs with the perceived service when choosing between suppliers in a sourcing process. This meant that the choice of supplier was done depending on the feelings of the people included in the decision and were therefore not always based on hard facts. For the past years, Volvo Group Logistics Purchasing has done an extensive work to optimise logistics costs for Volvo Group in their numerous sourcing projects, similar to working with total cost of ownership. Currently, Logistics Purchasing have a supplier selection model in place to evaluate the total logistics cost, see Figure 9. The model was put in place to assess all costs that come with a supplier selection in sourcing projects, not only cost of rates. An X in the figure corresponds to that a cost calculation for that part of the model is in place.

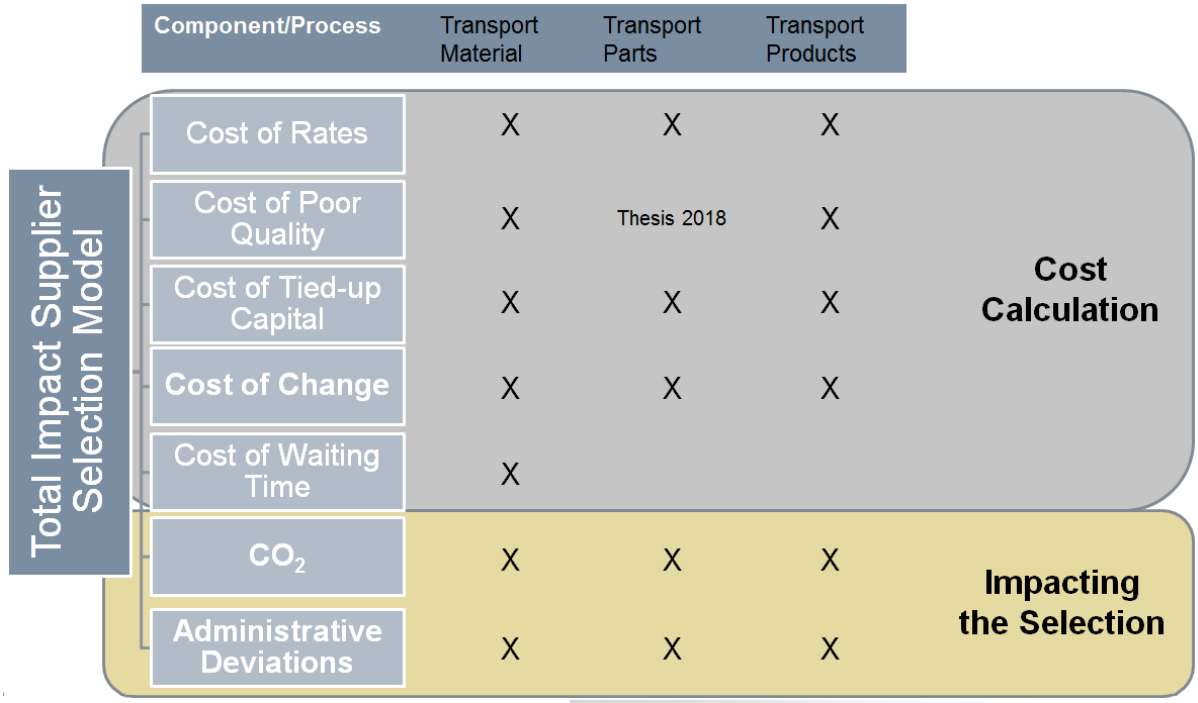

Figure 9: The Supplier selection model at Volvo GTO

The three processes that the model is consisting of are:

- Transport Material: The process of material transport is inbound transports of raw material and components from Volvo Group's suppliers to Volvo's plants and other facilities.
- Transport Parts: Transportation of spare parts. The flow goes from distribution centres which then ship the spare parts to Volvo Group's dealers.
- Transport Products: Shipments of finished products, such as trucks, from Volvo Group's factories to dealers and customers that have ordered them.

The seven parameters in the model are:

- Cost of Rates: In order to estimate the total cost of a supplier selection, the rates (i.e. price) must be taken into account.
- Cost of Poor Quality: At the moment the model includes the cost of poor quality for Transport Materials and Transport Products. It is used to measure the cost of late deliveries using inputs such as average cost for a late deliveries and delivery precision. For Transport Products, the model also differentiates between deliveries going to a body builder or a dealer.
- Cost of Tied-up Capital: Estimation of the cost impact when changing the lead times. Input includes material value, transit times and interest for capital tied up. For Transport Parts, the formula also takes current safety stock value into account.
- Cost of Change: Cost of change is related to the cost of changing supplier during the contract time and is segmented between all three logistics processes.
- Cost of Waiting Time (Time slot delivery): The model estimates cost of transport providers queuing at the destination and the impact of using time slot deliveries. The model only includes Transport Materials since waiting time is not a problem for Transport Parts nor Transport Products.

- CO_2: The estimation for CO2 is divided into the tree different commodities; road transport, sea transport and air transport since the variation is great between the modes. A thorough investigation is done regarding the CO_2 emissions at the time of writing.
- Administrative Deviations: There are also soft factors influencing the supplier selection that are not translated to costs but are still important to consider when doing sourcing projects, examples being language barriers and invoicing.

As mentioned, cost of poor quality for Transport Material and Transport Products is based on delivery precision and does not include any other aspects of poor quality. This could imply that including other aspects in cost of poor quality is too troublesome or even impossible. According to Hammarstedt and Hedin (2016), who previously did a Master's thesis at Volvo Logistics Purchasing, mapping the costs of poor quality for transport parts is very hard, and to include more aspects than delivery precision could therefore be impossible. As example, for Transport Material, the cost of poor delivery precision constant is consisting of three parts: cost of additional rush transports, changes on the production line and administration. The administration is based on how much time is spent on activities such as replanning of production and trying to locate goods if there is no deviation report.

The Supplier selection model is an important tool for Volvo since it makes it possible to estimate the total cost of choosing a supplier when using the model. The Supplier selection model's way of translating factors and aspects into costs, makes it easier to choose the overall best transport provider that may not have the lowest cost of rates. During the meetings with the purchasing management team during the sourcing process, the persons in charge of the procurement project must motivate their decision of transport provider, especially when it is not clear that the choice is the cheapest option. This is made easier when using the Supplier selection model since it has a more official index which most people at Volvo trust.

4.4. Distribution of Spare Parts

As Volvo is a worldwide organisation with production at several locations around the world and dealers at countless locations, there are enormous flows of spare parts that need to be coordinated. In total, Volvo stocks around 650 000 different spare parts for all their products. This means that it impossible for Volvo to be certain of the need for a certain spare part at a specific time and location in advance. Therefore, Volvo calls their logistics related to spare parts for "just in case" logistics.

The spare parts are delivered to the dealers in different ways before they are assembled in the end-product. Every dealer who maintains vehicles or sells spare parts to vehicle owners has a stock of spare parts in connection to their workshop. Due to the high variety of spare parts, it is impossible for every dealer to have all spare parts in stock and therefore it is important to carefully consider which spare parts should be available at the dealer's site and which parts that should be stored in other places of the supply chain. The majority of the stock at the dealer is managed by Volvo but owned by the dealer, accordingly is Volvo also deciding about the majority of the orders to the dealers. What the distribution from supplier of the spare part to dealer looks like is illustrated in Figure 10. The dotted lines illustrate the reversed logistics, that can be either buy-backs due to

obsolete items or returns due to discrepancies such as damages on shipment or wrong part delivered.

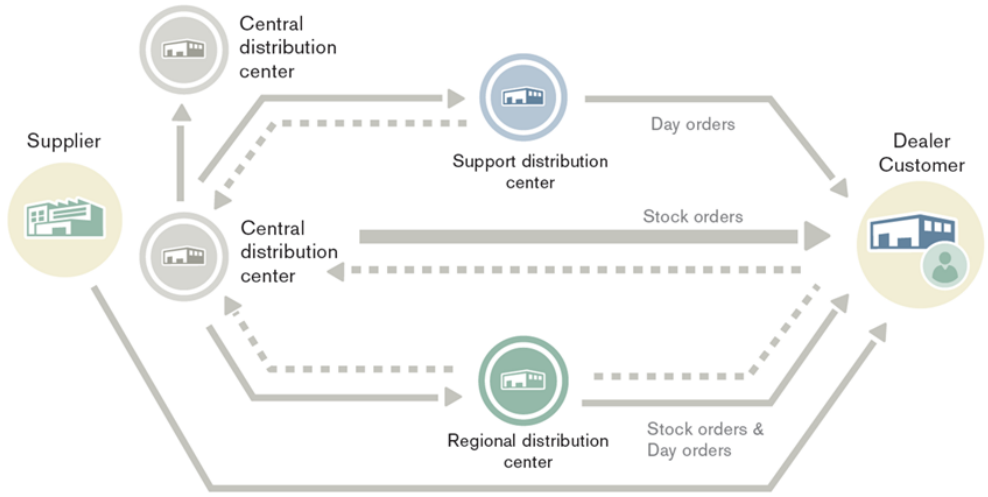

Figure 10: Volvo's distribution structure of spare parts

There are four types of spare part orders:

- Stock orders: Orders from the CDC that fill up the stock level at the dealer. The frequency of stock orders varies depending on several factors as region, country and brand.
- Refill orders: Orders from the CDC that fill up the stock level at the Supporting Distribution Centre (SDC) and Regional Distribution Centre (RDC).
- Day orders: Daily order based on customer needs.
- Vehicle off Road orders (VOR orders): Emergency deliveries to support a vehicle that is standing still due to the need of the spare part.

The majority of spare part deliverers are stock orders and refill orders, and these are sent with road and/or sea transports. The day orders are mainly sent by road. However, a small share is also sent by air, but these are tried to be held to a minimum. The reason for this is to keep the costs and environmental impact as low as possible. Stock orders are often sent with two different transport providers, one from the CDC to a terminal, which usually managed by the distribution transport provider, and from the terminal to the dealer, illustrated in Figure 11. Since there are two separate transport providers, Volvo has two different contracts in place for the route. Furthermore, this has implications for the delivery precision since the distribution transport provider should not be blamed from problems caused by the transport provider for the linehaul, i.e. the transport between the CDC and the terminal. This is discussed further in chapter 0

KPIs at Volvo.

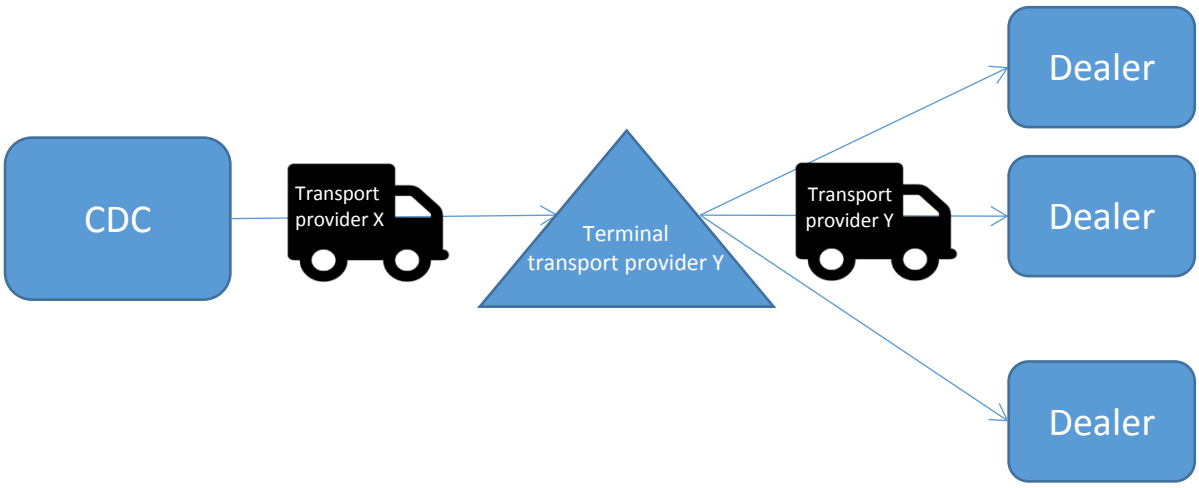

Figure 11: Distribution structure with two transport providers **from CDC to dealers**

For the four types of spare parts deliveries to the dealers, Volvo are using three different types of distribution centres to store the parts between supplier and dealer. The CDC stores all spare parts for the products of the region it is serving and holds them for the whole lifecycle of the spare parts, which often is much longer than the time the truck is sold by Volvo. The CDCs deliver refill orders to the other types of DCs. The RDC delivers stock orders and day orders to the dealers. The stock at the RDC varies depending on the products of the region it is supporting, but it is not a full assortment. The SDC stores parts that the dealers normally do not have in stock. Accordingly, the SDC delivers day orders as well as VOR orders.

The distribution network consists of 8 CDCs, 28 RDCs and 8 SDCs globally. The spread of the distribution centres is illustrated in Figure 12.

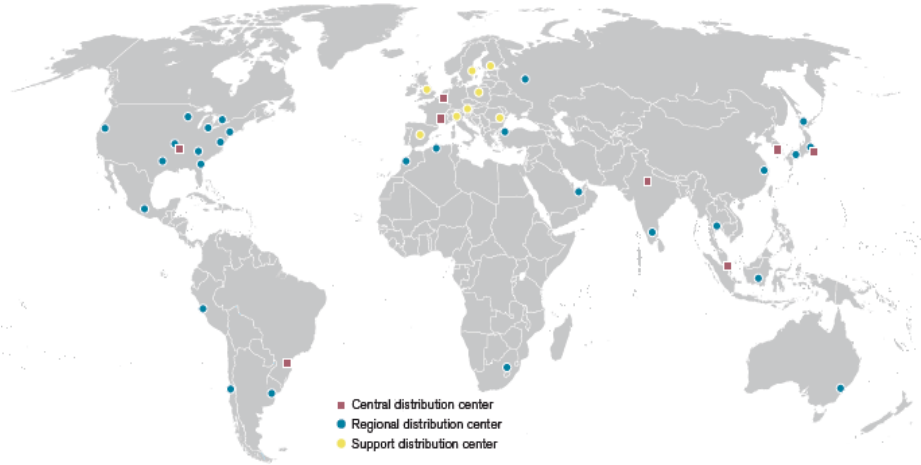

Figure 12: Volvo's distribution of CDCs, RDCs and SDCs

Important to note is that not all deliveries to the dealers are sent from the distribution centres. During a VOR order, the delivery will be sent from any available source, including directly from the production or from another dealer if the part is not in stock in any distribution centre. To get the vehicle in operation as soon as possible, the VOR order can often be sent by airfreight or courier services. According to the interviewed employees within the service centre and purchasers, these transports can be more than 30 times more expensive than a regular day order.

4.5. Internal stakeholders

There are three main actors within Volvo that has contact with the transport providers during the contract period. These are the operation, supplier management and the purchasers, who all have different responsibilities depending on the current status of the transport provider's performance and point of time.

4.5.1. Operation

The operation is the first point of contact when there is a deviation for a shipment, and they also log deviations and follow-up certain performance indicators. The operation consists of two types of actors doing the day-to-day work regarding the transports, service centre and transport coordinator.

Service centre handles all problems and deviations regarding individual shipments, thereby service centre is the contact intermediary between the transport provider, dealer and the DC. How the deviations are handled at the service centre is described further in 4.6 Communication Between Actors. Within EMEA, there are 11 service centres responsible for different parts of the region, see in Figure 13. A table with list of countries within each service centres' scope can be found in .

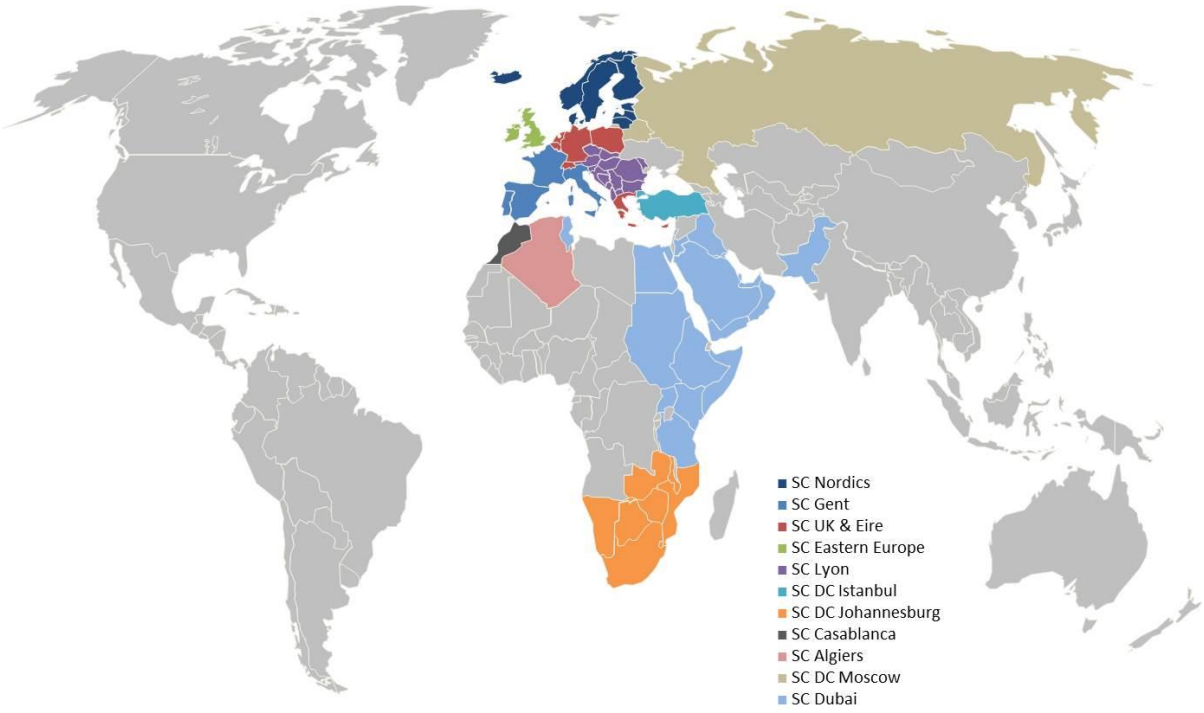

Figure 13: Map of service centres within EMEA and their catchment areas

Within each service centre, there is a manager and multiple helpdesk coordinators. In addition to communicate regarding orders, another task that the service centre is responsible for is placement of VOR orders. How a VOR order is place is further described in 4.6 Communication Between Actors. According to the service centre Nordics, the normal work load is 100 cases per week and employee. As the most time for the employees at the service centre are dedicated to handle cases, it implies that each case in average takes approximately 24 minutes with a 40 hour workweek.

The transport coordinator has the main responsibility for the contact regarding deviations with the transport provider on a more elevated level than for each particular transport. In the escalation process, seen in Figure 14, the operation is responsible for level 0 and level 1. This means that the operation is the first to initiate a dialogue with the transport provider if they do not perform in line with set KPIs or if any other problems occur. Together with the transport provider, the transport coordinator also set the action plan for the transport provider when KPI levels are not met.

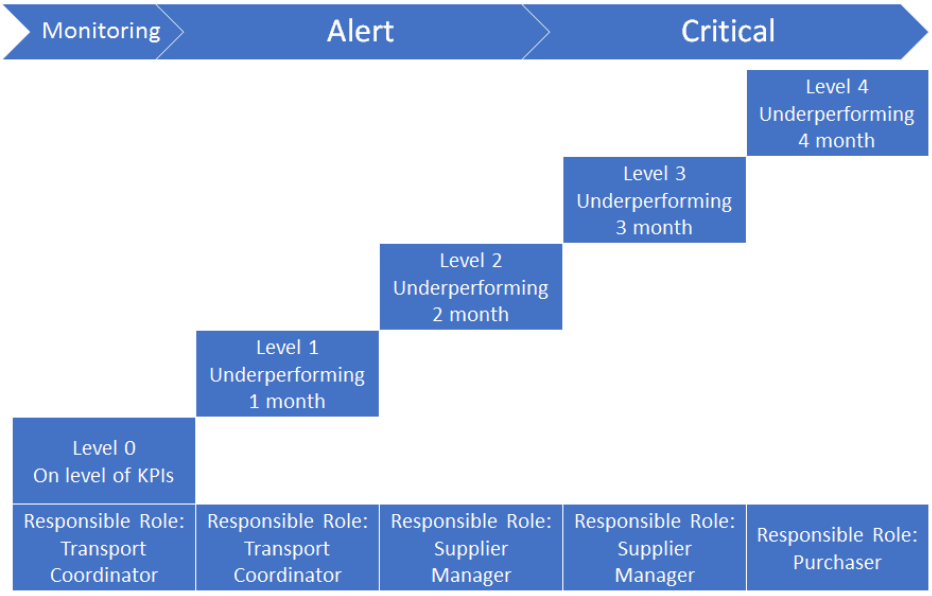

Figure 14: Volvo's escalation process of transport providers

4.5.2. Supplier Management

Supplier management have the main responsibility for analysis and follow-up of the KPIs. When the transport provider not have reached the KPIs during a longer time, the supplier management take over the responsibility from the transport coordinator and set further action plans with the transport provider. Furthermore, they have the tactical meetings with the transport providers. If a transport provider is escalated to level 3, supplier management are required to inform the purchasers about this so that the purchasers can start preparing their work if the transport provider reaches level 4.

4.5.3. Purchasers

The purchasers, also called buyers, are the contract owners and are responsible for the commercial relationship with the transport provider. They are informed about the transport providers (poor) performance in level 3 and must act in level 4. The purchasers are involved in the design of the transport flows and evaluation of the bids during the purchasing processes. Within EMEA, the purchasers are divided into product type (Transport Material, Transport Products or Transport Parts) as well as regions. If there are changes in the flow, for example need for increased frequency of

transports, the purchasers are involved in the negotiation of new prices. The purchasers also host so called business review meetings for the smaller transport providers where the agenda is foremost regarding the transport provider's performance. The business review meetings for the larger transport providers are usually hosted by the commodity team, who are category managers responsible for the strategy and development of a certain commodity, e.g. sea, road, air.

4.6. Communication Between Actors

The main stakeholders regarding the communication concerning spare part transports are dealers, Volvo's service centre and the transport provider. The distribution centre and the customers are also included in and affected by the communication. However, not all stakeholders communicate with all the other stakeholder groups. Which stakeholders that communicate with each other is illustrated in Figure 15 and is described further below. The dotted line in the figure indicates that the communication only occurs during a VOR order.

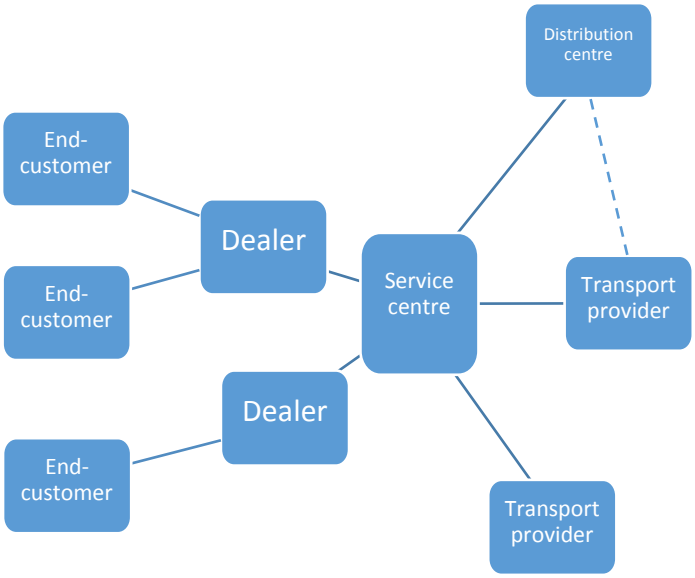

Figure 15: The communication flows regarding transports

All communication regarding transports between dealers and Volvo is supposed to go to the service centre through the communication system Argus. At the dealer sites', it is mostly the mechanics in the workshop that report in Argus and have communication with the service centre. The communication between transport provider and Volvo is also going through the service centre but instead the communication is mainly through e-mail. However, according to the employees at service centre, in some exceptions matters it can be communicated by telephone, both with dealers and transport providers. Further, the dealer is not supposed to have any communication directly with the transport providers but sometimes the dealers believe that they can solve problems faster by communicate directly with the transport provider. The service centre sometimes refers the dealers to the transport provider, because the service centre also believes that matters can be solved faster and better that way.

However, not all service centres use Argus as the communication channel with dealers. Service centre managers in the larger and the smaller markets argue that whether the service centre has implemented Argus depends mostly on the maturity of the market the service centre is operating in.

In other words, in mature markets Argus is usually implemented and is the most used communication channel. In more immature markets, Argus is not the commonly used communication channel but instead issues are often communicated by phone. According to the interviews with the service centre, immature markets may still have implemented Argus but it is then clear that the dealers do not use it frequently and prefer to communicate by phone. But since most dealers globally use Argus, the following section is focused on issues that are communicated through Argus.

4.6.1. Orders and their Related Communication

The different types of spare part orders are placed in different ways and by different actors within Volvo's supply chain. Day orders are triggered by a registration made by the dealer in the ordering system. The stock orders on the other hand are automatically registered in the ordering system, depending on the value of and former sales of the part. In the system, it is possible to see from which distribution centres the part is available, therefore the stock and day orders are placed directly to the respective DC. When the orders are placed in the system, they are visible to the DCs, that can start to prepare the pick and pack of the parts. The transport provider picks up the goods from the distribution centre without being informed in advance regarding exactly what kind of shipment that is to be picked up. According to the interviewed employees at a DC, the reason for not informing in advance is that the quantity is approximately the same every time and that it therefore would be unnecessary time-consuming communication.

Since VOR orders only should be placed when the part not is available in any of the commonly used SDCs or RDCs, these orders are not placed in the ordering system. Instead they are communicated through Argus to the service centre. The service centre searches for the availability of the part in all possible locations, such as other DCs and dealers, and then place an order to best available location. The complexity of placing a VOR order for the service centre depends on from where it is placed. For instance, a VOR order regarding a part retrieved from a dealer is often more complicated than from a DC since it includes a buy-back. When the VOR order is placed, the service centre gets back with information regarding from where and when the part will arrive to the dealer. Sometimes the part is not available from any DC or other dealer, in those cases the service centre will get in contact with the VOR order team in Gent who will investigate the issue further, through for example contacting the spare part supplier.

As the VOR orders are transported from locations where goods normally not are not sent from, often a special transport of the parts need to be booked. The transport is often booked as a door-to-door delivery from the pick-up point directly to the dealer because of the necessary short delivery time. In some situations, it can also be consolidated with other shipments if the delivery time is approximately the same as the door-to-door delivery. The booking of VOR transports is made by the distribution centre if a part is sent from that place or the service centre if it is sent between dealers.

If the transport of a spare part is carried through as planned and the dealer receives the right goods at the right time, the only further communication is a confirmation in the system that everything was delivered as planned. On the other hand, all employees at the service centres and the four interviewed dealers state that when a problem occurs regarding a transport, it requires considerable more communication which is described further below.

4.6.2. Communication Due to Transport Issues

Problems can occur during a transport and be discovered by the transport provider, or they can be discovered by the dealer after delivery. A flow chart of this is pictured in Figure 16. If a problem arises during the transport, before the shipment reaches dealer, the transport provider is supposed to communicate this directly to service centre. When the service centre receives the information about the problem, they should as soon as possible contact the dealer. If the dealer receives this information early, they can prepare and do preventing activities to minimise the impact of the issue. The preventing activities can include rescheduling of workforce as well as communication with the end-customer to inform them of that the vehicle maybe not being ready as planned. Usually, the transport providers send deviation reports to the service centre during the evening or night, meaning that the service centre does not see the reports until the morning the next day. Since many dealers have the agreed delivery time early morning, this means that the dealer will not know about the delay until after the shipment was supposed to be delivered even though the transport provider sent information regarding the delay before the shipment was supposed to be delivered.

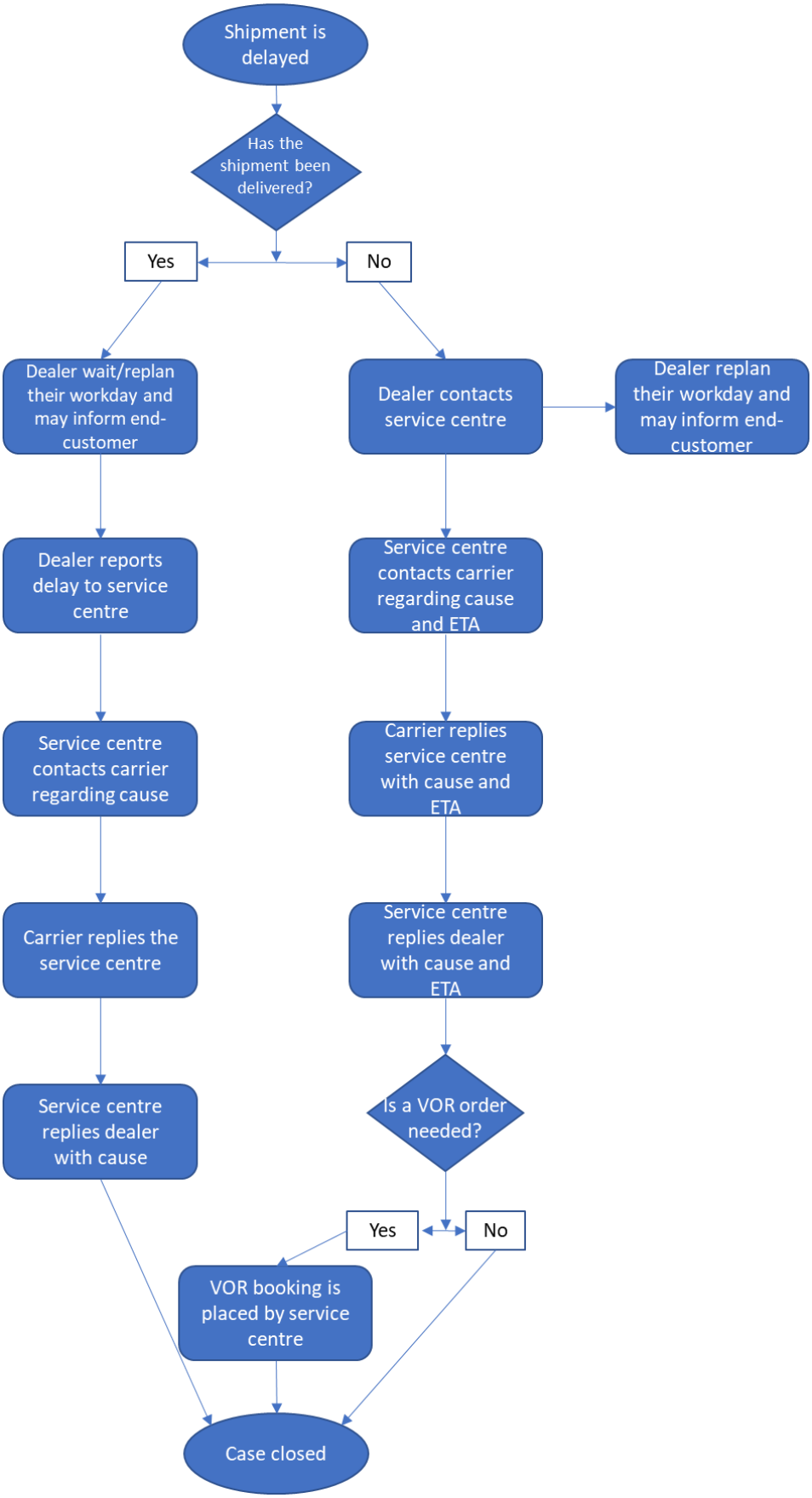

Figure 16: Flow chart of activities taking place when a shipment is delayed

If the dealer discovers a problem, they communicate this to the service centre by a deviation report that is classified depending on the type of problem. When the report is registered, it is possible for the service centre to review it and contact the transport provider to understand what caused the problem. After this, the service centre responds to the dealer with a summary of the problem and what may be done to solve it. After delivery, the transport provider should register the delivered shipment in the system with a notice about the delivery problem.

If the dealer has received a delayed shipment and not reported it before arrival, the dealer sends a deviation report in Argus which is classified with the category "Arrived late". According to all service centres, many dealers do not send these reports because the dealers do not see how they benefit of doing so. If the shipment was delayed, the dealer may already have a backlog of work and prioritise doing the maintenance or repairing with the spare part and will therefore down-prioritise reporting the delay. While many service centres receive some of these reports, not all do. One service centre states that for cases regarding delays, only 1 of 30 cases is the dealer reporting a delay that has happened while the 29 other is dealers wondering why their shipment has not arrived. In another service centre they argued that between 5 to 10 percent of the dealers send these reports. In a third service centre, they argued that they never receive these kinds of reports because of their way of working with the dealers. This does not mean that the service centres are poor at informing the dealers on beforehand, but instead means that dealers usually do not report delayed shipments if the shipment has already arrived, like discussed earlier.

Usually when something happens to a shipment, the dealer communicates this to the concerned customers since it can affect when and in what condition the customers will regain their vehicle. This communication, between the dealer and the customer, continue until the problem is solved. The interviewed dealers see the communication with the customer as an important factor to keep the customers' loyalty, as the dealers state that it is in situations where everything is not working smoothly that the customer opinion can be influenced as most.

As mentioned, a lot of dealers do not report delays to the service centre. According to the service centres and the dealers, Argus is a very cumbersome system. Because of this, some dealers choose to not report since they are unsure of how the system works and how to report in the correct way. Since Argus is a comprehensive and far-reaching system, many different issues are communicated through it, not just cases regarding delays, and it can therefore be difficult to understand all functions and codes that should be used for each case category.

The most reported cases regarding problems are instead the cases where the dealer has not received the goods as agreed and are still waiting. The dealer is therefore wondering where the shipment is or what happened to it. The classification of these cases is "Order not received". According to one service centre, these are all cases that are reported regarding late deliveries while another mean that it is as many of "order not received" as "arrived late" cases and the rest of the service centres are between these two statements. Usually when an "order not received" case are reported, the service centre contacts the transport provider to find out what has happened and/or where the shipment is. When there is a delay, an emergency delivery is usually not placed because of the extra cost that derives from the emergency order, instead the dealer and the end-customer

will just have to wait for the spare part to arrive. An exception is if the spare part ordered is a VOR order, in those cases a new VOR order is usually placed.

The time a case takes to solve differ a lot depending on what type of case it is. However, the employees at service centre Nordics state that the average time regarding all reported late delivery cases is about the same time as the average time for all cases in all categories. A general approach towards the "Arrived late" cases is that it is mainly just to open the case, write a short feedback and then close it. This takes approximately from a few to ten minutes. The time for an "Order not received" case is according to all service centres longer. This time varies more from case to case depending on how easy it is to solve. Two service centres say that it is impossible to estimate an average time. One service centre state that the average time is about 15 minutes while another state that the time in average is an hour and rest of the opinions lies between these times.

Continuous problems with a transport provider, leading to an escalation in the escalation process, also cause non-value adding communication. The escalation is not due to problems with one shipment, instead there must be issues with many shipments for a transport provider to be escalated. It could also be so that the issues are not related to shipments at all, instead they are related to the cooperation and relationship between Volvo and the transport provider. Since this thesis is regarding individual shipments and not overall relations, the communication related to the cooperation between Volvo and the transport provider was not investigated further.

4.7. KPIs at Volvo

As described, supplier management are responsible for setting and follow up of KPIs for the transport providers' performance. The only KPI measured for the transport of spare parts is delivery precision. When the transport provider reports that the shipment was not delivered on time, there are three reason categories; transport provider, Volvo or force majeure (extraordinary event beyond the control of any parties). Some causes when the transport provider is responsible for the delay are misrouted by transport provider, lost by transport provider, or breakdown of transport provider's vehicle. When Volvo is responsible for the delay usually due to the DC, such as loading was not finished on time, wrong packaging, parcel is lost, or EDI files are not sent. Force majeure includes ferry and train delays, extra customs check or that the shipment was late incoming from the external linehaul. Consequently, the distribution transport providers are not responsible if a linehaul transport provider has had delays. To make sure that transport providers are measured on their actual performance, and not judged on Volvo's or other transport providers' faults, the delivery precision that is used is where the delays due to Volvo or force majeure are excluded.

At Volvo, one common measurement for all kind of transports is not used to measure the delivery precision. For linehauls, the delivery precision is measured per vehicle which means that the delivery precision will be 50 percent if one of two vehicles is on time. For the deliveries between distribution centres and dealers, the delivery precision is measured per parcel. This implies that a delayed vehicle with many parcels makes larger impact on the delivery precision than a vehicle that deliver a few parcels.

Volvo do not themselves measure any KPIs, instead they trust the Excel reports sent by the transport providers where all shipments as well as deviations, and consequently the delivery precision, are

included. In the contract with the transport provider, the set goal for the delivery precision as well as the agreed delivery time is included. Therefore, in the monthly reports that are sent by the transport providers to Volvo, both agreed delivery time and actual delivery time are included. The Excel sheet then automatically calculates whether the transport was on time, delayed or if data is missing (i.e. the transport provider has not scanned the parcels at delivery). The shipment is categorised as a late delivery if it is one minute late, and delays are not categorised further depending on how delayed the shipment was. Therefore, Volvo does not have any statistics of the magnitude of the delays. Worth noting is that shipments where data is missing are excluded from the delivery precision calculations. While Volvo does not have a set limit for percentage of data missing shipments, it is an indicator that is tracked and followed-up with suppliers.

Supplier management also measure reporting quality which includes whether the transport providers have sent their monthly reports on time. At the time of writing, the transport providers are obliged to send the report for the previous month on the 10th of the next month, e.g. the monthly report for December must be provided to Volvo on the 10th of January. According to the supplier manager and the transport coordinator, there are discussions internally at Volvo regarding changing the now monthly reports to daily or weekly reports. It is very time-consuming to know whether a transport provider sent their report on time or not since supplier management have to check each Excel sheet. During the spring of 2018, there will be an implementation of a tool so that reporting on time will automatically show up in a program called QlikView. According the supplier manager, the supplier management spends a lot of time at the moment making sure that the reports are sent to Volvo and also checking and correcting reports from transport providers.

4.8. The Definition of Poor Quality in Volvo's Logistics System

As mentioned by Sörqvist (1997), poor quality and costs related to it arise because a company's products and processes are not perfect. In Volvo's case, it is not their own processes, instead the processes belong to the transport provider but the poor quality of them can still affect Volvo and their customers. This can make the identification and analyses of the aspects harder, in comparison to if Volvo would have full control of the processes. To clarify, if Volvo themselves would be responsible for the transports, the processes are clearly within their organisation and are therefore a part of poor quality if they are not satisfactory. At the moment, Volvo does not operate their own transports, but they are instead outsourced. This means that if the processes are not perfect and they affect Volvo's customers, it can still be a part of poor quality but the processes are not Volvo's.

Still, several aspects of poor quality from the transport providers that affect Volvo have been possible to identify. These quality problems trigger activities for multiple people at different levels at Volvo, ranging from the dealer to the purchaser for the logistics services.

4.8.1. Delivery Precision

As delivery precision is the only KPI that is used for the performance of transport providers today, it is an indication that it has a big impact and is important for Volvo. This is confirmed by everyone included in the purchasing process of transport services, e.g. purchasers and supplier manager, who all state that the delivery precision has a big impact on the whole supply chain. The reason why Volvo themselves do not measure delivery precision is because the scanning and actual receiving of

the goods is seldom done the moment the parts are received in the workshop, instead it can be done multiple hours after the delivery, leading to a skewed delivery time. Therefore, it is more realistic and reliable to use the delivery precision reported by the transport providers.

The four interviewed dealers all agree that a shipment cannot be delivered too early. Instead, they think that the earlier that they receive the parts, the better. The personnel in the workshop do not always have to be on site for the goods to be delivered, since the transport providers either leave it outside their door or the transport provider may have a key to leave the shipments in the workshop.

However, it is a consistent opinion from the four interviewed dealers that a late delivery always has an enormous impact. One dealer claimed that "If a delivery is late, the cost impact will always be bigger than the sales from the work that the parts should have been used for". Since this study has not looked into dealers' profits, it is not possible to guarantee if this statement is true, but all actors within the chain confirm that costs arise as soon as a delivery is late, regardless of how late it is.

4.8.2. Damaged Goods

Purchasers and dealers all mentioned damages as an important quality aspect related to the transports of spare parts. This was also stated by service centre Nordics who said that they take care of many cases related to those goods have been delivered damaged to the dealers. However, how big part of the damages that can be derived from the transport providers' performance is not clear according to service centres, the supplier manager or the process manager for Transport Parts.

If goods are delivered damaged to a dealer, this is communicated in Argus to the service centre. If the dealer easily can identify the reason of the damage, i.e. if it was damaged during the transport or if it was damaged at the DC, this is noted in the report. However, the dealer most often does not leave any notice about the reason since it is hard and time demanding to identify the reason. According to the interviews with dealers, three of the four dealers argued that it often is hard to know who caused the damages. This leads to that Volvo has data regarding the total number of damaged goods, but not regarding how large percentage of those that are caused by the transport provider. When the dealer has identified the damaged goods, and has done an Argus case, the damaged goods are sent back to the DC. Furthermore, Volvo do not always make claims regarding compensation from the transport provider even though it may be clear that it was the transport provider caused the damage. This is due to claim handling being a very time-consuming process, meaning that the costs of pursuing a claim can outweigh the income or benefits from it. Therefore, claims are only done if it is very clear that the transport provider was at cause and if the damaged part is of a certain value, i.e. the potential compensation is no less than a certain amount.

4.8.3. Communication

There are opinions that the communication from the transport provider is an important aspect of their performance. However, the thoughts about in what way that the communication is important are not the same for all actors. All interviewed purchasers mention that they believe the communication during on-going transports can have a big impact on how smooth potential problems are solved. Service centre Nordics and the supplier manager agree that the communication regarding on-going transports is important. However, service centre Nordics also

argue that the communication does not differ noticeable between transport providers and that the dealers are not concerned about it. Instead, they highlight that it is the reports sent to the supplier management that may differ in quality, which can be due to communication issues, e.g. the transport providers do not know or understand how the report should look. Furthermore, supplier management also state that communication with transport providers may differ, but communication with different departments of a single transport provider may also differ. A transport provider can for example have operations in multiple countries, and every country has their own country specific branch, and then Volvo has to have contact with all branches for their transports. Accordingly, it could be hard to determine a specific level for a whole transport providers communication performance and therefore not either be able to compare different transport providers' performance.

4.8.4. Goodwill

That transport providers' performance may lead to impact on the end-customers and their approach towards Volvo as brand is unified opinion throughout the organisation. Even though all interviewees think that goodwill and cost of lost sales should be taken in consideration when discussing the total cost of poor quality, no one has an opinion on how to quantify the goodwill. The knowledge regarding estimations of lost goodwill for deliveries of spare parts seems to be low within Volvo's organisation. Further, none of the interviewees can mention an example where goodwill is taken into consideration in the organisation today.

The interviewed dealers and respondents to the survey highlight that Volvo is supposed to be a premium supplier of trucks and spare parts and therefore is important that the aftermarket logistics live up to this as well. One dealer argues that the most important things for buyers of vehicles today are service, reparation and spare parts why it is very important that the aftermarket works well. All the interviewed dealers state that their customers are to a large extent affected by a late delivery and it is therefore important to avoid it to not lose the customers' trust. They also state that this can affect their own workshop when customers switch to another dealer because of disappointment with the service quality. Further, the dealers argue that customers may choose another brand in the future if Volvo do not live up to the high expectations in the aftermarket.

5. Analysis of Empirical Data

In the following chapter, the empirical findings and the answers from the survey are analysed to adjust the equation for potential cost of poor quality which was identified in 2. Theoretical Framework. Further, the activities that are part of the cost parameters for Volvo are determined and broken down into variables. These variables are analysed to estimate the size of them and in that way put a cost on poor quality. This is followed by reasoning about how the cost of poor quality can be applied in sourcing projects for transport providers. The chapter ends with a sensitivity analysis regarding the variables used for estimating the size of cost of poor quality.

5.1. The Aspects of Poor Quality

As described in 4.8 The Definition of Poor Quality in Volvo's Logistics System, different aspects of poor quality from Volvo's transport providers were identified to be damaged goods, communication and delivery precision. Due to limited abilities to do so, not all the aspects were analysed to the same extent, further described in the coming section.

As the definition of poor quality is not firmly stated by Volvo Group, the aspects that should be included in poor quality need to be decided. In line with Jonsson's (2008) arguments, that a cost can be attributed to more than one cost category, it is important to remember not to include any costs that are already covered in other parts of the Supplier selection model. If so, those aspects would be covered twice and therefore make a larger impact in the choice of transport provider than they should have. For instance, some could argue that cost of changing supplier could be a result of poor quality, but since it already was covered in the Supplier selection model it should not be included in cost of poor quality.

As mentioned in 4.2 The Sourcing Process, the main part of the purchasing projects in EMEA occur within Europe. This, in combination with difficulties in getting access to labour cost numbers for countries in Africa and Middle East, made the focus for this analysis to be on the countries within Europe to ensure that the results are as valid as possible. However, if getting access to the labour costs for Africa and Middle East, it would have been possible to put them in the cost of poor quality and get useable costs for these regions as well.

5.1.1. Damaged Goods

The cost of damaged goods has been identified as the number of damaged goods caused by the transport provider multiplied with the costs of a damaged goods shipment. Further, number of damaged goods delivered could be broken down into the two variables; the total number of shipments and the percentage of shipments that are delivered damaged due to the transport provider.

When looking at the findings from interviews with internal parties at Volvo and with dealers, it becomes evident that there exist challenges with identifying the percentage of deliveries that are damaged. Adding the fact that it is not known how many of these damages that are caused by the transport provider, it becomes impossible to estimate this number for any project. Accordingly, as Volvo at the moment cannot differ between which transport providers that cause damages, they do

not have reliable numbers of this. Therefore, it is within this thesis impossible to include damages in the cost of poor quality calculations.

5.1.2. Communication

In order to include communication in the cost of poor quality, Volvo would need to measure the performance of the communication from the transport provider. Further, they also need to be able to set a cost depending on how good the communication is. Having those two aspects, it would be possible to incorporate communication in cost of poor quality and the Supplier selection model.

As described in 4.8.3 Communication, the opinions regarding the importance of communication differ between actors in the chain. Both the service centres and the dealers claim that they do not experience communication with transport providers as a problem. Why dealers and service centres do not think that communication is an issue could be because they are only in contact with one, or a few transport providers. This would mean that they do not really understand or know how other transport providers communicate, since there is no real way to benchmark the transport providers' communication against another.

Furthermore, the communication from transport providers is not measured on actual performance but is instead based on supplier management's feeling towards the transport provider and the performance measurement is only regarding a small part of the whole communication that happens between Volvo and the transport provider. Since the communication is not based on actual performance and facts, it may be inappropriate to use it as a decision base. The evaluation of transport providers is not done by one person, but instead different people within supplier management, which could increase the differences between transport providers. Furthermore, the interviewed supplier manager stated that the communication with one transport provider may differ a lot, which can obstruct the possibility to measure one transport provider's communication performance.

As stated by Löfdahl and Sjödin (2013), measuring communication is often dependent on feelings and not hard facts. This implies that there is no good way to measure communication without taking gut feelings into account. If Volvo want the Supplier selection model and the aspects in it to be based on hard facts, it could mean that there is no adequate way to include communication at all, since there is no way to measure communication on actual facts and not people's perceptions. This goes in line with the arguments of Sarkis and Talluri (2002) (as cited in Löfdahl & Sjödin, 2013), since their advice on how to measure communication is a simple question where the answer will be on a scale and will be dependent on what the respondent believes about the communication.

It is therefore clear that at the moment, it is not possible to include communication in cost of poor quality since Volvo does not have the measurements in place and there are no relevant measurements developed by research. Further, the employees at Volvo does not have clear thoughts regarding what activities that poor communication leads to, making it very difficult to put cost on.

5.1.3. Delivery Precision

From the interviews held with dealers and employees at Volvo, it is clear that delays are the most crucial parameter within cost of poor quality. All interviewees at service centre Nordics, all purchasers and all interviewed dealers agree that delays are the issues that create the largest problems. Furthermore, delivery precision is one of the few KPIs that Volvo is measuring with regard to transport providers, meaning that it can be used as a decision base.

However, deliver precision itself is not enough to calculate the cost of poor delivery precision. Cost of poor delivery precision can be broken down to the variables: delivery precision, number of shipment and the cost of a late delivery. As mentioned in the 5.1.1 Damaged Goods, the number of shipments is known in all sourcing projects. Further, also the delivery precision is known as it is used as a KPI for transport providers. Accordingly, it is the cost of a late delivery that is needed to be decided.

Jonsson (2008) mentions that delivery precision can include both early and late deliveries. However, as mentioned in 4.8.1 Delivery Precision, the reports from the transport providers does not take early delivered shipments into account. Further, the dealers state that the earlier they receive the goods, the better. Therefore, too early deliveries do not seem to exist for Volvo's dealers. Because of this, only late deliveries have been taken into consideration when evaluating the cost of poor delivery precision.

From 4.6 Communication Between Actors, it can be concluded that two separate actors are directly involved and affected by poor delivery precision. These are the dealers and the service centre. Further, from the flow chart of activities related to a late delivery in Figure 16, it is possible to divide the activities for the dealer into two activity-groups. The first one being mechanics stand without work and the second all activities related to administrational work. For the service centre, one group of activities is triggered by a late delivery, administrational work. Furthermore, a late delivery can also lead to that a VOR order need to take place. Thereby, all activities triggered by a late delivery are identified and an equation for the cost of a late delivery can be created according to Equation 3. Accordingly, it is these four cost aspects of a late delivery that will be evaluated further.

Equation 3: Cost activities of a late delivery

$$Cost\ of\ a\ late\ delivery = Cost\ of\ mechanic\ without\ work + Administration\ Cost\ Dealer + Cost\ for\ Service\ Centre + Potential\ Cost\ of\ a\ VOR\ order$$

5.1.3.1. The Cost of a VOR Order

As can be seen in the flow chart in Figure 16, a delay sometimes leads to that a VOR order is placed. To be able to include the cost of VOR order into the cost of a delay, information is needed regarding what percentage of delays that leads to VOR orders and the cost of a VOR order. From the interviews, it is possible to confirm the arguments from Lumsden (2012), that these emergency orders often are sent in door-to-door shipments and that they thereby are expensive transports. The service centres and supplier manager stated that a VOR order is more than 30 times more expensive

than a normal day order. Thereby, it is plausible that a VOR order could be a noticeable cost aspect of a late delivery.

However, how large percentage of the delay that leads to a VOR order is not known by Volvo, and therefore the percentage of delays that are caused by the carrier that leads to a VOR order is not known either. Even if the dealers write in their Argus cases that it was due to a delay that they place a VOR order, this is not acknowledge in any good and manageable way. Accordingly, the cost of a VOR cannot be included in the cost of a late delivery at this point even if it could be a noticeable cost variable.

5.1.3.2. The Cost of Mechanics Standing Without Work

The average cost of mechanics without work was identified and stated as the labour cost per hour of a mechanic multiplied with the average time mechanics need to stand without work due to the delayed delivery. The labour cost used for mechanics was based on statistics from the European Union for workers working with repairing motor vehicles (Eurostat, 2017). However, not all countries in this project are included in those statistics and therefore other sources were also used, further explained in Appendix D - Labour Cost Levels.

When analysing the labour cost levels, it was soon clear that they differ a lot between the countries within Europe. Therefore, Europe was divided into seven sub-regions were one specific labour cost level were estimated for each region. When divided into sub-regions, two main factors were taken into consideration. Firstly, the labour cost levels in the countries, and therefore countries with similar cost level were placed together. The second aspect was how the countries today are divided during the transport purchasing projects, described in 4.2 The Sourcing Process. This led to the division of sub-regions illustrated in Figure 17. The list of all countries included in the sub-regions can be found in Appendix E – Sub-Regions in Europe.

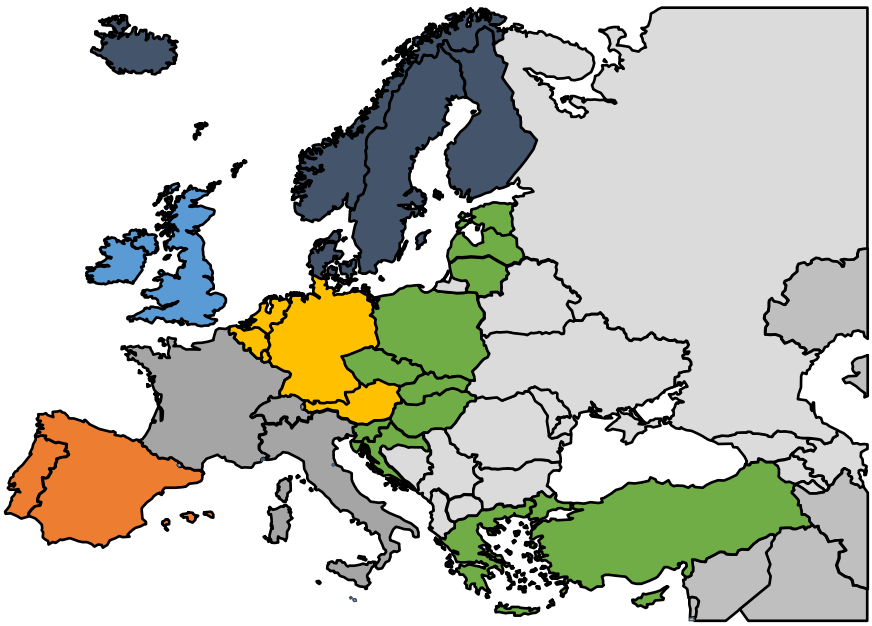

Figure 17: Division of sub-regions in the thesis

However, the labour cost levels are not equal in all countries within the sub-regions. Therefore, a weighted average hourly labour cost between the countries in respective sub-region was estimated, determined by the number of dealers in the countries. An example of how this was done for the Nordic region is illustrated in Table 2.

Table 2: An example of the calculation for the labour cost for a mechanic in the Nordic countries

Country	Number of dealers	Hourly Labour Cost Mechanic [Euro]	Product
Finland	29	30.41	884
Denmark	24	39.95	974
Iceland	1	38.77	38
Norway	59	41.31	2467
Sweden	95	37.53	3498
Total	**208**		**7883**
Weighted average = 7883/208 = **37.90**			

Like for the Nordics, the same calculations for the weighted hourly labour cost for mechanics were carried through for all sub-regions which led to the costs in Table 3. As seen, the costs differ a lot between the regions, and Nordics has more than 590 percent higher costs than Eastern Europe, the region with the lowest cost. This indicates the importance of the division into sub-regions, as the costs for countries in Eastern Europe otherwise would be 280 percent higher than now and for the Nordics it would be 45 percent lower. Accordingly, that would give the wrong indications when including the cost in the supplier selection.

Table 3: Hourly labour costs for a mechanic in the sub-regions

Region	Hourly Labour Cost Mechanic [Euro]
Nordic	37.90
UK & Eire	20.82
Iberian Peninsula	17.19
Central South Europe	30.47
Central Europe	31.80
Central East Europe	8.83
Eastern Europe	5.50
Average Whole Europe	20.91

The estimation of the time aspect for the cost of mechanics standing without work was based on the answers from the survey. According to the answers, the time range from 0 minutes up to 25900 minutes, se Figure 18. However, the dealer who responded 25900 minutes (equal to 430 hours or 18 days) has unfortunately clearly misunderstood the question. Therefore, that response will be disregarded in the analysis. Further, all the four interviewed dealers stated that the time mechanics stand without work is maximum a couple of hours, which further indicates that the dealer misunderstood the question.

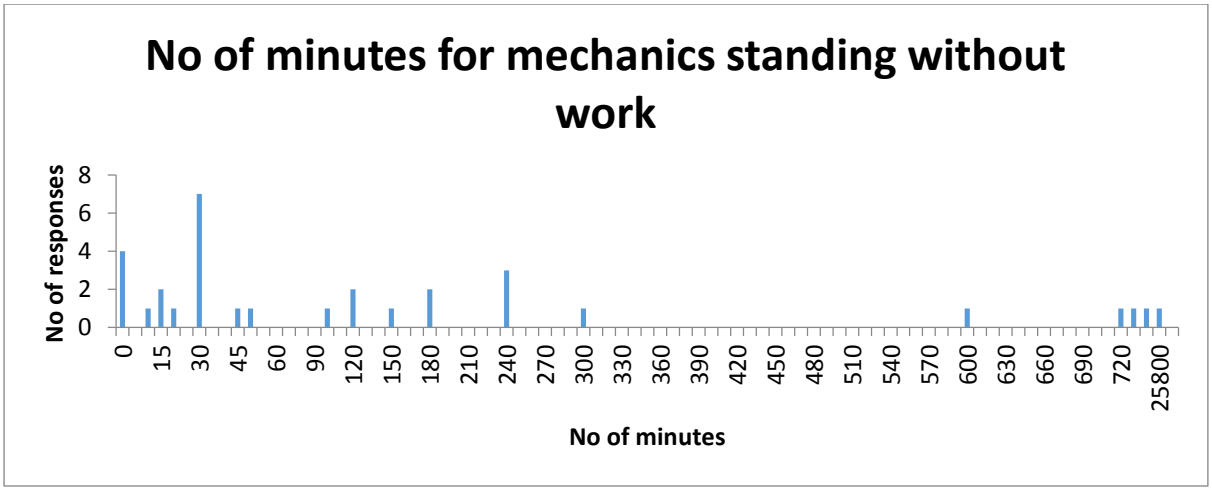

Figure 18: Answers to the survey regarding the time mechanics stand without work

It is important to note that the X-axis in Figure 18 does not have the same interval throughout the whole axis. Instead, the interval is closer between 0-60 minutes, compared to the other parts of the axis. The answers are actually even closer together between 0-60 minutes and a lot further apart from 600 minutes and upward.

The time mechanics are standing without work can be accentuated in different ways and in Table 4, three interesting calculated numbers are highlighted. With a standard deviation of 173.54 and, as discussed in 3. Methodology, with a low response rate, it is questionable if the answers can represent the whole population. Therefore, as outliners can have a high impact on the average result, the average value when the top and bottom 10 percent are disregarded is seen as the most appropriate number and will be used in the coming calculations. However, it still exists uncertainties with this figure and this is further analysed in 5.4 Sensitivity Analysis.

Table 4: Time for mechanics without work per delay

Variable	**Time [min]**
Median, illogical number disregarded	45.0
Average, illogical number disregarded	225.65
Average, illogical number and top and bottom 10 % disregarded	**113.40**

The average cost per delay related to mechanics without work can through this be estimated by multiply the time variable with the hourly cost variable for all sub-regions. This results in the costs seen in Table 5.

Table 5: Cost for mechanics standing without work per delay

Region	Cost per delay [Euro]
Nordic	71.62
UK & Eire	39.34
Iberian Peninsula	32.48
Central South Europe	57.60
Central Europe	60.10
Central East Europe	16.68
Eastern Europe	10.39

Furthermore, the dealers also answered how certain they are about their answer. With a mean value of 3.06 and a median of 3.0 on a scale ranging from 1 (Guessing) to 5 (Facts from a data system), it indicates that the dealers have an idea about the time but that they do not log it. By analysing the correlation between how sure the dealers state they are about the time aspect and the size of the time, it is possible to see that it is a weak linear relation between the variables with a correlation number of 0.27. This may indicate that the dealers who say they have good knowledge about their time also say that it takes longer time. Accordingly, the time for mechanics without work may have been higher if it was based on fact and not estimations from the dealers. However, since the correlation is so low and it is based on a low number of answers, it could rather be a coincidence.

5.1.3.3. The Cost of Administration for the Dealer

The administration cost for dealers depends on two aspects: the time it takes for the administration regarding a late delivery and the hourly labour cost. As described in 4.6 Communication Between Actors, the administration and communication related to a late delivery is mainly carried out by mechanics in the workshop. Therefore, the hourly labour cost for administration is the same as for mechanics without work in the earlier section, 5.1.3.2 The Cost of Mechanics Standing Without Work, see Table 3.

The responses regarding administration time for the dealer range from 0 minutes to 21900 minutes, seen in Figure 19. In this question, two dealers misunderstood the question the same way as in the question for mechanics standing without work so their answers, 3000 minutes and 21900 minutes, will be disregarded. In addition, all four interviewed dealers argued that the time for administration lies within maximum one hour.

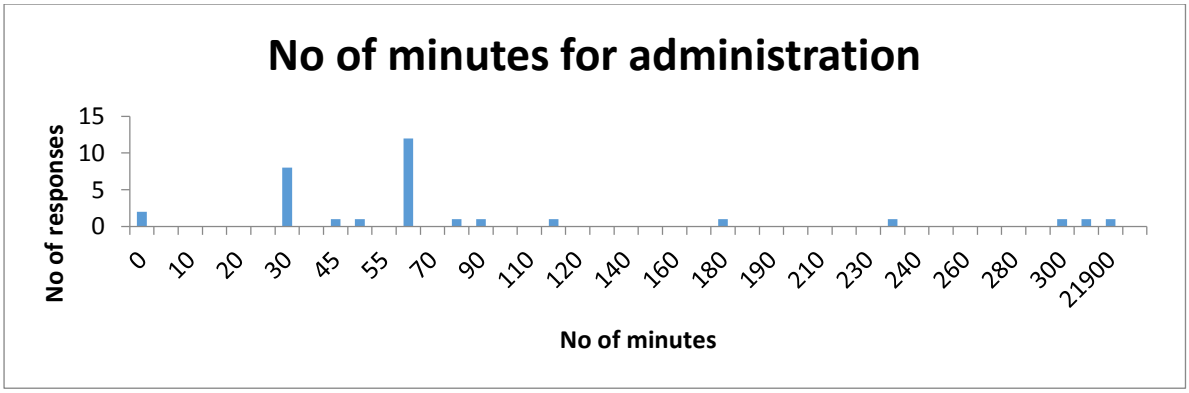

Figure 19: Answers to the survey regarding the administrational work due to a late delivery

Even though this question was a free text numeric field and not a multiple-choice question, a lot of the answers are at the same value. 69 percent of the answers lie within the interval of 30 to 60 minutes. This indicates that the time for administration does not differ as much between workshops as the time for mechanics are standing without work does.

The gathered responses are further confirmed when the median and average value are calculated, see Table 6. With the same arguments as regarding the time without work for mechanics, the average value further used in the analysis were chosen as the average value with illogical numbers and top and bottom 10 percent disregarded. However, as the values are so close to each other, the potential errors are smaller, further discussed and analysed in 5.4 Sensitivity Analysis.

Table 6: Time regarding administration for dealers per delay

Variable	Time [min]
Median, illogical numbers disregarded	60.0
Average, illogical numbers disregarded	68.83
Average, illogical numbers inclusive top and bottom 10 % disregarded	**54.79**

Thereby, both the average hourly cost for the sub-regions and the average cost per delay for administration are known. Accordingly, the total cost for administration for the dealer can be estimated for the sub-regions. This results in the costs in Table 7, and thereby is both cost aspects of the dealer determined.

Table 7: Cost per delay for the administration for dealers

Region	Administrational cost per delay [Euro]
Nordic	34.61
UK & Eire	19.01
Iberian Peninsula	15.69
Central South Europe	27.83
Central Europe	29.04
Central East Europe	8.06
Eastern Europe	5.02

Furthermore, for this question the dealers also answered how certain they are about their answer. In comparison with the time aspect of the mechanics stand without work, the dealers seem to have better knowledge of the administration with a mean value of 3.375 and median of 3.5 on a scale ranging from 1 (Guessing) to 5 (Facts from a data system). However, it is still surprising that the dealers do not believe that they have even better knowledge since many dealers answer the same number in the survey. This can indicate that the answers are gathered just because it is easy to say 30 or 60 min for administration when they do not really know rather than that is the actual time.

With a correlation value of –0.09, there is a very weak negative linear relation between the time aspect of administration and how sure they are about their answer. Accordingly, the dealers do not seem to answer a high or low number for the time when they are more confident of their answer. Further, when plotting the answers and how sure they are, it further indicates that is no clear relation between how sure the dealers are and how much time they spend, see Figure 20.

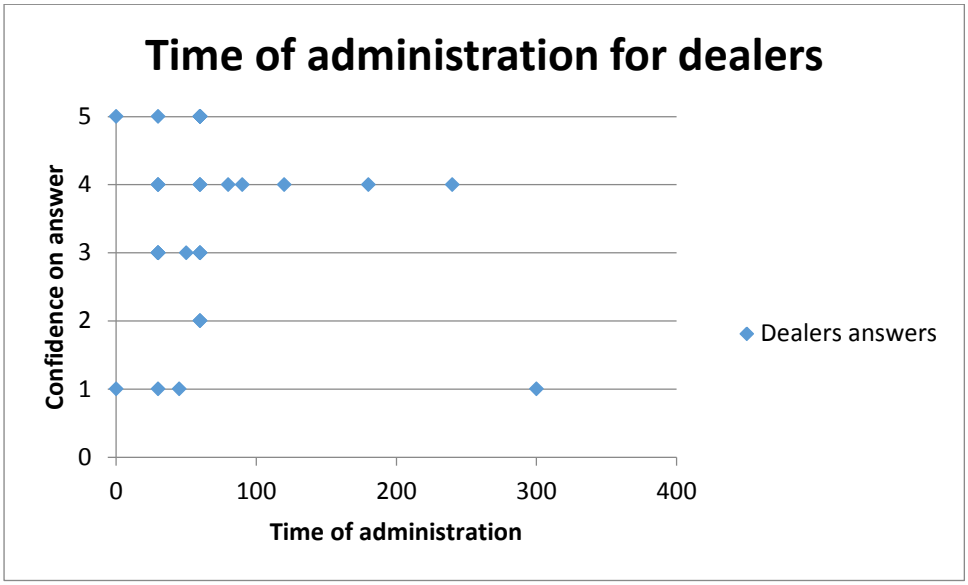

Figure 20: Relation between time of administration and confidence on the answer

5.1.3.4. *The Cost of Administration for the Service Centre*

The administration cost for the service centre depends on the same factors as for the dealers; the hourly labour cost and the time it takes to handle a case regarding a late delivery. The hourly labour costs for the service centres was estimated as the hourly labour cost levels for personnel working with "Information service activities" in the countries where the service centres are situated (Knoema, 2018). The labour cost levels can be seen in Table 8, and a further explanation of how they are calculated can be seen in Appendix D - Labour Cost Levels.

Table 8: Hourly labour cost for countries where Volvo has service centres

Country	Hourly cost service centre [Euro]
Sweden	47.50
Belgium	47.83
France	36.26
Austria	48.83
United Kingdom	45.94
Turkey	13.97
Russia	7.90

However, to know the cost per service centre for a delay is not enough. As for the dealers, the costs further need to be divided into the sub-regions to be usable. Some sub-regions are supported by several different service centres which need to be taken into consideration. This was done by weighted the average cost after the number of dealers in the countries supported by respective service centre, which is explain in see 4.2 The Sourcing Process. An example of these calculations can be seen in Table 9 where the cost for service centre Central South Europe is estimated.

Table 9: Hourly labour cost for service centre Central South Europe

Country	Number of dealers	Cost service centre [Euro]	Product
Malta	4	36.26	145
Italy	188	36.26	6817
France	449	36.26	16281
Switzerland	44	47.83	2104
	685		25347
Average cost region = 25357/685 = **37.00 Euro**			

Still, some of the regions where the whole region is supported by the same service centre, one single service centre cost could be used. The calculations of the hourly cost for all service centres resulted in the numbers in Table 10.

Table 10: Hourly labour cost for service centre in respective sub-region

Region	Hourly labour cost service centre per region[Euro]
Nordics	47.50
UK & Eire	45.94
Iberian Peninsula	36.26
Central South Europe	37.00
Central Europe	47.91
Central East Europe	42.29
Eastern Europe	18.94

As mentioned in 4.7.2 Communication Due to Transport Issues, there are two types of cases that regard delays; Arrived late and Order not received. The cases where the shipment arrived late take much less time than the average for all cases concerning delays. Through the interviews with the employees within service centre Nordics and the other service centre managers, an estimation of 5 minutes was considered appropriate for the total time spent on these cases.

However, as described in 4.6.2 Communication Due to Transport Issues, all service centres argue that not all delays are reported. Therefore, an estimation of the percentage of delays that are reported was done by the information retrieved from the service centre interviews. Further, an estimation of the percentage of reports that belongs to the types of delays was estimated in the same way. From this, it was estimated that 80 percentages of all delayed shipments are Arrived late-cases, but only 10 percentages of these are reported, seen in Figure 21. This is important to keep in mind since it is the average time of a delay that should be inserted in the equation for the cost of administration. By knowing the two types of cases, it is possible to divide and estimate the average time spent on administration regarding a late delivery by Equation 4.

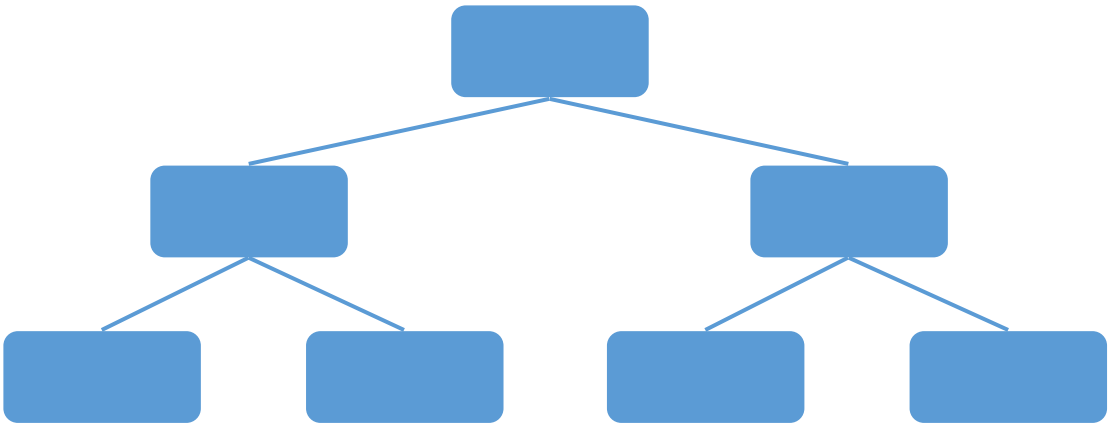

Figure 21: Split between service centre cases related to delays

Equation 4: Administration time per delay for service centre

$$Service\ centre\ administration\ per\ delay = Percentage\ arrived\ late\ shipments \times Percentage\ arrived\ late\ that\ are\ reported \times Time\ spent + Percentage\ order\ not\ received\ shipments \times Percentage\ order\ not\ received\ that\ are\ reported \times Time\ spent$$

Regarding the Order not received-cases, the time it takes to solve a case is much longer. However, much of the time is spent for waiting on other actors to respond and within this time the service centre can work with other cases. The time that the service centre really spends on a particularly case was estimated to 30 minutes. These cases are all reported since the once that are not reported become Arrived late cases. Thereby are all variables of the average time are known, see Table 11.

Table 11: Variables of service centre activities

Variable	**Value**
Percentage shipments arrived late	80 %
Percentage Arrived late that are reported	10 %
Time spent on an Arrived late case	5 min
Percentage shipments Order not received	20 %
Percentage Order not received that are reported	100 %
Time spent on an Order not received case	30 min
Total time spent for one delay	**6.4 min**

According to the calculations, the service centres spends on average 6.4 minutes per delay. Further, by calculating the average time for only the reported cases regarding late deliveries, we can see that the time is 21.66 minutes. This can be compared with the average time for all cases in the Nordics, which described in 4.5.1 Operation is 24 minutes. As argued by the employees at service centre Nordics, the average time regarding a late delivery case is about the same or little bit shorter than the time for an average case. Accordingly, the estimation in this thesis goes directly in line with the arguments from service centre Nordics.

Thereby, both the time and the hourly cost are known for the service centres. These variables can be multiplied to get the average cost per delay for all sub-regions. By doing so, the cost per delay is estimated for all sub-regions according to Table 12. The big differences can be explained by the differences in the hourly labour cost.

Table 12: Cost per delay for service centre in each sub-region

Country	Cost per delay for sub-regions [Euro]
Nordics	5.07
UK & Eire	4.90
Iberian Peninsula	3.87
Central South Europe	3.95
Central Europe	5.11
Central East Europe	4.51
Eastern Europe	2.02

5.1.3.5. The Total Cost of Late Deliveries

As Equation 3 showed and as earlier discussed, the total cost can be divided into three variables. These three variables can in its turn be broken down to five previously unknown variables (three time-variables and two hourly cost-variables) for two different actors, the dealer and the service centre. However, by the division into sub-regions, the two cost-variables are divided into seven variables each to be able to give a fairer estimation for the cost of a delay in the sub-regions. Accordingly, it does not exist a specific cost of a late delivery; instead it differs considering the sub-region that is investigated. These variables are now known for all sub-regions, and it is thereby possible to estimate the total cost for a delay by putting the numbers in Table 5, Table 7 and Table 10 into Equation 3. The result of this can be seen in Table 13.

It is noticeable that the part of the cost that consists of the dealers' cost and the service centres' cost differ a lot between the sub-regions. This can be explained by the locations of the service centres, seen in 4.5.1 Operation. As an example, the general labour cost is relatively low for the countries in the region Eastern Europe, while most of these countries are served by the service centre in Austria which has the highest labour cost of the service centres. This also means that the regions where a larger part of the cost is related to the service centre are also more sensitive to errors in the estimation of this cost and vice versa.

Table 13: The total cost of a delay in all sub-regions

Region	Cost per delay [Euro]	Dealer part [%]	Service Centre part [%]
Nordics	111.30	95	5
UK & Eire	63.25	92	8
Iberian Peninsula	52.04	93	7
Central South Europe	89.37	96	4
Central Europe	94.25	95	5
Central East Europe	29.25	85	15
Eastern Europe	17.43	88	12

5.1.4. Differences between the Sub-Regions

By dividing the answers from the survey into the sub-regions, it is possible to see some differences between the regions, see Table 14. The time for administration for the sub-regions dealers are still quite gathered around the overall value for EMEA. For the time without work for mechanics, the values are more scattered.

Table 14: Answers regarding time variables for dealers, divided into sub-regions of Europe

Region	Median mechanic [min]	Average mechanic [min]	Median administration [min]	Average administration [min]
Nordics	38	91	70	68
UK & Eire	20	55	60	56
Iberian Peninsula	15	15	60	60
Central South Europe	240	270	60	113
Central Europe	30	98	45	75
Central East Europe	65	216	45	90
Eastern Europe	50	50	50	50

However, it is important to remember that the survey only received 32 responses, which mean that the sub-regions have very few answers each and therefore can one answer have a big impact on the average. With that in mind, it is still believed that it was an appropriate way to estimate average values for EMEA and not one for every single sub-region. However, with a larger number of respondents it would have been possible to draw better conclusions to see if there are some sub-regions that stick out a lot from the other and then possibly should have been treated separately.

5.1.5. Goodwill

Even though all activities and the direct costs related to a late delivery are identified, it can in line with the discussion in 2.3.3 Goodwill, exist indirect cost in the form of lost goodwill related to a late delivery. In the survey, the dealers had to answer to what extent their customers are affected by a late delivery. It turned out that the dealers consider their customers to a high extent be affected by a late delivery, with an average of 4.44 on a scale from 1 to 5. This confirms the arguments from the interviewed dealers, who also stated that a delay has a big impact on their customers. As seen in Figure 22, only one of the dealers answered that it had a very low impact on their customers and as much as 63 percent believed it had a very high impact.

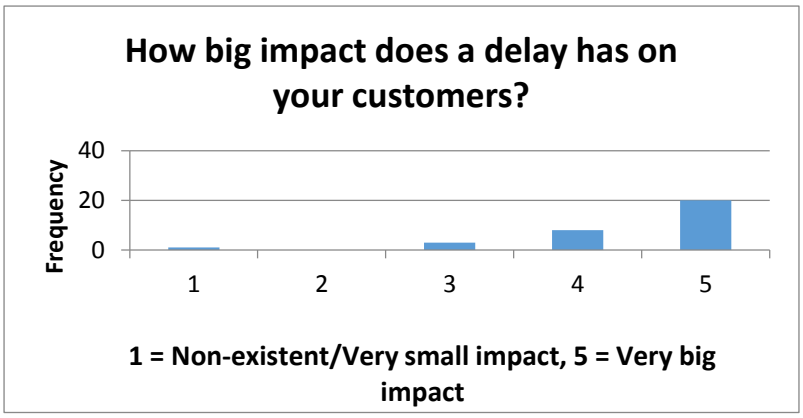

Figure 22: Answers to the survey regarding the impact a delay has on the dealers' customer

Further, the correlations are weak between how big the impact is on the customer and the impact on the internal activities caused by a delay, see Table 15. Accordingly, regardless of how large impact the delay has on the internal activities for the dealer, they all believe that a late delivery has a large impact on their customers.

Table 15: Correlation between the impact on customers and time variables for dealers

Variables	Correlation
Time mechanics stand without work & Impact on costumer	-0.10
Time for administration & Impact on costumer	-0.15

Several of the comments regarding the impact of a late delivery, underline how poor delivery precision can and will influence customers' perception. Furthermore, also how this in the end will affect the sales, since lower customer service will lead to customers using non-original spare parts and/or choosing other brands. Among the comments the following quotes can be found, "Customers loses Money. Volvo lose image and sales (now and in the future)", "Reputation, angry customer in part shop" and "In most cases the customer see this down to depot and not parts which means we could lose this customer."

These comments and opinions go in line with what various authors' state about poor delivery precision and the effect on goodwill. The arguments from Cohen et al. (2006), that the satisfaction with the aftermarket service is one of the most important numbers regarding if customer will make repetitive buying, goes directly in alignment with the comments from the dealers. The same apply on Jonsson's (2008) statement, if companies cannot fulfil the customers' requirements this will lead to effects on the goodwill.

However, as Liberopoulos et al. (2010) state, the indirect costs that the can be associated to loss of goodwill is very hard to estimate. This is also in line with the discussion in 4.8.4 Goodwill, where the employees at Volvo neither have any ideas for how to estimate the impact on goodwill. Therefore, it has not been possible to put a cost on loss of goodwill into the total cost of a late delivery. Instead, it is recommended to keep this in mind when using the cost. Consequently, it will be hidden cost that are not a part of the presented total cost of a late delivery and therefore "the real cost" of a late delivery will be higher than the calculated.

5.2. Total Cost of Poor Quality

All potential cost aspect of poor quality in the equation for cost of poor quality in the theoretical framework is thereby investigated. It can be concluded that all of these cost parameters can lead to costs, but only the cost of poor delivery precision can at this state be included in the total cost of poor quality for Volvo due to different reasons explained earlier in the analysis. Accordingly, it can be stated that the cost of poor quality in this case is the same as the cost of poor delivery precision. This means that the cost of poor quality will be estimated by Equation 5 and will use the same input values as in Table 13 for each transport provider in a specific sourcing project. Further, two variables still need to be decided in sourcing projects, which mean that it does not exist a specific cost of poor quality. Instead it depends on the number of deliveries and the delivery precision, which differs from sourcing project to sourcing project, but should be known for each project.

Equation 5: Cost of poor quality

$$Cost\ of\ Poor\ quality = (Cost\ of\ Mechanics\ without\ work + Cost\ of\ Administration\ for\ dealer + Cost\ of\ Service\ Centre) * Delivery\ Precision * Number\ of\ Deliveries$$

It can also be seen that this equation is very similar to the established equation for cost of poor quality within Transport Material. Since that equation is known and used within Logistics Purchasing, it is believed that this equation will easily be recognised and approved within the organisation.

However, as discussed in 3.1.2.4 Response Analysis, it can be discussed if the answers from the survey represent the total population. It may be so that dealers who did not answer the survey do not see late deliveries as a major problem for them and dealers who did answer see late deliveries as a large problem. If so, the result from the survey would overestimate the impact of late deliveries.

In the survey, the dealers had to answers how large percentage of their deliveries that have been late during the last 12 months. According to the answers, the dealers experience a high degree of late deliveries with an average of 15.59 percent of the total deliveries, which is much higher than the average number of delays for Volvo. It could be so that the dealers overestimate the number of delays, or it could be so that the dealers who experience a high degree of late deliveries is the ones answered the survey. Further, it is possible to see a positive correlation between how big part of the deliveries that are late and how long time the administrational work takes, see Table 16. Accordingly, this indicated that the dealers that answered the survey have larger problems than the average dealer, which indicate that the estimated cost of poor quality could be slighter higher than it should be to represent the population. However, the correlation is not strong and the response rate is low which mean that it can be a coincidence.

Table 16: Correlation between perceived percentage of delays and time variables for dealers

Variables	Correlation
Perceived percentage of delays and Administrational time	0.395
Perceived percentage of delays and Time mechanics without work	-0.045

5.3. Applying Cost of Poor Quality

As described earlier, the cost of poor quality is supposed to be used in the selection of transport providers. Therefore, Equation 5 for cost of poor quality made by the authors has been applied on some real cases to demonstrate the impact it can have in sourcing projects. However, the specific cases are only involving one transport provider each and therefore the cost has been applied by assuming different levels of delivery precision for that transport provider. The exact market for the projects are undisclosed due to confidentiality.

The first example is a project that involve transports from a transport provider hub to dealers in that country and another nearby country. In total it concerns 53 000 shipments annually. When adding the cost of poor quality to the cost of rate, the total cost differs with more than 158 000 Euro, equal to 2.13 percent, per year comparing a delivery precision of 100 percent with 95 percent, see Figure 23.

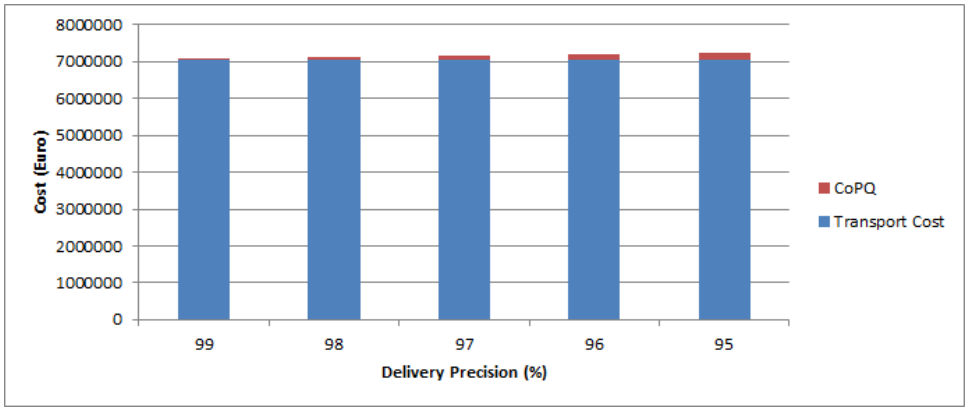

Figure 23: Comparison of how the total cost is affected by the cost of poor quality in example 1

Noticeable is that the first specific project did not concern a country that has among the highest labour costs in Europe, which indicate that the cost of poor quality could have a significantly higher impact for other projects. This is confirmed when looking into the second example. Here, the project concerns 6782 shipments annually in a country where the labour costs are higher and the shipments in average are shorter in distance. This leads to a larger impact on the total cost and, as can be seen in Figure 24, the total cost increase with 5.49 percent when the delivery precision goes from 100 percent to 95 percent.

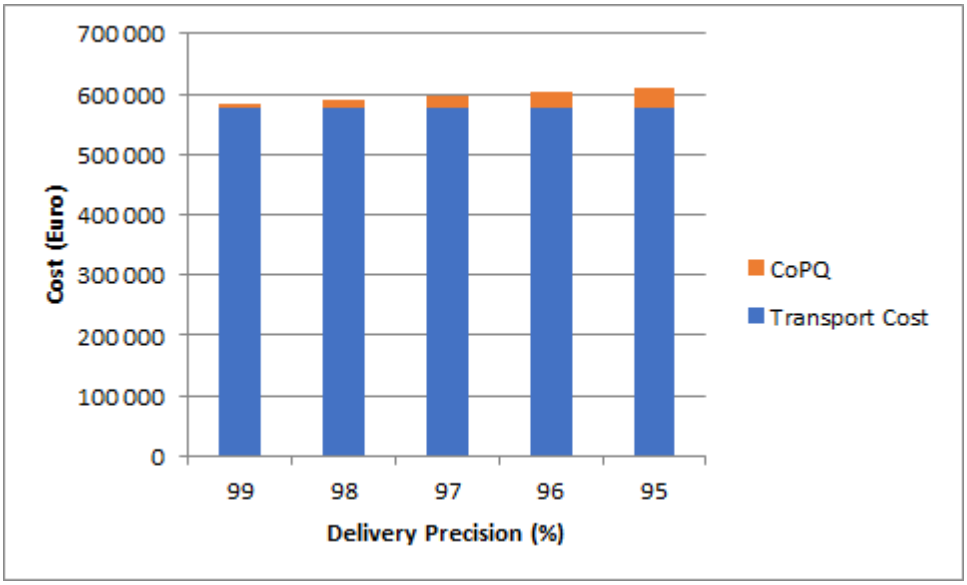

Figure 24: Comparison of how the total cost is affected by the cost of poor quality in example 2

A third example where the cost of poor quality is added to the transport cost can be seen in Figure 25. Here, it is applied on a smaller case with 788 shipments and where the transports come from another country, in this case meaning that the distance was longer. Further, the project concerns a country where the dealer costs are considerable lower than for the other two earlier examples due to the low hourly labour costs. With a difference of only 0.59 percent between 100 percent and 95 percent in delivery precision, the impact is less than 10 percent of example number 2.

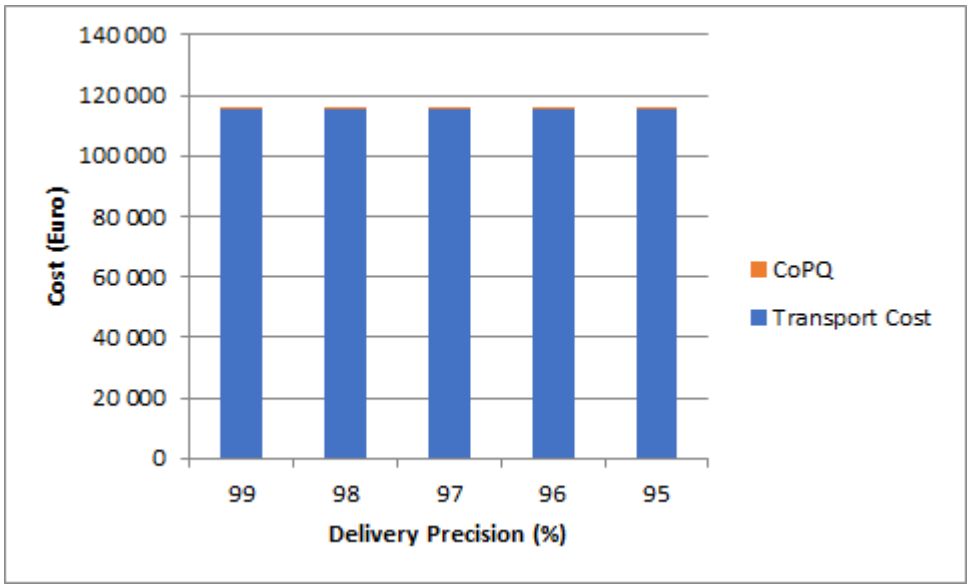

Figure 25: Comparison of how the total cost is affected by the cost of poor quality in example 3

From these three examples, it can be concluded that the impact of adding the cost of poor quality differ a lot from project to project. It certainly depends on the size of the cost of poor quality in the sub-regions, but it also depends on its relation to the transport cost. The transport cost in its turn depends on several variables, where some noticeable are the transport distance and market variables as market competition and laws. Accordingly, the cost of poor quality will have a higher

impact if the transport cost is relative low, which can be the situation when the transport distances are short and other cost variables as the fuel cost and the labour cost for drivers are low. In other words, the cost of poor quality will have a higher impact if the transport cost is relative low, which can be the case when the transport distances are short and other cost variables as the fuel cost and the labour cost for drivers are low.

5.4. Sensitivity Analysis

As the most numbers used to calculate the cost of poor quality in this study are based on estimations and not 100 percent fact, a sensitivity analysis was made to see how the result would be affected if one or several numbers are incorrectly estimated. Even if the numbers are correctly estimated at this point, they are changeable and thereby can this analysis show what impact any changes would have on the cost and the usefulness of it. Particularly the labour costs levels can be assumed to constantly increase with inflation wherefore the analysis of this could be of highest interest even if the numbers are correct today.

Since the labour costs in the study are based on statistic of the average labour costs in respective country, it is not sure that they are accurate for the personnel at Volvo or their dealers. Therefore, two sensitive analyses with the labour cost for the dealers' respective service centres' as variables were carried out. However, the labour cost levels will most likely not differ more than 10 percent from the statistic. Therefore, an analysis is made to see how the cost of poor quality is affected by an increase of 10 percent of these numbers, see Table 17. Of course, the labour cost could equally well be 10 percent lower than estimated but this would approximately give the same, but negative, result why only one of these analyses is presented below.

Table 17: Impact on the cost of a late delivery if labour cost variables increase with 10 percent

Region	As is [Euro]	Labour Cost Mechanics	Labour Cost Service Centre
Nordics	111.30	+9.54 %	+0.46 %
UK & Eire	63.25	+9.23 %	+0.77 %
Iberian Peninsula	52.04	+9.26 %	+0.74 %
Central South Europe	89.37	+9.56 %	+0.44 %
Central Europe	94.25	+9.46 %	+0.54 %
Central East Europe	29.25	+8.46 %	+1.54 %
Eastern Europe	17.43	+8.84 %	+1.16 %

As can be seen in Table 17, a difference in the labour cost for mechanics will have the biggest impact of the labour cost variables. In opposite, a 10 percent difference in the labour cost for the service centre will have relative low impact for all regions, even if the affect would be almost three times higher for Eastern Europe than the Nordics. This can be explained by the same arguments as in 5.2.1.4. The Total Cost of Late Deliveries, that the eastern regions are supported by distribution centres in the central Europe with relative high labour costs in comparison with the general labour costs in that regions. In the analysis, the same difference (10 percent) has been used for all regions. However, it is not necessarily that simple, it could be so that the Volvo employees in some countries are more expensive than the general employee and cheaper in some, and that the estimations therefore could be too low in some regions and too high in some.

Furthermore, as discussed consistently during the analysis, the time variables for the dealers and the service centres may not be 100 percent accurate since it is based on estimation from a relative low number of dealers. Therefore, a sensitivity analysis has been carried out on these variables as well. With a low response rate, big difference between median and average value as well a high standard deviation, the most insecure variable is the time without work for mechanics according to the authors. Therefore, a sensitivity analysis has been made with the lower median value and with the higher average value when top and bottom 10 percent are included. This analysis is picture in Table 18, where the percentage changes of the total cost of a late delivery are shown.

Table 18: Impact on the cost of a late delivery if mechanic without work time wrongly estimated

Region	As is [Euro]	If Mechanic = Median	If Mechanic = Average
Nordics	111.30	-38.82 %	+63.70 %
UK & Eire	63.25	-37.52 %	+61.57 %
Iberian Peninsula	52.04	-37.65 %	+61.78 %
Central South Europe	89.37	-38.87 %	+63.79 %
Central Europe	94.25	-38.46 %	+63.12 %
Central East Europe	29.25	-34.40 %	+56.45 %
Eastern Europe	17.43	-35.96 %	+59.01 %

Further, the same analysis as for mechanics without work has been carried out for the time of administration for the dealer. However, these sensitivity variables do not differ as much since the alternative values are closer to the used value. Regarding the time for service centre, the worst possible difference is assumed to be 30 percent and this is used in the sensitivity analysis, see Table 19.

Table 19: Impact on the cost of a late delivery if administration variables incorrectly estimated

Region	As is [Euro]	If Administration dealer = Median	If Administration dealer = Average	If Service Centre + 30 percent
Nordic	111.30	+2.96 %	+7.97 %	+1.37 %
UK & Eire	63.25	+2.86 %	+7.70 %	+2.32 %
Iberian Peninsula	52.04	+2.87 %	+7.73 %	+2.33 %
Central South Europe	89.37	+2.96 %	+7.98 %	+1.32 %
Central Europe	94.25	+2.93 %	+7.90 %	+1.63 %
Central East Europe	29.25	+2.62 %	+7.06 %	+4.63 %
Eastern Europe	17.43	+2.74 %	+7.38 %	+3.48 %

In a worst-case scenario, the situation could be that all of the variables are incorrectly estimated in the same direction. This would mean that the labour cost variables would differ with 10 percent, the time variables for the dealer are the average value and the time for service centre be increased with 30 percent. If this was the case, it would result in the cost of a late delivery seen in Table 20. With a as much as 90 percent difference, it could have a crucial impact in the choice of supplier.

Table 20: Worst-case scenario if variables incorrectly estimated

Region	As is [Euro]	Worst-Case [Euro]
Nordic	111.30	211.84
UK & Eire	63.25	119.39
Iberian Peninsula	52.04	98.31
Central South Europe	89.37	170.17
Central Europe	94.25	178.99
Central East Europe	29.25	54.10
Eastern Europe	17.43	32.57

The impact of incorrectly estimated numbers would mean that the cost of poor quality would get a too low or big impact in the choice of transport provider. Accordingly, a supplier with a higher total cost could be chosen in place of a cheaper alternative. However, as discussed in 5.2. , not all costs are included in the cost of late delivery, which means that the cost could come closer to "the real cost" by overestimate some numbers. However, this is nothing to strive for as it could create problems in the future if the scope is expanded to include these parameters. Also, it could create resistance towards the study if it not based on trustworthy numbers.

Furthermore, the cost could also be affected by variables lying outside of the control of this study. An example of this is the currency fluctuation. 19 of the 44 included countries in sub-regions to Europe use Euro as the currency. But for the other 25 countries, the currency fluctuation will have a direct impact of the result since the costs are calculated in Euro. This means that the more countries and dealers in a sub-region that do not use Euro as currency; the more sensitive that sub-region is for currency fluctuations. As example, in Eastern Europe, none of the countries use Euro while all countries in Central Europe are Euro countries. Accordingly, Central Europe is less sensitive to currency fluctuations in this case. Furthermore, currency fluctuations can impact the cost of rates and other parameters of the Supplier selection model, which can impact the relative influence of cost of poor quality.

6. Discussion

In the following chapter, the result and analysis will be discussed in four steps. Firstly, the impact of including the cost of poor quality in sourcing processes is discussed, which relate to the second part of the aim of this thesis. This is followed by a discussion about the actors and activities that are affected by poor quality and how these can be included in the cost of poor quality, which relate to the first part of the aim. Further, the usefulness of cost of poor quality in the supplier selection model is discussed. The discussion ends with suggestions regarding how to keep the cost of poor quality up to date.

6.1. The Impact of Including Cost of Poor Quality

Regardless of which of the three examples in 5.3 Applying Cost of Poor Quality that is considered, the cost of poor quality is far from the 25 percent that could be the case according to Sörqvist (1997). However, it should be remembered that not all aspects of poor quality are included in the cost calculations, meaning that the "real cost or poor quality" for Volvo could be much closer to the 25 percent. Nevertheless, this study has been able to prove the importance of including cost of poor quality for the management which according to Sörqvist (1997) is an important and good start of using it in bigger scale. Further, this study has shown the need of implementing measuring systems for other cost aspects, such as damages, to also be able to include this in the cost of poor quality, which according to Sörqvist (1997) is an appropriate next step.

The use of cost of poor quality in the supplier selection may however not only reduce the total costs for Volvo, it could also lead to other benefits for the whole supply chain and the society. If Volvo put a cost on damages or poor delivery precision, it could result in making the supplier improve their handling of goods and delivery precision. This would mean that less rush transport would be needed. While those certainly are very expensive, the rush transports also have a highly negative impact on the environment. The total footprint would therefore be lower if companies could lower damages and increase delivery precision. Furthermore, damages are in many ways even more damaging to the environment than poor delivery precision since the goods must either be thrown away or be picked up at the dealer.

6.2. Improving Cost of Poor Quality

The project has met different obstacles during the process, which have limited the scope of the cost of poor quality. By looking at the five possible obstacles of working with cost of poor quality stated by Eldridge et al. (2006), two of them can clearly be identified in this project. The lack of information has been a large obstacle due to the problems getting in contact with actors that could provide the authors with valuable information. But the lack of performance measurements can also be seen as an information obstacle. Further, confusion between organisational hierarchies can be identified as a second type of obstacle in the process. With a better and more transparent collaboration between divisions, the communication restrictions could possibly have been avoided, and in that way a better result of the survey could have been achieved. However, if removing these obstacles, Volvo could in line with the argument from Eldridge et al. (2006), have the possibility to broaden the scope of cost of poor quality for transport parts. The cost of poor quality that has been estimated by the authors consists of costs associated with poor delivery precision. But as been discussed in the analysis, there

are possibilities to extend the scope of the poor quality, both related to the cost of a late delivery but also to other aspects of poor quality.

The cost of a late delivery could first be extended to include the costs of VOR orders needed due to late deliveries. But this would require the decisions makers at Volvo to develop performance measurements and implement these in the organisation. In other words, it must be known how large percentage of delays caused by transport providers that result in VOR orders and what the cost of a VOR order is. Further, the cost related to loss of goodwill due to a late delivery could be included, but this is by the authors seen as a very difficult and complicated task. The impact that a delay has on the goodwill must be known in order to include it, and as stated by Liberopoulos et al. (2010) it can be almost impossible to identify.

If looking outside the cost poor delivery precision, the cost of damaged goods could be possible to include in the cost of poor quality. In line with what Caplice and Sheffi (1995) state, it is important to use performance measurements as it can have an impact on the vendor selection. Similarly to the VOR orders, it would be needed to a develop performance measurements to register the number of damages and the cause of damage in a better way. As argued by Lumsden (2012), it may be within spare part deliveries where the biggest costs lie since damages are more common on spare part deliveries than material or finished product deliveries. Accordingly, it is reasonably for Volvo to initially try to focus on measuring damages for Transport Parts before measuring for Transport Products or Transport Material. This could potentially be possible today, but instead of calculating the cost of a damaged shipment, this study had the focus to validate other numbers that could be used in the cost of poor quality and the Supplier selection model instantly.

That being said, some thoughts have still been made to approximate the cost size of a damaged shipment. The cost of would probably be higher than the cost of a delay, since many of the activities are the same, such as mechanics standing without work, administrational activities and a new order must be placed. However, the cost for damages may be higher since it takes longer time to get a part in useful condition which can create larger problems at the workshop. Further, as described in 4.8.2 Damaged Goods, a delayed part need to be sent back to the DC, which will cause extra transport costs. Though, the analysis of this is most likely more complicated since more actors and departments within Volvo are involved. Also, while damages of shipments cause costs for Volvo, Volvo can also get compensation from the transport provider that caused the damage, meaning the total cost could probably be an equation where *Total cost = Costs – Compensation*.

Furthermore, it is doubtful if the set-up today is the best to be able to estimate the percentage of damaged goods. As mentioned in 4.8.2 Damaged Goods, dealers state that they do not have the time or knowledge to put a lot of effort in investigating the cause of damages. Further, it can be questioned if it should be up to the dealers to determine who caused a damage. As the damaged goods are transported back to the DC, it may be a better option to let the DC investigate the damages. Through this, a more specialised person could investigate it and thereby find the underlying reason for a larger portion of the damages. On the other hand, if these changes would be made, it could be a conflict of interest from the DC when they should investigate a damage that could be caused by themselves. In those situations, it could be a risk that the DC blames another actor such as the transport provider or the dealer. As Sörqvist (1997) argues in his third step of

developing a measuring system, training is important where things like this can be taken in consideration, before implementing the changes in the whole organisation.

The authors believe that it is possible for Volvo to expand the scope of poor quality by start using performance measurements. The six first conditions of good performance measurements identified by Ploos van Amstel and D'hert (1996) should not be a problem for Volvo to satisfy if they give it an effort. Also, the 7th condition, that the cost of collecting the data must be lower than the potential benefits, must be kept in mind. However, the authors believe that within the cost of poor quality there is a large potential and therefore the cost of collecting the data will be lower than the benefit of getting access to the information.

6.3. How to Use the Cost of Poor Quality in Supplier Selections

As the use of cost of poor quality requires knowledge about the delivery precision for the transport providers that are compared, it may create some problems when comparing with a new transport provider who Volvo does not have any data about. Since these suppliers are not current ones, there is no historical performance to use as decision base, and it is difficult to know how this would be handled. This could be solved by letting the transport provider providing Volvo with data of its delivery precision for other customers. However, the delivery precision that a transport provider has with their other clients does not necessarily represent the delivery precision the transport provider will have for Volvo's shipments. This is not a problem that is unique for calculations using delivery precision; instead Volvo has the problem for all calculations in the Supplier selection model. Therefore, the issue would also exist if other aspects would be included in cost of poor quality since those would also be based on historical data that Volvo or the transport providers have measured.

As described in 4.2 The Sourcing Process, the Supplier selection model is today used in gate 3 of the sourcing process. However, it could possibly be used in other stages of the purchasing process. The optimal way to use the Supplier selection model in the sourcing process may be to use it throughout phase 2 until (and including) gate 3. This would mean that Volvo would put a lot of emphasis on the model and would not include suppliers in the short list that have a high total logistics cost. Unfortunately, this is not possible at the time of writing since the duration of phase 2 is short and there is not usually enough time to include the Supplier selection model during it. One could also argue that including the Supplier selection model earlier, and therefore having a longer time from use to implementation of the new contract, can cause problems since supplier KPIs can change drastically. The delivery precision can be dissatisfactory today but improve in the coming months, but that specific supplier will then have a too large cost for poor quality and may not be awarded the project. In other words, historical performance does not necessarily represent future performance. Using the Supplier selection model too early would therefore mean that today's information is used to make decisions regarding the far future which is not optimal; instead it could be better to use information closer to actual decision point which is possible when using the model in phase 3.

6.4. Keeping the Cost of Poor Quality Up to date

When the cost of poor quality was estimated, the numbers used to calculate the hourly labour costs was based on the latest available numbers. However, these numbers are constantly changing and therefore the cost continuously needs to be updated to be correct and fully useful. All the changes

can easily be done by Volvo in an Excel sheet created by the authors. In the Excel sheet developed by the authors for Volvo, it is clearly stated which numbers that need to be changed and updated in order to update the cost of poor quality.

Eurostat, that is the main source for the labour cost numbers, release new reference numbers regarding the labour cost for various professions every 4th year and therefore it is recommended that the labour costs in the calculations are updated according to the reference numbers every 4th year. The year that the reference numbers are released is always referring to statistics from two years earlier. Since the reference year the authors' used in this study is 2012, these numbers were released in 2014 (Eurostat, 2018a). This also mean that new numbers, with 2016 as reference year, will be released during 2018 and it is therefore recommended that the first update should be made later in 2018. Further, Eurostat release smaller reports regarding the average hourly labour every year but they are not related to a specific profession. Instead, those labour costs are average for all professions are taking into account the general wages and inflation. Therefore, it is recommended to also update these numbers once every year and, in that way, keeping the cost of poor quality up to date even between the major reports every 4th year.

The cost numbers that are gathered from other sources than Eurostat, which are labour costs for 10 of the 44 investigated countries, is recommended to be updated at the same time as the labour costs from Eurostat. This requires some more time than for the Eurostat numbers but is still easy to manage. Further, the labour costs for those 10 countries not included in the Eurostat statistics are based on exchange rate, which mean that these numbers could be updated every day since the exchange rate is constantly moving. However, the authors consider it as an appropriate balance between the accuracy in the cost of poor quality and the time it takes to adjust, to change this number annually.

7. Conclusions

Potential parameters of cost of poor quality have been identified to be cost of poor communication, cost of damaged goods and cost of poor delivery precision. However, due to lack of performance measurements and uncertainties regarding how to estimate the size of the parameters, only the cost of poor delivery precision can be included in the cost of poor quality at this point. Though, the cost of poor delivery precision could not be fully included, instead there are aspects that are not investigated such as costs of VOR orders due to delays.

The actors that are most affected by poor delivery precision from transport providers are identified to be the dealers, the service centres and the end-customers. Activities due to late deliveries and that lead to costs for the dealers are mechanics standing without work and administration. For the service centres, it is the administration and communication with concerned actors to solve the problems. The end-customers and cost of lost sales could not be included in cost of poor quality due to difficulties to measure and estimate it.

The cost of a late delivery is depending on the hourly labour costs where the actors are located, and the time spent for the actor. As the cost of a late delivery differs depending on the region, it is not possible to state a single cost for all activities and actors. However, the total cost per delay is estimated to be between 17 Euro and 111 Euro for the seven sub-regions in Europe identified in this thesis.

Adding the cost of poor quality in sourcing projects can have a considerable influence on the decision regarding which transport provider to employ. As shown by an example, it can lead to more than one and a half percent higher total cost when the delivery precision decrease with one percent. However, how large influence it has in the decision of transport provider can differ a lot between sourcing projects depending on the region and the relative size of the other costs in the Supplier selection model.

As not all aspects are included in the cost of a late delivery, the "real" cost of poor delivery precision will be higher than the estimated. Further, as only poor delivery precision is included in the cost of poor quality, the total cost of poor quality will be even higher. Accordingly, the cost of poor quality will not have as high influence in the choice of transport provider as it could have. However, adding the cost of poor quality will make it visible for everyone that Volvo care about the performance and not only the transport rate. This can make the transport provider work more to improve their performance, which will improve the service level and reduce the total cost.

To put a figure on cost of poor quality, performance measurements need to be in place to measure the differences between transport providers. The lack of existing performance measurements limited this study, and this is something Volvo need to improve if they should be able to include more parameter into the cost of poor quality. The performance measurements that may be needed to include is number of damages caused by a transport provider and measurements regarding a transport provider's communication.

This study has shown the complexity of identifying the cost of poor quality as every company and every supply chain are unique. It is therefore necessary to have a close collaboration between involved actors and decision makers. In this aspect, this study met resistance which reduced the response rate of the survey that were used to identify the cost of a late delivery. This has reduced the credibility of the result of this study and the sensitivity analysis need to carefully be taken into consideration. However, as not all parameters of a late delivery are included, the impact that potential overestimations could have is low, as the “real” cost probably still is higher.

As every company and every supply chain are different, the way that the cost of poor quality is applied on Volvo cannot be directly applied on other companies. However, the approach for how to estimate the cost of poor quality can be used and adjusted to each company's unique situation.

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Appendices

Appendix A - List of Interviewed Persons

A complete list of the interviewed persons follows below. Name of the participants are undisclosed. Not included in the list are the introduction meetings with Business Control, Commodity, EMEA, Americas, APAC and Vice President Logistics Purchasing. Furthermore, the persons present at the status update presentations of the project are not included in the list.

Title	Division	E-mail, phone, in person etc.
Regional buyer EMEA	Logistics Purchasing	In person
Regional buyer EMEA	Logistics Purchasing	In person
Regional buyer EMEA	Logistics Purchasing	In person
Transport Parts Coordinator	Transport Parts Management	In person
Supplier Manger Road	Transport Parts Management	Skype
General manager DC Eskilstuna	SDC Eskilstuna	Skype
Production Manager	SDC Eskilstuna	Skype
Manager European Service Centre	Service Centre Nordic	In person
Helpdesk Coordinator	Service Centre Nordic	In person
Helpdesk Coordinator	Service Centre Nordic	In person
Helpdesk Coordinator	Service Centre Nordic	In person
Group leader Discrepancy Transport Parts	Service Centre Gent	Skype
Group leader Service Centre	Service Centre Gent	Skype
Group leader Delivery & Planning	DC Gent	Skype
Manager Service Centre	Service Centre Lyon	Skype
General manager Service Centre	Service Centre UK & Eire	Skype
Order controller Service Centre	Service Centre UK & Eire	Skype
General Manager SDC	SDC Vienna and Bucharest	Skype
Manager Service Centre	Service Centre Turkey	Skype
Manager Service Centre	Service Centre Moscow	Skype
Service Centre & Operations Manager	Service Centre Casablanca	Skype
Customer Service Centre Manager Service Centre	Service Centre Johannesburg	Skype
Process Manager Reverse Logistics	Operations Excellence	In person
Process Manager Transport Parts	Operations Excellence	In person
Service Contract Offer Manager	Volvo Trucks Commercial Offers EMEA	In person
Head of Flow Optimization	TFO Americas	Skype
Service market manager	Dealer 1	In person
Parts Manager	Dealer 1	In person
Parts Manager	Dealer 2	Phone
Parts Manager	Dealer 3	Phone
Parts Manager	Dealer 4	Phone

Appendix B – Survey Questionnaire

Survey regarding late deliveries of spare parts

The aim of this survey is to identify the effects of late spare part deliveries. With a delay, we mean a delivery that is delivered later than agreed. E.g. if the agreed time is 07:00, the delivery is delayed if it arrives one minute or more after 07:00.

Answer the questions to your best ability. For question 2-5, we understand that it may differ a lot, but try to estimate an average for the last 12 months.

If you have any questions you are welcome to contact us by e-mail:
Anton Gustafsson – anton.gustafsson@volvo.com
Josephine Risberg – josephine.risberg@volvo.com

Thank you!

1a. Which city and country is your workshop in?
[Free text answer]

1b. What is the name of your company?
In order to know which dealers we have received information from we need to know your company name.
[Free text answer]

2. How large percentage of your deliveries have been delayed the last 12 months?
Answer in percent. With a delay, we mean a delivery that is delivered later than agreed. E.g. if the agreed time is 07:00, the delivery is delayed if it arrives one minute or more after 07:00.
[Free text numerical answer]

3a. Is there a point where a delay goes from acceptable to severe?
[Alternatives are “Yes”, “No”, or “Other” (free text answer]

3b. If yes, when does this point occur and what happens?
[Free text answer]

4a. If there is a delay, how much time are mechanics or other personnel without work due to the missing delivery?
[Free text numerical answer]

4b. On a scale, how sure are you of your answer to the previous question?
[Scale from 1=Guessing to 5-=Facts from a data system]

5a. How much time is spent with administration about one delay (e.g. replanning of work day, report in Argus and communicate with Volvo and concerned customers)?
[Free text numerical answer]

5b. On a scale, how sure are you of your answer to the previous question?
[Scale from 1=Guessing to 5-=Facts from a data system]

6a. How big impact does a delay has on your customers?
[Scale from 1=Non-existent/Very small impact to 5=Very big impact]

6b. In what ways are your customers impacted by delays?
[Free text answer]

7. Can you think of anything more that a delay can cause?
[Free text answer]

8. Do you have any additional comments, questions, or concerns you would like to share?
[Free text answer]

Appendix C - List of Service Centres and their Catchment Areas

Service centre name	Scope of countries	Department
SC Nordics	Denmark Estonia Finland Iceland Latvia Lithuania Norway Sweden	Gent & EU
SC Gent	Belgium Germany Greece Luxemburg The Netherlands Poland Switzerland	Gent & EU
SC UK & Eire	UK Ireland	Gent & EU
SC Eastern Europe	Albania Austria Bosnia and Herzegovina Bulgaria Croatia Czech Republic Hungary Macedonia Moldavia Montenegro Romania Serbia Slovakia Slovenia	Gent & EU
SC Lyon	France Italy Spain Portugal	Lyon & RMEA
SC DC Istanbul	Turkey	Lyon & RMEA
SC DC Johannesburg	Botswana Lesotho Malawi Mauritius Mozambique Namibia South Africa Swaziland Zambia Zimbabwe	Lyon & RMEA
SC DC Casablanca	Morocco	Lyon & RMEA

SC Algiers	Algeria	Lyon & RMEA
SC DC Moscow	Belarus Kazakhstan Russia	Lyon & RMEA
SC RDC Dubai	Bahrain Egypt Ethiopia Iraq Jordan Kenya Kuwait Lebanon Oman Pakistan Qatar Saudi Arabia Somalia Sudan Tanzania Tunisia Uganda United Arab Emirates Yemen	Lyon & RMEA

Appendix D - Labour Cost Levels

Mechanics

The labour cost levels for mechanic have been estimated by using the hourly labour cost for personnel working within "Wholesale and retail trade; repair of motor vehicles and motorcycles" during 2012 (Eurostat, 2017). These costs have then been translated into 2017 cost level by comparing the average labour cost for 2017 with the average labour cost for 2012 (Eurostat, 2018b). By doing this, the hourly labour cost for mechanics are given as in Table D1.

Table D1: Labour costs for mechanics in the countries including in the statistics from Eurostat.

Country	Hourly Labour Cost 2012 Mechanics [Euro]	Growth 2012 to 2017 [%]	Hourly Labour Cost 2017 Mechanics [Euro]
Belgium	37.64	4.16	39.20
Bulgaria	3.11	43.27	4.46
Czech Republic	9.29	13.11	10.51
Denmark	37.66	6.09	39.95
Germany	27.16	7.98	29.33
Estonia	7.88	36.52	10.76
Ireland	22.15	2.18	22.63
Greece	14.63	-7.82	13.49
Spain	17.97	0.28	18.02
France	29.71	4.20	30.96
Croatia	8.15	11.81	9.12
Italy	24.07	0.75	24.25
Cyprus	14.10	-4.71	13.44
Latvia	5.30	36.13	7.21
Lithuania	5.17	36.29	7.04
Luxemburg	25.94	10.17	28.58
Hungary	7.01	23.31	8.65
Malta	9.57	16.75	11.18
Netherlands	27.90	6.03	29.58
Austria	27.49	11.66	30.69
Poland	6.15	19.29	7.33
Portugal	12.11	5.94	12.83
Romania	3.77	52.17	5.73
Slovenia	14.81	9.04	16.15
Slovakia	8.14	24.02	10.10
Finland	29.18	4.21	30.41
Sweden	35.87	4.64	37.53
United Kingdom	17.65	17.94	20.82
Iceland	21.10	83.70	38.77
Norway	46.24	-10.67	41.31
Switzerland	46.58	15.62	53.86
Republic of macedonia	3.41	15.62	3.94
Serbia	4.45	15.62	5.15
Turkey	4.97	15.62	5.75

For the countries in Europe that are not included in the statistics from Eurostat, the labour cost of a mechanic is estimated by comparing the labour cost of a mechanic with bordering countries. The hourly labour cost of a mechanic that this result in can be seen in Table D2.

Table D2: Labour cost of a mechanics in the European countries not included in the Eurostat statistic

Country	Hourly Labour Cost 2017 Mechanics [Euro]
Albania	5.15
Bosnia and Herzegovina	5.15
Ukraine	5.56
Russia	5.56
Belarus	5.56
Montenegro	5.56
Azerbaijan	5.56
Moldova	5.56
Georgia	5.56
Armenia	5.56

Service Centre

The hourly labour cost for the personnel working at the service centres in the European countries, has been estimated in the same way as for the mechanics but by using the cost of personnel working with "information service activities", see Table D3 (Knoema, 2018).

Table D3: Labour cost of personnel working with information service activities in the European countries

Country	Hourly labour cost 2012 service centre [Euro]	Growth 2012 to 2017 [%]	Hourly labour cost 2017 service centre [Euro]
Belgium	45.92	4.16	47.83
France	34.80	4.20	36.26
Austria	43.73	11.66	48.83
Sweden	45.39	4.64	47.50
United Kingdom	38.95	17.94	45.94
Russia			7.90
Turkey	12.08	15.62	13.97

Appendix E – Sub-Regions in Europe

The following countries in Table E1 are included in the sub-regions that the authors have divided EMEA into and that cost of poor quality is calculated for.

Table E1: Regions included in the sub-regions presented

Region	Country
Nordic	Finland
	Denmark
	Iceland
	Norway
	Sweden
UK & Eire	Ireland
	United Kingdom
Iberian Peninsula	Portugal
	Spain
Central South Europe	Malta
	Italy
	France
	Schweiz
Central Europe	Netherlands
	Luxemburg
	Belgium
	Germany
	Austria
Central East Europe	Estonia
	Latvia
	Lithuania
	Czech Republic
	Poland
	Slovakia
	Hungary
	Croatia
	Slovenia
	Cyprus
	Greece
	Turkey
Eastern Europe	Belarus
	Russia
	Moldova
	Ukraine
	Azerbaijan
	Armenia

	Georgia
	Romania
	Albania
	Macedonia
	Bosnia and Herzegovina
	Serbia
	Bulgaria
	Montenegro