



**UNIVERSITY OF GOTHENBURG**  
**SCHOOL OF BUSINESS, ECONOMICS AND LAW**

Master Degree Project in Logistics and Transport Management

## **Same Day Availability with a D2D Setup**

A case study of Volvo Group

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## **Abstract**

In order to deliver high uptime service to end customers, it's important for companies, within the manufacturing industry, to have high availability of spare parts at the dealers, as they are the face towards the end customers. To be able to do this, companies need to balance costs of having big inventories, including all parts, with the service they want to offer. This thesis focuses on how the availability within a manufacturing company, such as Volvo Group, can increase their availability by grouping dealers, by using a general model, with the purpose of implementing inventory pooling between the dealers.

The thesis is structured in such a way that it starts with presenting the general model, which can be used by organizations for better management of their dealers and their services through them. The thesis later delves into the logistics aspects such as inventory planning and transport services for emergency orders. These two aspects answer the research questions for this Master Thesis. In order to generate quality results, it was considered important to study the current processes at Volvo and their dealers as they are the two main stockholders in this project.

*Keywords:* Availability, Service level, General model, Grouping dealers, Scenarios, Inventory pooling, Transport solutions, Dealer process, Order process, D2D

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## List of abbreviations

D2D	Dealer To Dealer
LPA	Logistic Partner Agreement
LTL	Less Than Truckload
FLT	Full Truck Load
OEM	Original Equipment Manufacturer
VMI	Vendor Managed Inventory
EOQ	Economic Order Quantity
VOR	Vehicle Off Road
CW	Central Warehouse
RW	Regional Warehouse
SW	Support Warehouse
BOR	Back Order Recovery

# **1 Introduction**

*This chapter starts with a presentation of the background of the study explaining the growing importance of aftermarket services and how an organization like Volvo Group works with this service. The chapter also includes a problem discussion, which underpins the reason for this study to be conducted together with the purpose of the thesis. Followed by this, the kind of research questions that needs to be answered in order to solve the existing problems are presented together with the scope and limitations for this study. The chapter ends with a presentation of the expected results.*

## **1.1 Background**

The first thought that comes to mind when talking about a product based company is about their manufacturing and selling of products. The loyalty and service of a company towards its customers does not end there though; it starts from there with its “Aftermarket” services. Aftermarket, which earlier used to be considered as an afterthought by companies has now become one of the most important deciding factors from a customer’s point of view and a competitive factor from a company’s point of view (Cohen et al, 2006). Aftermarket service has various definitions in literature and these definitions can range from product support to technical support (Saccani et al, 2007). The most important role for aftermarket business in any industry is to reach high customer satisfaction. Customers first expect the manufacturers to fix the issue soon rather than to get it fixed with high quality. Therefore to have this success factor, it is important to have the right part at the right place in the right time and in the right quantity. In short, availability of the products is the main concern for any company with aftermarket services (Cohen et al, 2006).

Aftermarket business in any industry is at a place where the growth is much faster than any business in the industry. Problems can occur in the aftermarket when there exists incompatible components giving rise to proprietary aftermarkets (Shapiro, 2007). There are many challenges that are faced by the aftermarket department of OEM’s (Original Equipment Manufacturer), one of the main challenges being the uncertainty of the demand for parts as well as the large amount of stock keeping units. On a positive side, they also account for high margin in the business in turn giving the organization high profit levels (Cohen et al, 2006). Researchers also discuss about studies, which prove the relation between the quality of a firm's aftermarket services and the stock prices which are directly related. Researchers also agree that to attain high profits, manufacturers should focus on the aftermarket services of a company (Saccani et al, 2007).



The distribution strategy for the aftermarket services can be analyzed from the costs that are associated in holding stocks at multiple locations, which can either be using a single distribution point or multiple distribution points.

Aftermarket services are of high importance in the automotive industry who are into manufacturing construction equipment, trucks and buses as these segments are supposed to have a high “up-time” of their products. Big automobile manufacturers are already operating with multiple locations concept to provide the customers with a high level of service and at the same time not being dependent on one location. Automobile manufacturers serve their customers through dealers who stock parts for the respective companies. The number of stocking points and the types of dealer network needed mainly depends on the kind of service level, which has been promised to the customers by the manufacturers. Therefore this also leads to a market with high competition levels (Maheswaran et al, 2012).

Volvo Group is an organization that is a leading manufacturer of buses, construction equipment, marine engines, trucks, industrial engines and sells its products in more than 190 markets. The organization today owns six different brands spread over the world, Renault Trucks, Prevost, Mack, UD, Nova bus and Terex, and four brands with joint venture set up, SDLG, Dongfeng brands, Sunwin and Eicher. (Volvo Group, 2016d)

Today about 100 000 people are employed within the organization and they have 18 production facilities located around the world. The vision for the organization is to become a leader within sustainable transportation solution with their focus being on the end customer and their needs. The organization today has 10 different business areas, where Volvo Group Truck is the largest area that cover 68% of the company's net sales (Volvo Group, 2016b; Volvo Group, 2016c; Volvo Group, 2015). Within Volvo Group Truck operation exist Volvo Logistics Services, which is responsible for optimizing, designing and managing its logistics services for all the Volvo Group brands. Their goal is to have an efficient and sustainable supply chain with reduced costs and causing minimum environmental impact. The main goal of aftermarket services is to have high customer satisfaction, which is only possible by managing the global availability of aftermarket parts at the dealers in the right quantity, time, place and cost. (Volvo Group, 2016a)

Today, Volvo Group provides aftermarket service with a defined level of service. Volvo’s end customers are served through dealers in every market. There are a given set of service models differentiating the distribution based on part numbers’ characteristics (price, frequency, forecast) in the strive to have spare parts available to the end customer. This is to a great extent being performed by managing dealer network inventory according to Volvo’s VMI (vendor managed inventory) concept called LPA (Logistics Partner Agreement). As the vast majority of

parts provided to end customers are managed by the LPA concept, it has a big impact on the parts availability and also Volvo's aftermarket cost. Therefore this is constantly under refinement and development to secure world-class end service towards end customers.

## **1.2 Problem discussion**

High availability is one aspect that is important for companies that work within the equipment-intensive industry. In order to have high availability, spare parts needs to be available to reduce customers downtime, when a product needs to be repaired (Wong et al, 2007; Kutanoglu, 2008; Braglia & Frosonlini, 2013) The amount of spare parts that are needed within this industry is considered to be high since for every new vehicle introduced in the market, introduces 500 to 1500 new parts as well. Adding to this, frequent launch of new models in the market also indicates short product life cycle, which may have demerits in the supply chain management of the aftermarket. Every OEM has a predefined service level, which depends on the life of the product. Based on this, the stocking level at the warehouse and dealers, service strategy and procurement are all handled by the aftermarket department of any OEM (Maheswaran et al, 2012).

For Volvo Group it is important to deliver high service to their end customers, to have high uptime and get vehicles back on the road as soon as possible in case of an emergency. Last year 26% of Volvo Group's net sales consisted of aftermarkets products and services and the aftermarket service is an ever-increasing competitiveness factor for the company. In order to have a high availability, this requires that the company is able to have spare parts available at different dealers around the world. (Volvo Group, 2016a; Volvo Group, 2015) Today the department of materials management within Logistics Services steers the inventory at dealers, on a global level, to make sure that Volvo Group's aftermarket services function efficiently. They also have a number of warehouses located around the world to be able to balance costs and manage the extreme demand that the company faces and there is also a consistent focus on optimizing the stock level in different warehouses, in order to reduce the capital that is tied up to it. (Volvo Group, 2016a)

To be able to be competitive in the market it is important for Volvo Group to make sure that their aftermarket service is able to have a quick response time to the customers' requirements. As always when forecast demand is based on historical demand which deviates more or less from actual demand, due to the uncertainty that comes with it. With increasing expectation from end customers on high availability on spare parts together with short lead time without any increase in costs, a pressure exists for Volvo Group and the Aftermarket Services to meet this expectation and challenges.

Therefore grouping dealers, with an optimal time difference between the dealers, could lead to a decrease in the lead time and an increase in the service level, which would be beneficial to manufacturing companies who make the parts available to the end customers through their dealers. This is the reason why this master thesis will focus on: how dealers can be grouped in general in a cost efficient manner in order to facilitate the sharing of spare parts between dealers and also look into the grouping process for Volvo Group. With this aim, there are many advantages that exist but at the same time there are a few obstacles as well which need to be considered when grouping dealers. Obstacles such as when dealers within the network need to go from competitors to collaborators, when they need to share sensitive information with each other and agree on which parameters that should be considered within the network and also how the cost allocation should be distributed between the members in the network (Wong et al, 2007; Kutanoglu, 2008; Braglia & Frosonlini, 2013).

### **1.3 Purpose**

Based on the problem discussion above, the purpose of this study is to investigate how manufacturing companies in general can group their dealers in order to increase the availability. This will include a cost efficient solution by constructing networks of dealers who are able to share their inventories, in order to increase their service level and be competitive in the market.

### **1.4 Research questions**

Taking all the aspects discussed in the problem discussion above into consideration together with the legal and cultural aspects that can occur when grouping dealers both within national borders and across national borders, the aim with this study is to answer the following two research questions:

*RQ1: How can manufacturing companies improve same day availability of parts from a management perspective?*

*RQ2: How can same day availability be achieved from a logistics point of view?*

The first research question relates to the problem of how companies within the manufacturing industry can improve the same day availability of spare parts by managing the parts sharing between dealers and their processes in a more efficient manner. This will be answered by developing a general model that can help achieve a better availability irrespective of the market and the company.

The second research question caters to the logistical aspects that play a vital role in ensuring a higher and faster availability of parts. This question will be answered by suggesting a better model for the steering of inventory and a suitable transport solution for the same.

### **1.5 Scope and limitations**

The scope of the research is to investigate from a D2D (dealer to dealer) perspective the possibility of how parts can be better moved locally, have a better transportation solution and availability solution from a legal and business point of view. This study will also investigate the current aftermarket service provided by Volvo Group to their customers, which will be used to decide the future performance potential with a better degree of planning the service activities. The study will be limited to Volvo Truck brands in two countries. This is due to the time constraint, but with the possibility to investigate important markets with different characteristics. Two countries which were chosen to be a part of the case study that has been conducted were Sweden and Norway, since these markets contain different types of ownerships and also because Sweden is a part of EU and Norway is not, which makes these two markets good samples and can be used to give a generalized view as well.

In the construction of networks, the parameters which have been used are limited to the costs, time, capacity and distance as these parameters are of high importance while constructing clusters in comparison to the other parameters which are not directly related. The other reason to limiting this study to these parameters is also due to the time constraints that exist. There have also been certain limitations while working on the literature required as the main focus here has been on the construction of networks for better parts sharing.

### **1.6 Expected results**

The study aims to investigate how a D2D setup can be created in a cost efficient manner to enable shorter lead time for the availability of spare parts at a manufacturing company, such as Volvo Group. It also aims to work as a prerequisite to share inventory within the dealer clusters and from that gain potential in a more cost efficient inventory planning and improved end customer service. Therefore the expected result from this study is to create a general model that can be used to group dealers with the purpose of implementing inventory sharing within these groups. The expected result is also to present two scenarios that can be used to steer the inventory in a more efficient way together with appropriate transport solution to these scenarios.

## **2 Literature review**

*This chapter presents the theoretical framework, which begins with describing the aftermarket in general and is followed by network planning. This is then continued by a deeper explanation on network structure and construction, including mathematical explanations on the parameters that can affect the network construction. The theoretical framework continues with transportation networks and different network models that can be used. The chapter ends with a presentation about the concepts of inventory sharing, legal aspects, and performance indicators that need to be considered – and a summary of the literature is presented.*

### **2.1 The Aftermarket**

In today's fast paced society people have become customers to products which require repair, servicing, maintenance work etc. Investments are being made by the end customers in products which require frequent repair. Such repair works and services are mostly common for sophisticated equipment's, i.e. car parts. Customers with lack of knowledge about the products they own or the new products in the market get locked to one product or brand (Klein, 1996). This lock down to one brand by the customer makes it difficult and also costly to move from one brand to the other.

The aftermarket business in the industry is dominated mainly by three elements. The first element in this is the fact that a consumer usually purchases products which are made of many components which give the value to the product (Shapiro, 2007). The next element is the fact that these components may be bought at different points in time or at the same time. The third element is that these products and components have some degree of costs attached to them which cannot be recovered when the consumer changes brands (Shapiro, 2007). As the aftermarket business is widespread, it involves a high volume of commerce.

### **2.2 Network Planning**

Networks exist all around us and can be defined as both entities, like networks of collaboration or neural networks, but also as tangible objectives in the Euclidean space, like subway, highway system or as the internet (Boccaletti et al, 2006). As mass customization and globalization create high complexity, demand volatility and uncertainty causes an increase in the challenges that companies face regarding the planning, designing and the operation of a network with time (Mourtzis et al, 2015).

A typical supply chain consists of the suppliers, plants, warehouses, distribution centers and retail outlets with the flow of raw materials, work in process inventory and finished products

between these facilities. Therefore to structure and manage the materials and these facilities, it is important to deal with the process, which is responsible for the same which is, network planning. (Simchi-Levi et al, 2007)

Network planning manages the supply chain in order to match the supply and demand under unseen circumstances by managing and positioning inventory effectively, make proper use of resources by sourcing the products from the appropriate source and find the right balance between manufacturing costs, inventory and transportation. Due to the complexity involved in this process, it is important to make decisions with a hierarchical approach which involves network design, inventory positioning, resource utilization and the overall management. All this together will help in reducing the cost and in increasing the service level. (Simchi-Levi et al, 2007)

To understand this planning process better, it is divided into three steps. The first step is *network design*, it determines the physical and infrastructure configuration of the supply chain. This includes decisions on the number, size of the plants, warehouses and location of the plants etc.

The second step is *inventory positioning*. The importance of proper positioning of inventory, coordination of inventory decisions and transportation policies are evident from a long time. When talking about customer service level and supply chain costs, they might be impacted when managing complex supply chains. There can be several forms of inventory that needs to be managed and has its own control mechanism, for example raw material inventory, work in process inventory and finished product inventory. (Simchi-Levi et al, 2007)

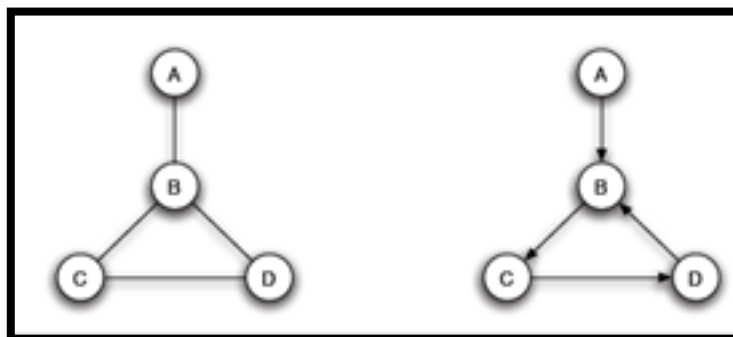
The third and last step is *resource allocation*, which means that on a monthly, quarterly and annual basis, a firm has the responsibility to utilize resources effectively within a fixed logistics network. For this planning, a supply chain master plan is developed, which coordinates and allocates production and distribution strategies and resources to maximize profit and system wide costs. (Simchi-Levi et al, 2007)

### **2.3 Structure and construction of network**

The network structure is the construction behind the graph theory (Easley & Kleinberg, 2010). This theory is the “The mathematical study of the organization of network structures (called graphs)” (Graph theory, 2013). The theory explains the function and structure of a network by analyzing the different nodes and edges that exist within the network and the reachability

between two nodes in a network is a central concept within this theory (Boccaletti et al 2006; Graph theory 2013; Easley & Kleinberg, 2010).

*Nodes* in a network are the objects of study or interest. It can be the sources, destinations or even the intermediate points in a network (Oracle, 2016). The edges are the links that connect two different nodes that then can be seen as neighbors or adjacent points. The relationship between the different nodes can be a symmetric or asymmetric relationship (Boccaletti et al 2006; Easley & Kleinberg, 2010). When a symmetric relationship exists between two nodes, this can be referred to an undirect graph since both nodes point to each other, while in an asymmetric relationship a direct graph exist, since one node point to another but not the other way around, this can be seen in Figure 1 below (Easley & Kleinberg, 2010). What decides the direction of the edge in a network is dependent of the relationship the nodes have with each other but also on the type of the network that exist under the study (Rozenblat et al, 2013).



**Figure 1:** An undirected graph and a directed graph  
**Source:** Easley & Kleinberg (2010)

A *path* within a network is a sequence of nodes and edges which link these nodes. The number of edges indicates the length of a path. If there exists at least one path between the nodes then the two nodes are said to be reachable. The nodes are considered to be connected if there exists at least one path between the two nodes. (Rozenblat et al, 2013)

In the case of transportation network it is important that connection within the network exist, as the main reason with the construction of a transportation network is to create an opportunity for vehicles to go from one node to another within the network (Easley & Kleinberg, 2010). Clustering is an operation that can act within a graph with the purpose of connecting nodes that are strongly connected by the nature and presence of the edge between them. By clustering different nodes, groups within the graph can be identified, which can result in the representation of nodes on a graph is easier to understand. It is not feasible though when it comes to directly applying the concepts of graph theory in practice to a geographical space. The graph theory helps more in providing tools that consider the direction and the value of

edges into account when building a network. These directions are important in a geographical context as they help in modeling a network in the right way (Rozenblat et al, 2013).

In the construction process of a network, there are different parameters that need to be considered. One of these is distance. The distances between the different nodes in the network are important, especially in a transportation network. The reason why distance needs to be considered is because it gives the information about how long it takes to travel from A to B (Easley & Kleinberg, 2010). In a communication or a transportation network, the shortest-path is important. The average shortest path length is given by the typical separation between two nodes, which can also be referred to as the characteristic path length (Boccaletti et al, 2006).

A simple model can be used to construct a geographical group of networks that explains the basic features. The model includes the dimensions in the network, dimensions about the competing preferences if it's either short graph distance or short Euclidean distance between vertices (Gastner & Newman, 2006).

As mentioned above, distance is important in a network, and from a user's perspective often a short path is more preferable. The way to calculate distance can differ between an air network and a road network, since the way of considering distance can differ. In an air network it is more important to look at the number of legs, while in a road network the miles become important when considering distance. To be able to calculate this, each edge is assigned with an effective length. "n" is the number of nodes and the effective length is calculated by  $0 \leq \lambda \leq 1$ .  $\lambda$  is the one that defines the preference of a user in order to measure distance regarding legs or miles. The factor of  $\sqrt{n}$  is not necessary but it is convenient. The effective length becomes infinity if no path exists between i and j. To determine the total distance that exists between two nodes, the sum of the effective length that exists in the path of all the edges needs to be calculated. After the distance is calculated and defined, the user's preferences are received then the network can be constructed. (Gastner & Newman, 2006)

Another parameter that can be important to consider is cost. The cost of building and keeping the network is proportional to the total length of the edges. To calculate the cost, the following equation can be used:

$$\text{Cost} = \sum_{i,j} \text{edges}(i,j) d_{ij}$$

i and j stand for the nodes and  $d_{ij}$  represent the Euclidean length of the edge that exists between the nodes. According to Gastner & Newman, (2006) is the plausible starting point, even if the result only can be seen as approximately true.

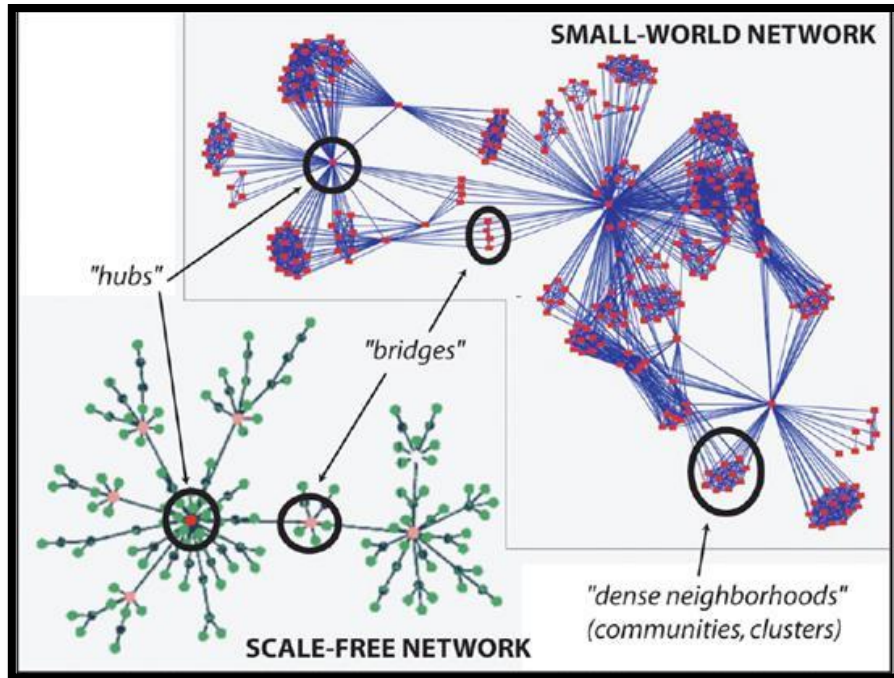


## 2.4 Transportation networks

The transportation model can be expanded in several ways to accommodate the complications in distribution planning. One way is by the use of Multi-commodity flow model. By using this model multiple products are transported from sources to destinations and share capacities on directed arcs. These kinds of models are used in describing flows in an express network where each origin/destination pair is treated as a separate commodity. This model shares the transportation capacity with other commodities using the same directed arcs though. The other way by which the transportation model can be generalized is by involving a choice among the modes of transportation which can be used on each directed arc. The transportation model related to this generalization would be where unit costs on flows decrease with volume. High flows will allow better utilization of FTL (full truckload) shipments, which are economical than LTL (Less than truckload) shipments associated with low flows (Shapiro, 2007).

Networks that are embedded in real space, where the edge in the networks are real physical connection and the nodes that exist within the network occupies an exact position in two or three - dimensional Euclidean space, calls spatial networks. A network that can be referred to these kinds of networks is a transportation network, examples of this can be seen in figure 2 (Easley & Kleinberg, 2010).

A transportation network is studied from a branch of mathematics which is known as the graph theory, as explained above. Today, transportation networks internal efficiencies and vulnerabilities have been better understood which has led to it receiving attention. Classic graph theory and qualitative analysis have been of interest among scientists who are interested in the transport networks. Methods like circulation routing approach and flow optimization are mainly focused on the transportation costs whereas the complex networks integration by transport specialists is very recent in nature and complements the above mentioned methods. Transportation networks can be analyzed on the basis of the topology, morphology, their spatial structure and on the basis of geometry. Network developments are made either to support an existing network or to compete with an existing network. These developments can be made either by expanding geographically or topologically or in both ways (Ducruet & Lugo, 2013). Three types of transportation networks for distribution are explained below:



**Figure 2** Examples of two types of networks  
**Source:** Ducruet, & Lugo (2013)

### 2.4.1 Hub and spoke

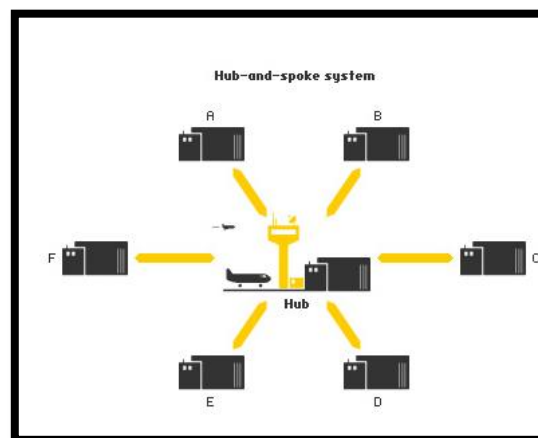
A hub and spoke network is mainly concerned with locating hub facilities and then the hubs are allocated with the demand nodes, which can be seen in figure 3 (o Ekárt et al, 2011). In the transport network of the hub and spoke, hubs perform the transshipment operations and the depots or hubs link the end customers with the hubs (An et al, 2011). A hub-and-spoke network is not always considered to be the most environment friendly and sustainable network, but when the network is concentrate on traffic consisted of few spokes, the network can lead to a reduction on transport congestion, air pollution and noise problem (Rodrigue et al, 2013).

There exist two types of the hub and spoke networks: single allocation and multiple allocations (o Ekárt et al, 2011). In the first type of model which is the single allocation model, the sending and receiving depot is assigned to one single hub. Whereas in multiple allocation model, sending and receiving depots are assigned to multiple hubs (An et al, 2011).

Recent research shows the advanced practical features that have been incorporated to this network model of hub and spoke. Features such as nonlinear economies of scale, congestion effect are a more sophisticated solution (o Ekárt et al, 2011). Reducing the cost of the transport will force the traffic to take a small number of hubs, which in turn will lead to congestion at the

hubs as well. It is suggested that since the effect from congestion will reduce the advantage which can be obtained from a hub and spoke network, therefore direct service between nodes should be encouraged as well as capacities at hubs should be expanded as well (o Ekárt et al, 2011).

Some studies show that the selected hubs usually operate as they have been planned unless disruptions due to natural calamities take place. In case of logistics networks, facilities that provide service to customers may be affected due to such disruptions (An et al, 2014). In order to prevent this and to have a better backup plan for the same, authors talk about the reliable facility location model. Authors try to minimize the transportation cost that is expected which is generated by receiving service from the back up facilities with the assumption that the unavailability at all the nodes is the same (An et al, 2011). Lim et al (2009) talks about two types of facilities, one, which is completely reliable, and the other which is unreliable. The reliable facilities are usually more expensive and so they are not subject to disruptions whereas in case of unreliable facilities, it is vice versa.



**Figure 3:** An example hub-and-spoke network  
**Source:** DHL (2008)

## 2.4.2 Milk run

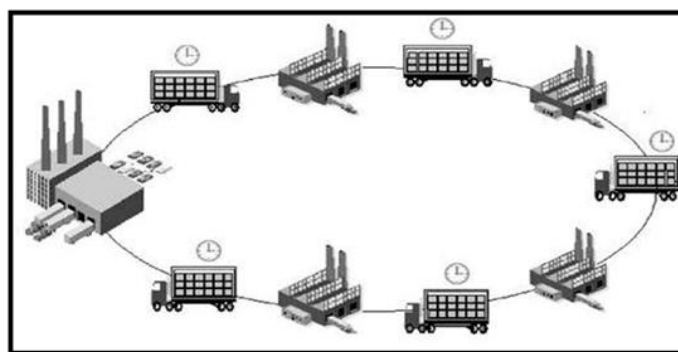
Milk run concept has been taken from the dairy industry where the requirement is covered by a transportation network (Bowersox et al, 2002). Milk run has been widely used in supply chain and logistics studies which has helped in decreasing the costs associated in the transportation of materials and finished products (Sadjadi et al, 2009). Milk run system has been known to be one of the cost effective research tools, which also helps in reducing the travelling path and at the same time reduce the fuel consumption (Brar & Saini, 2011). This system has been widely used in the automobile industries and other global product manufacturers. Depending on the

requirements and objectives of the company, milk run is modeled accordingly. This system decides the type, the schedule, the route, the volume of parts which need to be transported in a way that the vehicle carrying these, returns empty to the source, only then is it fulfilling the milk run concept (Sadjadi et al, 2009). In this network, the process is followed as such where one vehicle covers the input and output requirements of all the stations with a schedule that is preplanned or decided, the concept is illustrated in figure 4 below (Bowersox et al, 2002). In this network the volume is generally less than a truckload and is also economical. This model acts as an important strategy for lean logistics (Baudin, 2005). Authors also discuss the cost advantages of this system when it is used for short distances and consignments with high frequency of delivery to be made. Studies also show that there have been optimizations in the integration of the inventory and the transportation distribution systems. Algorithms have been used which can help in balancing the transportation and inventory costs, which in turn would reduce the overall aftermarket costs (Lin & Cha, 2010).

There are many reasons why the Milk Run Network concept can be beneficial:

- i) Demand fluctuations with a flexible logistics solution can be handled by the use of this concept.
- ii) It can also help in shortening the lead times with a minimum lead time concept as well as lower the costs by reducing the distribution costs.
- iii) Minimum environmental impacts is the third concept which is very important when it comes to logistics, as the milk run concept will help in the reduction of CO<sub>2</sub> gases when compared to other models.

These concepts can to a great extent be achieved by using the milk run concept (Brar & Saini, 2011).



**Figure 4:** The milk run concept  
**Source:** Hitachi (2012)

### **2.4.3 Direct Shipment**

In the case of any product based company, it is highly important for the company to have a good logistics system with the major focus on the flow of goods from the manufacturers to the customers. Along with having a good logistics system comes the critical factor of having a system, which is at a reasonable cost as well. Researchers have therefore looked into the possibilities of delivery systems with the most cost effective methods of delivery (Lee & Whang, 2001). One common type of delivery system is the direct shipment system. This system allows each facility to operate individually and also by having their own individual fleet of goods. By having a direct shipment, each facility gets the opportunity to have specific shipments coming to the facility alone unlike other transportation networks. This method is therefore suggested by researchers to be used in cases of short lead times or when the lead time is tight and the shipment needs to be delivered in urgent scenarios. Researchers also suggest the use of this delivery model in cases where the shipments are large as well. This system has the advantage of visiting only one customer in a trip. (Liu et.al, 2003)

### **2.5 Inventory Planning**

In today's scenario, inventory planning is done in a more traditional setup where "pull" type of inventory is used. The stocking levels in this traditional setup are based on parameters such as demand, costs and service requirements. This can also lead to lower inventory levels in turn when compared to the push type method. Push and pull type of inventories help in deciding when and where the inventories should be moved. In the "push" type, a make to stock environment is characterized whereas in case of a "pull" type, make to order is characterized. (Ramachandran et al, 2002)

Inventory planning is to a large extent based on the forecasts as well as on the sales and demand. The demand is usually structured to be fulfilled from the primary assigned location. In case the demand is not able to be fulfilled as required then it turns out to be backordered. In inventory planning, Economic order quantity (EOQ) plays a vital role. Based on the EOQ are methods like reorder point, min-max and periodic review etc. used. Pull type of inventory ranges from EOQ based on stock to demand approaches. Associated with the inventory are variables like the holding cost, capacity and product availability. Therefore depending on the type of the stocking method used, the quality of the product availability can be seen as a result. (Ballou & Burnetas, 2003)

In a normal scenario, planned inventory does not guarantee a high level of customer satisfaction. Authors have discussed that the planned inventory could still lead to backorder and in some cases lost sale. In cases where the part is not available at the primary location then

this requirement is usually checked at secondary or tertiary locations. Authors have even discussed the high possibility of fulfilling the demand from secondary location even when the availability at the primary location is low. This concept will be discussed in detail below. (Ballou & Burnetas, 2003)

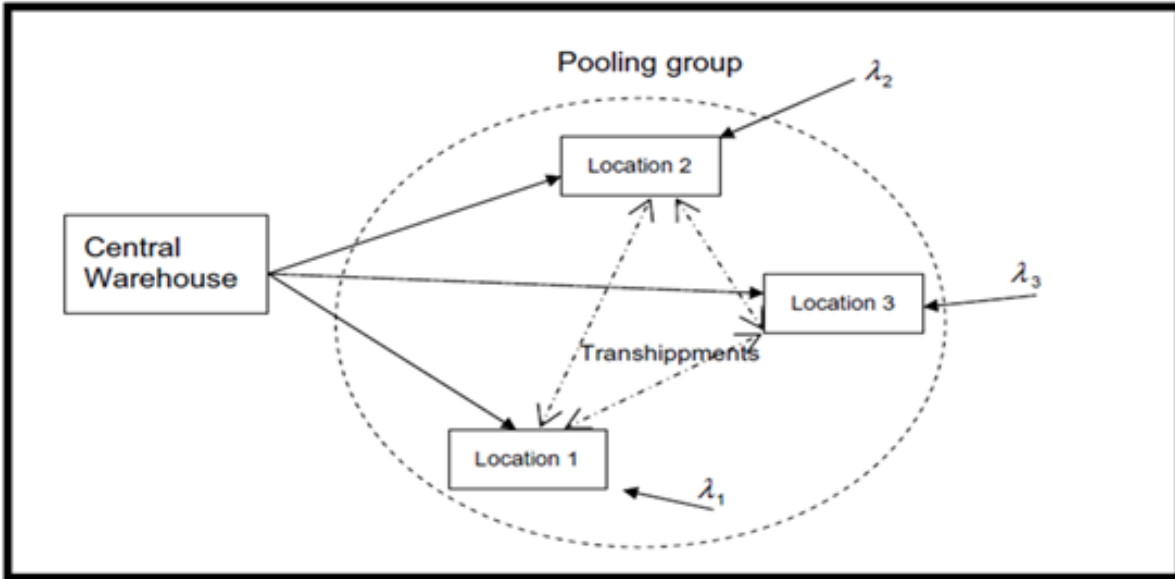
### **2.5.1 Inventory Pooling**

Parts service is an area in the automobile industry where the low level of inventory management has grabbed the attention of a few authors. Fill rates estimation and inventory sharing is focused in some studies where facilities are grouped into pools. Every pool is connected to the central warehouse and is replenished by the same. (Kutanoglu, 2008)

Inventory pooling is defined as a complex system where the main aim is to reduce the costs involved while improving the overall performances by sharing inventories with the help of different stocking points, which can either be inter operational or intra operational. This is therefore named as Virtual pooled inventory and this helps in locating emergency parts either locally or from remote locations within the same company (Braglia & Frosolini, 2013). The demand at these facilities can be fulfilled in either of the following ways:

- i) If the facility holds the required demand as current stock in its inventory, then it is used to fulfill the demand
- ii) If the facility does not hold the requirement in its stock, then it is checked with another facility, which is then fulfilled by a lateral supply between these facilities.
- iii) If the requirement is not available at any of the facilities in the pool, then this requirement is satisfied by the central warehouse which has the requirement in stock by sending it through a direct shipment (Kutanoglu, 2008).

These kinds of lateral shipments were first considered by Lee (1987) who has studied the system of pooling groups which have similar facilities (Lee, 1987). This can be better understood from the figure 5 below.



**Figure 5:** An inventory system with inventory sharing  
**Source:** Kutanoglu (2008)

This therefore leads to the study of emergency lateral transshipments, which helps a firm in getting the necessary requirements from another company which has surplus in stock. This can be better explained with the help of a scenario where if the demand coming from a local facility cannot be fulfilled because it's out of stock then in that case it is fulfilled by another facility, which has the stock for the required part, by the use of an emergency lateral transshipment. (Kutanoglu, 2008)

Depending on the type of company, its service varies. Some companies' main focus can be to have a high time based service level. For certain product types, time based service levels are very important as it can be directly related to their equipment downtime, which can cause them huge losses. Authors also discuss the type of contracts that are preferred by customers to have the best service level. Examples of time based contracts are 80% of the service is completed within 4hrs or 100% of the service is provided within a day. This process induces the consolidation of parts or products for which a limited number of locations are selected as sources and these as it is in many cases can be a single facility. Studies suggest the consolidation of these parts at the facility which has the least standard deviation of lead time. Studies also suggest that strategic advantage can be achieved by using an appropriate order splitting approach. Pooling of inventories have also been considered to be one of the effective strategies, which can help improve the availability of parts and at the same time decrease the total costs of management. It also has to be considered that the actors involved in the same market can also act as competitors for each other, but this depends on the market. So it is

important to convince the actors involved in this setup about the benefits that they will receive rather than subsidizing. (Kutanoglu, 2008)

Another important aspect to consider when establishing inventory sharing is that even if companies are able to agree on the different aspect discussed above, there still remains one question that needs to be answered and that is how to solve the cost allocation problem. According to Wong et al (2007) the total system cost can be distributed or allocated among all the members such as transportation, holding inventory and down-time costs that are incurred by one company. It must also be noted that by having more and more companies in inventory pooling, the savings will be higher. However, there should be a proper balancing of the benefits and the risks which could lead to optimal policies for the companies involved in the pool thereby leading the project to a failure in the end (Braglia & Frosolini, 2013).

By having the inventory pooling setup the difference in the service levels can be calculated with the help of the formula below:

$$\text{Service level in \%} = (Ps / TD) * 100$$

Where Ps = Part of demand that can be delivered directly from stock

TD = Total Demand

(Jonsson & Mattsson, 2009)

### **2.5.2 Legal aspects when sharing inventory**

Establishing inventory sharing and creating new networks consisting of different parties, such as individual companies, requires that legal aspects are taken into consideration. When sharing inventory the parties may need to have contractual agreements that handles aspects such as information sharing and responsibility. By creating a contractual agreement, the different parties can agree on various aspects of the transaction and apportion the responsibility and liabilities. The legal aspects can become more complex if the networks cross jurisdictional boundaries.

To start with, privacy must be taken into consideration, both concerning business and personal information that is collected, shared, stored and used. Liability is another aspect that needs to be considered since it's important to decide who should bear the risks that is associated with problems that can occur within the network. When sharing inventory and IT-platform, it's also important to consider data security as well as the enforcement, not only if something goes wrong, but also when something can or is close to happen that can cause a risk for the system.



Finally, compliance with regulation and standards are also something that needs to be decided upon within the contract.

Inventory sharing may occur across national borders, which includes legal challenges. Below are topics that may be relevant to be considered:

- Tax regulations.
- Difficulties in agreeing on the foreign applicable contract law.
- Formal requirements, e.g. licensing and registration procedures.
- Language of the contract, communication, documents, etc.
- Problems with cross-border delivery; e.g., customs.
- Difficulties faced by a party in finding out about the provisions of a foreign contract law.
- Problems in resolving cross-border conflicts, including costs of litigation abroad
- Obtaining legal advice on foreign contract law, etc.

(Basu Bal, 2016; OECD, 2013)

## **2.6 Performance Indicators**

If one cannot measure it, one cannot improve it – this has been stated by Lord Kelvin. In order to benchmark the current levels of service with the best in class, it is important to measure the service levels provided by an organization (Anand & Grover, 2015). Key performance indicators (KPI) or performance metrics main objective is to provide the organization a visibility of the processes and the accuracy of how the process is executed (Gopal & Thakkar, 2012). In general, organizations have performance measures for financial performance assessment but organizations in general are not aware of performance measures related to the supply chain. Organizations now have started understanding the importance in measuring the supply chain performance and therefore are looking into areas such as continuous improvements in the supply chain. These continuous improvements will not only benefit the organization but also the stakeholders associated to organizations such as suppliers, manufacturers, dealers, retailers, end customers etc. Authors also have discussed the uncertainty that increases along with an increase in the variety of products by companies. These cause an uncertainty in the demand and supply structure of the products (Anand & Grover, 2015). Therefore authors suggest that by identifying the performance indicators, the improvement areas and the percentage gaps can be identified and worked upon. The performance indicators have also been categorized into different levels such as ground level, mid-level and top level (Hoffman, 2004). Some measures to check the performance of a supply chain are categorized into cost, flexibility, time and quality (Shepherd & Gunter, 2006). Authors have narrowed down the performance indicators for retailers into transport

optimization, resource optimization, information technology optimization and inventory optimization (Gunasekaran, 2001).

#### *Inventory Optimization*

When it comes to optimizing inventory, researchers look into ways how an optimum level of inventory can be achieved to serve the customers. Researchers have also looked into the relationship between the inventory turns and the floor space where stores with a good performance level have higher turns in the inventory per unit area (Raman et al, 2001).

#### *Transport Optimization*

Authors have identified logistics as one of the highest costs involved when it comes to international trade (Bowersox et al, 2005). The performance indicator associated to logistics indicates the efficiency of an organization when it comes delivering goods and services at the right place, in the right time and the quantity required by the customer. Logistics is a very important performance indicator as this indicator links all the stakeholders of an organization such as the suppliers, sellers, manufacturers, distributors, customers etc. Therefore this is a very important indicator of how well the customers are being served (Anand & Grover, 2015).

#### *Resource Optimization*

This performance indicator indicates the importance of having the right mix of workforce at the right place. Retailers work not only in making sure that the total cost is optimized but also that the right workforce is available at the right time and place. By optimizing the workforce, it leads to minimizing the variance in the budget (KPMG, 2011).

#### *Information Technology Optimization*

Under today's scenario, businesses are developing by having best in class information technologies. Same way the optimization of information technology plays a vital role in retail operations by processing the flow of information, services and the goods. Some authors also prove the importance of information technology in aligning the supply chain of an organization (Rajaguru & Matanda, 2009). Therefore authors suggest that by sharing information, it helps in balancing the loss, gain, risks, costs etc (Ballou et al, 2000).

## 2.7 Literature Summary

This chapter started with a presentation about the general aftermarket followed by an explanation about the network planning – a three step process including network design, inventory positioning and resource allocation. When planning the network design it is important that the networks are able to fulfill the requirements. The main aspects in a network are the nodes, edges, paths and how these can be clustered. Networks are built with these basic aspects in any scenario, be it the transportation networks, programming networks, web networks, retail networks or electrical networks. In this study, the main focus is on transportation networks which are studied from a branch of mathematics called graph theory. There are three types of transportation networks that have been discussed: the hub and spoke network, the milk run concept network and the direct shipment.

Construction of networks is done as a pre-requirement for something major to be achieved, which in this case is to make inventory sharing cost and time effective. Therefore, the literature also deals with different aspects of inventory planning and pooling. With inventory pooling the main aim is to reduce the costs involved in holding high levels of inventory and at the same time this helps in reducing the number of transport flows from the central or regional warehouse as well. To be able to implement inventory pooling there exist different legal aspects that needs to be taken consideration, in order implement it in an efficient way and avoid potential future problems, which been discussed in this chapter. The chapter ends with a brief description of the performance indicators, which measure these services and indicate the potential improvement areas.

## 3 Method

*This chapter describes the method and methodology that has been used in order to conduct this study. The chapter starts with classifying the research, which gives an overview about how this research can be classified according to the purpose, process, outcome and logic of the research. This is followed by an explanation about the study's paradigm, a description of the case study and how the literature and the data were collected. The chapter continues with a description of the method that has been used in the data analysis. The chapter ends with discussing the studies validity, reliability and generalizability together with a summary of the chapter.*

### 3.1 Classifying research

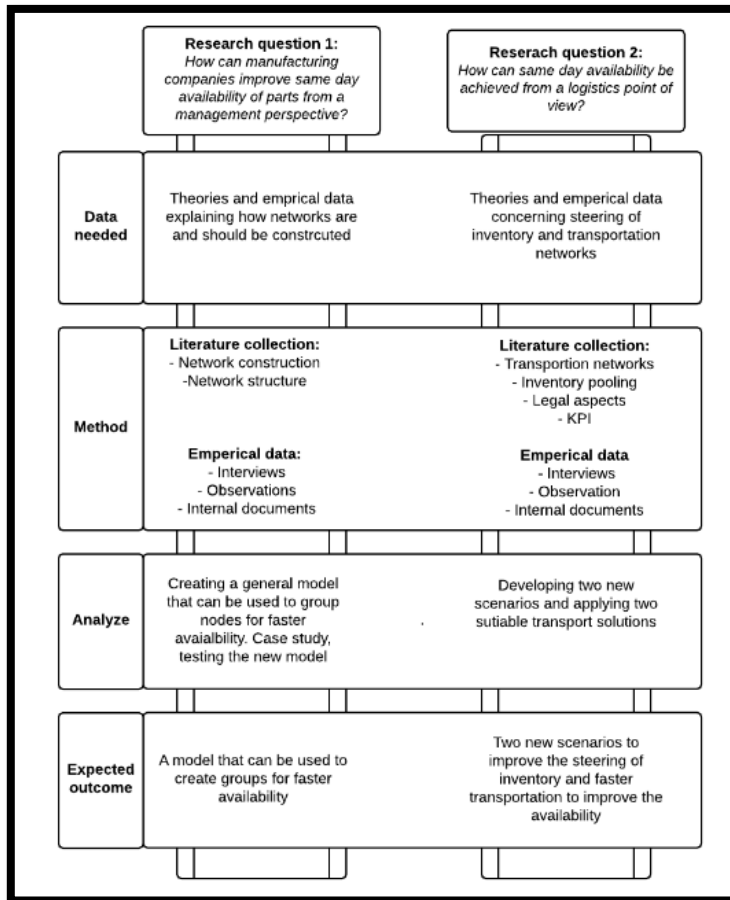
According to Collis & Hussey (2014) research can be classified according to the purpose, process, outcome and logic of the research. To clarify how this study has been conducted, the different classifications will be described in this chapter. The purpose of the study is to investigate how a manufacturing company can group dealers to increase the availability of spare parts in a cost efficient way. According to Collis & Hussey (2014), this purpose can be referred to their description of a predictive research. A predictive research means that it looks into answering the 'how', 'why' and 'where' questions and the answers or solutions generated from this analysis will be used to generalize in similar studies, where applicable.

The process of the study refers to what kind of data that is collected during a study in order to answer the research questions (Collis & Hussey, 2014). The research questions for this study are:

- *How can manufacturing companies improve same day availability of parts from a management perspective?*
- *How can same day availability be achieved from a logistics point of view?*

In order to answer these questions, both qualitative and quantitative data needed to be collected, which according to Byrman & Bell (2011) is referred to as mixed methods research. A mixed method research is used when both research strategies are used within one study, which is the case in this study. The qualitative data refers to the interviews that were conducted, both from knowledge sharing interviews that were made in order to get experts within the field to share their knowledge about the current situation, and also the interviews that were made at a later stage in the study to get information about the particular areas that the study was aimed to investigate. The qualitative data also refers to the observations that have been conducted in the study, in order to understand the current process. The quantitative data

refers to the numerical data that was collected to calculate the improvement in the availability of spare parts from the current availability as well as what percentage of expensive transport could be reduced such as air transport for example. Both qualitative and quantitative data have also been collected through internal documents and systems that have been provided by Volvo Group. The research process can also be seen in figure 6 below.



**Figure 6:** Research process

As described above, the purpose of the research is to group dealers, since it will result in better availability of parts, something that is important for some companies to be able to deliver high service to their end customers. This explains why the outcome of the research can be connected to an applied research method as described by Collis & Hussey (2014). Applied research refers to a study, where the goal is to solve a problem and since companies face challenges regarding lead time, costs and customer satisfaction, this can be related to a problem that this research aims to solve.

Before the grouping process of the dealers began, a theoretical structure was created, with the purpose of being tested later on in the process of the research. This structure of the process indicates that the study was made under a deductive approach. A deductive approach refers to the empirical observations that are tested against an already developed theoretical structure and the fact that the method goes from general to particular. (Collis & Hussey, 2014)

### **3.2 Paradigm**

A research process is guided by a paradigm, which can be referred to a framework that is based on people's assumption about the nature of knowledge and the world but also based on people's philosophies. There are two main paradigms that exist: interpretivism and positivism. Interpretivism refers to the fact that social reality is subjective, since social reality shapes people's perception. This paradigm focuses on exploring the complexity of social phenomena, while in a positivist paradigm it is more about measuring the social phenomena (Collis & Hussey, 2014). A positivist paradigm focuses on different theories that can be explained by the social phenomena that exist. Since this study is about constructing a dealer-to-dealer solution that includes a development of a new network by using theories about network construction and inventory sharing, this refers to the study that is done under a positive paradigm. There are different philosophical assumptions that underpin the paradigm and since this study is done under a positive paradigm, the philosophy that is used in the study is methodological assumption since a particular aspect was studied and also because the association between the variables were looked into. (Collis & Hussey 2014)

### **3.3 Case study**

A general model, have been developed within this study, that could be applied in different markets and companies in order to improve the availability at dealers, which can be referred to the fact that the study is generalizable (Bryman & Bell, 2011). To be able to test the model a case study has been conducted, showing how dealers within Volvo Group can be grouped in an efficient way. A case study is more common under an interpretivist paradigm, but can also be used under a positivist paradigm. The point with a case study is to investigate a single case or phenomenon by using different methods. In this study, an experimental case study has been used, since the point was to implement techniques and procedures that were new for Volvo Group. (Collis & Hussey, 2014)

Collis & Hussey (2014) described the different stages that occur in a case study, stages that have been followed in this study. As explained above, the case was first selected, followed by a preliminary investigation, which was done by knowledge sharing with experts within the field.

During the pre-interviews, both primary and secondary data about dealers geographical position was collected, which was then used to map the dealers.

To test the model, a web-based program was used called Map Business Online. The program was developed by SpatialTEQ, inc and was used in the study, since it provided advance geographical analysis tools that could be used in order to map different transportation routes, which was an important factor in the creation of the different networks (SpatialTEQ Inc, 2010). The different steps in the case study are presented below:

1. The first step was to collect all the dealers' coordinates, which could be used to plot the dealers on a map, by using the Map Business Online program. The coordinates were gathered from Google maps, by entering the dealer's address, that were given by employees at Volvo Group.
2. The next step in the process was to follow the different steps in the model to be able to group dealers in the most efficient way. From the general model, Volvo specific information was taken into consideration, to be able to apply the model for this specific company. This process resulted in three types of groups in Sweden and one type of group in Norway, together with groups both within the countries and across borders.
3. In order to confirm the accuracy of the travel times given by the program Map Business online – Another program, Google Maps, was used to test the travel time between the different points.

### **3.4 Literature collection**

To be able to create the theoretical framework, literature had to be collected. The literature that was searched for and collected can be referred to as secondary data, which means that the data already existed before the study began. To find relevant literature, as published in articles and journals, the first step was to identify the scope of the research. The scope of the research was to investigate from a D2D perspective the possibilities of how parts can be better moved locally, have a better transport solution and availability solution from a legal and business angle. By having the scope defined, it is possible to have some limitations, which will improve the literature search. (Collis & Hussey, 2014)

After the scope was defined, the search for literature began. By using different databases provided by the university's library, together with keywords relevant literature could be found. The following databases have been used in this study: *Business Source Premier* and *Web of Science*. The following keywords were used when searching the databases: *Transportation*,

*network, dealership, dealership network, car dealership network, virtual stocking, inventory sharing, inventory pooling, network planning, hub-and-spoke and milk run.*

By studying the gathered literature, other relevant sources and primary sources were found. The use of primary sources was important in the study in order to give the study high validity.

### **3.5 Data collection**

To be able to conduct this study, data needed to be collected from different sources. This chapter will include a presentation about how both qualitative and quantitative data was collected through interviews, observations, internal documents and systems.

#### **3.5.1 Interviews**

Interview, is a commonly used method within qualitative research and within this study two types of interviews were used: unstructured and semi-structured interviews, depending on the person and the situation. The interviews have also been divided into two parts – knowledge sharing and interviews, to be able to collect knowledge about the processes at first and then use this knowledge to have a more in depth interview. Unstructured interviews refer to an interview that is as the name states, unstructured and it's more similar to a conversation (Bryman & Bell, 2011). This type of interview was mostly used during the first part of the interviews, the knowledge sharing part, since this type allows the interviewee to answer more freely and also for the authors to ask questions related to the interviewees answers, because of the use of open questions (Collis & Hussey, 2014; Bryman & Bell, 2011). Open questions are according to Collis & Hussey (2014), good to use when the authors want to explore and gather broad information, which was the point in the first interview phase.

The other type, semi-structured interviews, refers to when the questions in the interview is related to a specific topic. These kinds of interviews have been needed in the later state of the study, in the interview part, where the goal was to collect answers regarding specific topics. To be able to conduct this type of interviews, the authors needed to prepare questions before the interviews, to be able to get the answers that they were looking for. Most of the interviews that have been conducted during this study, both knowledge sharing and the interview, have been face-to-face interviews and due to the fact that some interviewees were located in other countries or other places in Sweden, some interviews have been conducted through Skype, something that is quite similar to a face-to-face meeting. The interviews were also recorded, to give the authors the possibility to listen to them afterwards. (Collis & Hussey, 2014; Bryman & Bell, 2011)



The interviews in this study have been done with people from different departments (Material management, Transport optimization, Purchasing, Sales, Legal, business implementation) within Volvo in order to get input from the relevant departments. To exemplify, employees for material management gave information about current setup of inventory steering. Employees from the transporting optimization, purchasing and sales gave information related to how the current transportation set up is today together with input on how the transportation can work with the new set up constructed in the study. The list of interviewees is found in Appendix 1.

When conducting interviews, there exist some problems that need to be considered. In the case when more than one interviewee exists, it's important for the authors to recognize both of them, to get the right person to answer the question (Collis & Hussey, 2014). In this study only a few interviews included more than one interviewee, but during those interviews the authors paid attention to both of the interviewees and directed the questions to the person who was the most appropriate to answer the question, depending on their role within the company. This has been possible, by asking the interviewees to describe their role in the company in the beginning of each interview. Since one of the topics that have been covered within this study relates to the current situation at Volvo Group, it has been important for the authors to recognize when personal feelings have been expressed and when facts have been expressed, in order to give the right picture in the study. To be able to do this, different interviews regarding the same topic have been conducted, which was helpful in the explanation of the current situation. (Collis & Hussey, 2014) There might be a chance that there is a discrepancy between the theoretical descriptions of how the company operates and how the company operates in reality. In order to ensure that the interviewees had the possibility to be honest when describing the current processes, the authors decided not to tie quotes to individuals that have been interviewed.

### **3.5.2 Observations**

Observations can be done in natural or laboratory settings, where observations in a natural setting are referred to fieldwork. In this study, only observations within natural settings have been conducted, meaning that people in their real life have been observed (Collis & Hussey, 2014). According to Collis & Hussey (2014) different types of observations exist, and the participating observation has been used in this study, which refers to the authors that have been involved in the observations in order to understand the motives, values and practices of what they observed (Collis & Hussey, 2014). The first observation that has been done in this study refers to the employees at Volvo Group in Gothenburg, by observing how the current process of order handling in the aftermarket works. This gave the authors the opportunity to see the process through their own eyes, which gave an understanding that couldn't be gathered through

interviews (Bryman & Bell, 2011). The second observation that has been conducted refers to a visit to two dealers located in Sweden, which gave the authors an understanding of how they see their process and how they work when they are searching for a spare part. This visit generated knowledge that couldn't be gathered by only observing and interviewing employees at Volvo Group. The dealers that were observed were chosen based on their size and ownership structure, in order to get an overview of how different dealers work since different construction of dealers exist within Volvo Group, such big, small and independent dealers.

Using observations gives an opportunity to experience unexpected situations as Bryman & Bell (2011) discussed, which could give information that the interviews couldn't. The fact that the possibility was given to the authors to observe two different dealers and a number of employees within Volvo, conclusions could be drawn since the different observations could be compared. By observing two dealers the demand characteristics could be reduced – something that can happen during observations, when an observed person can think about how they work in order to show their best side. Observing different people and asking questions could avoid this. (Collis & Hussey, 2014)

### **3.5.3 Internal documents and systems**

Qualitative data can be both interviews and observation, but it can also be figures, diagrams and texts that are presented in printed materials (Collis & Hussey, 2014). Data from printed materials have been collected within this study. To be able to answer the research questions, information from Volvo Group was collected, which in this case is referred to internal documents. The internal documents have been helpful in the process of defining the current situation at Volvo and were provided by employees at Volvo. The documents have also provided information about dealers' addresses that was used to find the coordinates, which later could be used to plot the dealers on a map in the case study.

The quantitative data that has been used in this study refers to the numerical data that has been used to calculate the increased availability and the decrease in the percentage of transportation at some of the dealers within Sweden, which was provided by internal documents and systems. Regarding the transportation costs, secondary data has been used, meaning that the data already existed before the study began. To be able to calculate the availability, primary data was needed meaning that the data was collected from an original source provided by Volvo. When analyzing quantitative data a sample needs to be decided. Since the calculations only have been done on dealers located in Sweden, these dealers can be referred to as the population in the study. From this population, one group was selected as a sample, since this is one of the bigger groups which were considered to be enough to show what percentage of availability of parts

will increase even by having the same service level as today and only by grouping the dealers. This will also indicate what percentage of transportation could be reduced for emergency orders as the parts can be made available in the group itself. After the sample was selected, the variable was stated. In this study both rational and nominal variables have been used. (Collis & Hussey, 2014)

### **3.6 Data analysis**

This chapter includes what kind of the methods that have been used in order to analyze the qualitative and quantitative data which have been gathered.

#### **3.6.1 Qualitative data analysis**

As authors have discussed, it is common when qualitative data is used in a study that the analyzing process starts during the collection of the data. In this study a general analytic procedure has been used to analyze the qualitative data (Bryman & Bell, 2011). This suits the study, since different data collection methods have been used.

The analyzing method includes data reduction, which is a process where the authors select what they should focus on, since a lot of data has been gathered. Collis & Hussey (2014) describe two different ways of doing this: anticipatory data reduction and continuous data reduction. Anticipatory data relates to studies where the data is ignored due to the theoretical framework that have been conducted in the study and continuous data reduction means that the data is reduced if no relationship between irrelevant data and collecting data exist. In this study the first alternative that has been used, since the theoretical framework was first developed in order to know what kind of data that needed to be collected. The next step is data display meaning that the data should be summarized, which in this study has been done by using a network, linking the data together. In this study four categories of data have been created when the qualitative data was summarized: information about current process at Volvo, information about grouping dealers, information about inventory steering and information about transportation networks. The last step was to analyze the data, which was done by relating them to the existing theories. (Collis & Hussey, 2014; Bryman & Bell, 2011)

### **3.6.2 Quantitative data analysis**

To analyze the quantitative data correlation has been used, which means that the variables that have been used in this study have been tested against each other to see if any relationship exists. (Collis & Hussey, 2014)

The emergency order data for one dealer group was collected and evaluated in order to understand what percentage of orders are sourced from the different warehouses. This data was used to identify the different scenarios and from that calculate the difference in the availability at dealers individually compared to the difference when the dealers are grouped.

The quantitative data in this study has been used to calculate the percentage difference the grouping of dealers can cause compared to the present setup. This percentage will also indicate reduced percentage of parts that need to be sourced from outside the groups. By calculating the increased availability, the percentage reduction in transportation can be seen as well which will thereby indicate the decrease in transport costs. This can be referred to authors who state that with quantitative methods of analysis is positivism attached to. From this a social phenomena can also be measured (Collis & Hussey, 2014) Different scenarios for one group of dealer was used in order to check the impact that was created by the grouping process. As suggested by Jones (2001) and Martin et al (2010), when the data involves uncertain demands, then in such cases a clear view of the supply chain is required as the methods from quantitative forecasting can be hard to manage.

### **3.7 Validity, Reliability and Generalizability**

The validity in a study is important and there exist different types of validity (Bryman & Bell, 2011). According to Collins & Hussey (2014) validity refers to how well the results reflect what the author actually wants to study. According to Bryman & Bell, (2011) validity in a study is one of the most important criteria. What can underpin the research are the research errors like poor sample, inaccurate measurement and according to Collis & Hussey, (2014) different ways of how the validity in a study can be ensured exist and the authors' gives example of constructs validity and face validity

Construct validity refers to the problem that can occur in a study regarding the phenomena that authors are not able to observed, such as ambition, anxiety, ambition and satisfaction. This is something that has been taken into the consideration in the study as explained regarding the interviews and the observations. Different people have been interview and observed regarding the same topic in order to be able to ensure that right data is collected.

Face validity refers to the fact that the things measured in the study actually test what it is supposed to test. This can be ensured in a study by the authors consulting experts within the field to ensure the results. In this study this been confirmed by the authors conducting the different test and later asking experts to review the results, which in this case refers to expert within Volvo Group. The authors have used multiple sources and experts within the company with good knowledge within the field, which ensures that the conclusions are based on solid data. Since multiple interviews were conducted the authors were able to eliminate personal views and filter out the actual key concerns that multiple employees and experts had. (Bryman & Bell, 2011; Collis & Hussey, 2014)

Reliability in a study refers to the measurements precision and accordance together with how well a study can be replicated. By using documents and the systems provided by Volvo, the same results could be achieved by other author/authors, which show that the study is replicable – which is a sign of reliability. One problem that exists if the study were to be replicated is that access to Volvo Groups databases would be needed (Collis & Hussey, 2014).

Generalizability refers to which extent the results from a study can be generalized. The study includes two levels of generalizability. The first level concerns the development of the general model itself. The general model has been generated from current research and literature. Since it has been developed from theories and studies that don't focus on Volvo, the model could be able to be implemented in other companies that rely on dealers and that have similar logistical challenges, no matter industry. The second level of generalizability concerns the case study that focuses on Volvo group's dealers. The case study involves implementation of dealer logistics on two markets – dealers in Norway and Sweden. One can argue that the implementation of the grouping model on other markets could be a problem, but since these two markets cover many of the important aspects the generalizability must be consider very high in the case of Volvo. The markets included dealers with varying size, different ownership constellations, different nationalities, cultures and legal requirements. (Collis & Hussey, 2014)

### **3.8 Summary**

To be able to conduct this study, different methods have been used, which have been presented in this chapter. The chapter starts with presenting how this study can be classified based on the purpose, process, outcome and logic of the research, which is followed by a presentation about the positivism paradigm that has been used in the study. To test the general model that has been developed a case study has been done on Volvo Groups dealers in Sweden and Norway. The

process of how the case study was conducted is presented in this chapter, followed by a presentation of how the literature is presented in the theoretical framework of the study.

To be able to conduct this study, both qualitative and quantitative data were needed, which resulted in collecting them through interviews, observations, internal documents and systems, which have been used to gather the right information. The data that has been collected is presented in the interview together with an explanation about how the qualitative and quantitative data has been analyzed, in order to use it in an accurate way. The chapter ends with discussing the validity, reliability and generalizability.

## 4 Results and analysis

*This chapter<sup>1</sup> starts with presenting the current processes followed by Volvo Group in their aftermarket services and the processes followed by Volvo dealers in acquiring spare parts from the company for their end customers. The chapter then delves into the challenges faced by the current processes in order to achieve time and cost efficient services. Followed by this a “General Model” is developed which can be tested and applied to any manufacturing company. The general model is proposed for better management of dealers in order to achieve better services towards their end customers. Based on the general model, two new scenarios will be presented on better parts sharing along with suitable transportation setup for each scenario. The general model is then later tested for two markets where Volvo operates. The case study shows how dealers, within Sweden and Norway, can be grouped to have same day availability of spare parts.*

### 4.1 Current Setup

Volvo Group provides its services to its end customers through two different types of dealers: LPA and Non LPA dealers. The dealers which follow the VMI (Vendor Managed Inventory) concept are termed as LPA dealers whereas the dealers which do not adhere to the VMI concept are considered as Non LPA dealers in Volvo terms. Some markets have both types of dealers whereas some have only one type. As this project is focused on looking into optimal ways of setting up D2D solution to support same day availability, only these dealers and their processes will be looked into in detail. The next subchapter will present the current processes followed by Volvo Group in making the spare parts available at the shelves of LPA dealers.

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<sup>1</sup> All data presented in this chapter comes from different interviews and observations that have been conducted in this study, together with internal documents and systems provided by Volvo Group. For a complete list of interviews see Appendix 1.

### 4.1.1 Volvo process

Volvo Group today has around 2300 LPA dealers spread around the world. The process of refilling these dealers can be done in different ways depending on where in the world the dealers are located, as shown in figure 7 below.

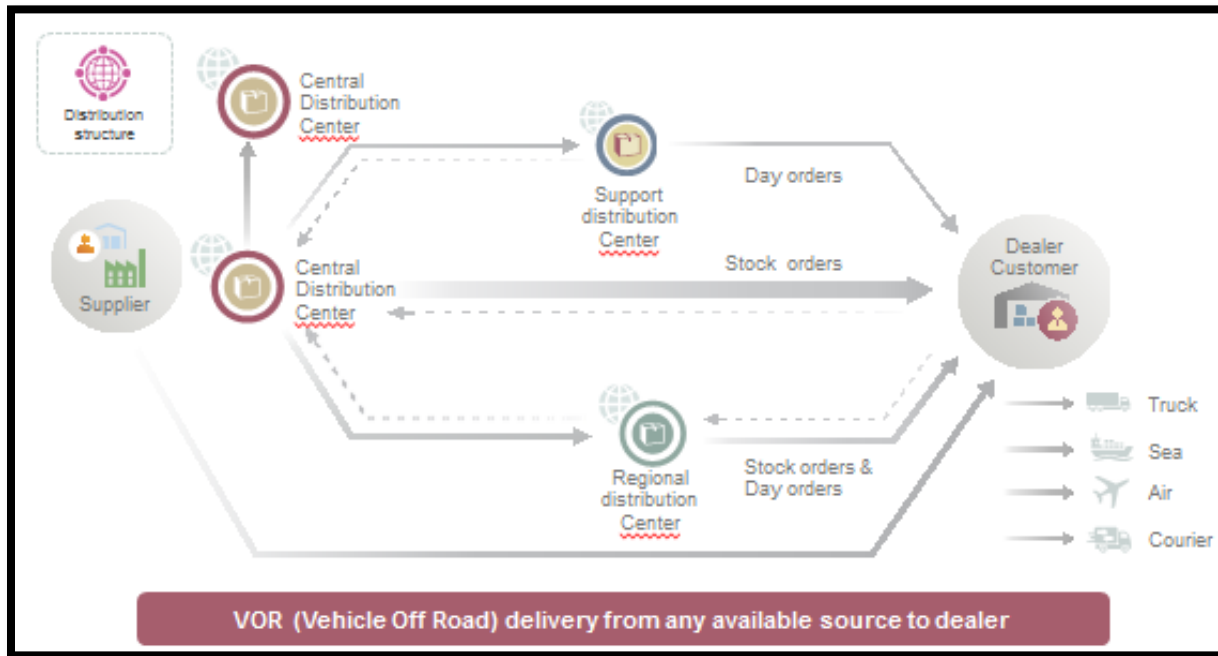


Figure 7: Order flow within Volvo Group

Volvo has six central warehouses spread around the world, 17 regional warehouses and 10 support warehouses. The service level at each of these warehouses differs as their functions differ. To be able to support their different dealers Volvo has divided their markets into different regions that are supported by one of the six central warehouses together with the regional and support warehouses, which can be seen in Figure 8 that show the different warehouses location around the world.





**Figure 8:** The locations of Volvo Group warehouses around the world

The flow of spare parts starts at one of the Volvo Group Trucks' 1500 suppliers that deliver the parts to the different central warehouses, which either distribute the spare parts directly to the dealers or to the regional or support warehouses. These orders are called stock orders and are refilled by Volvo Group to the dealers based on various parameters and forecasts. Regional warehouses exist in different markets to support the central warehouses by delivering stock orders to dealers and are often located closer to the dealers, as the lead time from the central warehouses to the dealers are too high. In Europe, there exist support warehouses that act as the name suggests, as a support to the central warehouse, which carry parts that are too expensive for the dealers to carry themselves. The dealer can attain these expensive or exotic parts by placing a day order to the support warehouse when the spare parts are needed. A day order can, as shown in figure 7, be delivered from the central/ regional or support warehouses and is an order that is placed by a dealer when the dealer does not have the part and when it's not included in the stock orders. When a day order is placed by a dealer, it needs to be done within a certain time frame as the warehouse that receives the day order should be able to pick, pack and send the consignment so that it reaches the dealer within 24 hours. To exemplify this better, in Sweden the support warehouse is located in Eskilstuna and if a dealer in Gothenburg needs a part, they need to place a day order before 4.30pm in the evening to have the part by 07:00am next day morning.

Today Volvo approximately has 600 000 different parts stored in their warehouses and in case of an emergency, a VOR (Vehicle Off the Road) order is placed. A VOR order is placed when an urgent part from an emergency situation is not available in the dealer stock and needs to be transported on an urgent basis from anywhere in the world. Volvo's customer support team receives a VOR order and it is first their responsibility to locate the part, within the facing warehouses, and if this does not work then the responsibility passes to the BOR (Back Order Recovery). This team continues to locate the needed part outside the normal distribution channels for the dealers and who fix the problem with an express transport solution. The goal in this situation is to find the part as soon as possible and deliver it to the dealer. This can result in taxis going from one dealer to another or airlifting the part from a warehouse and delivering it to the dealer.

#### **4.1.1.1 Key Performance Indicators (KPI)**

Performance indicators show the measurement of the processes in the aftermarket parts flow. They help in supporting the goals of the company. The KPIs, which the materials management department mainly focuses on is the availability at the central warehouse, regional warehouse, and support warehouse and most importantly at the dealers. The other KPI, which is associated to the availability, is the cost involved in holding these parts and shipping them on urgent orders when the parts are not available on an urgent basis at the dealerships. The Key performance indicators can be measured from the start of the process which can be at the suppliers, the three types of warehouses and at the dealers. Below three performance measurements will be described.

Aftermarket Dealer Service Index (DSI) - This performance indicator measures the ability of a dealer to serve its end customers based on a dealer's stock capacity. This measurement is made based on the weekly forecast of sales. If there is a high service index then a high delivery capacity to dealers can also be achieved.

Aftermarket Parts Availability - This performance indicator indicates how big share of all orders being entered towards the warehouse can be fulfilled. The warehouses being the central, regional and support warehouse.

Aftermarket Delivery Precision - This performance indicator measures the ability to deliver parts in the right quantity, at the right place, in the right time and in the right condition.

The service level at each dealer is based on the inventory planning done by Volvo. Over the counter availability for dealers is a consequence, which varies according to the availability at the central/ regional warehouse. The table below shows an example of how Volvo supports

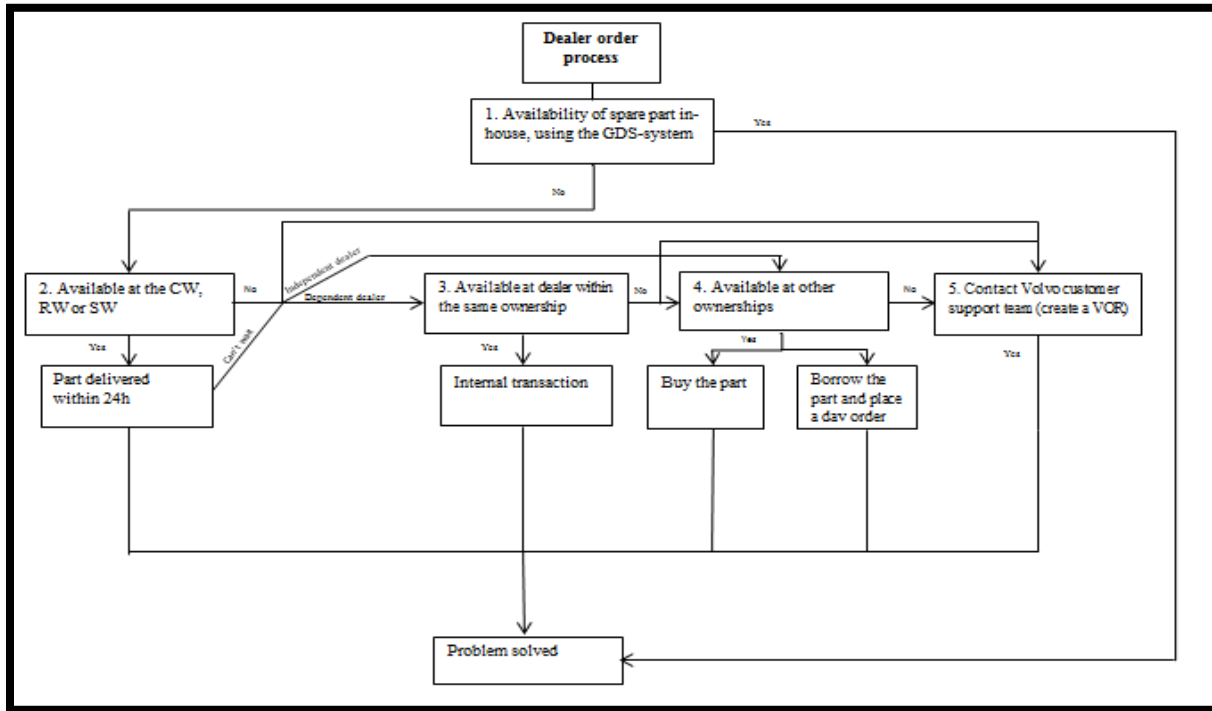
their end customers. It also shows that the end customers' orders are not completely fulfilled from the dealer stock and therefore, in general around 7-10% of these orders are served from the facing warehouses. In normal cases where the markets are advanced, 90-93% from over the counter availability is for the end customers. The rest is divided between Day orders and VOR orders in which case these types of orders are further divided on the basis of orders fulfilled from support distribution centers and central or regional distribution centers. 7-10% of the total demand is split on the basis of where the order is fulfilled. On average 90% of these day or VOR orders are fulfilled from the support distribution centers and the rest 10% are fulfilled from the central distribution centre, which in Volvos' terms is called the split factor. The 10% of these orders, which are sourced from the central warehouse, is done mainly using air transport to achieve the next day availability. The orders which cannot be fulfilled by any of these warehouses then goes to the BOR team who have four days of time to locate the part and ship it.

**Table 1:** Service distribution at the dealer

<b>Order</b>	<b>Service level</b>	<b>Availability Time</b>
SI (regular stock)	90-93%	Immediate
Day order & VOR	7-10%	24 hours
Back order recovery	0,02%	4 days
Total	100%	

### 4.1.2 Dealer order process

When a dealer needs a spare part, there are different steps they go through to search for the parts. These steps are presented in figure 9 below, together with an explanation about each step.



**Figure 9:** The dealer order process

1. The first step in locating a part by the dealer is to search within their own warehouse. This is done with the help of an IT system, i.e. GDS in Europe. If the part is available in the warehouse it's collected from the shelf and the problem is solved.
2. The second place to search for the part, when it's not available in their own warehouse, is in the central-, regional- or support warehouse, depending on what exist within the market. If the part is available in any of the dealer facing warehouses, a day order is placed and the part will be delivered to the dealer within 24h and Volvo handles the transportation. If the spare parts is not available in any of the warehouses, or if it's an emergency and the dealer is not able to wait for the part, this leads to the third step for dependent dealers, meaning that they are part of an ownership, the fourth step for an Independent dealer and in some cases directly to the last step.

3. The third step as mentioned above is for dealers that are dependent and belong to an ownership. In this step, the dealer can, via their IT-system, see if the spare part is available at any of the other dealers that belong to the same ownership. If the stock is available, the dealer can then collect it from the other dealer and solve the transaction internally, but need to take care of the transportation themselves and the risks involved.
4. The fourth step in the procedure can be used by all dealers, both individual and dependent dealers. This step is used to search for the part at other dealers, outside their own ownership but within the same country. If the part is available, then there exists two different ways of how the part can be transferred from one dealer to the other. The dealer can either buy the part, at a regular price (also known as over the shelf costs) or at a discounted price, which varies from dealer to dealer and their situations. The other way is that the dealer can borrow the part from the dealer and at the same time place a day order to Volvo. This means that when the dealer receives the day order, this part will be given back to the dealer that lend the part at first and the dealer that borrowed the part will pay for the day order and handle the transportation. What also needs to be noted in this step is that there are some dealers that don't use this step and instead go to the next steps directly.
5. The last step is used when the dealer is not able to find the spare part in any of the other steps explained above. In this case, the dealer needs to create a VOR in another system. By creating a VOR, the dealer contacts the Volvos customer support team that take over the search for the part, as explained above.

#### **4.1.3 Transport Processes**

Today Volvo has one transportation setup for the aftermarket services, which varies depending on the type of the order. These flows originate either from a central-, regional- or support warehouse depending on the type of order which will be briefly discussed below for a better understanding of the current transport flows and processes:

##### **Stock order:**

Stock orders are orders, which are shipped in huge quantities to the dealers. These are therefore either carried as FTL (Full Truck Load) consignments on trailers or in containers by sea. These quantities can be shipped to the dealer either from the central warehouse closer to the market company or from the regional warehouse in the market, depending on what the dealers are connected to as a facing warehouse. Frequency of these shipments on an average is 1-5 times.

**Day order (24 hours):**

Day orders, as explained above, are orders placed by a dealer when they do not have the part in stock and need it on an urgent basis with a lead time no longer than 24h. These types of orders usually come in small quantities compared to stock orders therefore the type of transport used is either a small truck or the orders can also be combined with another order which is in transit. These orders can be fulfilled either from a central-, regional- or support warehouse. The dealer on a daily basis can place these types of orders before the cutoff times depending on the region, which is again based on the transport solution purchased for the region so that the dealer can have the part the next morning. This setup also has certain exceptions, which depend on where the dealer is located, and which type of warehouse is located close to it.

**VOR (ASAP):**

VOR orders are orders placed when a vehicle has broken down when in transit, therefore the urgency of a part for the vehicle to be up and running in such a situation is of the highest importance for the customer. If the dealer close to the end customer does not have the part required then a VOR request is placed in which case due to the urgency, the part can be either airlifted or transported by other modes depending on how far away the part is located from the dealer. This transport is therefore much faster and expensive compared to the other two order types explained above. The frequency for such deliveries cannot be forecasted and therefore depends on the breakdown of the vehicle.

**4.1.4 Current parts sharing**

The relationship between dealers varies from market to market and also within the same market. In some markets, dealers see each other as competitors, while in other markets they see each other as collaborators. In the later case, it is more common that dealers share parts with each other in case of an emergency. For example, in Sweden it's common that dealers share parts with each other, either by buying or borrowing the part, as explained in the dealer order process above. In other markets such as South Africa, Dubai, Thailand and Russia it so happens that the dealer shares parts with each other, depending on the situations, such as in the case when the support/regional warehouse is too far away. What is common in these markets is that the dealers are able to see each others inventories, since they share the same IT-platform. Something notable from this is that Volvo today isn't involved in the parts sharing, expect when Volvo owns the dealer.

Regarding how the transaction and payment is solved, it differs between the markets and depends on the relationship between the different dealers and their agreement between each other. What is common in some markets, like in South Africa and Russia, is that the price that the dealers need to pay to another dealer is often 10% higher than the price that Volvo takes for

the part. This 10% often exist to cover the administration costs that the dealers need to take when transferring a part to another dealer. Since Volvo isn't involved in most of the parts sharing between the dealers, the transportation is solved by the dealers.

#### **4.1.5 Challenges from the current processes**

From the current processes presented above, certain challenges could be identified that indicate the need for an improved setup or process.

Since the dealers do not hold all the Volvo parts, which can be from very old part range to very new part range therefore over the counter availability for the dealers is never 100%. In practical terms having an availability of 100% has its own negative aspects like capital costs, parts loosing value etc. and therefore is not suggested. This is the reason Volvo has the structure with the day order set up to secure a faster response whenever parts are demanded and cannot be covered from dealer stock, but unfortunately not every country has a support warehouse nor is the support warehouse able to solve this issue completely at all times.

The other prominent issue that Volvo deals with is the transportation costs and the long lead times it takes to solve these emergency issues. In case of an emergency today, parts are often airlifted from different warehouses, causing huge transportation costs for Volvo together with expensive taxi transports used within the same country. Today, dealers in some countries help each other in case of an emergency by sharing parts with each other. This requires dealers to be transparent, but a phenomenon that exists is that dealers hide parts from each other. Dealers do this due to the fact that some parts are difficult to refill by Volvo. Another challenge today is that Volvo isn't involved in the process, a process that could increase the availability Volvo could offer their end customers.

Because of these challenges it is suggested that Volvo needs an improved setup, which can increase the availability and reduce the emergency orders.

#### **4.2 D2D Setup**

After understanding the current processes and the challenges involved in the current processes for Volvo and from interviews conducted with other brands acquired by Volvo a general setup is suggested called the "general model". This section of the chapter starts with explaining how the general model can be constructed and used by any company and in any market. This will be followed by two new scenarios along with suitable transportation setups which is later tested in two Volvo markets as discussed in the introduction of this chapter.

### **4.2.1 General model**

Every established automobile manufacturer has dealers, which serve the end customers with their needs. Therefore keeping the requirements of such dealers in mind a general model is designed, which can be seen in figure 10 below. The suggested model designed is also keeping in mind a faster availability of parts and high uptime of the vehicles. This model can be used in any market for companies within the manufacturing industry. The grouping can be done on various parameters but it depends on which are the most important parameters for the particular company. To group these dealers it is also important to narrow the landscape of a country based on the right parameters in order to reach to the final groups. In general, a country can be seen as a big group of dealers which needs to be further narrowed down to get the best possible dealer groups fulfilling the main requirements from this grouping process. The dealers presented on the maps below will be referred to as nodes for this model whereas the distance between these nodes will be referred to as the edge in this grouping process. The grouping process is shown in figure and explained in steps below based on the parameters which are most important for this project:



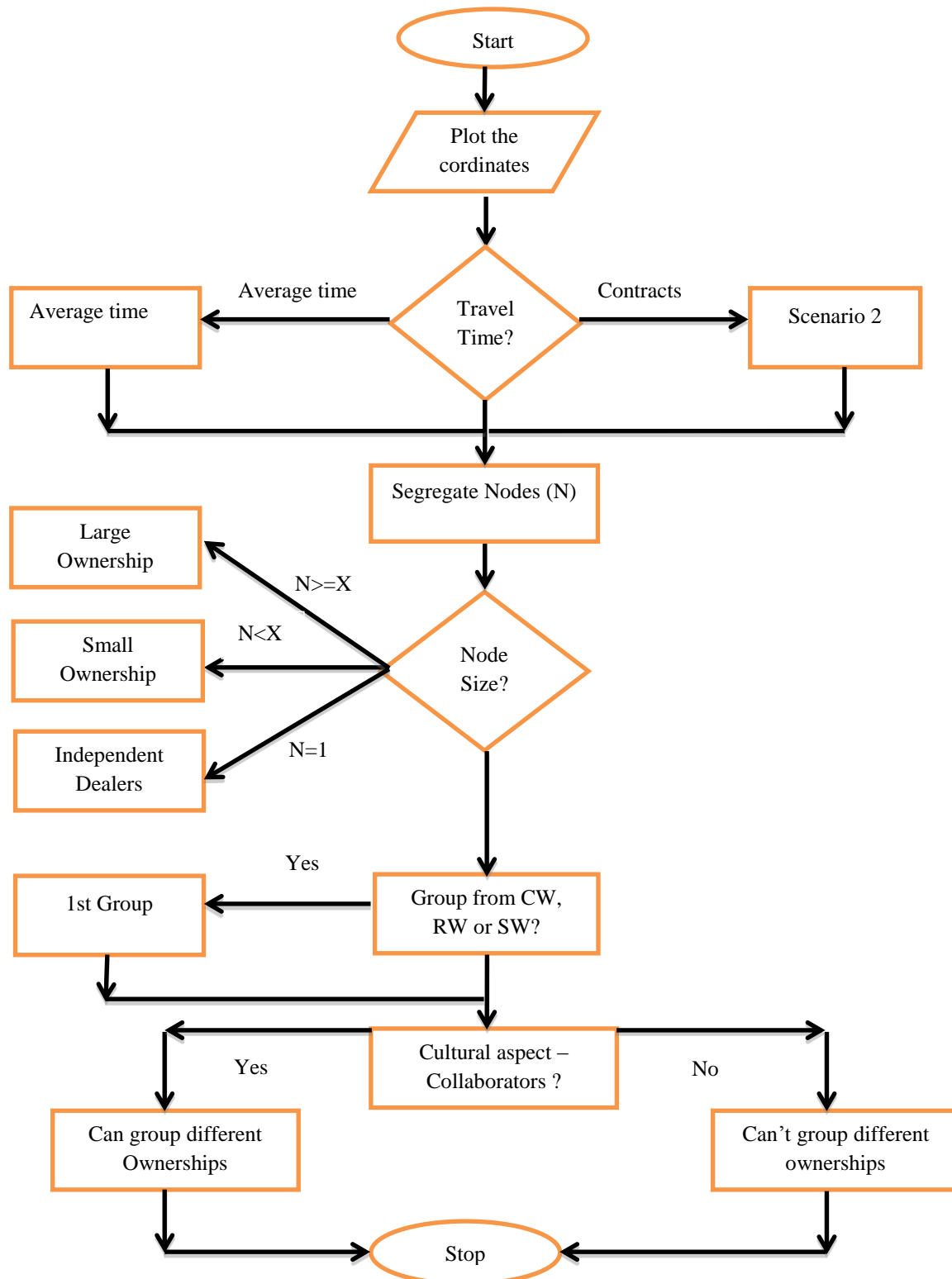


Figure 10: A general model that can be used to group nodes

### 1. Plot the nodes

In order to start the grouping process, the dealer points need to be plotted on a mapping application or software. The plotting of these points is done based on the dealer coordinates as can be seen below in the maps of USA and Italy.

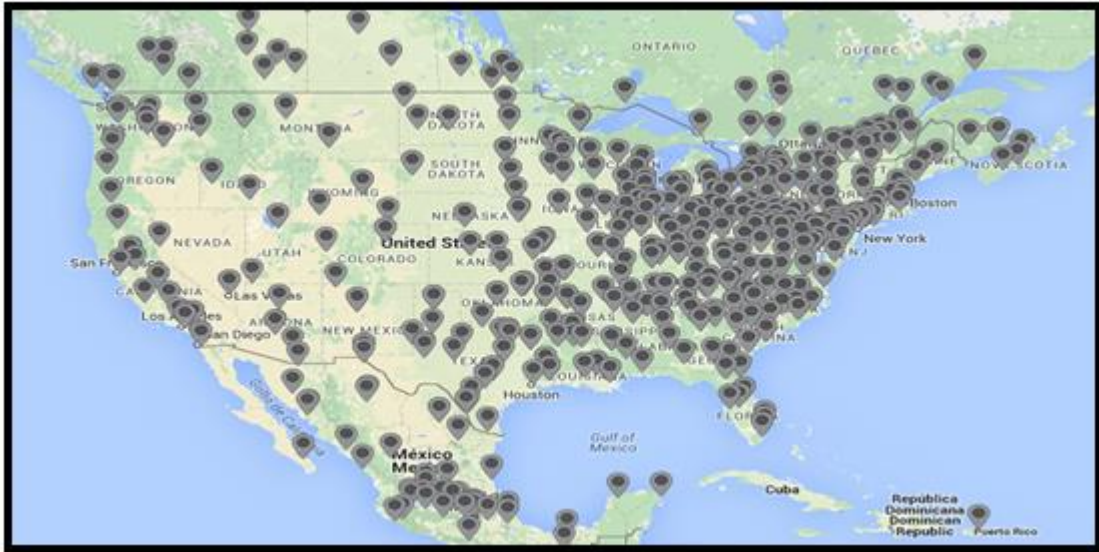


Figure 11: Volvo dealer locations in the USA



Figure 12: Volvo dealer locations in Italy

## 2. Travel Time

In order to start with the grouping process, it is important to first consider the parameters for grouping. It is also important to understand the reason for the grouping process well enough to get to the right set of groups which are based on the right set of parameters. The main reason behind this process of grouping dealers/nodes is to ensure faster availability of parts in case of an emergency. Faster availability indicates the fact that dealers, which are close to each other need to be grouped together. The closeness of a dealer can be seen in two ways;

1. Based on the distance between the nodes
2. Based on the travel time between the nodes

The distance between two nodes can be small but if the road conditions or the type of roads (no highways) are not fit for heavy duty vehicles then this might take more time between nodes compared to nodes which are a bit far away yet the road conditions are better and therefore take less time to travel. Taking this as the main argument, it is suggested to base the groupings on travel time as it takes into consideration the distance as well.

Associated to the travel time are many costs such as transport costs, waiting time costs to be given to the end customer etc. It is important therefore to decide a suitable travel time between the nodes. The travel time which is decided should be suitable for same day availability as that is the main objective from this grouping process. Therefore two different ways for deciding the travel time are presented below. The first way is based on the average travel time, and below are two different scenarios presented on how this can be calculated. This is followed by the second way of how travel time can be decided based on companies contract towards their end customers.

### ***Scenario 1: Dealers/ Nodes are close (travel time) to each other***

This step can be mathematically tested by checking the travel time from one node in this region to 5 or 10 neighboring nodes and calculating the average travel time. The same step can be repeated for few more nodes and an average of these average travel times can be decided for this scenario. This can be better understood from the example below where the suggested travel time for this scenario will be 2,23 hours.

**Table 2:** Calculation of average time on nodes close to each other

	Travel Time (Hours)						
Node	A	B	C	D	E	F	Average
X	3	2	1	3	4	1	2,3
Y	2	4	1	3	2	1	2,1
Z	1	3	1	2	4	3	2,3
							2,23

**Scenario 2: Dealers/ Nodes are far (travel time) from each other**

This step can also be mathematically tested in the same way as in scenario 1, where an average travel time from one node to 5 or 10 neighboring nodes is calculated. The same step can be repeated to get an average travel time from a few more average travel time calculated and decided for this scenario. This can be seen from the table below for a better understanding.

**Table 3:** Calculation of average time on nodes far from each other

	Travel Time (Hours)						
Node	A	B	C	D	E	F	Average
X	12	8	10	8	9	12	9,8
Y	9	12	12	9	8	10	10
Z	10	9	10	8	9	11	9,5
							9,7

The second way to decide on a suitable travel time can be based on the contracts offered by the company to its end customers. These contracts are basically based on the availability of spare parts in case of emergency. If companies don't use these kinds of contract, the decision on travel time can also be decided on a lead time target for the type of service they want to offer to their end customers.

**3. Segregation of nodes**

The next step in the grouping process is to segregate the nodes in a manner, which will be useful when clustering the nodes. The nodes may have different characteristics, such as being part of different types of ownership and based on the project's requirement, these can be segregated into different groups. For this project, it was noted that some nodes were a part of a big group or in other words have many branches (more than one node/branch) whereas some nodes are on their own. Therefore taking this as the main consideration for this step of segregating the nodes, three groups were decided – Large Ownership, Small Ownership and Independent dealers.

Ownerships with less than X nodes/branches are considered as Small Ownerships, whereas ownerships with X or more nodes/branches were considered as Large Ownerships. The nodes with no branches were considered as Independent dealers.

#### **4. Regional /Support/Central Warehouse**

The fourth step in this process is to start the grouping of nodes based on the above mentioned parameters from the regional, support or central warehouse available in the country. This step is selected as the starting point for the grouping process. With the travel time decided by the company the first group from the regional-, support- or central warehouse is constructed. From availability point of view, the regional or support warehouse carries a higher service level of parts therefore this group can have the regional, support or central warehouse as a hub. In case this step does not suit the company, then it can continue with the next step avoiding this step in the process.

#### **5. The Cultural Aspects**

Culture is a very important aspect in the grouping process as this gives an idea of the country/ markets situation in parts sharing. In some markets dealers may see each other as competitors whereas in some markets the dealers may see each other as collaborators. Therefore before proceeding to the next set of groups, it is important to consider this step and get an idea of the kind of relation that exists between dealers in a particular market. If the dealers/nodes see each other as collaborators or are willing to share parts between each other, then different ownerships can be grouped together in one group based on their closeness to each other. If the market only consists of Independent dealers that are competitors, then this could be a big challenge for the company to create policies where they can still be grouped together.

#### **6. Large Ownership**

In this step of the grouping process, it is suggested that if nodes of a Large ownership are within the travel time decided, then they should be grouped together in one group so that they stay together and also because it is then easy for the steering of inventory from the company's point of view as well.

#### **7. Small Ownership**

The next step in this grouping process is to group all the small dealers/ nodes together in a group. This step also gives way to grouping different ownerships together as the nodes, which are a part of the Small ownership, may be very few to have a group on their own both from an inventory steering as well as from a transport perspective. Therefore keeping the steering and transport parameters in mind, it is suggested that Small ownerships can be

grouped together. When clustering small groups of dealers/ nodes, it is also suggested to limit the number of different ownership in one group.

### 8. Independent Dealers/Nodes

The last step in the grouping process is to group the nodes, which are independent. This step can be conducted only if these independent nodes lie within the travel time decided by the company. If these nodes are not located within the decided travel time then it is suggested that these nodes are grouped together with the closest Small ownership groups. This can be better explained with an example; if there are three independent nodes located close to each other and a Small ownership group with three branches close to each other, then these six nodes/ dealers can be put together in a group.

#### 4.2.2 Steering scenarios and transport solutions

To be able to increase the availability of spare parts two new scenarios have been developed, based on the different groups that have been created in the general model above. Below is the two new scenarios presented together with models showing how they work.

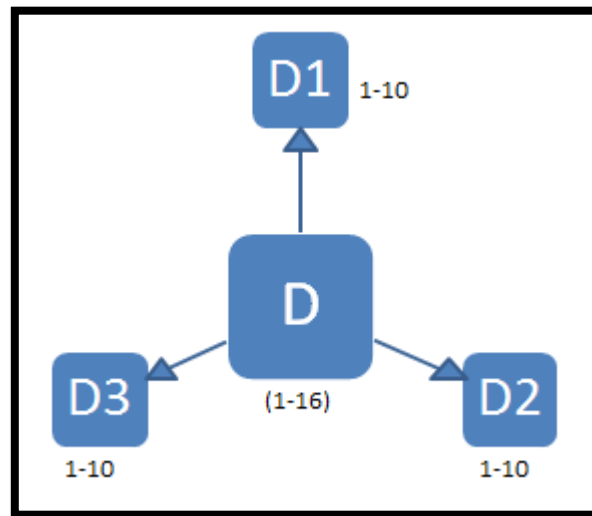
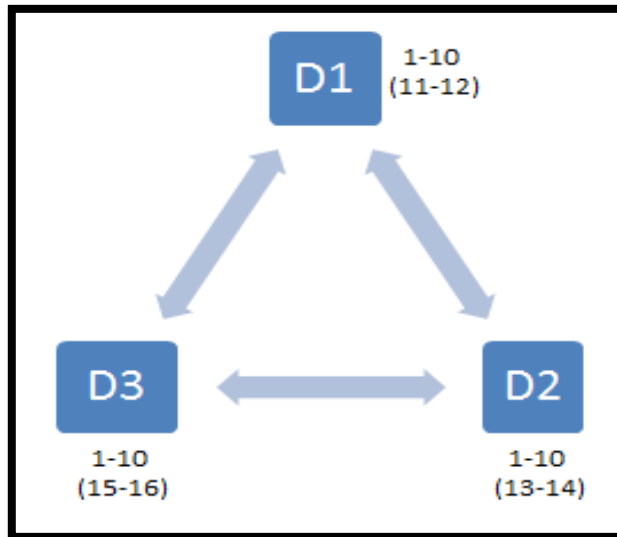


Figure 13: Single Dealer level

The first scenario, which can be seen in figure 13 above, is developed to utilize sharing of part between two parties. In this scenario it is suggested that a node with a higher stock holding capacity having nodes around it is made the hub in the group. This scenario is called Single dealer level as one node in the group supports the other neighboring nodes by holding inventory when in need. To exemplify this better, from the figure above it can be seen that the

fast moving parts such as 1 to 10 can be stocked at all the nodes in the group whereas the entire part range (1-16) can be stocked at the hub, which in the figure is D. With the steering of the parts comes the transportation of parts between nodes. Therefore the suggested transportation for such a scenario can be the hub and spoke system where the transport starts at the hub and supplies parts to the spokes, which in this case are the other nodes. Depending on the size of the group and on the company a milk run can also be used as a transport solution in this setup. A milk run transportation set up means that a truck starting from one node going around to the other nodes included in the group.



**Figure 14:** Group level

The second scenario suggested for nodes within a group can be seen in the model above, Figure 14. This model is known as Group Level, since the stocking of parts in this setup is done by all dealers in the group, but not all the dealers carry the same parts. To exemplify this better, from the figure above it can be seen that the fast moving parts such as 1 to 10 can be stocked at all the nodes in the group whereas the slow moving or exotic parts will be distributed in the group in a way that it can be shared among the nodes when needed. Moving to the transportation setup for such models, milk run suits best for this type of need. This is because there will be parts moving in and out from each node and not one common point as in the hub and spoke system.

### 4.3 Case study

A case study was performed to put the general model into practice for a pilot batch and to test the results. For this case study, Volvo Groups LPA dealers in Sweden and Norway were selected due to the following reasons:

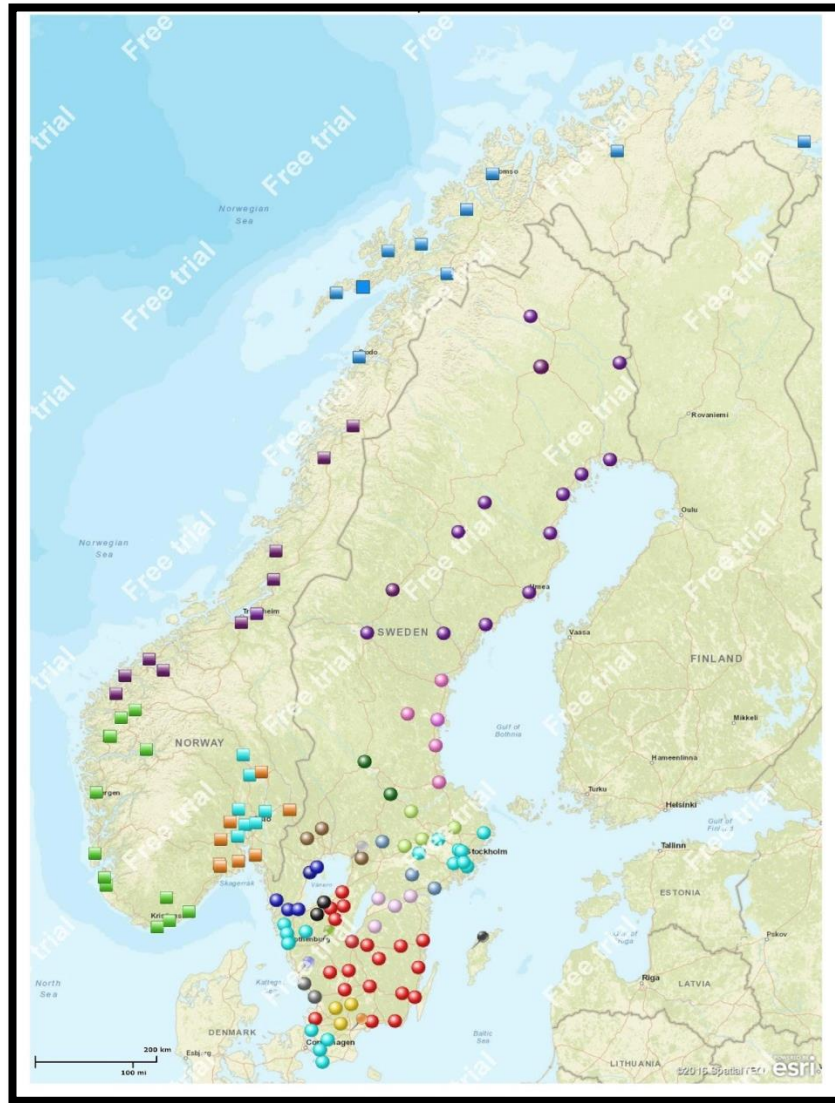
1. Sweden and Norway are two mature markets for Volvo Group aftermarket services.
2. In these markets cross border parts sharing can be tested.
3. These markets are part of EU and Non EU.
4. These markets have all the three types of ownerships.
5. The authors are close to these markets, which make it easy for them to visit dealers.

In total these two markets have 152 LPA dealers, 97 dealers in Sweden and 55 dealers in Norway. Sweden has dealers which are part of an ownership as well as independent dealers whereas Norway has dealers which are only part of an ownership and there are no independent LPA dealers. Based on this basic information, the groups for both the markets were built as follows:



## 1. Plot dealers

As described in the general model above, the first step is to plot the dealers on a map to be able to continue with the next steps and create different groups. In order to plot the dealer locations on mapping software, which in this case was Business Maps Online, the coordinates of these dealers had to be searched. After the coordinates were gathered, all the dealer locations were plotted on the map as shown in figure 15 below, where the different colors represents different ownerships.



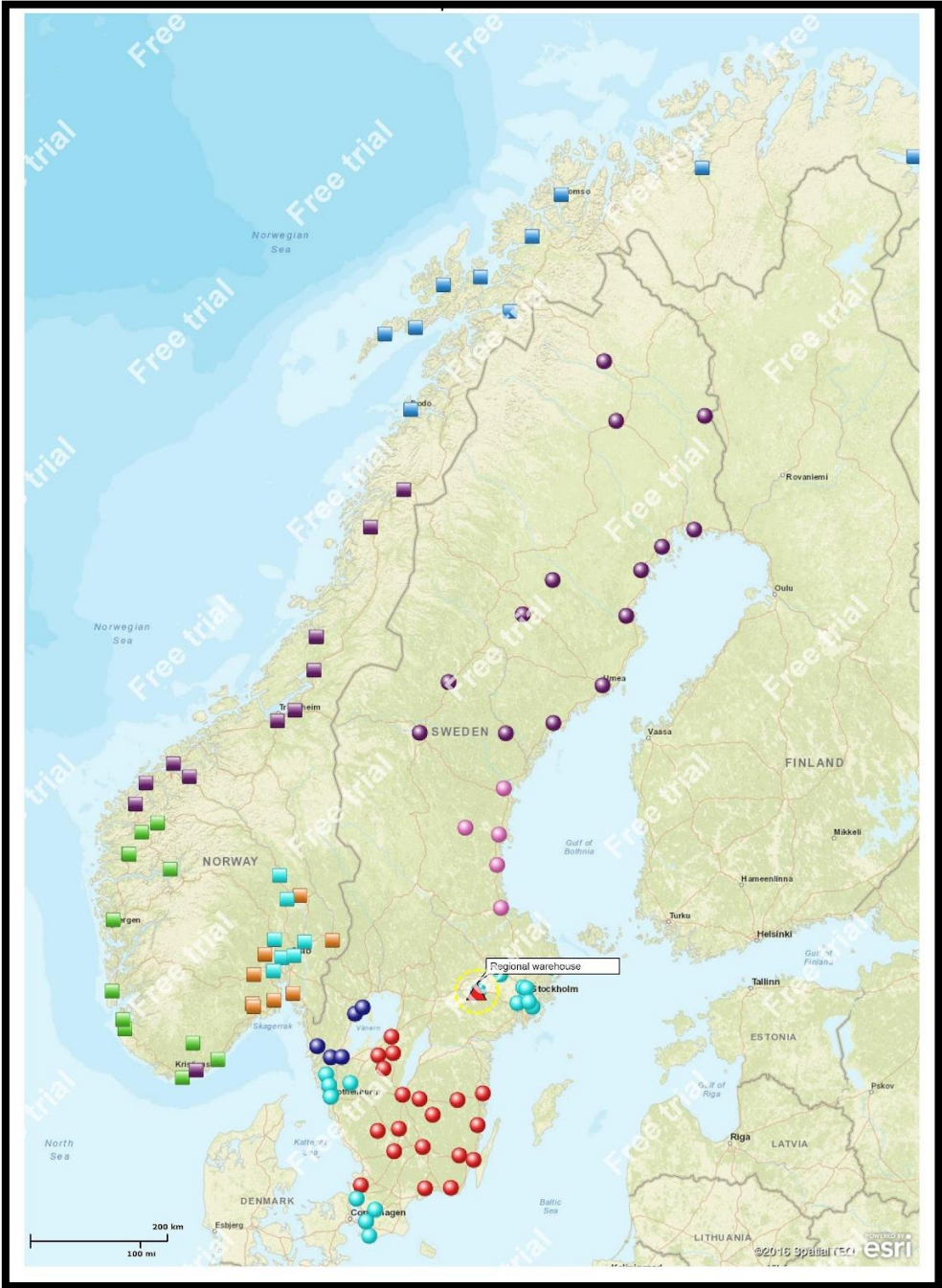
**Figure 15:** The location of Volvo Groups dealers in Sweden and Norway  
**Note:** The colors represent the different ownerships of dealers

## **2. Travel Time**

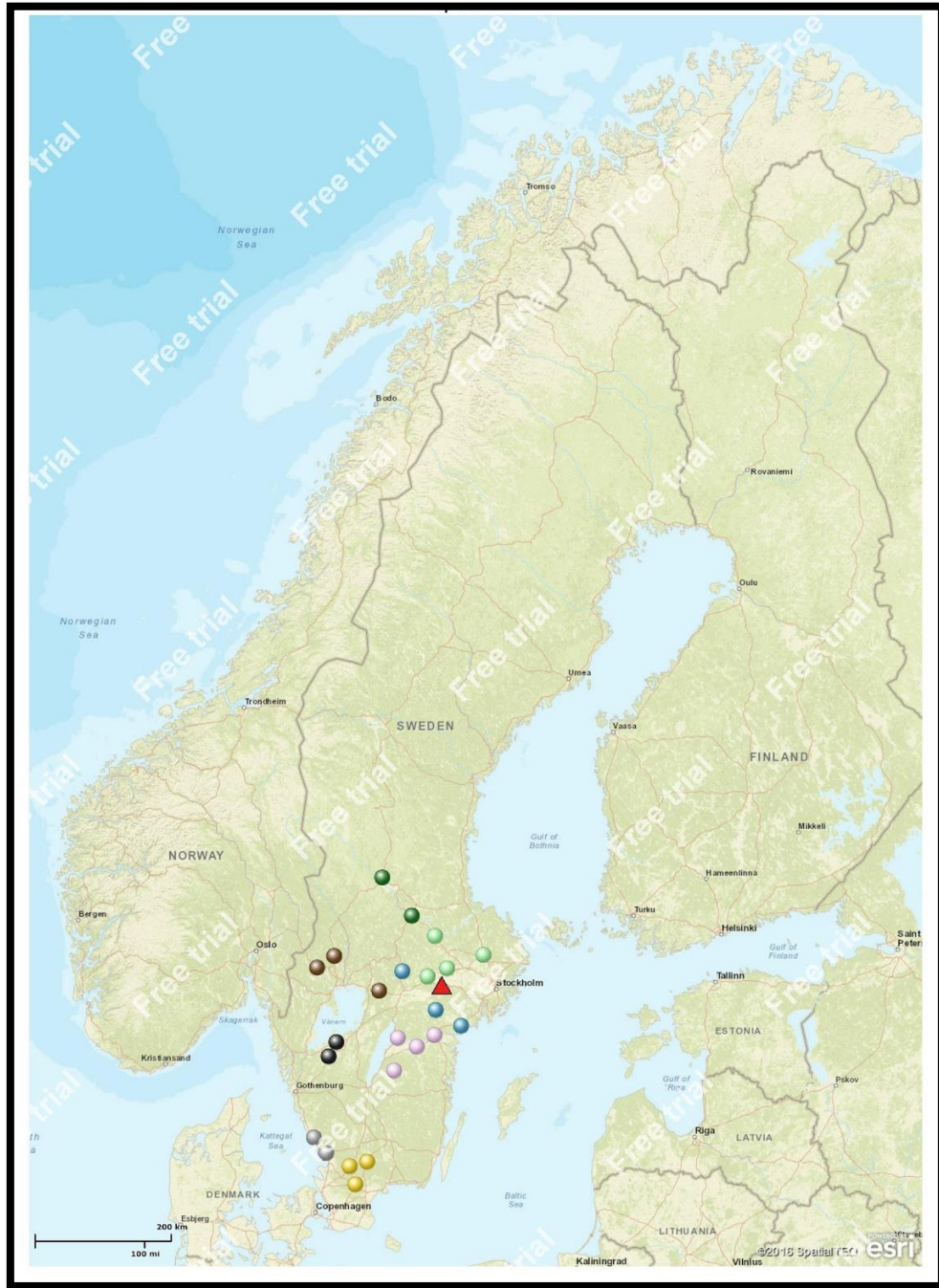
In the second step, the travel time for grouping was decided. This step can be based on two factors as explained in the general model above. One way of deciding on a travel time is based on the average time taken between the different nodes and the other way is based on the contracts that are offered to the end customers in case of emergency situations. Volvo offers different contracts to its end customers, Gold contract promises the fastest uptime of vehicles in case of an emergency, which mean that the part should be delivered within four hours. Therefore, a travel time of three and a half hours has been used to group the dealers with 30 minutes allocated for picking and packing of parts. The goal with the group is to improve the availability and increase the service.

## **3. Segregation of Nodes**

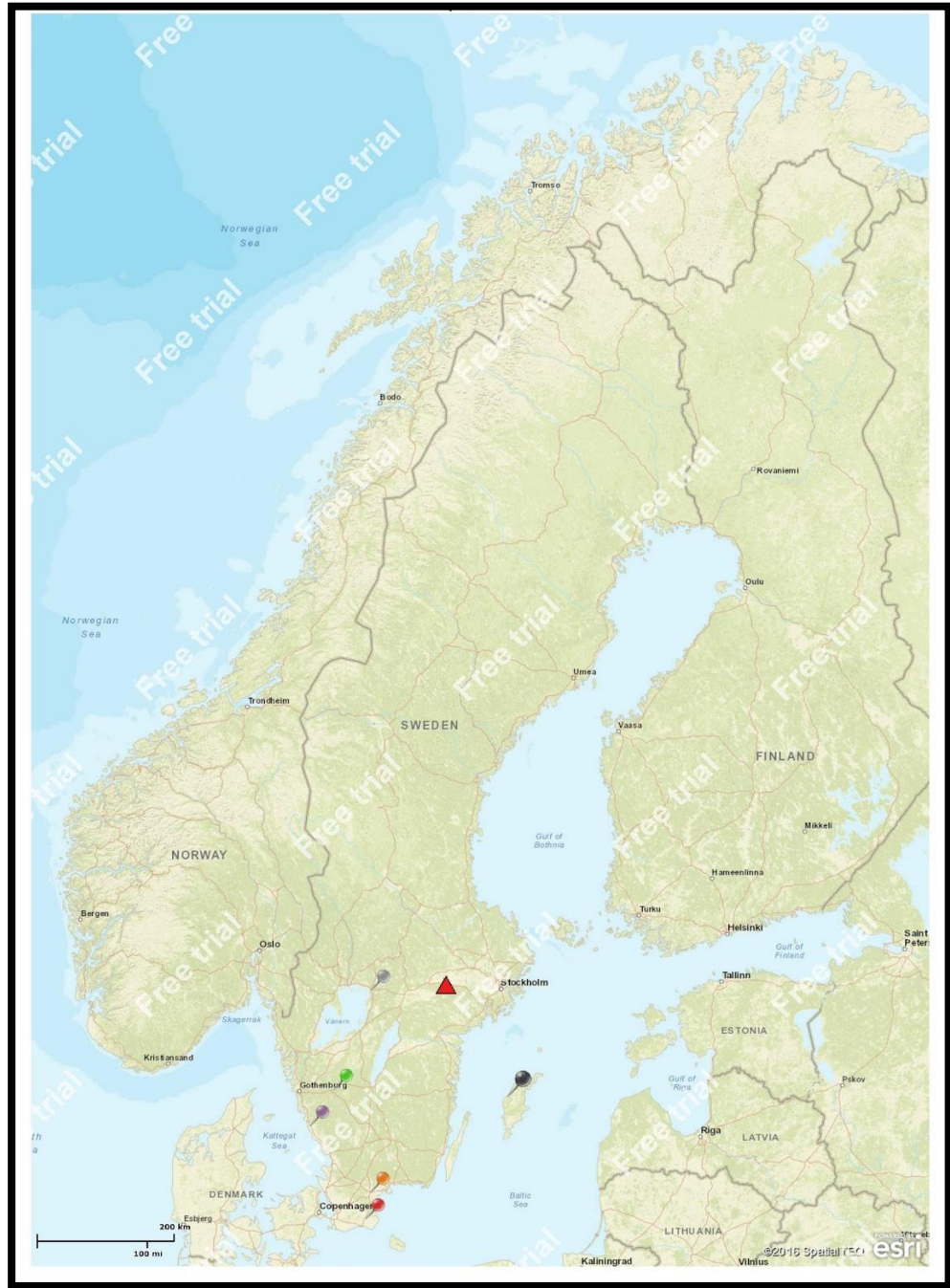
In the third step, the entire list of dealers was segregated into three different types for Sweden. In case of Norway, the entire list of dealers was segregated into one type. The Swedish dealers were segregated into; Large ownership if there were five or more dealers within one ownership, Small ownership if there were less than five dealers within one ownership and Independent dealers if there were one on their own. The breaking point at five dealers was based on a pre-study made at Volvo that came to the conclusion about five or more dealers within one group, since it was suitable for inventory planning. The Norwegian dealers were only divided into Large Ownership, since this was the only type of ownership that existed within the market. The segregation of these dealers can be seen in figures 16, 17 and 18 below:



**Figure 16:** The segregation of nodes into Large ownerships



**Figure 17:** The segregation of nodes into Small ownerships



**Figure 18:** The segregation of nodes into Individual dealers

#### 4. Regional/ Support/ Central Warehouse

After the segregation of nodes, the first set of grouping was done, this from the support warehouse located in Eskilstuna in Sweden. Taking a travel time of three and a half hours, a polygon was created around the support warehouse in Eskilstuna which clustered the dealer points. This grouping was done in the mapping program and the groups were checked for its accuracy using another mapping program, Google Maps, which gave the same result. The group can be seen in figure 19 below, where only the small and independent dealers are shown, since Larger ownership will not have the support warehouse as a hub in the group.

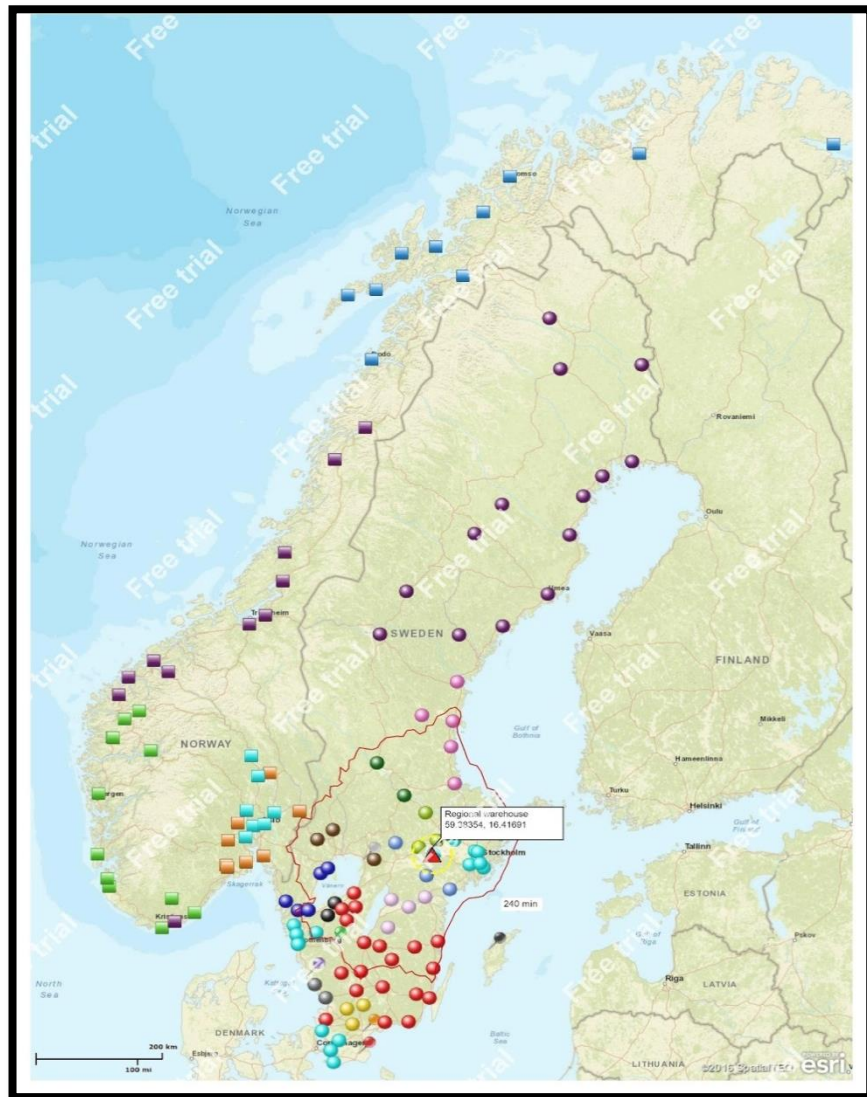


Figure 19: Dealer group based on 3.5-hour travel time from the support warehouse

## **5. The Cultural Aspects**

The next step was to look into the current scenario of parts sharing in Sweden and Norway. Dealers in both these countries see each other as collaborators and are willing to share their parts between different ownerships. This step therefore allows dealers to be grouped with different ownerships together as well in the following steps, which can be seen in figure 21 below.

## **6. Large Ownership**

In this step, the dealers which from an earlier step were segregated into Large ownership were plotted on the mapping software based on their coordinates. These dealers are part of big ownerships, which have a main dealer in every group. Therefore from the main dealer in every group taking a three and a half hour travel time, polygons were drawn on the map. There are certain ownerships, such as the green dealer group, which are a very big ownership spread over a very large area, such ownerships were therefore further divided into two groups. What also can be seen in figure 20 is that two groups are cross-border groups, with dealers located both in Sweden and Norway.

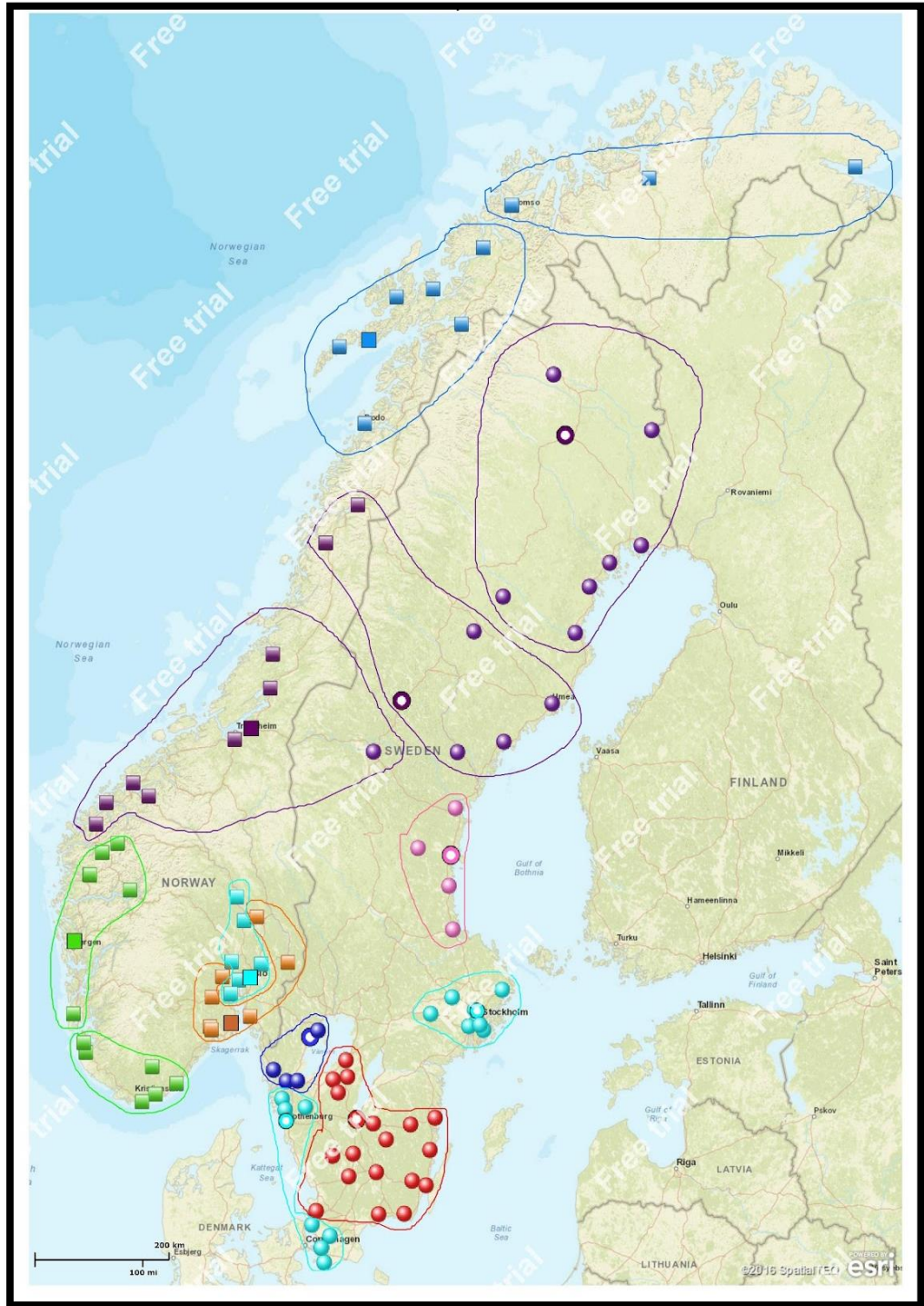


Figure 20: Large ownerships groups



## 7. Small Ownership

In this step, groups with different ownerships were grouped together as they have less than five dealers under their own ownership. These Small ownerships exist only in Sweden and they are all located in the high density area in Sweden. Therefore using the travel time of three and a half hours, from the bigger dealer in each location, drive time polygons were created. When creating these small groups, effort was taken to limit the clustering of only two different ownerships in a group, which can be seen in Figure 21 below:

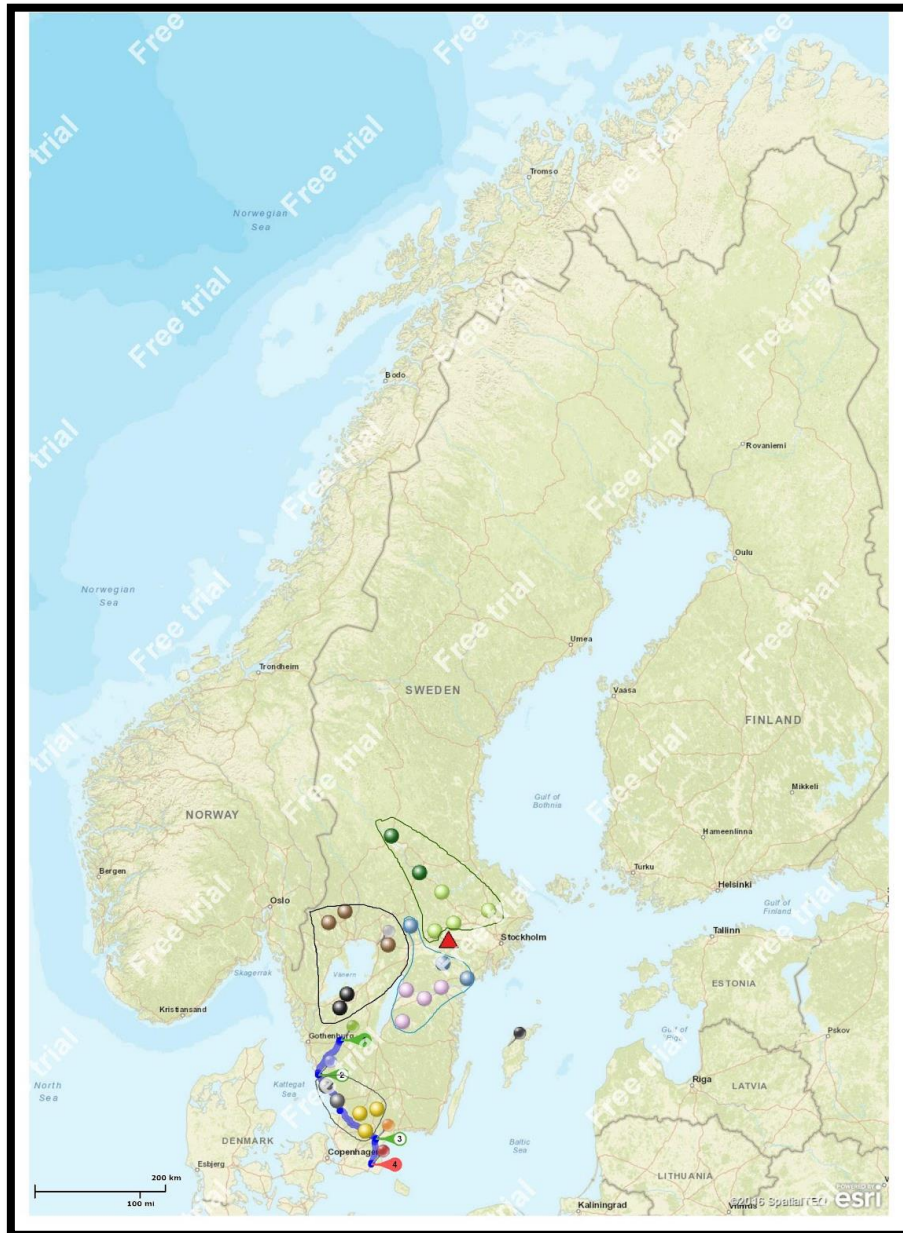


Figure 21: Small ownerships and Independent dealer groups

### **8. Independent dealers**

In the last step of the grouping process, a three and a half hours drive time polygon was created from the biggest independent dealer. As with the Small ownership, this group only exists in Sweden and in high-density area, which also can be seen in Figure 21 above.

From the case study, it can be seen that Sweden and Norway together have 14 big groups, four small groups and one group of independent dealers in Sweden, which can be used to increase the availability of parts at group level. The impact from this setup will be discussed in the next chapter.

## **5 Discussion**

*This chapter starts with a discussion on Volvo Group's current processes and is followed by a discussion about the general model that has been developed within this study and how groups can be created. This is followed by a discussion about the two new scenarios that have been developed, discussing how this will change the steering of inventory towards dealers, how inventory pooling can be implemented and what challenges that exist with the concept. The chapter ends with a discussion that concerns how same day availability within the groups can be achieved by using new transport solutions, the new dealer order processes and how the availability can be improved by the grouping process.*

### **5.1 Current processes**

Today Volvo Group dealers' requirements are fulfilled from three different types of warehouses with different functionalities. As can be seen in the flow of parts process in figure 7, the dealer is the face of the company to its end customers. The flow of the parts in the supply chain today takes place through the same facilities as described by the author Simchi Levi et al (2007). This flow of parts through these various facilities is usually the same when comparing manufacturing industries due to their functionalities in the supply chain but the source and destination for the parts may differ between companies. It can also be noted that the flow process for a stock order is different from the flow process for a day order or VOR order. The main reason for this difference is due to the demand for parts.

In case of a stock order, the demand is known and is based on a push type of inventory. This setup is based on the previous sales which indicate what level of sales can be expected from each dealer and as stated by authors such as Ramachandran et al (2002), these types of inventories help in deciding when and where to move the inventories. Whereas in the case of a VOR or day order, the demand is not known and therefore cannot be predicted exactly, as a breakdown can take place anytime. To handle such kinds of emergencies, it is important that the dealers have all parts in stock at all times in order to take care of these situations without having to make the end customer wait. There exist both advantages and disadvantages with keeping all the parts in stock as an inventory by the dealers. The advantage is that the customer receives a high uptime of the vehicles and the dealer creates a good image with high customer loyalty, but the disadvantage from keeping high stock is the high capital cost tied up to this high inventory. In addition to the high capital costs, there are other costs associated to this – such as the warehousing costs that include the extra warehouse space to carry all parts. Other common costs associated to this storage are the degradation and potential obsolescence of parts and the costs associated to it (Simchi-Levi et al, 2007).

As the role of a central warehouse includes holding all the stock for the markets dependent on it, therefore there exist six central warehouses in the world to serve all the Volvo markets today. The role of these central warehouses is to supply the production sites with parts and the dealers with regular stock orders. The inbound flow to the central warehouses can be from the suppliers and production sites whereas the outbound flow is to many facilities like the production sites, central-, regional- and support warehouses, dealers etc just as discussed by the authors who state that every pool is connected to the central warehouse and is replenished by the same (Kutanoglu, 2008). The role of the regional and support warehouses of Volvo are designed and positioned in such a way that they serve the purpose of efficient inventory steering to the dealers. As described in the current process of Volvo, this states that the support warehouse acts as a support to the central warehouse by carrying the exotic parts. By applying the general model and the two scenarios developed within this study, the current setup will be changed. This will be discussed within this chapter together with the pros and cons at a general level.

## **5.2 General model**

This part of the discussion concerns the importance of availability of spare parts for companies within the manufacturing industry to be able to deliver a high service level to their end customers. The chapter will discuss the general model that has been developed within this study with the main focus on how this can improve the availability.

Manufacturing companies function in different ways to be competitive in market and to attract more and more customers to their brand. When it comes to construction vehicles, buses, trucks etc the competition is even higher as these vehicles in general mainly carry business. Therefore companies manufacturing such heavy equipment vehicles have to be extra sharp in making sure that their customers vehicle is up and running as soon as possible after a breakdown. To make this happen, the parts which are distributed or sold by dealers have to have a very high stock of parts which are not 100 or 200 types of parts but more than 10 000 parts in general, which varies depending on the market and the new vehicles on road. It is not wise to carry all the parts by all the dealers due to the high capital costs tied up to it as well as due to the high inventory holding costs especially if the parts are from very old vehicles. Therefore a model that can improve the current setup without needing to stock expensive parts at all dealers was developed.

The new model was designed by keeping in mind all the requirements which are needed to be fulfilled by any manufacturing company's aftermarket service. As stated in the processes

above, the main requirement from an aftermarket service is high uptime of vehicles in case of emergencies together with faster availability of parts. The latter requirements can be fulfilled by grouping dealers in every market which will be discussed below.

This grouping process is a general grouping process, which can be modified based on specific requirements that companies may have. This process can also be referred to the discussion by Rozenblat et al (2013) on how nodes can be clustered better. To discuss this better, it is important to understand what kind of dealers the company has for their parts distribution and therefore how they should be grouped or clustered. The three aspects that are important to be considered in network planning are network design, inventory positioning and the resource allocation (Simichi-Levi et al, 2007). This includes the number of nodes within one group, location of the dealers and how the service level will be affected by the positioning of the inventories. Therefore when clustering or grouping these dealers such parameters and criteria were taken into consideration from which a cost and time effective solution could be suggested. Below mentioned are the steps used for the grouping process within the general model:

### **1. Plot the nodes**

The first step suggested in this grouping process is the plotting of the dealer points which according to the literature is referred to as nodes on a map as this makes the grouping process easier and better (Oracle, 2016). The reason this plotting of nodes is decided as the first step is because it gives the researcher an idea of how the dealers are spread in a market and how should the next steps be decided and the process be designed. The grouping of dealer points will be accurate only if these dealers are plotted on the basis of their coordinates and not merely their addresses or pin codes. This is the reason the dealers suggest that the nodes are plotted on the basis of the dealer coordinates only.

### **2. Travel time**

The next step in this process is supposed to be the most important step from a grouping perspective. This step decides or is the basis for the other steps. Therefore it is suggested that this step is the second step in the process and is done with utmost accurateness. The reason this step is suggested as the second step in the grouping process is because the main reason for grouping is high and faster availability of parts. This can be performed only by measuring how close the dealers are to each other. Measuring the closeness can be done on the basis of distance and on the basis of travel time. It might be a little confusing as to why the travel time has been considered, as travel time will be calculated on the basis of distance. That is true but from the interviews conducted in the study, information about poor infrastructure in certain

markets leading to higher travel time even in shorter distances were understood. Therefore, travel time is suggested to be a more accurate form of measuring the closeness between the dealers.

There are two ways of deciding the travel time between the nodes as suggested by the dealers. It is in this step where the plotting of nodes on a landscape becomes more useful. From the maps, in the case study, it can be seen that certain nodes are close to each other whereas some of these nodes are far from each other. Therefore, it is suggested that an average travel time for these areas are calculated in order to conclude what travel time should be taken as an average in these areas. This can be related to Boccaletti et al (2006) description about the importance of the shortest-path in a transportation network and that the average time, which can be referred to the characteristic path length, which is the separation between two nodes. It is also possible that in some markets an average travel time in general between the nodes will be similar and therefore only one travel time for the market can be decided for the grouping process. This might not be the case in all the markets due to their geography, population etc which may show different average times for these high and low regions, therefore in such scenarios it is suggested that two travel times are taken for the grouping process. This is the reason why an example has been shown of both the types of average travel times.

The second way of deciding a travel time is based on the contracts that the company may have for their end customers. These contracts basically promise the end customer the best service as early as possible that can be provided by the company in case of an emergency. Some companies have such contracts while some may not have such contracts as these depend on company policies. These contracts may vary depending on the type of services offered by the company and the different type of end customers a company has (Kutanoglu, 2008). In the case of Volvo Group, the best contract offered in terms of fastest uptime of vehicles in emergency situations is the Gold contract where the company promises its customers 100% uptime within four hours. Therefore for the grouping of dealers in Sweden and Norway, the lead time provided by Volvo for Gold contract was used as it offers the best service and fastest availability of parts. This lead time of four hours was therefore used when grouping dealers in Sweden and Norway. This lead time of 4hours included a travel time of three and a half hours and the pick and pack time of 30 minutes. The travel time of three and a half hours was also cross checked for these two regions with the help of the first way of grouping dealers that is using the mathematical average method. It should be discussed that the company

can decide to use another travel time based on their lead-time target, which is up to the company to decide.

### **3. Segregation of Nodes**

In this step of segregating the nodes, the dealers are segregated into different groups in order to keep similar dealers, which are based on numbers of dealers within one ownership, in one group and steer inventory in these groups with similar service level. Interviews conducted with Volvo representatives in different markets gave an idea about the different types of dealers that existed in every market. Based on this dealers were divided into three different groups. These three groups of dealers were Large, Small and Independent dealers were then plotted into three different maps in order to make the grouping process easier on the software and also to keep similar dealers together on maps. This can also be seen in the case study, figures 20 and 21, where Sweden has all three types of dealers whereas Norway has only one type of ownership. The case study reveals that different types of dealers exist in different markets and therefore how this segregation process can be of help in any market.

### **4. Regional/ Support/ Central Warehouse**

In order to start the grouping process, it is important to start from some point. Therefore it was considered best start the grouping process either from the regional-, support- or central warehouse depending on what exists in the market. There may also be markets which have neither of these warehouses, in such cases it is suggested that the next steps in the grouping process is followed. A group consisting of having a regional-, support- or central warehouse can always have the warehouse as the hub for the group. This can be a positive aspect in parts sharing as the warehouse always has high levels of inventory as well as frequent outbound transport as well. This step can be clearly seen in the case study, figure 19, where the regional warehouse in Eskilstuna, Sweden is considered as the hub and from this a three and a half hour travel time is used to create the first group of dealers. This first group consisted of all the three types of dealers but the dealers which are a part of Large ownerships were excluded from this first group because the aim was to keep all the dealers under the Large ownership as one group together, provided they can be reached from their main dealer using the three and a half hours travel time which in this case did fulfill that aspect.

This step as stated above is not a compulsory step and can be altered as per the company's requirement. This step can also be related to the first step in network planning, where the first step is to decide the design of the network. By starting from the regional-, support- or central warehouse, the physical and infrastructural

configuration in the supply chain has been decided (Simchi-Levi et al, 2007). What needs to be noted in this step is that if a company chooses to use this step, the warehouse will act as a hub and the travel time will be based from this. If Volvo decide to use this step, they also need to consider the aspect of changing the current inventory handling set up that exists within the warehouse today in order to be able to implement inventory sharing within this group.

### **5. The Cultural Aspect**

The cultural aspect is considered to be another important checkpoint in this grouping process. Whether dealers in a particular market consider each other as competitors or collaborators is vital. If dealers see each other as competitors it can be difficult to group different ownership together, whereas if dealers see each other as collaborators then dealers from different ownerships can easier be grouped together. This aspect can be very well seen in the case study, figure 20 and 21, where dealers in Sweden and Norway see each other as collaborators when it comes to parts sharing. Therefore the dealers in these markets, with different owners have been grouped together. If the cross ownership grouping is successful then huge savings on time and costs for parts sharing can be made. It's important to give the dealers an understanding of all the benefits that can be received by participating in this process (Kutanoglu, 2008).

### **6. Large Ownership**

The next set of grouping begins with ownerships, which have X or more branches in a group, where X is decided by the main company. The grouping process starts from the main dealer in each ownership. By using three and a half hours of travel time, the groups are created from these main dealers, in the case study, this can be seen better in figure 20. There were cases when some dealer points fall out of the three hours travel time, therefore in such cases it is suggested by the dealers to make more than one group of dealers. For Volvo, it is suggested to have at least five dealer points in a group, since this was stated from a pre-study for steering of inventory which was done by Volvo. The groups in Sweden and Norway were created from using these five dealer points. It can also be seen from the maps that there are certain groups which stretch across border. The reason this is considered as a good way of grouping is because there are points across borders which can be reached faster than dealer's points which are in the same country. This can be seen clearly in the case study where the blue dealer group is a major dealer who has branches in both Sweden and Norway. These were grouped into three different groups across borders. From certain interviews conducted, this was suggested as a good move by the transport department as Norway does not have a good



road infrastructure compared to Sweden. As a consequence certain shipments going to the North of Norway go via Sweden by taking a de tour.

### **7. Small Ownership**

As can be seen from the map in figure 21 above in the case study, there exist very few dealers which are a part of the Small ownership. These ownerships may not have X branches under an ownership and therefore it is not suggested to keep these dealers in a group alone as this will be a costly affair for the company. Therefore by clustering these ownerships together, it is suggested to have them as one group.

### **8. Independent Dealers**

The independent dealers are suggested to be grouped together in the same group if these dealers are located within the travel time of three and a half hours from each other. This can be seen from the case study, in figure 21, where Sweden has only six independent dealers, out of which four dealers follow the travel time of three and a half hours. Therefore it can be seen that most of the independent dealers can be grouped together. Although, there can be certain cases where independent dealers don't fall under the same group or can't form their own group – either because of the travel time being high or because there are less than five dealers in a group. In such cases it is suggested that these dealers either are left out of the grouping process or that these dealers are grouped with one of the Small ownerships. The Small ownership might be able to manage this extra dealer as well. The decision is left to the company to decide based on their requirements.

## **5.3 Scenarios**

To achieve same-day availability there are different aspects, from a logistics point of view, that needs to be considered – such as the steering of inventory and the transportation networks. By analyzing the structure of the network the reachability between nodes can be seen, which is important when striving to achieve same day availability (Boccaletti et al, 2006; Graph theory, 2013; Easley & Kleinberg, 2010). The two scenarios that have been developed within this study are based on the concept of inventory pooling to improve the availability of spare parts at dealers within the manufacturing industry.

Inventory pooling, is a kind of lateral transshipment that was first considered by Lee (1987) and by using inventory pooling, also known as virtual pool inventory, the service level can be improved as well as the costs can be reduced. It suggested that, by adapting inventory pooling, the company would also use an efficient strategy, which can be considered to be important for

companies that strive to attain a high service level, like companies within the automobile industry. (Kutanoglu, 2008; Braglia & Frosolini, 2013)

The concept of how inventory-pooling works is explained by Kutanoglu (2008) who describes how dealers, in this case, can search for a part at a secondary location by creating an emergency lateral transshipment between each other. After grouping dealers based on the general model that has been developed and discussed within this study, the two scenarios can be applied which will improve the service level at the dealers. This is something that is important for Volvo to deliver to their end customers and something that also can be related to Kutanoglu's (2008) discussion about the importance for some companies to be able to deliver high uptime service, as this incurs high costs for both Volvo by sending the parts through an expensive mode of transport and to the end customer as a standstill cost for the vehicle.

The first scenario, Single Dealer Level, is based on the fact that one dealer acts as a hub, supporting the other dealers with stock. This can be referred to Kutanoglu's (2008) description about consolidating parts within a limited number of locations. The scenario is recommended to dealers within a Larger ownership, which suggests that by being within the same ownership it's easy to collaborate with each other, something that could be considered to be a challenge in this concept. By being within the same ownership it's easier to share parts between each other and give one dealer the responsibility to carry all the stocks for the others. The decision of who is going to be the hub or how many hubs that should exist within one network depends on the design of the network, as Simichi-Levi et al (2007) discussed. This is in the first part of network planning that this decision is taken regarding where the inventory should be located and how many locations that should exist (Simichi-Levi et al, 2007) In some of the Large ownership groups, it can be necessary to use two hubs or even divide the group into smaller units, in order to achieve same day availability, since the truck need to be able to reach all dealers within the same day. With too many nodes within one group, this can be problematic and something that the main company need to consider, when deciding the size of the group.

The second scenario, Group level, is based on the fact that all parties within one group should share the responsibility of carrying the stocks. This means that all of the dealers within the group will be carrying some of the parts, like the fast moving parts. The carrying of slow moving parts will be divided between the parties. In this scenario all dealers will help each other by carrying some of the parts, meaning that the dealers become dependent of each other.

All groups created by the general model can use the second scenario, compared to the first one. The scenario can be applied to Large ownership groups, as well as for Independent dealers and Small ownerships. This setup will also avoid dealer to be able to hide parts from each other,

mainly due to the fact that by giving all the dealers within the group the responsibility, decreases the risks of dealers parasitizing other dealers within the same group if they are part of a Small ownership, since they will all be dependent of each other.

### 5.3.1 Challenges within the scenarios

As Braglia & Frosolini (2013) discussed the number of parties involved in inventory pooling will affect the possible savings that can be made from the concept. The more dealers participating in the concept the more money can be saved. But there are also risks that might come with too many parties involved, such as the risk of not being able to deliver within the decided time frame or the risk of creating high costs due to the need of trucks going to and from the different nodes. This creates a challenge when it comes to deciding how many nodes that should be grouped together. In the case study were all the Large ownerships are grouped together and to be able to apply the second scenario into these groups, some of the larger groups can be divided into small groups, which can be seen in figure 22 below.



Figure 22: Large ownership group divided into two smaller groups

This is suggested in order to be able to receive same day availability in the second scenario, since it's especially important that the number of nodes within the group isn't too big, since the spare parts will be divided between the dealers, and this can result in one dealer needing a part

both from dealer A and dealer B. It's also important to get dealers to understand the benefits that can be received with this scenario in order to get them to go from being competitors to being collaborators, as Kutanoglu (2008) described. Due to the fact that different ownerships are grouped together, this will create some challenges regarding the transaction, compared to if all the parties are within the same ownership since everything can be handled internally, which is a simpler procedure (Basu Bal, 2016). One way to solve this is to do it automatically, by the main company creating a credit note to the dealer sending the part and an invoice to the dealer that receives the part. This including that the main company buys the part back from the dealer and sells it to the other dealer, which includes some legal aspects that will be discussed below.

Before the scenarios can be implemented into groups, there are some legal aspects that need to be dealt with. To start with, the parties need to sign a contract between each other, which either can be done by signing a contract between all the parties involved or the main company creating a master contract that involves all the participants. By having dealers creating contracts between each other, there is a risk that different contracts are constructed – something that in the end can cause negative effect on inventory sharing and the main company will not be able to have control over the situation. In case of Volvo, it's recommended that Volvo creates a master contract with all dealers, due to the huge administration that other views would be needed if all dealers within a group should sign a contract with each other. By creating a master contract, Volvo either can add information to their already existing LPA contract or create a new one. By creating the contract, Volvo is receiving power that could be used in deciding that the dealer needs to sell the product to Volvo that in turn can sell it to the other dealer, which can be a challenge in this concept since this can affect the willingness to send parts from a dealer to another dealer. It should be noted that it can be a challenge when it comes to pricing of parts, which can affect the dealers' willingness to sell the part back to Volvo when needed, at the price quoted by Volvo.

Regarding the contract, there are also some other legal aspects that need to be considered depending on if the group is within the same country or not. Groups that exist within the same country rely on the same national law, while in the cross border group there can be more aspects concerning multiple national legislations that needs to be considered, (Basu Bal, 2016; OECD, 2013). Due to the fact that Sweden and Norway have a good relationship with each other, Volvo only needs to pay customs every time a truck cross the national border, but with today's technology this can be handled electronically – which reduces that administration costs. In other cases, if no trade agreement exists, and/or the legislation in the countries isn't harmonized and/or their national laws differ the sharing of inventory can be problematic (Basu Bal, 2016; OECD, 2013).

As Braglia & Frosolini (2013) discussed the parties participating in an inventory sharing concept also need to discuss how the costs should be divided between the parties. There are different ways that this could be done, either by dividing all the costs, such as transportation costs, holding inventory and the down-time costs, between all the participants, like Wong et al (2007) suggested. In interviews made within this study it have been discussed that Volvo should take the transportation costs, since this otherwise, will be an obstacle for the company to get the dealers onboard with the new concept. Regarding the handling costs, this is something that the dealer will need to take, as they already do today. But something that can be discussed is whether it should be included in the transportation costs taken by Volvo. For some dealers the holding costs will be higher, especially for those dealers that will act as a hub. That's another reason why the first scenario is recommended to dealers within larger ownership, since they can divide the costs between each other. Depending on how the steering of inventory will be in the end it doesn't necessarily mean that dealers adapting the second scenario have to get a higher holding costs, since they will divide the parts between each other. This is also something that needs to be seen in relation to how the availability will increase at the dealers and the costs they can save by quicker solving a problem and send a truck back on track.

To summarize, it can be stated that different challenges such as number of dealers within a group, transaction, cost allocation, transportation solutions and responsibility exist when creating groups with the purpose of sharing inventory by using one of the scenarios discussed above. This indicates that before this setup can be implemented, it's important for the main company and the participants to discuss and clearly state how everything should be solved and work in order to get this setup to work as efficient as possible.

### **5.3.2 Transportation network**

To be able to achieve same day availability it isn't just the groups and the scenarios that need to be implemented but also new transportation networks needs to be developed. As Easley & Kleinberg (2010) describes, a transportation network is a spatial network consisting of edges and nodes, which in this case are dealers and roads. As described in the current process, Volvo today uses different transportation networks depending on the order types. Regarding the stock order, there will be no changes since these orders will not be included in the inventory sharing. For the parts transferred with the D2D setup that will be collected within the new groups, new transportation networks will be implemented in order to achieve same day availability and increase the service at the dealers. Depending on the scenarios that are implemented to the groups, two transport solutions from the three described in the literature above are recommended as they suit the need:

For the first scenario, Single dealer level, it's recommended that this group uses a transportation network called hub and spoke. As O Ekárt et al (2011) describes, two types of hub and spoke network exists, single allocation or multiple allocation and as discussed above both are recommended for this scenario, depending on the number of dealers within a group, due to the possibility to achieve same day availability but also due to the environmental aspects. Even if the hub-and-spoke network is not seen as the most environmental friendly and sustainable network, traffic congestions, air pollution and noise problem can be reduced by having a smaller number of spokes within the network, which is the reason why it's recommended that Larger ownerships, like the red group in Sweden, uses multiple hubs and by that reduce the effect on the environment. By using this transportation network, a symmetric relationship between the nodes exist, meaning that the nodes will go from the hub to the dealer and back, which can be referred to as an undirected graph (Easley & Kleinberg, 2010). An asymmetric relationship can also be used in this network, by applying a milk run as a transport solution, but to be able to do this the groups need to have less number of dealers compared to a group that uses hub and spoke. If a Large ownership group wants to use milk run, it's recommended that the group is divided into smaller groups with multiple hubs (Easley & Kleinberg, 2010).

For the second scenario, Group level, where all dealers carry some of the divided parts, it's recommended that a milk run is used as the transportation network. This implies that a truck starts at one point in the network and goes to all the other points. It also involves that the dealers that use this kind of network, need to stick to some cut off times in order to achieve the spare part the same day. Something that could be seen as a problem, but due to the fact that dealers today already are used to cut of times, this problem is consider to be small, and as Sadja et al, (2009) describes, the milk run can be modeled according to the situation, which indicates that the taxi/van/truck can start from different points each day, as well as skip some stops if it's not needed, which indicates that the system is flexible and it's suitable for some of the groups. For Volvo, milk run is a good transportation network to be used, due to the fact that it can reduce both travel time and fuel consumption (Brar & Saini, 2011).

In case of an emergency, when the cut of time in the milk run network has passed or if no truck is available from the hub, one solution is to order a taxi. This is something that both Volvo and the dealers use today. It's more expensive, but it needs to be related to the time it can save, the stand still costs that affect the company and the service they can provide to the end customer. As well as the fact that with the new groups and scenarios, the part will be maximum three and a half hours away.

### 5.3.3 New dealer order process

The current dealer processes are more of a pull type process performed by the dealers. The reason it's a pull type process is because the dealers order only in case of emergencies when the part is not available in their stock (Ramachandran et al, 2002). The stock orders are different from this type of ordering process as they are pushed to the dealer's inventory based on their EOQ. By adapting the new scenarios, the dealer order process, will still be a pull type of process when it comes day orders and VOR, but the step in the process will be reduced from five to three steps, which can be seen in the Figure 23 below.

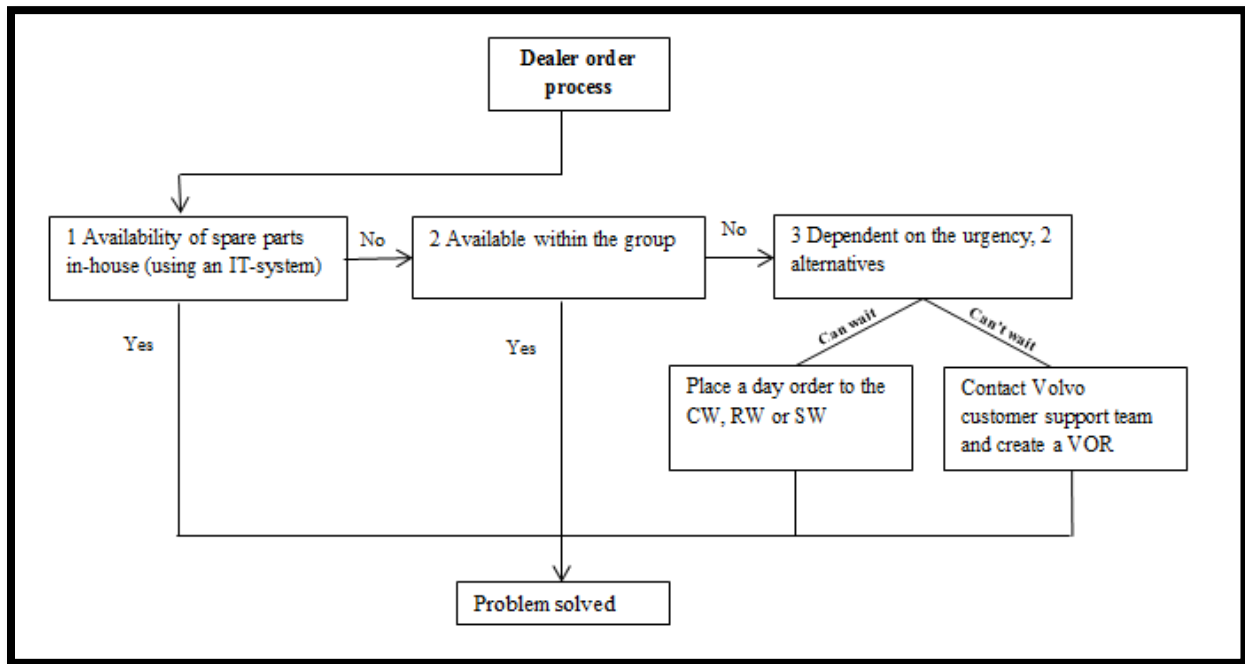


Figure 23: New dealer order process

The first step is, as in the old process, a basic step of locating the required parts within the dealer's stock itself before proceeding to the next steps. This step is carried out with the help of an IT system which should be a common system for all the dealers within the group. In the case when no common IT system exists, it's this a matter of legal requirements that need to be handle before the setup of inventory sharing can exists, since it's about company information that will be transferred (Basu Bal, 2016).

The second step is that instead of searching for the parts in one of the three types of warehouses located close to the market, is to search of the part within the new group. If the part is available the dealer can order the part from the other dealer. As mentioned above the

transportation and transaction in this case will be handled by Volvo, meaning that the dealer only is responsible for sending the part. By Volvo taking care of the transaction, the dealer that search for the part can buy it from Volvo to the purchasing price. This is a way of how the cost allocation issue, as discussed by Wong et al (2007) can be solved, in the inventory sharing setup. By collecting the part from a dealer within the same group, will the service the dealer can offer the end customer be improved, while Volvo will save money due to the reduction in transportation cost.

The last step within the new scenario is that if the part is not available within the dealer's own warehouse or within the group, they should contact Volvo. The dealer can either create a day order, if not too urgent or a VOR. In the case of a VOR or a back order recovery, Volvo has the opportunity to now act faster since they now can exclude other dealers that are closely located to the dealer, since they already know that they dealer has searched within the group for the part. Today Volvo doesn't have information on whether the dealer has searched for the part or not, which results in extra lead time.

#### **5.4 Impact on availability after grouping dealers**

The table below shows how the availability differs after using the grouping model for this case study, of Sweden and Norway. It also shows the impacts from the regional and central warehouse and the support warehouse in terms of availability and transportation. The availability scenario for one week for the red dealer group, in the case study, was taken as a sample and was analyzed to see what percentage of these emergency orders that can be solved from the grouping process. The data was calculated by using the formula presented by Jonsson & Mattsson (2009).



**Table 4:** Availability differences after using the grouping model on one group located in Sweden

Week 15 VOR/ Day orders availability in the group			
Warehouse	Red Group	Formula	Result
	% of VOR /Day orders can be solved within the group	(No. Of VOR/Day orders solved in the group)/ (Total number of VOR/ Day orders from the group)*100	77%
	% of VOR /Day orders cannot be solved within the group	(No. Of VOR/Day cannot be solved in the group)/ (Total number of VOR/ Day orders from the group)*100	23%
Regional Warehouse Impact	% of VOR /Day orders can be solved within the group	(No. Of VOR/Day orders solved in the group)/ (Total number of VOR/ Day orders solved by regional warehouse)*100	79%
	% of VOR /Day orders cannot be solved within the group	(No. Of VOR/Day orders cannot be solved in the group)/ (Total number of VOR/ Day orders solved by regional warehouse)*100	21%
Central Warehouse Impact	% of VOR /Day orders can be solved within the group	(No. Of VOR/Day orders solved in the group)/ (Total number of VOR/ Day orders solved by central warehouse)*100	57%
	% of VOR /Day orders cannot be solved within the group	(No. Of VOR/Day orders cannot be solved in the group)/ (Total number of VOR/ Day orders solved by support warehouse)*100	43%

In the case of the red group, the total number of VOR and day orders for one week was calculated at the end of the week. These emergency orders were then checked for availability within the red dealer group. To exemplify this better, it can be explained with the help of an example of a part number XYZ, which was a VOR in dealer A belonging to the red group. The availability of this part was then checked in the stock balance from the previous week for the red group as a whole. If the part was available then it meant that the group itself could solve the VOR and if the part wasn't available within the group then a VOR or a day order would be placed. The table shows this percentage of VOR and day orders of the total emergency orders, which cannot be solved, from the group and therefore a VOR or day order has to be placed. In a similar way this method was used to check for all the VOR and day orders and the percentage of availability and unavailability is listed above.

The impact this grouping makes to the parts sourced from the central and support warehouse is also shown above. From this impact it can be seen how the transportation will be impacted as well. To exemplify this better; 57% from the total emergency orders placed at the central warehouse are seen to be available in the red group which can be seen in the table above. This therefore indicates that 57% of the transports from the central warehouse can be reduced which is mainly air transport. This reduction will also therefore reduce 57% of the transport costs for orders placed by the red group individually and not when part of a group. By being in a group the transportation cost will reduce as the parts then need to be sourced from within the group

which will use road transport. The data shows the high availability that can be achieved by grouping the dealers together in a group. From this data it can also be noted that this grouping process will or does not solve all the VOR and day orders but will reduce these emergency orders from the warehouses and in turn solve them within the groups created. Emergency orders will still take place but the percentage of these emergency orders that needs to be solved from outside the group will be much less, thereby reducing the overall management costs as suggested by Kutanoglu, (2008). The grouping process is described as a strategic advantage that can be used by the companies. This data also shows the percentage of orders sourced both from the regional and central warehouse. From this data two things can be analyzed. The first thing that can be seen from this is the difference in the percentage of orders that originate from both these types of warehouses. It shows that most of these emergency orders can be solved by the regional warehouse and therefore the remaining of only 21% of the orders need to be sourced from outside the group. Moving to the orders which were solved by the central warehouse, 57% of those orders were available within the red group. These figures also indicate what percentage of transport could have been avoided and in turn be sourced from dealers which are closer to each other. As we know from the current scenario, the mode of transport used for these emergency requirements are express transports such as by air or by expensive road transports which are customized as per the requirement. These lead to huge costs in delivering the parts which can be avoided by grouping dealers and having faster and cheaper transport setups.

The second table, table 5, shows the current counter availability and new availability for one big group. From the figures presented in the table it can be seen and confirmed that there will be a rise in availability for bigger ownership groups even with the same over the counter availability of parts as it is today.

**Table 5:** The current and new availability for one large group in Sweden

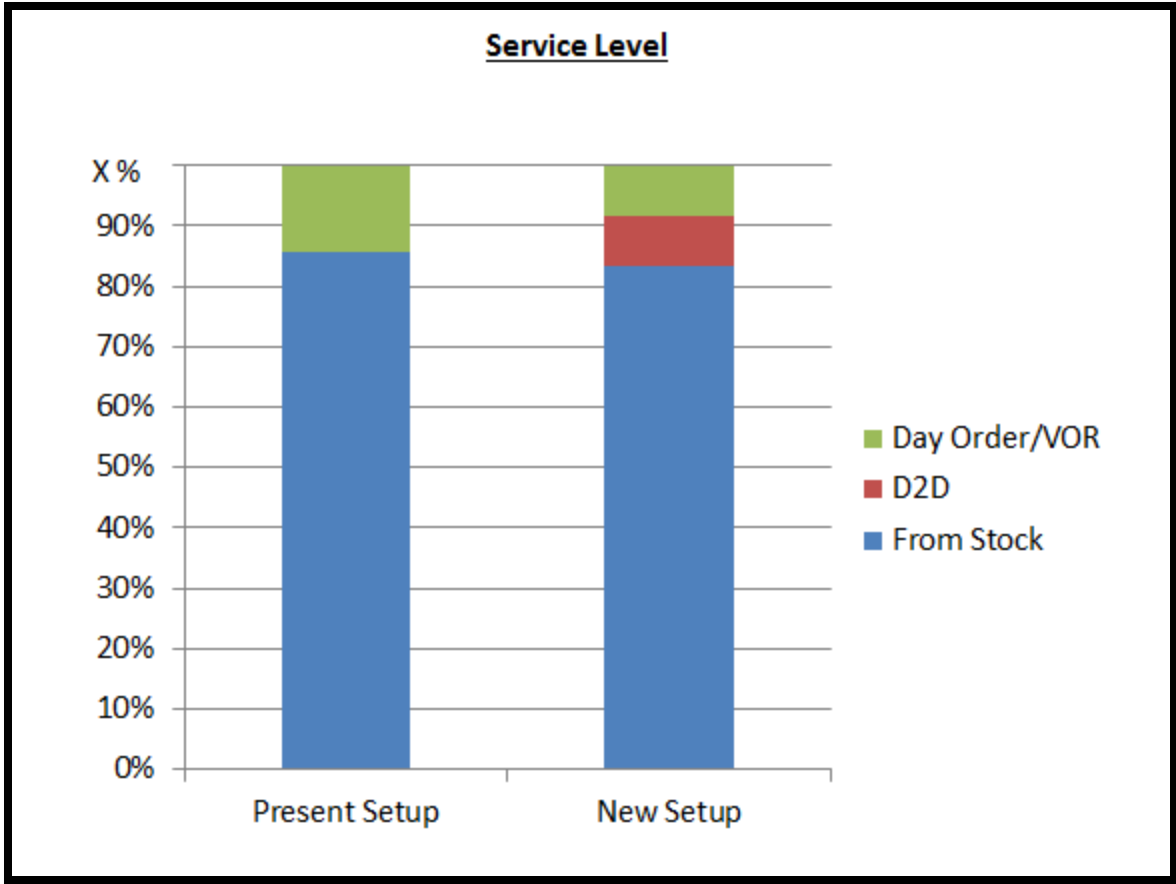
Dealer Group	Dealers in the group	Current counter availability	New availability (Group)
Red Group	19	91,7	96,09

The increase in the availability of emergency parts by merely grouping the dealers while still keeping the same service level at the dealers can be seen from the table above. This clearly shows the increase in the availability by using the D2D setup.

## 6 Conclusion

Having a high uptime service for vehicles is an important aspect for companies within the manufacturing industry where aftermarket services are offered. High uptime of vehicles can only be achieved by having an efficient availability solution for spare parts. This type of service is provided by the company dealers who are the company's face to the end customers. It increases the importance of improving the availability at the different dealer locations. A challenge that companies like Volvo Group always works with in order to improve the service towards their end customers. This study's main focus is on how availability can be improved for a company, like Volvo Group, and how same day availability can be improved and achieved. In order to succeed with this, a general model has been developed which includes a number of steps that should be followed in order to create groups. These groups that can be related to clusters, that are grouped together in order to help each other out in case of an emergencies by being close to each other, in Volvo's case, a maximum of four hours away. This means that from a management perspective companies can improve their same day availability by following all the steps in the model, creating groups that in a later step adapt the concept of inventory pooling.

In order to achieve same day availability at dealers for a manufacturing company, there are other aspects besides grouping dealers together, which include the logistical aspects that need to be taken into consideration. To start with, for a manufacturing company to have same day availability it is recommended that the company implements inventory pooling, meaning that dealers within the group should be able to share inventory. Before this can be done, there exist some challenges that needs to be discussed and concluded by different parts, including the main company and the dealers, such as legal aspects, transaction, pick and pack of parts and transportation solution in order to avoid any future conflicts. In this study, two scenarios have been developed in order to enable part sharing between dealers. The first scenario, called Single dealer level, is based on the fact that one node within a group should act as a hub, carrying parts for the other dealers in the group. To be able to succeed within this it is recommended that a hub and spoke network is used as a transport solution, or if the group can be divided into smaller groups or if multiple hubs are used, then a milk run can also be applied. The second scenario, called the Group level, is based on the concept that the slow moving or exotic parts range is equally distributed among all the dealers in the group. To be able to have same day availability it is recommended that a milk run is used as the transportation network.



**Figure 24:** The present and the new setup

As can be seen in figure 24 above where X% depicts the total end customer demand, the percentage difference in VOR/day orders is a comparative difference, which can be seen between the two setups. D2D setup covers a part of the emergency orders today which can also be seen from the graph above. By using the D2D concept, different groups can be created that could apply one of the scenarios together with a transport solution, which will improve the same day availability both from a management and logistical point of view, which is presented in the study. From this concept, transportation costs as well as the impact from unwanted transport can also be reduced on the environment. As Volvo Group is known for its contribution towards sustainability, this process will add to the company's endeavor in being an environmental friendly company by reducing the impact it causes from the services it provides.

## **6.1 Recommendation**

After conducting this study, it's recommended that Volvo Group uses the general model to create groups with the purpose of improving the same day availability of spare parts to their dealers. By using the model, depending on the structure of the markets, different groups will be created that can apply either of the scenarios. Depending on the construction of the groups, together with one of the scenarios and with one of the recommended transport solutions, the company's availability as well as service will increase in turn reducing the transportation costs.

Regarding the different challenges that exist within the company, it's recommended from a legal aspect that Volvo creates a master contract, in order to have control over the situation and also the possibility to have the same contract with all groups. It's also recommended that Volvo takes care of the transactions for the parts, by buying back the parts and selling them to the dealers, while the transportation goes from one dealer to another. By using this method, Volvo can decide the price that the dealer pays and by that problems regarding unfair treatment can be avoided.

Regarding the transportation, it's recommended that Volvo takes care of the transportation which means that they arrange and pay for the transportation. This is due to the fact, which has been presented earlier, that will increase the chances of a dealer's participation in the D2D concept. Another reason why this is suggested as a recommendation is because Volvo today already takes care of the transportation, which is expensive due to express transport solutions used. This can be replaced by Volvo taking care of transportation between dealers, which are four hours away from each other and also at shorter distances. It also is better for the environment since the air transport, with this set up will be reduced.

## **6.2 Limitations**

The general model developed in the study has been developed from literature and current research. While it is possible to implement the suggested grouping model for Volvo, the general model outlines the method, however there can be limitations to when and where it can be implemented. Creating groups that involves dealers in different nations may be harder due to political and legal aspects, as well as cultural and infrastructural aspects. Another limitation in the study is that the calculation that showed the improved availability was only done on one dealer group in the case study. However, it's reasonable to assume that grouping dealer based on the general model will improve the availability.

### **6.3 Future study**

This study has focused on how the availability of spare parts at dealers can be improved by grouping dealers together. In the study only one case study has been conducted and for future studies, it would be interesting to see how the model can be applied to other markets and companies. It would also be interesting to see in the future, if a new technology can improve the two scenarios that have been developed, together with the two transportation solutions that have been presented.

In future studies, it would also be a good idea to use telematics for better management of parts distribution between dealers. It is believed that telematics can completely reduce emergency orders as the company or the dealerships will get information of the part that will be required prior to its requirement which will allow proper planning to solve such cases. It will also be interesting to study the possibility of using 3D printing for the aftermarket services, which can reduce the unwanted transports and in turn solve the emergencies on site.

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## Appendix 1

<b>Position</b>	<b>Located:</b>	<b>Type of interview:</b>	<b>Interview date:</b>
Retail Logistics Manager	Thailand	Skype	11-jan
Vice President Legal & Compliance	Sweden (Gothenburg)	Face-to-Face	11-jan
Theoretical optimization Specialist	Sweden (Gothenburg)	Face-to-Face	19-jan
Dealer Inventory Manager EMA & Volvo Penta	Sweden (Gothenburg)	Face-to-Face	25-jan
Logistic Manager	Sweden (Gothenburg)	Face-to-Face	25-jan
Project Manager	France	Skype	27-jan
Manager, Dealer Inventory Management North America	USA	Skype	29-jan
SOI Key User, Global Logistics, Volvo Construction Equipment	Sweden (Eskilstuna)	Face-to-Face	29-jan
Manager Transportation Network Optimization	Sweden (Gothenburg)	Face-to-Face	29-jan
Manager DIM & Refill Europe South	France	Skype	03-feb
Process & Solution Implementation Manager	Sweden (Gothenburg)	Face-to-Face	03-feb
Act Dealer Inventory Manager Europe North & Dealer inventory manager	Sweden (Gothenburg)	Face-to-Face	05-feb
Dealer inventory Manager, Volvo Construction Equipment	Sweden (Eskilstuna)	Face-to-Face	05-feb
Manager Business Control & Operations	Sweden (Gothenburg)	Face-to-Face	08-feb
Dealer Inventory Manager	Dubai	Skype	08-feb
Manager European Service Centre Nordic	Sweden (Gothenburg)	Face-to-Face	09-feb
Manager Backroder recovery	Gent	Skype	09-feb
Transport Developer	Sweden (Gothenburg)	Face-to-Face	08-mar
Transport Developer Manager Logistic Support	Sweden (Eskilstuna)	Skype	11-mar
Director Operational Development	Sweden (Gothenburg)	Face-to-Face	18-mar
Project buyer	Sweden (Gothenburg)	Face-to-Face	08-apr
Assistant professor Maritime and Commercial Law at The School of Business Economics and Laws	Sweden (Gothenburg)	Face-to-Face	12-apr
Director	Sweden (Gothenburg)	Face-to-Face	19-apr
Inventory Manager	Sweden (Gothenburg)	Face-to-Face	11-mar
Director European Aftermarket support	Sweden (Gothenburg)	Face-to-Face	14-apr