Automotive Route Optimization for a Logistics Service Provider

Pre-study for Route Planning and Optimization Software Investment

Master's Thesis in the Master's Programme
Quality and Operations Management
Supply Chain Management

ALDIN AVDIC
ZHENGYANG XIANG

Department of Technology Management and Economics
Division of Service Management and Logistics
CHALMERS UNIVERSITY OF TECHNOLOGY
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ALDIN AVDIC
ZHENGYANG XIANG

Tutor, Chalmers: Gunnar Stefansson
Tutor, Company: Patrick Magnusson

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Chalmers University of Technology

SE-412 96 Gothenburg, Sweden
Telephone: + 46 (0)31-772 1000

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ABSTRACT

Due to the fast development of the global market, the Swedish automotive logistics industry has experienced tough competition and price pressure in recent years. In this case, the end customers including both single customers as well as different car brands or wholesalers are asking for a whole solution provider through the whole value chain. With the background of this, the Swedish biggest vehicle logistic provider with over 90% of market share, Nordic Car Logistic (NCL), is moving forward with the aim to be a 4PL in this industry step by step. In order to doing so, a suggestion on the route and load planning system implementation is made for Autolink, a subsidiary of the NCL-brand which focuses on the vehicle distribution to the end customers all around the Sweden.

By combining theoretical findings within route planning, customer relationship management and information and communication technology, it was possible to identify a model based on literatures that contains the potential factors which influence the actual route and load planning in Autolink. Several case studies were done in order to clarify the potential benefits with the use of a route and load planning system within different industries. Moreover, with the chosen interviews of respondents from different organizations including Autolink, customers and hauliers, different demands or requirements from different points of perspective including managers, planners, customers etc. were collected and concentrated into the final evaluation criteria which includes five main groups with 22 sub-features in the software benchmarking model as the last part of this report. Therefore, based on the criteria identified, one software providers were stand out in most of the five categories among all the three softwares and was chosen as the final recommendation of the potential route planning system investigation.

Furthermore, four interesting points that is found during the study were discussed in the last chapter including total transportation solution, capacity issues, centralized or decentralized route planning and the future trend which were beyond the scope of this study. These areas were believed as the fields that worth Autolink looking into as the next step after the route planning system implementation toward the road to be a 4PL or a whole solution provider in the vehicles logistics industry.

Keywords: route planning system, information and communication technology, customer relationship management, vehicle industry

Abbreviations

AL: Autolink
CB: Car Brand
CIC: Centralized Information Control
CMS: Compound Management System
CRM: Customer Relationship Management
CTM: Collaborative Transportation Management
CVRP: Capacitated Vehicle Routing Problem
DCVs: Destination Coded Vehicles
DM: Distribution Manager
EDI: Electronic Data Interface
ERP: Enterprise Resource Planning
ETA: Estimated Time of Arrival
FMS: Fleet Management System
FTL: Full Truck Load
ICT: Information and Communication Technology
IoT: Internet of Things
IT: Information Technology
ITS: Intelligent Transportation Systems
IVC: Inter-Vehicular Communication
LSP: Logistics Service Provider
NCL: Nordic Car Logistics
PDI: Pre-delivery Inspection
RPS: Route Planning System
SCM: Supply Chain Management
SKT: Skandia Transport
SMT: Scandinavian Motortransport
SP: Software Provider
SVRP: Stochastic Vehicle Routing Problem
TDM: Transportation Demand Planning
TM: Transport Manager
TMS: Transport Management System
TP: Transport Planner
TTEA: Trip Time Estimation Agent
VDS: Vehicle Distribution System
VIN: Vehicle Identification Number
VRP: Vehicle Routing Problem
VRPTW: Vehicle Routing Problem with Time Windows
3PL: Third-party Logistics
4PL: Fourth-party Logistics

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1. Introduction

The Swedish automotive logistics industry has in recent years been characterized by tough competition and price pressure (Business Sweden, 2016). Meanwhile, customers are showing an increased interest in functional solutions that have more or less forced companies to compete in supply chains (Agrawal et.al, 2015). In order to create successful business, companies now have to come together and create value for customers.

According to Autolink (2017), the Swedish automotive logistics industry is a rather underdeveloped one. It is heavily influenced by older business models and ways of working. Therefore, it is not uncommon for the Swedish automotive logistics industry is subjected to several delays, capacity issues and overly costed services. The European Commission (EC) (2011) clearly states the importance of transportation in today's society and economy, highlighting how future transportation should be developed in a more efficient manner. To overcome issues and move towards a more efficient transportation flow, companies are constantly trying to find advantages to improve their flow of goods.

Furthermore, the EC (2011) has in recent years concluded that the Swedish transportation market is moving from road to rail, even though road makes up roughly 62% of the transportation made within the country (EC, 2011). On the other hand, the Swedish Transportation Administration state that Swedish railways suffer from capacity problems on several lines. The same phenomena have been experienced by Autolink and its business partners, whereas even the road transportations are suffering from capacity problems and inefficient vehicle transportation flows (Autolink, 2017). The EC (2012) has also predicted an increase in transportation services needed in the future along with the GDP. This is considered to be a hard-managed demand increase according to Autolink (2017) and the Swedish Transportation Administration (2012) since the increase in demand cannot be argued from a socio-economic point of view. As a result, logistics service provider companies are doing everything in their power to continuously find more efficient solutions and ways to overcome potential problems, while conducting business in a rather underdeveloped market. While this is true, Autolink (2017) is adamant that the potential for improvement is huge and that there are plenty undiscovered areas which have not been tapped into.

Such trends have in recent time affected the Swedish automotive industry, more specifically the logistics activities of importing vehicles (Skandiatransport, 2016). The continuous increase in GDP has resulted in monthly increases in vehicle purchases. Skandiatransport (SKT), Autolink (AL) and Scandinavian Motortransport (SMT) are companies who provides such logistics services. Everything from unloading the cars, inspection and delivery to car dealerships is covered by their service offerings. Once competing firms has now evolved into a joined venture due to changing market demands and high competitiveness, owned by Nordic Car Logistics (NCL).

The joined venture NCL’s organization structure is primarily structured through Scandector and Autolink Group, where both groups have an equal 50% share. As shown in figure 1.1, Scandector consist of SKT and SMT, where SKT offers customized vehicle management and pre-delivery inspections to general agents and dealers of new imports vehicles based on the four ports around the Sweden and SMT provides logistics solutions for inland distribution for general agents and dealers of new and used vehicles in Sweden and Denmark. Autolink, as another part of the jointed venture, have almost the same functions as Scandector but with the focus on the Swedish and Norwegian market. The NCL-brand as a whole is able to offer pre-delivery inspections, storage opportunities, workshop services and transportation services to newly imported cars from all over the world.

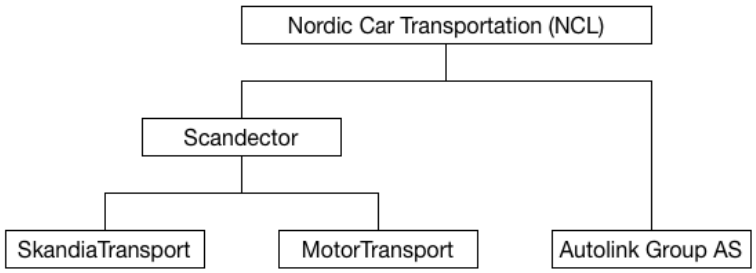

Figure 1.1 - Company Structure

Below in Figure 1.2 is a simplified figure of how the NCL-brand is integrated to the automotive supply chain. Depending on where the producing car brand is located geographically, the supply chain can look differently. The idea is that both SKT, Autolink and SMT can supply the dealerships with the right cars, in the best possible quality within a certain time limit in order to satisfy the end customer.

Figure 1.2 - NCL Supply Chain Scope

The firms have realized synergistic benefits in cooperating as one brand. As a result, the ventures have identified a series of issues, mainly within their cargo planning and route optimization processes. Currently, cars are not being sent in full truckloads and there are delays during deliveries (SKT, 2016) (LM, 2017). In addition, as LM (2017) states, Autolink and the NCL-brand are also facing potential issues such as; increase in the distribution volume, shortage of truck drivers, increased customer base while also being affected by lead time and capacity requirements. Consequently, this has led to negativity towards the current structure of their system and customer dissatisfaction which increase the workload and reduce the working efficiency at the same time.

Instead of outsourcing this function to a third-party logistics (3PL) company, Autolink prefers to integrate the function into their own system. LM concludes the reason of this decision is based on two points of consideration: First, this operation can help the company to gain more freedom and it is easier to control the situation. For example, when facing an increased distribution volume, with a build-in system, Autolink can force the department to delivery instead of asking for the approval from a 3PL provider. While the second reason is due to the better cooperation between the inner company inside of NCL and enable them to work as a whole service provider (one-station service).

Constructing schemes and plans for optimized routes has become a task for companies in the field of transportation in order service the customers in the best way (Berhan et.al, 2014). It is commonly referred as a problem, defined as the vehicle routing problem (VRP), due to its complex nature of designing optimized routes for transportation. Such issues have been affecting Autolink whereas they don't feel in complete control of their route planning of vehicles (LM, 2017).

Currently, Autolink is handling over 90% of car imports made to Sweden from their ports in Gothenburg, Halmstad, Malmö and Södertälje. This is executed manually through a spreadsheet that has to be managed continuously in a complex manner. The company has identified that the desired way to work is with a system that is able to automatically compute optimized paths depending on certain characteristic and parameters to simplify the workflow and transportation planning.

1.1 Aim

With the issues stated above, the aim of this thesis report is to find a way to improve the current route planning operations of Autolink based on their needs and market demands.

1.2 Purpose

The intended purpose is to address the issues Autolink has with their current route planning methods and potentially improve their operations. It is the interest of the company to identify which set of parameters and characteristics that influence route planning and optimization based on market preferences and customer offerings (LM, 2017). Furthermore, the report has the purpose of establishing sufficient information to make a decision regarding a potential IT-software investment that seeks to improve the planning process for Autolink.

1.3 Research Questions

In order to address the issues Autolink has with their current route planning methods and potentially improve their operations, different elements which have impact on their route planning should be taken into account. Some factors can be found in previous studies, but there is still a need to go for another direction to find specific parameters or characteristics which align with Autolinks current logistic situation. The following research questions have been formed to be answered in the end of the thesis report and to follow the aim:

- *What requirements have an impact on the planning and optimization of routes and cargo for Autolink?*

To successfully gather the complete set of data, the needs and requirements of customers is also important. Customers also impose needs on Autolink and it is therefore the objective of this thesis report to also gather data from customers to get overview of how the network looks like and operates while at the same time satisfying the customers. The following question will therefore be answered:

- *In terms of customer requirements, which needs do they impose on the route planning and how does it affect Autolink?*

As required by the company, the result of this degree project will be a basis for a future investment made in a software. This will not only help them with the current route planning and optimization but also could help Autolink in face of the increasing demand by the customer side like more detailed delivery time windows instead of a time limit etc. Since the software has not being implemented yet, the question below should be solved:

- *How does a software implementation benefit Autolink to improve their planning process? And which kind of solution is most suitable for Autolink?*

1.4 Limitations

The thesis report will solely put focus information that is beneficial for a future software investment decision. This means that report will not cover the actual implementation or execution of the software. Furthermore, the report does not aim to find a solution to any theoretical hypothesis or model concerning route planning or optimization.

As mentioned previously, the whole chain of the business process of the jointed venture is ranging from the car arrival in ports until the vehicles are delivered to the customers including several steps as shown in Figure 1.3.

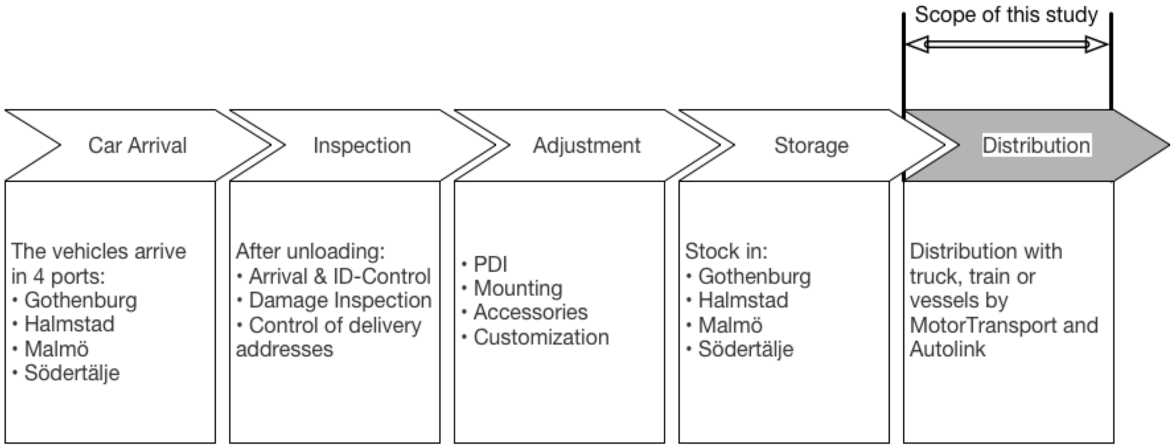

Figure 1.3 - Scope of this Study

Since the report is going to put the main focus on the route planning operations, other areas of business like pre-delivery inspection (PDI) etc. will not be of concern and only the distribution phase will be taken into the scope of this thesis work. Even if the route planning is affected by other elements of the business, they will not be covered in detail. In addition, this means that only truck transportation on Swedish roads will be focused on, whereas other transportation modes like railway and vessels will be disregarded.

Besides these, the final benchmarking model is rated by the researchers of this study. Since the study in the company may influence the researchers to rate different software providers based on their personal judgement or wrong rating due to the unbalance available information of each provider, the rating can be seemed as bias and may lead to a defective result.

2. Method

This section describes the method of how the master thesis team plan to collect and analyse data in order to fulfil the purpose of master thesis as discussed above. Furthermore, the chapter intends to show how the work is going to be executed and which sources of information that will be used

2.1 Research Strategy

Bryman & Bell (2015) state the research strategy is very important because it gives writers a general direction to conduct the business research. The qualitative research strategy is chosen to collect and analyse the empirical data both from Autolink and their customers because the fundamental information regarding the current logistic situation will put more focus on the interview of people from different department levels within Autolink. As concluded by Bryman & Bell (2015), qualitative research usually emphasizes on words rather than numbers in the data collection. However, quantitative data collection will also be done through the thesis project. Data such as and load of the different trucks that the company already have, dealers' locations and needs etc. will be collected in the beginning to support the further research.

According to Bryman & Bell (2015), the abductive research approach is more suitable to use in this study. This means the existing theory and empirical data in the master thesis will be used in an interactive process to develop theory (route planning). Since this problem starts with a puzzle, it will involve back-and-forth engagement with the social world as an empirical source for theoretical ideas which aims to find the most appropriate way for Autolink to optimize route planning as well as for their future software investment.

2.2 Literature review

The secondary data that is intended to be used for this thesis report will serve as a theoretical framework when analysing the findings. Topics that intend to be covered in the report will be based on customer relationship management (CRM), information technology (IT) and route planning and optimization.

Such data is going to be collected through the Summon 2 engine which is implemented on the University of Chalmers library webpage and Google Scholar search engine as both engines are well suited to find literature. Furthermore, additional secondary data will be collected from the firm webpages if deemed relevant to the thesis project. The aim is also to utilize external expertise from professionals if possible. This suggests that the thesis report might include other external sources of information through interviews with experts in the subject fields.

2.3 Empirical Study

The thesis report aims to provide primary data from Autolink and their customers in order to conduct a proper analysis. One way to do this is to perform interviews with involved parties. According to Kvale (1996), there are three different ways of performing interviews; structured, semi-structured and unstructured.

2.3.1 Choice of interviewees

To make sure that there is enough primary data collected to make a sufficient analysis, different stakeholders and employees will be interviewed so that a broad range of information and preferences are gathered. The choice of interviewees will therefore be based on which connection they have to Autolink, where a close connection is most preferable. Which entities to interview, as of now, will be presented below.

- **Employees and executives in Autolink** - In order to get a proper analysis of how the system currently operates and functions it will be most beneficial to interview the people who work in the system on a daily basis. In addition, different departments of Autolink will also be considered, such as; marketing and administration.

- **Customers** - It is important to capture the needs and desires of customers in order to create something that is also connected to their operations and processes. Examples of customers in this case would be; car brands, car dealerships and hauliers.

- **Partners** - Since Autolink is working closely with SKT and SMT input from their end would also be beneficial to determine how work is carried out and which preferences they ask for. While it is also important to take the hauliers into consideration since the trucks and drivers are under their management.

- **Suppliers** - Additional contact will be kept up with the many software providers to determine their service offerings.

2.3.2 Interviewing technique

As mentioned in the beginning of the chapter, there are certain ways of conducting interviews according to Kvale (1996). The aim is to utilize a semi structured interview methodology in a way that questions are prepared in beforehand for each interview while giving the interviewee the freedom to expand their answers into relevant topics which might not have been considered at first.

It is deemed necessary to have some prepared questions according to Kvale (1996) as conducting fewer interviews with a focus on quality often receive better results. Therefore, a large emphasis is going to be put on asking questions that are relevant for each specific interview. This means that the questions will be based on literature that has been read in beforehand while focusing on gathering information to answer the research questions. The aim is also to conduct an interview where their goal is to create a friendly a non-judgmental communication in order to reach common understanding and allowing the interviewee to answer to its full potential. This suits well with the semi-structured approach of an interview while the interviewee is guiding the interview.

2.3.3 Observations

While conducting the empirical data collection the goal is also to successfully observe how Autolink works with their planning and administration of their transportation network. By observing, the aim is to find out how the planners work with dispatching vehicle transports and get an overview of the process.

2.3.4 Case Study

Besides the interviews and observation, several case studies will be investigated in order to show the potential influences that may be brought by the implementation of a route and load planning system. The results of the case studies can be seen as a reference in addition to the final recommendation from this study and help Autolink to facilitate the decision-making process.

2.3.5 Benchmarking

Additional data is going to be gathered on potential suppliers that can provide a software solution. In addition to holding interviews with the suppliers, a benchmarking comparison will be outlined to analyse the potential benefits and drawbacks of each supplier compared to others. The benchmarking is aimed at making the decision in the end whether the company should invest simpler by providing a straight comparison depending on specific preferences and needs.

The benchmarking model is used in this study with the aim to compare the different software providers and support the final software decision-making process. The benchmarking model is a representation of a similar benchmarking method used at Autolink. In this model, different software features are compared between the software providers. Furthermore, the authors of this report will connect the benchmarking model to the theoretical framework used in this thesis report in order to choose which features and functions to compare. To determine the result of the benchmark, a Likert scale from one to five will be used to rate each feature criteria. The rating is made by the researchers of this report with information obtained from the software providers website and proposal documents provided by Autolink.

2.3.6 Validation of data

In order to guarantee a high degree of quality and credibility, it is of high importance to validate the data that has been gathered. Validation can be done through checking with the respondents or firms if the data gathered is true and interpreted correctly (Denscombe, 2009).

Furthermore, the questions that are going to be asked and sent to participants might be biased towards the theory in the theoretical framework. This type of validation is deemed necessary since there are clear objectives towards gathering data which reflects the nature of the research carried out in the thesis report.

2.3.7 Ethical Considerations

Ethical issues are critical to be considered in business and management researches. Bryman & Bell (2015) state four ethical areas: harm to participants, lack of informed consent, invasion of privacy and deception.

To deal with these potential issues, researchers shall give a presentation of themselves and introduce the purpose and process including interviews and survey which may occur in the study. The companies and the interviewees whom involved in this study will also be asked if they are willing to show their name in the research and the security of piracy information should be granted. Permission of recording the interviews will also be obtained before the interviews and the participants will be noticed about their rights to refuse answering particular questions, review or modify their answers. Last but not least, researchers will make sure all the contents quoted from others are referenced to avoid plagiarism.

2.3.8 Presentation and analysis of data

The report aims to clearly present the data and empirical findings in a way that is satisfactory and simple for the intended readers to interpret. In a structured way, the data is going to presented in matrices that are based on the theoretical framework. In such way, the reader can easily find a connection to the theoretical framework and the empirical findings. The theoretical framework will further be used to analyse the data that has been retrieved while allowing flexibility in terms of company demands and requirements.

3. Theoretical Framework

In the following section of the report, the theoretical framework and secondary data is going to be presented. As mentioned in the previous chapters, the focus will be held on route planning, CRM and ICT in order to give proper theoretical backbone to the subject of this report.

3.1 Route Planning

Route planning is quickly becoming an increasing subject for logistics driven companies in order to maximize their transportation performance and profitability (Wang. X., Kopfer. H, 2013). Logistics service providers (LSP) are becoming more aware of methods that concern taking shipments from point A to B in the most efficient way depending on certain constraints derived from the demands of the markets, customers and other influences (Berhan E. et. al., 2014). Consequently, route planning is set to achieve certain goals - which is to find routes or set of routes that aim to fulfill the demands of customers in the fastest and most cost-efficient way possible. However, with the amount of constraints and requirements that are imposed onto a route planning system (RPS), such as; time, distance, capacity, road conditions and others, it becomes increasingly complex to manage the systems. Denos C. et. al. (1997) argues that drivers and planners plan and select their routes depending on both unknown and known data. The more data that is known, the better decision can be made when planning optimal routes. In addition, Selamat. A et. al. (2013) discusses how such data can be obtained and coordinated by different agents in order to compute a real estimation on the actual travel time.

3.1.1 The Vehicle Routing Problem

The complexity of route planning is referred to as a problem called Vehicle Routing Problem (VRP) (Kumar. S. N., Panneerselvam. R, 2012; Berhan. E et. al., 2014). Being connected to route planning, the VRP is defined by designing optimal routes for vehicles that aim to fulfill the demands of certain customers under the influence of constraints, as mentioned before. Such designs are constructed in a way where the solutions consist of certain routes that both start and end at a given destination, whereas each customer in the design is visited once by one vehicle without the demand exceeding the capacity of the vehicle while the total cost for the trip is minimized (Berhan. E et. al, 2014).

To properly display the problem, it could be better described as a network consisting of nodes connected by lines. In route planning scenarios, the nodes are customer destinations and depots, while the lines represent the roads between the nodes (Berhan. E et. al, 2014). Each road is affected by certain parameters and constraints that are either known or unknown, which will be described later in the chapter. From a central unit or depot, vehicles with certain limitations are dispatched on the roads to fulfill the customer demands at each customer destination (Berhan. E et. al, 2014). As mentioned before, the objective becomes to gather all the roads into a optimal route, which considers certain elements and constraints, for the vehicles to complete at the lowest cost possible. The Figure 3.1 below shows a simple visualization of how the network first looks like and then how a possible solution might look like.

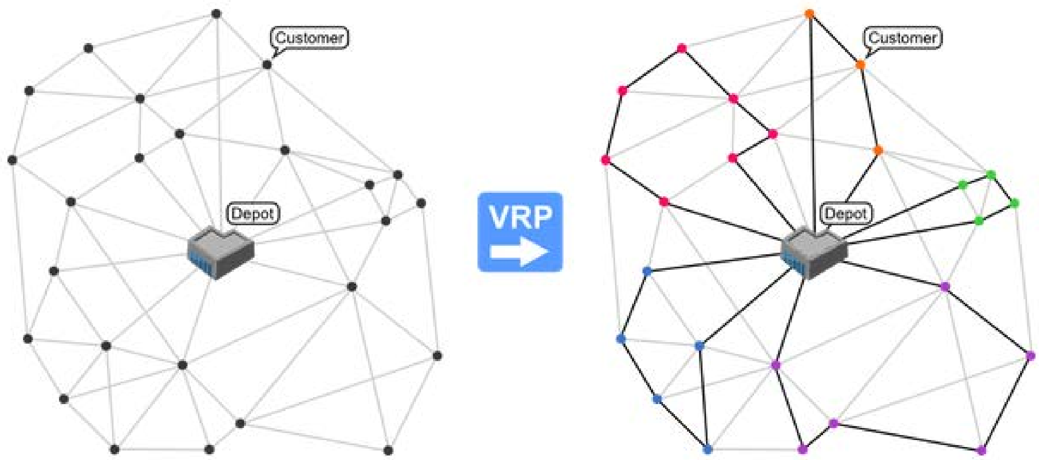

Figure 3.1 - Visualization of the vehicle routing problem

3.1.2 Stochastic VRP (SVRP)

As mentioned before, much of the complexity that arises in VRP and RPS are the parameters that are unknown or random and too complex to manage (Denos. C et. al., 1997). When such data and parameters become random to handle, they are stochastic in nature. The idea and desired outcome is to manage the random data to the point that SVRP can be optimized (Berhan. E et. al., 2014). When a high portion of the data is random it becomes increasingly difficult to create systems that fulfil all constraints (NEO, 2013). According to Networking and Emerging Optimization (NEO, 2013) there are three common SVRP mentioned, such as;

- Stochastic customers - where customer locations are random
- Stochastic demand - where customer demand is random
- Stochastic time - where both service times and delivery times are random.

In the end, the objective of solving SVRP becomes to minimize the fleet time or travel time necessary to supply each customer according to their needs and requirements in the best way possible (NEO, 2013).

3.1.3 Route Planning System

To effectively manage the different constraints, parameters and data that affect the network, route planning systems (RPS) are implemented. Such systems make use of data and information to determine optimal routes and later communicate the decision to the vehicles (Denos. C et. al., 1997). The aim with RPS's is to determine optimal vehicles routes based on the data fed into the system. Consequently, such systems need to be able to handle certain actions and procedures in order to work properly.

3.1.3.1 Order Handling

According to EECA Business (2017), advanced RPS should be able to handle the input from customer orders. This is necessary in order to generate the optimal plans for all customers and deliveries. Orders contain information such as; customer destinations, goods volume, type of goods and delivery dates (delivery times) which is fundamental for RPS to function properly

(EECA, 2017).

3.1.3.2 The Optimization Procedure

The following procedure can be considered to be the core of the RPS as shown in Figure 3.2. The figure below depicts the logic explained by Selmat. A et. al. (2012) in the article *Route planning model of multi-agent system for a supply chain management*.

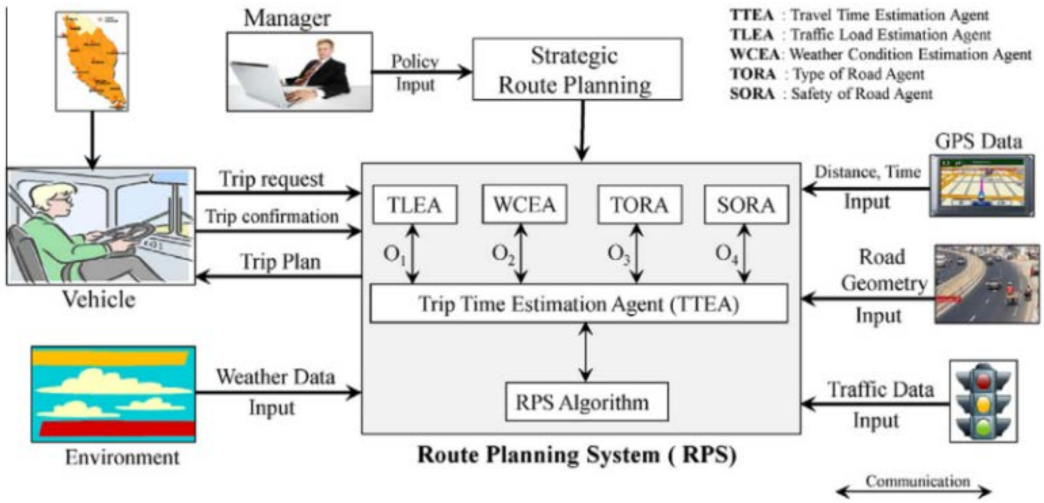

Figure 3.2 - Simplistic layout of a route planning system

As the figure shows, the system consists of several agents responsible for reporting their input to the system based on data that has been received. In this case, the agents can be replaced with databases that are connected to the RPS to collect and store data. As mentioned before, there are several constraints that affect route planning, which is being shown in Figure 3.2 with incoming data (time, distance, traffic, weather, trip plans, road) to decide the optimal route. The data is stored and gathered to a Trip Time Estimation Agent (TTEA) which is the decision-making body in the system who uses the RPS algorithm to compute the optimal route and a trip plan. As mentioned previously, when data points and parameters are stochastic in nature, it becomes increasingly hard to handle them (NEO, 2013). Either the system plans a route with some constraints unfulfilled, or it has corrective actions implemented making it possible to iterate the trip, route or plan depending on updates or new data EECA (2017). In addition, the system also takes top management decisions into considerations. This means that the RPS can be strategically aligned depending on the policies and strategies developed by company managers (Selmat. A et. al., 2012).

3.1.3.3 Route Dispatch and Communication

When a trip plan has been established by the responsible personnel and system algorithm, it needs to be communicated and forwarded to the drivers (Selmat. A et. al., 2012). This is done so that the driver receives information about which route and which cargo to transport to the customer destination. Figure 3.2 shows how a trip plan is transferred to the drivers and trucks. This communication takes place telemetrically by having the vehicle and driver linked to the RPS (Lee. J et. al., 2007). According to Lee. J et. al. (2007), the main reason why telematics are implemented is to be able to monitor the vehicles and drivers while on road. The telematics technology combines navigation capabilities and geographical information with radio communication so that the planners and drivers are able to communicate together.

This is particularly effective since planners are able to handle real-time data and be up to date with vehicle speed, traffic conditions, accidents and more (Lee. J et. al., 2007). In turn, the driver is able to receive updated information on the trip on the vehicle device that is connected to the RPS and its servers. Figure 3.3 shows how the resources and technology are connected into one system to enable telematics communication.

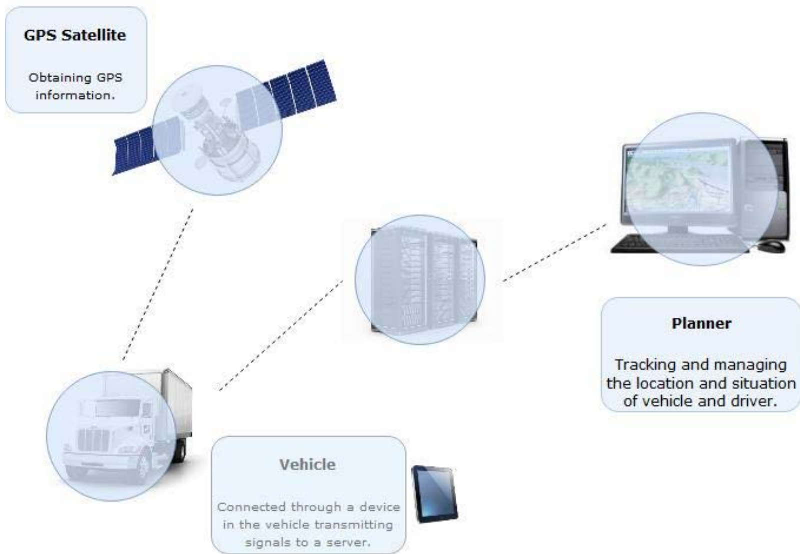

Figure 3.3 - Telematics connection

3.1.3.4 Reporting and Invoicing

Since route planning systems are designed towards optimally calculating the best route for any given vehicle, it is important to manage how successful the operations are. With the amount of data that is available in a RPS, it is greatly beneficial to be able to form relevant key performance indicators of the data. According to Coredination (2017), different work report templates is a beneficial feature for a RPS in order for the drivers, planners and managers to quickly track the performance of the transportation operations. Reports on distance, working time, travel time, load factors and more are all relevant performance measures in determining how well logistics service provider is performing.

With the handling of orders and route planning in RPS, invoicing can be integrated into the system to implement an effective billing procedure, according to Coredination (2017). The invoices are able to show the real costs for each order, depending on the trip plan that has been generated by the software. This means that each customer can be billed in a simple way, corresponding to their demand (Coredination, 2017). The idea is to have a price structure or model integrated with the invoicing function of the RPS which in the end results into an effective invoicing process.

3.1.4 Parameters

Since certain parameters inherit a certain randomness, it becomes important to properly manage and coordinate them in order to make controlled decisions (Selmat. A et. al., 2012). In the following part of the report, the different parameters will be outlined and explained to show what kind of data RPSs could consists of. Even though some parameters have been mentioned before, they will now get a more detailed description.

3.1.4.1 Travel Time

Travel time is the parameter that states how long it takes the transportation vehicle to perform a certain route under certain conditions when it comes to route planning. According to Selamat. A et. al. (2013), the above definition is referred to as *travel time.* Depending on the conditions and constraints, there is going to be a specific time estimation of the travel time when planning optimal routes (Selamat. A et. al., 2013). Consequently, LSPs are then able to make much more reliable time estimations of their vehicle transports, which is the goal. Selmat. A et. al. (2013) present how certain conditions affect the estimation of time in route planning. They specifically mention a couple of parameters that are managed by the RPS, such as;

- **Road conditions**

In terms of safety, road conditions are, used to determine the safety factor of a road (Selamat et. al., 2012). In turn, such factors apply to overall safety of the driver and the goods while simultaneously putting a effect on the travel time. Selamat et. al. (2013) goes on to describe that road engineering determines road defects and triggers that may cause errors (accidents). In turn, such errors usually cause a deviation in RPS and need to be accounted for in beforehand so that such roads can be avoided. Road classification data is available in road databases as an input from engineers, where roads are rated depending on their condition. Additional data can be gathered from police, hospital and construction reports (Selamat. A et. al., 2012). The Table 3.1 below displays an example of how such classification can be made.

Table 3.1 - Road condition classification

Type of road.

Linguistic value	Condition
Good	Normal traffic, separated tracks for different models of vehicles.
Average	Different models of vehicles in the same track. None motorized vehicles; hilly road is less than 5 km.
Bad	Bad congested, too many pedestrians, hilly road is more than 5 km.

- **Traffic conditions**

The conditions of the traffic flow determine how the traffic behaves under a given time period or road length. Speed limitations, intersections and other traffic elements have a prominent role in determining the traffic conditions (Selmat. A et. al., 2012). The capacity and certain time periods of roads determine the level of congestion on the roads. High traffic congestion means that transportation vehicles will have a more difficult time traveling to their destinations, which affects the estimation of travel time.

- **Weather**

Weather has an effect on the road condition and speed of transportation vehicles (Selmat. A et. al., 2012). Even though the effect is slight according to Selmat. A et. al. (2012), it still has an impact on long distance trips. Weather that is considered disruptive (rain, snow, wind) cause inaccurate time estimates, which is why it needs to be accounted for.

- **Unloading and loading**

Included in the estimated travel time, loading and unloading times specify the time it takes for the truck drivers to load their cargo at a terminal and in the end unload at a customer destination to fulfil the need (Kumar S. et. al., 2012).

- **Distance**

Distance is one of the most common parameters to determine when planning routes. As mentioned in previous chapters, VRP takes different destinations into consideration such as; central dispatch depot, customer depot or destination and end destination (Berhan. E et. al., 2014). This means that customer destinations and other potential end destination have to be known in terms of addresses, in relation to the starting destination. The more accurate the information is, the better the distance estimation will be. The distance it takes to a destination also specifies the time it takes to any given destination.

3.1.4.2 Capacity

In route planning scenarios, the customer demand on a given route cannot exceed the vehicle load capacity (Berhan. E et. al., 2014). This implies that the dimensions of a transportation vehicle play a role in how much can be loaded onto it. Both the weight of the load as well as the volume affects the capacity restrictions on transportation vehicles. Companies generally want to maximize their load factor by as much as possible as long as it does not overflow the available capacity (Santén. V, 2016). According to Santén. V (2016), the load factor is something that should be regarded as a key factor when improving the efficiency. To determine the load factor, the current required capacity (customer demand) needs to be compared to the available capacity (truck/trailer load capacity), as presented by the formula:

$$Load\ Factor = \frac{Required\ Capacity}{Available\ Capacity} \text{ (Santén. V, 2016)}$$

This means that the capacity of the trucks needs to be known and which type of vehicle combination is being used when optimizing route and load plans. In theory, by achieving a higher load factor, companies are able to reduce the number of trips and the cost as a result (Santén. V, 2016)

3.1.4.3 Customer Input

Customer demands are increasingly becoming important to manage in transportation systems, and LSPs will need to become more responsive towards demands. Regan. A et. al.(2000) describes how demand planning has to be connected to Transportation Planning and calls it Transportation Demand Planning (TDM). By connecting demand with transportation, the customer aspects are connected to the firm's ability to deliver valuable services and products.

In route and load planning scenarios, there are customer aspects that need to be taken into consideration. In order to determine how much should be transported to each customer destination, the customer demand needs to be known (Selamat. A et. al., 2012). This should be fed into the RPS in the form of order schedules and plans. In turn, these order schedules should easily be able to display the quantity that needs to be delivered to each customer destination, type of cargo (dimensions), delivery dates and customer verification (Chandra. P, 1994). Orders are generally connected to a certain lead time in which the delivery has to be made. In certain route planning scenarios, there might even be situations where additional cargo needs to be picked up along the road, which also needs to be accounted for. This suggest that planners need to account for the demand at each customer depot, to make sure that all quantities are considered for in order to plan optimal routes (Chandra. P, 1994). Even in such scenarios, the customer demand cannot exceed the capacity of the transportation vehicle (Berhan. E et. al. 2014). The prediction of customer demand is becoming increasingly important for transportation companies in order to handle potential variations to accommodate capacity while keeping the customer satisfied (Gopalakrishna, D. et. al., 2012).

Time windows restrictions are also being specified by customers stating that cargo should be delivered within specific time window (Berhan. E et. al., 2014). In turn, such demand has to be accounted for when estimating the travel time so that the cargo arrives within the time window. Additional specified demands are put on cargo that need urgent delivery to the end destination, a so-called cargo prioritization. Prioritized cargo units need to be accounted for when planning optimal routes since it decides which cargo needs to be delivered first on a route.

3.1.4.4 Vehicle and driver

In order to carry out a route transport, transportation vehicles need to be available in the system (Selamat A et. al., 2012). According to Selmat A. et. al. (2012), trip confirmations are sent to the RPS system in order to make sure that the vehicle is ready to load the cargo and start a route. Consequently, this also means that the right combination of vehicle and trailer needs to be used in order to allocate the cargo capacity.

- **Vehicle Condition**

According to Selamat et. al. (2012), RSPs should be able to recognize the conditions of the transportation vehicles based on rating systems that outline defects, damages, deteriorations, emissions and others. This is implemented in order to further check if a certain transportation vehicle is available to use for a certain route trip and whether a repair is needed. Table 3.2 shows how such rating system can look like.

Table 3.2 - Vehicle condition rating system

Rating	Condition	Description
1	Excellent	No visible defects, near new condition
2	Very Good	Some (slightly) defective or deteriorated component(s)
3	Good	Moderately defective or deteriorated component(s)
4	Fair	Defective or deteriorated(s) in need replacement
5	Poor	Critically damaged component(s) or in need of immediate repair

- **Fuel efficiency and emissions**

Fuel efficiency has become a relevant subject towards defining how a company is performing. This is why companies are increasingly taking control of their fuel costs when investing in new equipment and resources, according to Highway and Public Works (HPW) (2016). While a large portion of the fuel consumption is decided by the type of vehicle being driven, careful planning has also proven to improve the environmental performance (HPW, 2016). In route planning, this means being able to avoid routes with many turns, heavy congestion, hills and many other factors. Being able to identify with routes are flat, with the least turns and fastest could greatly improve the environmental performance as well as result in additional cost savings according to HPW (2016). By being able to monitor the fuel consumption and economic driving from a planner and driver perspective, companies can gain more control of the environmental performance. Parameters such as idle time, braking and accelerations can be monitored in real time to plan the route more optimally.

- **Driving patterns**

Different driving patterns affect how vehicles perform on the road. According to Winter. S (2002) certain driving patterns affect the shortest path algorithm. In his article *Modelling Costs of Turns in Route Planning,* turn costs are looked into. By doing as little turns as possible in an efficient manner you avoid deviations in the planned route. A route with minimal deviations is considered to be optimal (Winter. S, 2002). Turns make the vehicle slow down and brake, which adds to the fuel cost. Additional waiting time ensures as well since turns do not represent straight roads due to its turn radius.

- **Driver regulations**

According to Swedish working laws, there are restrictions on how many hours a driver is able to operate the vehicle (Transportstyrelsen, 2015). In turn, this puts a maximized limitation on the availability of drivers in the system. The restrictions are expressed in working hours per day, week, month and year and is implemented to prevent the driver from fatigue, minimize accidents and promote a good relationship between drivers and LPS's. The information obtained from Transportstyrelsen (2015) puts emphasis on the driving hours and break time of drivers and how it is regulated in multiple ways (Transportstyrelsen, 2015). The following driving and rest regulations are set by Transportstyrelsen;

- **Driving Hours**

1. The daily driving limit is limited to 9 effective hours, with the exceptions that driving hours can be extended to 10 hours twice a week.
2. The maximum driving limit per week is 56 hours and 95 hours for two weeks that follow each other.

- **Breaks**

1. When the driver has had a driving period of 4.5 hours, there is a mandatory 45-minute break as shown in Figure 3.4. The break can be replaced with a daily or weekly rest. The break can also be split into one 15-minute break and one 30-minute break within the same driving period, as shown in Figure 3.5 and Figure 3.6.
2. When the break is over, another 4.5 hour driving period starts.

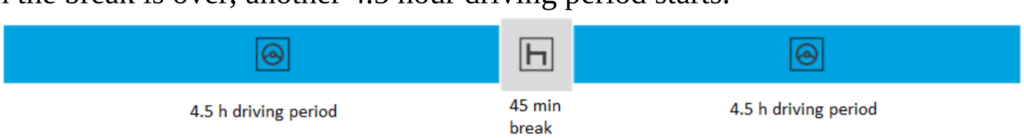

Figure 3.4 - Example 1 break time and driving hours

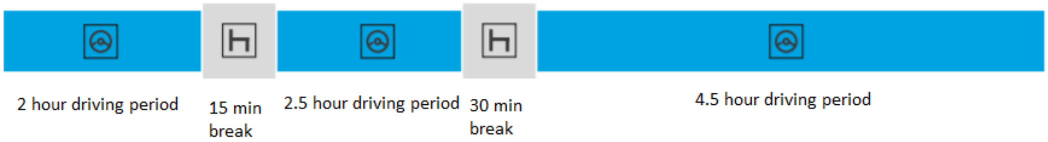

Figure 3.5 - Example 2 break time and driving hours

Figure 3.6 - Example 3 break time and driving hours

- **Daily Rest**

1. The daily rest implies that drivers should have a minimum of 11 hours rest after a 9-hour working period. Alternatively, the daily rest could also be split into two resting periods which amass into at least 12 hours. The further means that the first period needs to be at least 3 hours and the second at least 9 hours long.
2. A driver should, at the latest, have another daily rest approved within 24 hours of the back of a daily rest.
3. Daily rests can also be reduced to 9 hours, but are limited to 3 reduced daily rests per week.

- **Weekly Rest**

1. The definition of a week made by Trafikverket is Monday 00.00 to Sunday 24.00. The weekly rest is either defined as normal or reduced.
2. A normal weekly rest should at least be 45 hours long, while a reduced weekly rest cannot fall under 24 hours.
3. At the latest, after six 24-hour periods at the end of a weekly rest the drivers are able to begin a new weekly rest. However, if the weekly rest begins in one calendar week and carries onto the next, it needs be rearranged so that it is counted for one calendar week.
4. At least two normal weekly breaks, or one normal and one, should be taken in a period where two weeks follow each other.
5. There is nothing that hinders the driver to take several weekly rests under a calendar week.

3.1.4.5 Cost

In the case of route transportation and optimization, cost is often referred to the extent which resources are used (Litman. T, 2009). Furthermore, Litman. T (2009) exemplifies how costs can be incurred depending on different aspects. In the article *Transportation Cost and Benefit Analysis Techniques*, *Estimates and Implications* it is explained how transportation cost can be affected by internal (user), external (others) and societal parameters. The notion is that transportation costs are affected by many different parameters. This further implies that parameters such as; time, distance, traffic conditions, fuel consumption and capacity utilization (mentioned in the chapters above) do not only affect the reliability and quality of transportation services, but also the cost of transportation. Since route planning is more or less stochastic in its nature, the total transportation cost is going to be heavily influenced by parameters in route planning scenarios. Besides, the price structure of different contracts the company have will also influence the total cost in an indirect way. Ultimately, the cost decides if a route is feasibly executable, with the end goal of minimizing the costs as much as possible (Berhan. E et. al., 2014).

3.1.5 Fleet Management

Nowadays, with the increasing number of outsourcing logistics, logistics services provider (LSP) has become an important element in the market who offers a wide range of services to customers. As a LSP, transport can be seen as one of the most important service which require the LSP to have an efficient fleet management to establish a high level of customer service (Vivaldini, M. et. al., 2012).

Fleet Management, is a term of management of a wide range of transportation tools including cars, vans, trucks, trailers and other way of transportation like aviation, ships as well as rail cars (Wikipedia, 2017). It is function of oversee, coordinates and facilitates various transport and transport related activities, not limited in planning, supervision and control of fleet operations based on constraints, but also including operational activities like vehicle financing, maintenance, driver management, speed management, fuel management and health and safety management etc. (Billhardt, H. et. al., 2014; Wikipedia, 2017). With the use of fleet manage system, the companies can reduce and minimize the overall costs by a fully utilization of resources such as vehicles, fuel, spare parts etc., and reduce risk associated with vehicle investment while increase quality of service to the customers. (Billhardt, H. et. al., 2014; Logistics Operational Guide, 2017; Wikipedia, 2017)

As conclude by Logistics Operational Guide (LOG), the fleet management can be divided into several aspects range from identifying needs, acquisition process, insurance for the vehicles, vehicle leasing (internal & external), vehicle management including fleet management systems and vehicle maintenance and upkeep to vehicle life-cycle management and health, safety & security which contains comply with legislature and security requirements as well as driver management.

Due to the rapid development on the technology in sensors, communication and networking technologies as well as geographic information system, Hu, Y. C. et. al. (2015) states the Fleet Management Systems (FMS) has evolved into complete enterprise management tools and there is a trend of turning this into planning tools. Currently, the FMS is going toward the direction of real-time or dynamic management focusing on current fleet locations and prediction of planned tasks. And Billhardt, H. et. al. (2014) have taken the autonomous (self-driving) vehicles into consideration and conclude a possible structure called smart cyber fleet management system which include cyber vehicles drivers with cyber interfaces.

3.1.6 Case Study: Route Planning and Optimization

In order to outline potential benefits of implementing a RPS, different case studies on route optimization are going to presented. The case studies aim to show benefits in performance, reduction of waste and minimization of costs.

In this section, three case studies were conducted not only to find out how a software implementation beneficial to the logistics provider but also aims to help Autolink benchmarking the companies which have already install the related software and find out the areas for further improvement.

3.1.6.1 Fast-moving Consumer Goods

The first case is regarding how a four years of continuous utilisation system influence a fast-moving consumer goods distributor (Hereinafter referred to as A) in Croatia by replacing the manual routing process.

A is a big fast-moving consumer goods distributor which has an average of 1400 orders per day to handle with over 6000 active delivery locations during the last two years. As stated by A, there is about 1400 orders generated from 700 delivery locations per day on the average which means it is possible there are more than one orders from the same location. Besides the huge number of orders, there are also constraints on the customer side which can be classified into the follow session:

- Time window delivery
- Fleet sizes and types
- Working time limitation
- Multiple and partly overlapped geographical regions, depots and satellites
- Unpredictable service time
- Designated vehicle delivery for specific orders

Optimization Process

During the four year of everyday software implementation, many different scenarios have had to be considered to face different requirements and constraints. The relaxation of constraints and acceptance of infeasible solutions are used a lot during the optimization process not only aims to reduce the cost but also to fulfil all the constraints and eliminate penalties due to delay etc.

The four years' experience make A figure out it is more suitable to put dispatchers in the central position beside the system where one can choose the most suitable optimization solver. The manual and automatic routing should work as a complementary to each other. It is quite clear that it is impossible for one solver to suit every situation, the dispatchers' experience can be valuable to handle special requirement or something hard to predict in the model. Only the dispatcher can do changes in working time or relaxation of some other minor constraints when the benefit it brings can outweigh the additional cost or lose.

The final optimization process including manual modification takes around half an hour on the average and is done once a day during the afternoon. Figure 3.7 below shows the whole optimization solution.

The automatic optimization system has two solvers called default solver and fixed solver. While the default solver can be divided into two phases with the use of different algorithm, the first phase attempt to construct a feasible solution that uses a minimal number of vehicles and the second phase aims to reach a minimal total time of the routes. On the contrast, the fixed solver is used for peak days. As stated above, the default solver aims to generate a feasible solution but the fixed solver will enable a maximum vehicles usage even relax some constraints if a feasible solution cannot be constructed. However, this solution is not encouraged by the algorithm itself which means it can only be approved by the dispatcher.

During the system implementation, the geographical factor is also improved to further reduce the cost. A has closed four small remote depots and replace them by satellite locations (which refers to locations where goods are transferred from large vehicles to smaller outbound vehicles that are used for delivery in the surrounding territory) with no inventory holding facilities at all.

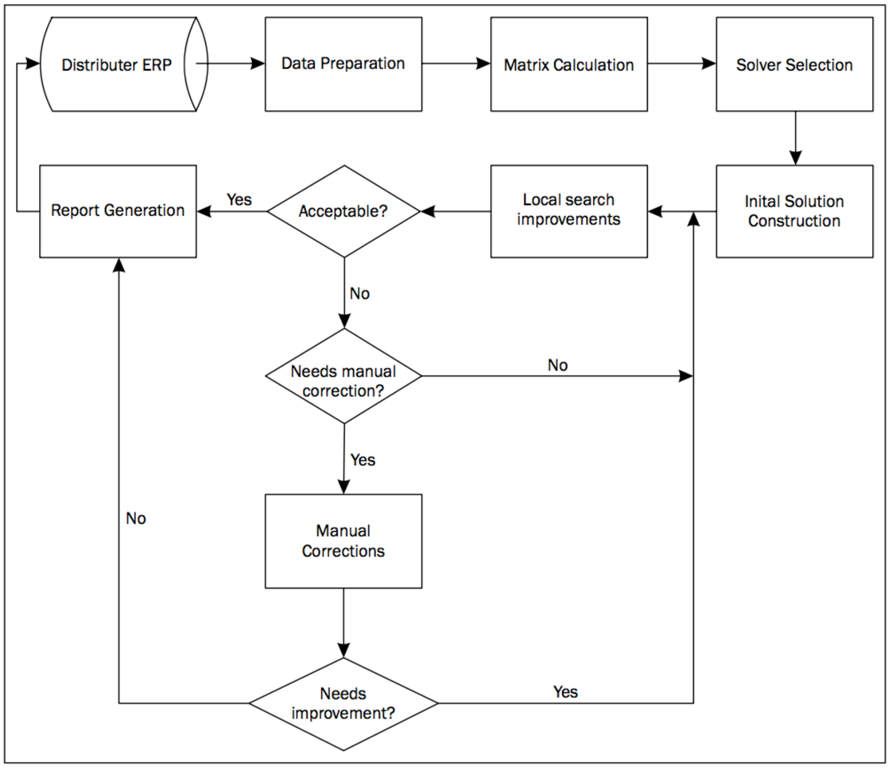

Figure 3.7 - Optimized RPS solution

Benefits

In this case, a delivery optimization system is implemented in a distributer of fast-moving consumer goods. The problem is modelled as a mix fleet multi-depot VRPTW with multi-commodity. With over four years implementation, the computer-aided optimization system works well with dispatchers' work. Several significant benefits were gained through this process which can be concluded as follow:

- Reduce the overall distribution costs, total time and fuel consumption.
- More efficiency vehicle fleet.
- Close down several depots to serve a leaner process.
- Handle more customer requests without invest in the vehicle fleet.
- Reduced number of dispatchers.

At the second year of implementation, due to economic recession in Croatia, the business model has changed since customers trend to order smaller amounts of goods but more frequently. In face of this scenario, the dispatcher works with the system to enable a cluster delivery. Through the simulation, the new delivery method can save up to 26% in distance, 15% in overall cost and a significant drop on working hour by 78%. While here the the computer aided optimization system is not only a system that saves dispatchers working load but also has served as a decision-support system for the company management. As the mentioned in the case study "*The engineering skill to mix old routines with new tools was very important too, because the* *interactive use of manual and automatic routing arises like a winning combination in practice.*" With this in mind, the following strategic benefits which could come from the computer-aided system can be summarized as follow:

- Enable the dispatcher to start thinking differently and use software tools instead of their own experience.
- Have a reliable decision-support system with quantitative information.
- More adaptable drivers who can work in different regions since the knowledge of geographic location become less important.
- A better organization of transport which gives clear picture to the management.

3.1.6.2 Bergendahls Food AB

The second case focuses on a wholesale and retail trade company called Bergendahls Food AB. It is one of the subsidiaries of the fifth largest trading group of Sweden, Bergendahls & Son AB which acts within three business units including food, fashion and home furnishing.

The customer base for Bergendahls Food AB consists of 30 large supermarkets and 200 smaller convenience stores while the case study focuses on one third of the customers which is served by their own fleets. With the large investment in the company which leads to a strong company growth in market share. Comparing with the growth on market share, the organization is not complied with the spend of the growing complexity in the route planning with a manually route planning based on experience.

Optimization process

With the simulation and analysis through route optimization tool Route Planner, the potential of improvements of the current transport plan were primarily analysed. The framework of the optimization is shown below in Figure 3.8 and can be concluded as four steps:

Step 1: Input data

First of all, all the data regarding vehicle, customer information, orders, constraints etc. is putting into the Route Planner as the preparation for the current situation simulation.

Step 2: Current situation simulation

The first simulation aims to identify the basic setting of the program. All the information are exactly the same as they were expected in reality and the result is served as the control group.

Step 3: Optimization of current situation

From the first simulation, it is found the orders are easily be split up into two which increase the mileage when two trucks need to visit the same location on the same day. In this step, this is optimized by brought these split orders into one.

Step 4: Optimization for the future scenarios

The final step can be divided into two future scenarios which is "New time windows" and "Deliveries six days/week". The scenario "New time windows" was simulated with a larger time windows with 7 AM to 10 AM and 9 AM to 2 PM for large supermarkets and convenience stores respectively. While the second scenario “Deliveries six days/week” aims to shift the demand from weekdays to weekend to make the flow of goods more levelled and the costs of additional deliveries were compared to the saving in the weekdays due to the shorter distances.

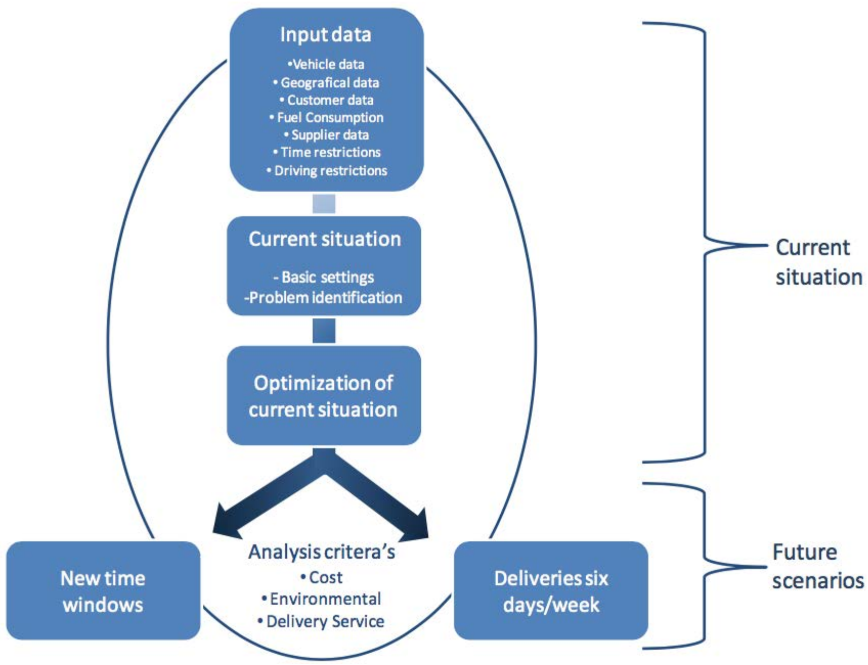

Figure 3.8 - Optimization Steps

Findings and Benefits

Four simulations were conducted to each scenario listed above. One critical problem was found in the first simulation that the actual number of distance is 325 kilometres higher than the simulation according to the information inputted to the software. The key reasons is concluded in the case study as the fact that the truck drivers will leave their trailer to make the routes more smooth and flexible and sometimes the difference on route can reach up to 80 percent. With this in mind, if Bergendahls Food AB can eliminate 50 percent of the additional distance, they could save up to 590 000 SEK per year with 5 percent reduction on emission which equal to 49 tons CO_2 and 0,4 tons NO_x.

By using the route optimization software, the split orders and external transports can be eliminated by doing the second simulation with 5000 SEK and 3000 SEK per day respectively. Based on the current situation, the cost saving can up to 530 400 SEK on average per year and the same, 5 percent on the emission reduction.

When comes to the future scenario, a more significant benefit stands out base on the simulation on the Route Planner. With a wider time-windows, more amount of solutions are possible to be evaluated. The distance can be reduced on average by 1910 km per week which results in a cost reduction up to 1,4 million SEK per year and 9 percent on the environmental saving. On the contrast, the six days per week delivery enable a more even distribution of the orders and help transportation planning. Even it does not provide any economic benefits but the smoother planning and shorter routes benefit the customers by removing the supply peaks, less lead time and lower inventory costs.

To sum up, with the implement of the route planning software, the benefits can be achieved according this case study as listed below:

- Cost reduction
- Minimized the environmental impacts
- Avoiding complex planning solution by planners' manually work
- Better distribution and customer service
- Positive effect on the stores and final customers

3.1.6.3 Further improvement opportunity

The final case can be seen as an add-on beside the previous two cases which shows how the freight cost can be reduced in today's market.

Thomas A. Moore concludes four steps in the past for the cost reduction evolution which starts from negotiation through streamlining, enhanced communication and into route optimization. Each phase has been summarized as one sentences:

- **Negotiate price:** *All the big opportunities to negotiate lower costs are gone*;
- **Streamline operations:** *All the big opportunities to streamline are gone*;
- **Communicate with carriers:** *Partnerships and communication, while worthwhile, won't generate big savings*;
- **Optimize routing:** *The low hanging fruit is gone.*

The next step

With the above information in mind, the author starts thinking about the next step for further cost reduction. The answer is "Shipping full trucks" which is quite obvious to everyone. The reason for this answer is due to several aspects:

- The trucks should not only be loaded at maximum weight but also supposed to be loaded at the maximum space level.
- Shipments going out on longer trailers planned than the actual need.
- How to balance the customer order which only reach the minimum quantity for free freight.
- Different goods on the same origin and destination but each being "full" by a different constraint like weigh, cube or floor position, i.e. the displays could put on the top of the bricks and the transportation cost for it is almost free.

Optimization process and benefits

Stand on the basis of traditional way for route and load planning by ERP and route planning system to reach the "low-hanging fruits", the optimization of "Truly filling shipment" need consideration on not only axle, weights, carrier-lane capacity or how the position loads in the truck, but only on the optimal mix for allocating different products.

With the use of sophisticated vehicle load builder, the optimal mix can be reach to enable 7% improvement in load size by the research from P&G. The outcome of this sophisticated vehicle load builder system should be a set of detailed load plans down to "*Which case pick cases must go on which pallet – and how they stack to minimize the potential for damage.*".

One example in this case is shown in Figure 3.9. Two "full" truck with different goods inside can be optimized by the system to reach the optimal mix and enable 37% improvement on the total weight delivery with the same workload for drivers as well as the truck usage.

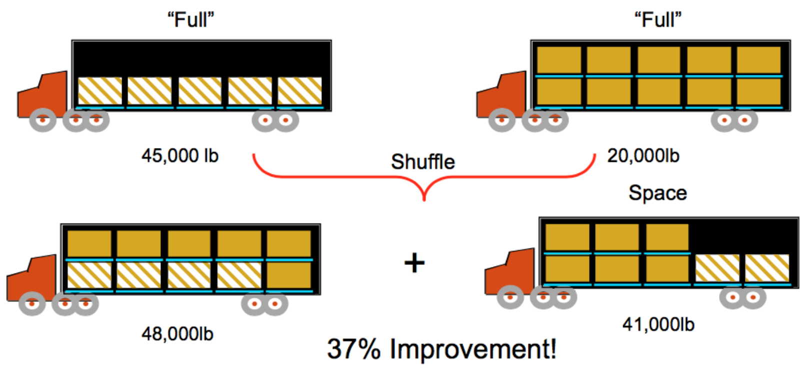

Figure 3.9 - Truly Filled Load Planning

In the end, Moore T. A. states with the truly filling truck, the opportunity to plan better loading solution can save the freight cost up to 4% to 10% lower than the traditional way with the route and load planning by analysis through sophisticated tools.

3.1.7 Conceptual Model: Route Planning

In order to summarize the information obtained from the chapters above, Figure 3.10 has been constructed by the authors of this report to show a simple visualization of RPS solution. The conceptual model displayed below is similar to the logic used in Figure 3.2 which is theorized by Selmat. A et.al (2012). In simplistic terms, Figure 3.10 shows how sets of data parameters affect the planning and the decision making. The authors of this report chose to set up data categories in which specific data is included. For instance, the Customer Input category contains specific data such as volumes, type of cargo and lead times obtained from the customer agreements.

The inclusion of data categories and specific data is explained mainly from the theory used in this thesis report. Papers from Berhan. E et.al (2014), Kumar S. et.al (2012), Selmat. A et. al (2012), Winter. S (2002) and Litman. T (2009) were used to obtain which data is necessary in a RPS and how the cost is affected accordingly. Information obtained from EECA Business (2017) was used to show the relation between order handling, RPS and the inclusion of data obtained from the customers. In chapter 3.1.3.4 it is described how Invoicing and Reporting works in a planning environment by Coredination (2017). Lee. J et.al (2007) is used as theoretical background to describe the telematic capabilities necessary between the drivers, trucks and the transportation planners. Once all the data is computed by the planners and the algorithm, a final decision is made and trip plan is sent to the drivers.

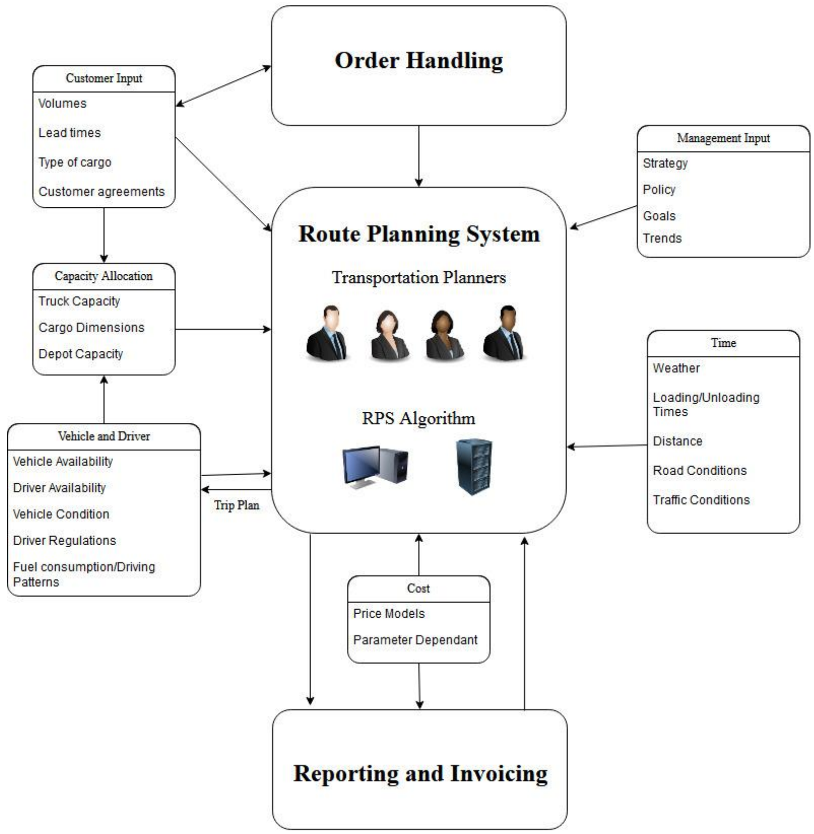

Figure 3.10 - Visualization of RPS Solution.

3.2 Customer Relationship Management (CRM)

Over the past few years, Customer Relationship Management (CRM) have got a lot of attentions by senior level managers as well as academicians, and it has been considered as one of the most important key factors which influences the success of the organization (Bhat and Darzi, 2016). As defined by Mohan and Deshmukh (2013) "CRM is *the combination of business strategies and processes with technologies to acquire and analyse the customers for gaining and retaining the customers' confidence on organisation and its offerings, while keeping in mind cost, quality and profitability of its offer*."

Many research papers have investigated the influence of the CRM implementation. For example, Bhat and Darzi (2016) state the positive effect of CRM on customer loyalty as well as the competitive advantages with the use of structural equation modelling; Mithas S. et. al. (2005) concluded that CRM applications are positively associated with improved customer knowledge and higher customer satisfaction. While from the game theory point of view, Ren, Z.J. et. al. (2010) also point out that the long-term supply chain relationship leads to a more efficient, truth-sharing outcome compare to one time relationship among supply chain parties that without forecast sharing and supply chain.

Considering the focal company in this thesis report, the customers of Autolink are all the dealers and some individual customers around the Sweden while the suppliers of Autolink are different oversea car brands which want to import car into Sweden. Autolink serves as an intermediator between supply and demand which shows a urgent demand to integrate the CRM into the daily supply chain management (SCM). Mohan and Deshmukh (2013) state the link and differences between SCM and CRM, while SCM seeks to optimize the supply side with the focus on production and execution, CRM seeks to optimize demand which is revenue focused and aim to satisfy customers need. They state the integration of SCM and CRM which named as SC^2M-R is the best way for organizations who have a demand to match both supply and demand sides so as to reap the advantages of the synergy and its associated multiplier effects. Ku, E. C. et. al. (2016) also conclude with the combination of suppliers and customers view, the company can integrate customers' opinions and queries for the planning and development of new products and redefine their business models.

However, when CRM is linked to route planning, the traditional vehicle routing problem (VRP) only focuses on developing the routes planning for vehicles in order to minimize the total cost, distance or lead time travelled by the fleets under a set of constraints. The focus has only shifted towards customer requirements in recent years (Groër, C. et. al., 2009). As mentioned above, the customer integration in the SCM is quite beneficial for company to reach a better performance. Through the data collection based on 200 plants in different countries by Danese, P. and Romano, P. (2013), it is found the customer integration alone is not enough to ensure the cost reductions of the supply chain, the reason is due to the fast supply network with a good network design is served as a moderator between the customer integration and efficiency relationship. Also with the use of CRM system, the focal company can assess the locations of customers in a visualized way and reduce the travel time and costs through the optimum route.

3.3 Information and Communications Technology (ICT)

As concluded by Roche, E. M. (2016), Information and Communications Technology (ICT) is going through a rapid progress since Turing (1936) defined that all the calculation can be represented in a binary way and started the computer age. Over the past 80 years, ICT has walked through several steps from a single calculate machine to a internet-based communication platform and currently with the emphasis on big data as well as Internet of Things (IoT).

Based on the recent advance of ICT, it becomes possible to come up with innovative new business and operational paradigms within transportation area in order to make transportation more efficient and environmentally friendly (Hernández, S. et. al., 2011). By studying over 100 service firms and their customers, Polo Peña, A. I. et. al. (2014) claim that ICT capabilities have a positive impact on value co-creation between service firms and customers, as does value co-creation will influence customers perceived value and loyalty as a next step. According to Chinomona, R. (2013), with the focus on Small and Medium Enterprises (SMEs), the ICT serves as a facilitator of suppliers' collaborative communication, network governance and consequential relationship longevity with their clients in a significant way.

When comes to the transportation improvement, Wagner, S. M. (2008) conclude the transportation industry is a traditional area which operates in an extremely competitive environment with endless seeking of lower cost and higher service level. Due to this reason, the competitiveness of logistic service providers is increasingly depending on the technology innovation. Also, since the supply chain are becoming much more complex and globalized, the ICT systems are adapted by more and more transport and logistic service companies in recent years, not only to enhance the collaboration with business partners but also aiming to coordinate and plan operations, as well as supporting the decision-making process (Hosie et al., 2012). According to the literature study by Evangelista, P. and Sweeney, E. (2014), the implication of ICT in the field of freight transportation has many potential benefits including reduce cost, improve customer satisfaction and thereby leverage the competitive advantages (Hong et al., 2010; Wallenburg and Lukassen, 2011; Forslund, 2012). For example, in the current case of this thesis report, the lead time of deliver cars from ports to dealers by road distribution could differ a lot depend on the many factors including weather, traffic congestion, possible accidents on the roads etc. But with the implementation of different ICT like real-time road situation forecast or traffic alert, majority of these potential issues could be prevented in order to avoid possible delay or a better route replanning. In the next session, several widely used ICT in the transport and logistic field will be introduced:

3.3.1 Intelligent Transportation Systems (ITS)

Intelligent Transportation Systems (ITS), which is considered as a part of Internet of things. Many scholars have made definitions on this topic, although ITS may refer to all modes of transport, EU Directive 2010/40/EU (7 July 2010) defined ITS as "*Systems in which information and communication technologies are applied in the field of road transport, including infrastructure, vehicles and users, and in traffic management and mobility management, as well as for interfaces with other modes of transport*." While Zapata Cortes, J. A. et. al. (2013) argue a brief definition based on the summary of previous research, they define ITS as the set of multiple applications aimed to improve transport systems, for both passengers and cargo.

Two broad groups can be categorized in ITS which named by Zapata Cortes, J. A. et. al. (2013) as: ITS located in vehicles (so called "smart vehicles" which equipped with communication technology) and ITS located in infrastructure or in the transportation mode (like traffic guidance system, dynamic signals etc.). Different way of classification can also be found by another author, Zhang, J. et. al. (2011) have distinguished the data-driven ITS as Vision-Driven ITS, Multisource-Driven ITS, Learning-Driven ITS and Visualization-Driven ITS. While Mirzabeiki, V. (2013) states 9 different widely identified freight ITS named traffic control and monitoring systems, WIM systems, delivery space booking systems, vehicle location and condition monitoring systems, route planning systems, driving behaviour monitoring and control systems, crash prevention systems, freight location monitoring systems and freight status monitoring systems.

Based on these categories, different technologies are developed which focus on the single category or on the interaction between two categories. Wikipedia (2017) has taken four main technological applied areas of ITS implementation according to the United States Department of Transportation: Basic management systems (Navigation system, traffic signal management system etc.); Monitor applications (Security CCTV systems etc.); Advanced applications (Parking guidance and information systems and Weather information system etc.) and Predictive techniques based on big data analysis.

These ITS technologies are widely used all over the world and it is believed that the ITS implication can not only support a more efficient and safer traffic management, but also enable information exchange between drivers to better control traffic congestion as well as managing cargo fleets and vehicles planning (Zapata Cortes, J. A. et. al.,2013). Weber, K. M.et al. (2014) illustrate four case studies with innovative use of different ITS in Austria and Norway ranging from real-time traffic information service, displays and management system to electronic ticket system and parking system. Joseph, A. D (2006) summarize 10 ongoing ITS projects in different countries all over the world with the focus on different aspect of transportation issues. besides the road transportation, Zapata Cortes, J. A. et. al. (2013) also state the implementation of ITS in other transport mode like air, maritime as well as railway.

3.3.2 Collaborative Transportation Management (CTM)

According to the Collaborative Transportation Management White Paper (2004), Collaborative Transportation Management (CTM) is defined as *a holistic process that brings together supply chain trading partners and service providers in order to drive inefficiencies out of the transport planning and execution process.*

With the fast growing of urbanization and industrialization, more and more roads and highways are built in recent years. The demand of passengers and freight transportation are growing rapidly, while among all the modes of transportation, road can be considered as the most important mode. From the survey by Fraunhofer (2014), goods transported by road made up the lion's share of the survey, with 78 percent of the total tonnage (14.5 billion tons) transported compare to other ways of transportation like sea, rail and pipeline etc. Kimms, A. and Kopfer, H. (2016) state a high-performance transportation is one of the key-factors of the success logistic-network. Especially for small and medium size companies, the horizontal collaboration of transportation parties is considered as a promising support to reduce the operational cost. Audy, J. F. et. al. (2012) also conclude the logistics collaboration is one means of reducing the logistics activities cost, increasing service level, gaining market share, enhancing capacities, and reducing the negative impacts of the bullwhip effect.

When it comes to the more general parts of CTM, LM Carroll (2013) conclude 5 points of benefits of implementing CTM which are “Reduced transportation costs”, “Increased asset utilization”, “Improved service levels”, “Increased revenue & end-customer satisfaction” and “Increased visibility” based on some quantitative data. While Sutherland, J. L. (2006) states 9 enablers which could facilitate the CTM implementation which named: Common interest, Openness, Recognition who and what is important, Clear expectations, Leadership, Cooperation (not punishment), Trust, Benefit sharing and Advanced information technology. Besides these factors, it is also crucial for companies to continue managing the CTM since it involves many parties in the supply chain and the interaction between different parties are quite complex. Audy, J. F. et. al. (2012) point four key questions for entities that involved in CTM to discuss from the very beginning, the four questions are shown below: determining who will be responsible for what, who will own the leadership, how benefits will be shared and which type of information will be needed.

As claimed in CTM White Paper (2004), it is extremely hard for a single party in supply chain to solve supply chain problems and this is why more and more organizations have considered the collaboration among supply chain as an essential element of company strategy. To sum up, CTM is not only a partner strategy between carrier and shipper but it is also a new kind of business model which includes the carriers as a part of the supply chain for information sharing and collaboration while the traditional supply chain management only focus on the retailers and suppliers (Chan, F. T. and Zhang, T., 2011). Many researchers have done a plenty of work on the objectives and benefits of implementing the CTM in the company. Chan, F. T. and Zhang, T.

(2011) conclude the transportation service occupy a large part of the order lead time which refer to the time from a order placement till the ultimate delivery to the end customers. Take this as a basis, it is quite easy to understand why the CTM White Paper (2004) define the objective of CTM as *improving the operating performance of all parties involved in the relationship by eliminating inefficiencies in the transportation component of the supply chain through collaboration.*

With the use of Multi-agent technology, Li, J. and Chan, F. T. (2012) found that the CTM is an efficient mechanism to handle demand disruption in the supply chain, and the model they built also illustrate the performance of a CTM supply chain is better than a supply chain without CTM by enhancing the cooperation among companies as well as improving the competitive ability of companies. Özener, O. Ö. (2014) identify road transportation as the highest petroleum consuming sector in the world which contributes to the total greenhouse gas emissions in the world. The mechanism based on CTM Özener built enable a logistic network with multiple customers served by a single carrier in order to minimize the transportation cost, allocate the emission and resulting cost among the customers in a fair manner. With the use of CTM, the real-time route planning becomes possible for dynamic road congestions, Riad, A. M. et. al. (2012) state a so-called On-line and Real- time Dynamic Route System (ORDRS) to minimize service delivery and travel time during rush hours downtown. While Hawas, Y. E. and El-Sayed, H. (2015) define an inter-vehicular communication (IVC)-based algorithm for real-time route guidance in urban traffic networks by enable the communication between vehicles in the network to enhance the network productivity.

3.3.3 Route and Load Planning Software

As mentioned in the chapters above, the route planning system aims to help operating the fleet more efficiently, reducing costs and improving profitability and competitiveness. William Salter (2015) concludes a good route planning system can drastically optimize the transportation planning schedule. Ten key capabilities for a good route and load planning software are also identified by William Salter ranging from the basic functions like route and load optimization etc. to some soft aspects like “support clients” and “backup planning” while also considers the software development as well as statistical summary. EECA Business (2015) states, besides a digital map of the road network, the road planning system software also help the companies to hold information in the following aspects including customer locations, delivery and collection windows, quantities and types of goods to be delivered or collected, vehicle availability and capacities and driver shift patterns. Customers’ orders can also be input into the system in order to optimize the route. Six common functions or modules of route and load planning software are summarized by Daniel Harris (2017) as “Dispatch & scheduling”, “GPS tracking”, “Route planning and optimization”, “Rates and quotes management”, “Load optimization” and “Fleet maintenance”.

Besides the information about the system, it is important to have a basic understanding about how the softwares operate before software implementation. Since the information regarding how the route and load planning system actually work is rare in literature, the flowchart in Figure 3.11 from Dhara S. et. al. (2016), which shows the flow of solving the Capacitated Vehicle Routing Problem (CVRP), is used as a basis to illustrate the flow of how the route and load planning system work in practice. As state by Dhara S. et. al. (2016), the flow chart is different between single and multiple depot CVRP, considering the current terminal setup of Autolink, the method of multi depot CVRP is chosen in this thesis since the transportation of the company starts from 4 ports around the Sweden.

Since the initial flow is only used for the CVRP based on the Clarke and Wright savings algorithm, in this case, the criteria will be much more complex, so the calculation will have based on the different software setup of objectives, algorithms as well as the working mechanism of the software providers. The authors identify the following graph as the working flow of the route and load planning software.

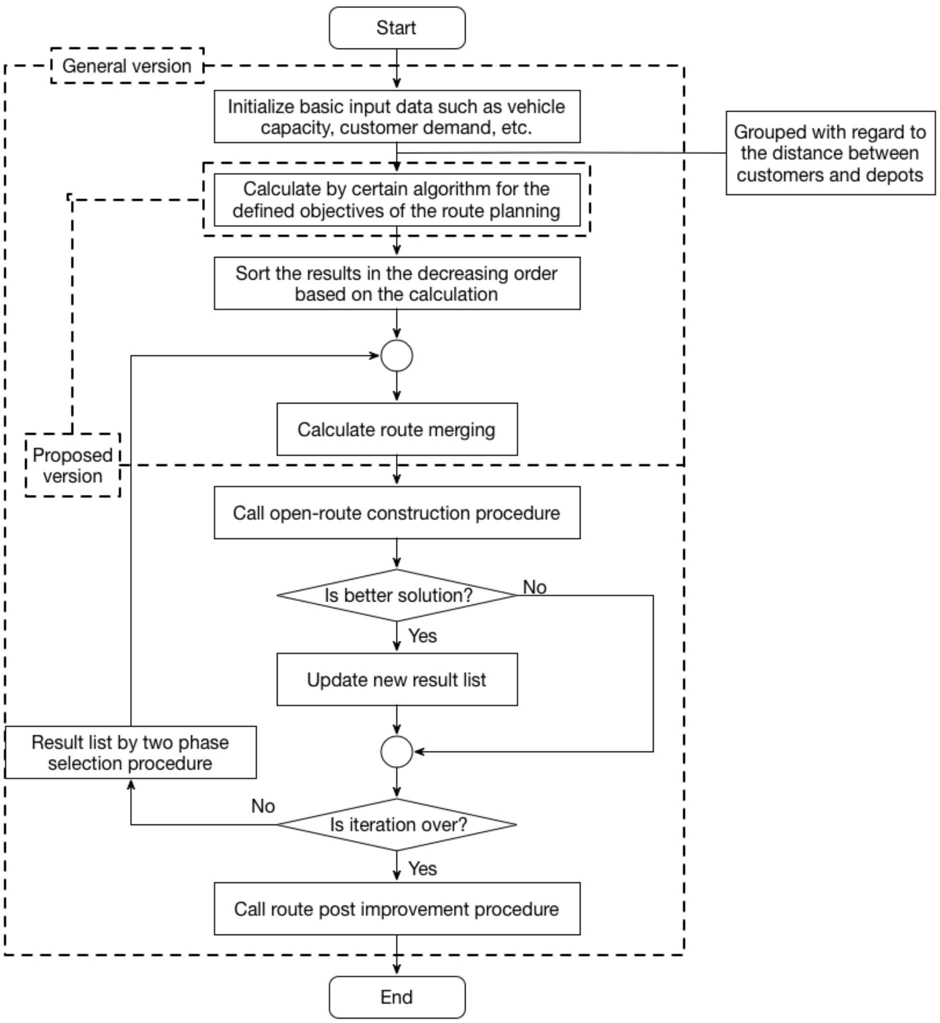

Figure 3.11 - Flowchart for Software Route planning

3.3.4 Centralized or Decentralized Software Implementation

There are two ways to implement the route and load planning system which is centralized or distributed system structure. But as Craig Borowski (2016) states “centralized” and “decentralized” are two ends of a spectrum, and most organizations are somewhere in the middle since both methods have some obvious advantage and disadvantages with the same objective of improving the operation performance.

3.3.4.1 Centralized route planning

Portatour (2015), which is one of the route planning software providers on the market, concludes that a centralized route planning is done by the in-house team in the company headquarters or in the same place of the company. This way makes the route planning decision based on the communication with the field staff or field sales representatives first and assigns the planning to all the branches or person. In software implementation, this means all the information from the fields are collected and show in the system in the decision centre, while the center can make the decision based on all the shared information and assign the optimized plan to all the parts of the company.

The advantage of doing a centralized route planning is quite obvious, many researchers or organizations has identified the following points: First, the centralized route planning can ease the management process and may reduce cost for the hardware expenses as well as the operation cost of the system. Second, since all the information are integrated into the same place/system, any algorithm can be used based on the general goal of the company which can allocate all the resource in a better way and also improve the productivity of the IT staff. Finally, the centralized system can strategically develop a complex framework route because of the better information sharing as well as the general picture of the current situation. (Portatore, 2015; Aalto University, 2015; Craig Borowski, 2016)

On the other side, the disadvantages of such kind of system are also listed as: First, the plans are vulnerable since once the single part of the system break down, the whole system will be influenced. Besides this, it is hard for a centralized route planning system to consider short-term changes like traffic jams or cancelled appointments which means it is not flexible enough to face uncertainty.

3.3.4.2 Decentralized route planning

Decentralized route planning is the other side of the route planning which mean the field representative conducts the route planning separately based on the local customer requirements as well as other factors. Link this with the software implementation, this mean in each field of the company, a software system can work individually based on the local information and experience.

The advantage is this kind of system is much flexible compare with the previous one because each site will have different customers' demand, react to the changes faster as well as consider different other factors which may create a lot of uncertainty. And this is something a centralized is not able to take into consideration. Also, a decentralized route planning system have a higher rate of tolerant since the other system can serve a backup for the units in other fields which increase the information safety and faster responses to new software trend.

The drawback of the decentralized system is the incensement of the installation cost as well as maintaining cost while companies also need additional staff to take responsibility of it. Also, since the single site only make decision based on the local information, it becomes hard for the company to achieve the benefit from a bigger perspective. (Portatore, 2015; Aalto University, 2015; Craig Borowski, 2016)

Based on these basic knowledges about two kinds of system structure. Tarau, A. et. al. (2009) conduct a research for the choice of centralized or decentralized route planning system used in the Destination Coded Vehicles (DCVs). This kind of vehicles is used in the airport to handling baggage and works as a “mini” railway system. They found the best performance is obtained using centralized optimal control but it becomes intractable when a large stream of bags has to be handled. On the other hand, the decentralized control method usually gives worse results than the centralized method but with a lower computational pressure and a higher speed. Gazis, D. C. (1995) provide a solution based on the centralized management of route allocation for congestion abatement in ITS which aims at minimizing the use of roadway facilities and the resulting congestion by allocate the use of roadways to individual traffic units in a way that minimizes the overall delay of the system. Li, J. et. al. (2009) conclude centralized information control (CIC) route guidance mechanism is an effective way to improving the traffic efficiency and avoid the potential congestion in large-scale crowd’s activities. Sun, Y. S. et. al. (2014) points out two different algorithms for route guidance problem in vehicular network: MCMF-R for centralized route planning and TS for distributed route planning, the research shows both algorithms perform better than the traditional GPS-based navigation and randomized routing. A hybrid system combine MCMF-R and TS is then proposed to provide better deployment and routing decisions for different traffic volume.

4. Empirical Data Collection

In the following chapter, the empirical data is going to be displayed from the interviews, statistical analytic data, observations and benchmarks. First off, the chapter is going to present information gathered from manager interviews and employee at Autolink, SKT and the NCL-brand. The goal is to get a view of which requirements the managers have on a potential software while also gathering information about how the transportation planners work.

4.1 Manager and Internal Personnel Interviews

Since the RPS receives and uses input from top management, it is of high importance to gather the view and strategic visions from top management. The data that is going to be presented in this chapter will be gathered from the Chief Operations Officer (COO), Logistics Manager (LM), marketing manager (MK) and Lead Transportation Planner (LTP). The chapter aims to show the current issues, state of works in Autolink and general information about the company from different point of views of managers as well as planners.

4.1.1 Chief Operating Officer (COO)

The COO COO oversees the operations taking place at Autolink and makes sure that activities are executed accordingly. The interview with COO (2017) will revolve around how the company operates on a daily basis, with inclusion of future predictions on operations. The operations that are going to be mentioned in this interview will be focused on the logistics services offered by Autolink and NCL.

4.1.1.1 Current Situation and Vision

As mentioned above, one of COO (2017) focus areas are the current operations that are taking place, as well as planning for the future. The current notion is that the current car logistics activities and operations are under-developed. More focus is put on inbound logistics then outbound according to COO (2017). COO (2017) further believes that other car brands and LPSs are becoming specialized within their core business and that NCL, along with Autolink, needs to do the same - specialize at logistics services for the car industry in order to stay competitive. The vision is more or less to be able to offer qualitative logistics services for its customers in a solution based way across the whole supply chain. Some issues are needed to be resolved first according to COO (2017).

However, COO (2017) is increasingly confident that the current company focus on fast and cheap deliveries that are qualitative is the way to go. The notion is that NCL has to create a solution for the customer rather than just transporting cargo from point A to B.

4.1.1.2 Issues

The belief is that vehicle planning is hard due to inherited weaknesses according to COO (2017). For one, car logistic service providers rarely have accurate e-commerce with its customers. The planning of transporting vehicles begins when the cars are stored at the outbound factory inventory and not according to production schedule. In certain times, this causes imbalances in the capacity and demand planning, and Autolink wants to have as much time as possible to plan in advance (COO, 2017). In addition, it is hard to receive the correct information due to the involvement of many different companies in the chain, including sales and demand companies.

In turn, Autolink is also experiencing smaller demands for customers all over Sweden, with quantities ranging from 500-700 cars a year (COO, 2017). According to COO (2017) this means that the demand is less than a truckload for that destination and problems arise. The system support is currently not there for this to be handled and there is a need for the RPS to handle different kind of distribution flows (COO, 2017).

4.1.1.3 Future Trend

The reasoning behind the necessity of handling different flows comes from the fact that Autolink is experiencing a growth in leased cars according to COO (2017). COO (2017) further explains that this would imply that the NCL brand needs more capacity, information and frequent transportation to accommodate the new flow of cars. The new flow will need transported cars to be delivered within shorter lead times and higher delivery precision in order to satisfy the customers. The discussion with COO (2017) moved on to time windows and how such flows "*Will ask for more and more flexibility, and we have to be prepared for it*".

One of COO (2017) focuses has also been automation and digitalization, which he motivates as the biggest reason behind the system change that is taking place. The belief is that both automation and digitisation is going to be a large influencing factor in the future planning and distribution of cars. More specifically, NCL has shifted their thinking towards having self-driving cars and trucks, while also being able to communicate with them. COO (2017) believes that NCL will benefit greatly from adopting a new thinking that includes digitalisation and automation in order to specialize and stay competitive.

4.1.2 Logistics Manager (LM)

As the manager responsible for the daily logistics operations, LM was able to give insights into the current issues of Autolink, while also talking about the vision of the company and its future requirements (LM, 2017).

4.1.2.1 The Vision

Currently, Autolink is working together with a group of companies under the NCL-brand. Each company offers a particular logistics service which has made NCL realize great potential. With the set of services that are possible to be offered by NCL, the brand has created a vision to start focusing on total supply chain solutions for the automotive industry (LM, 2017). In turn, this has made LM (2017) realize that there are areas of improvement for Autolink in order to keep up with the vision.

4.1.2.2 Issues

In order to satisfy customers, LM (2017) has put much effort into explaining that Autolink has to create value for the customers. With the current company situation, Autolink is not able to completely offer full customer value and satisfaction (LM, 2017). According to LM (2017) this has much to do with the current issues that are affecting both Autolink and NCL.

- Autolink and the NCL-brand are facing issues in finding additional inventory space to store incoming cars to Sweden. Additional inventory space requires both great innovation and investments to expand spaces. At the same time, buffers are being created to satisfy car brand and customer needs.
- Demand fluctuations are affecting the planning heavily. One period it could be 2000 units,

while the next is 3500 and it becomes hard to manage this with the current setup at Autolink. According to LM (2017), Autolink is predicting that the volumes will be even greater in the future.

- Autolink are currently experiencing a shortage of truck drivers which has, in some cases, affected the availability to transport goods.
- The current IT-structure is not beneficiary for Autolink or its partner companies in terms of planning, integration and communication with another supplier or customer softwares. Often, disruptions are present and work cannot be done optimally.

4.1.2.3 Issues and Aims of Route and Load Planning Software

The focus of this report will be to present data for the latter case, the route and load planning aspect of the IT-system. LM (2017) believes that current software that is being used is unable to optimally plan routes for Autolink and its vehicles. LM (2017) states that some functions and knowledge of the system is not present at the moment.

Currently the system is limited and the transportation planner does not receive full system support. Much of the work being done in the system is done manually (LM, 2017). Furthermore, everything is not considered by the system in terms of data and parameters. The system is not able to handle real time data efficiently, which affects the decision-making process. LM (2017) believes himself that the system should be able to handle certain type of parameters in order to work optimally. In the list below, the parameters are listed;

- Able to handle real time data on road and traffic conditions.
- Manage capacity restrictions on transportation vehicles and inventory space.
- Able to display all vehicle types that are used by Autolink in order to have system support for vehicle capacity. Consequently, cargo dimensions need to be handled as well, so that capacity can be allocated optimally.
- Successfully and clearly present the travel time for the transportation vehicles.
- Be able to consider the freight options (like road, railway or boats) based on cost, time, destinations etc. and the priority of different orders should be classified.
- Prioritization of cargo units is done automatically by the system and not manually by the TP.

Furthermore, LM (2017) has expressed that the software needs to be user friendly for the transportation planners (TP), giving them enough system support to plan routes optimally. The TP should be able to work automatically with the software, whereas they are able to make iterations and modification depending on real time data changes or mistakes, and in the end feed it to a route algorithm. The goal should be to give the TP a *"suggested route that is generated by the software"* according LM (2017).

As a result, LM (2017) wants a future RPS system to work as a module in the ERP system. This means that there is a need to ensure that the RPS is able to be integrated with other modules, softwares and systems. Currently, the system is also not setup to gather statistical data that might be of interest. Consequently, this has made LM (2017) question the current RPS, expressing concerns that Autolink is not able to track the fill rates of trucks and measure how good each planner performs their task based on backlogs, volumes and cost. The idea is also to have a monitoring system in place so that TP can be reviewed on their performances.

4.1.2.4 Autolink Long-term Vision

As LM states, currently Autolink is a part of the Nordic Car Logistic (NCL) and take responsibility as a modern vehicle logistic company and solutions for the automotive industry in Sweden. Within the NCL, Autolink served as a final step of the business to transfer the prepared car from ports to the dealers or individual customers. But as an individual company, currently Autolink can only access to the lead time of the transport phase within their ERP system while have no idea about the former lead time of other functions in the whole supply chain as shown in Figure 1.2 in the first chapter. However, the long-term vision of the company is to reduce the lead time of the whole supply chain and make the supply chain more flexible, for example, the delay in the earlier process can be adjusted in the later part like in the transportation part. This means the different modules will need to be connected and share information with each other in the future. Therefore, the vision of Autolink demand the software having the following features as well:

- The route and load planning system can work well with the existing ERP system or at least should be able to input data from the current system.
- The software should not only be able to work independently but also have the potential to expand or integrated as a module in order to fulfil the future need.

4.1.3 Marketing Manager (MM)

The voice of customers is one of the most important prerequisites to have a good customer satisfaction as well as achieve a great service level. An interview is also made with MM who is the marketing manager with the customers in order to have a general image of the customer need and the current situation within the company.

4.1.3.1 Vision and Goal

First and foremost, the vision and future goal of the NCL is stated by MM (2017) which is quite similar to the information from the interview with LM. He said the long-term ambitious goal is to become the leading logistics provider in Europe. Currently, NCL holds over 90% of the car input delivery to the whole Sweden and according to MM (2017), the NCL currently wins operations in the whole Scandinavia and Baltic areas, the future expectation will be to expand to the rest of Europe and create a one-station service.

4.1.3.2 Customers Demand

Considering the position of MM (2017), some key parameters which required by the customers were asked based on his rich working experience with customers, he noticed that among all the requirements, the lead time of delivery and damages are pretty much the most common or essential requirement by the customers. But beside these, it is quite common for them to receive some requirement which they cannot offer, as stated by MM (2017) "*Many customer demands are unreasonable, they want to cover penalties, it-integration, everything to the slightest detail. It is a tendering process which needs to be monitored and checked closely so that nothing is missed.*" As he showed to us, everything depends on the tendering documents with different customers, and there is a huge amount of list which serves as a guideline they need to follow and deliver the right results.

4.1.3.3 Future Trend on Vehicle Transportation

Then, the authors take a step further with the topic that has talked with LM which is the recent change or the future trend of the customers' demand. From a marketing side of view, MM (2017) gave us some much more detailed information.

Firstly, the on-time-deliveries and more specific time-window delivery are becoming more and more common in the current market which is also mentioned by LM. Secondly, digitalization is also one of the future trends in this industrial and this is also a area which MM (2017) pointed out in the vision of the company, they want to develop a system where the customer can be a part of Autolink. Customer should get fast responses and the right responses, i.e. "*When is the car going to arrive to my destination?*" while these questions should be reacted quickly and reliably. An app is also a way toward digitalization to make it easier for customers to access information about their vehicles remotely like track and trace the cargo from the phone etc. while also keep it safe and confidential to the customers. What is more, the inventory space is becoming less and less for vehicles which stated by MM (2017) "*Space is not designed optimally by experts. There are barely areas for us to unload cars at the customer sites.*" as the third trend in the car logistic industry. Then the last which is also the most important one is concluded as "*Better collaboration with customers*". MM (2017) mentioned this aspect a lot during the interview, for example, when he talked about the vision of the company, he said "*We want to lead in offering services that make sense for the customers or the market in order to keep as well as developing new customers. The high responsiveness to the market demand i.e. what the customers asking for, need to be aware and followed up by the offerings.*" while he also stated "*Precise logistics solutions made with the customers where we can offer the necessary services for them and their supply chain.*" as the trend in this industry. All of these insights require the company to have a better connection and integration with the customers in order to increase the service level.

4.1.3.4 Customer Integration

So, based on this information, the authors asked him about their current procedure to develop new customers and how the customers react to the integration of the route planning system to enable a better data sharing as well as communication.

As told by MM (2017), currently, the marketing procedure of the company is largely depending on the key account managers to visit the customers and cultivate a good relationship with them in order to develop or maintain a good image of the NCL. And the key account managers also take charge of the overall flow for vehicles transportation from Autolink to the end customer and they communicate with the customers on a daily basis. When interact with the customers, the main focus areas of the key account managers will put on price, quality and reliability, the first two areas are easy to understand and this is one of the strengths of NCL in the market while the last area reliability here refer to the communication or collaboration with customers which is not that good at this moment. As told by MM (2017), most of customers are willing to be integrated in the system of Autolink, and this part of customers has been classified based on the extent of collaboration which states in the agreement along with different service level, but still, some customers have not realized the value of the close partnership which will be the future focus area of the NCL.

In the end of the interview, MM (2017) gave a suggestion for the current route planning system in Autolink from the marketing point of view which can be summarized as flexibility. The same as LM said, the order volume fluctuates a lot in different periods. For example, one order could be 3000 cars and the next could be 6000 and this will not only have a big impact on the truck planning (capacity) but also increase the working load of the employees. This require Autolink either to better allocate capacity or talk to customers so that they can be a part of the solution. And since the delayed delivery happens very often in Autolink, MM (2017) committed that is handled bad nowadays. As customers can also see in the Track and Trace of the vehicles distribution and they often ask the marketing department why it is late. This is not only puts lots of pressure on the company but also increase of the cost of the company since each delay will have some penalty which stated in the agreement. So, based on the phenomena stated above, MM (2017) concluded "*The route planning system should integrate with the demand planning and transportation planning as well.*"

4.1.4 Lead Transportation Planner (LTP)

With over 20 years of experience in the transportation sector, LTP is the head transporting leader of the facility in Halmstad. LTPs experience ranges from driving the trucks to working with transportation planning on all levels. In the interview with LTP (2017) talking points such as; how the planning is conducted, software implementation and general planning information was discussed in order to further visualize the current state.

4.1.4.1 The planning and working process

In order to completely understand the planning process at Autolink, the transportation planning process was discussed. According to LTP (2017), the process starts by receiving the order for the cars through the electronic data interface (EDI). Usually these orders give the planner the information they need, such as;

- Chassis number (VIN), which is unique for every vehicle that arrives to the compound. The chassis number also has a description in the system where the dimensions and weight can be viewed for each car.
- The number of cars that are going to be delivered to Sweden.
- Car model depending on the car brands.
- The car retailer destination.

At this point, LTP (2017) further explains how manual work arises when working with the order documents. Some of the documents need to be converted into files that are accepted by the current software MobiLast, which in usual cases takes hours of a day to completed. LTP (2017) concludes that this is due to system integration and that partner systems do not communicate well with MobiLast.

When the orders have successfully entered the system, the planners are allowed to make transportation plans for the cars in the software (LTP, 2017). This is executed manually according to LTP (2017) and nothing is planned automatically by the software. Consequently, Mobil=Last mainly serves as a tool that overlooks all the necessary data to plan manually. LTP (2017) continues to explain how the planning is conducted more or less at the compound; "*The planning takes place on the out-loading area*" while referring that once the cars have arrived, the planning can begin. "*We cannot plan in any other way, we need to plan when the cars arrive at the compound, not before*" which is mostly explained by the order schedules and the not having full information. "S*ome of the order schedules do not have destinations written on them.*" which further complicates the allocation of vehicles onto the trucks. Furthermore, this hinders the ability to plan optimal loads since the destinations are unknown for some cars (LTP, 2017). LTP continues to explain that; "*The planning horizon is essentially in seconds, minutes or hours, not* *days or week*s" referring to that pre-planning cannot be done. Instead, the planners have to rely on their experience and skills when planning. "*Some of the personnel starts work 2 hours before the actual necessary working time in order to stay ahead of schedule and within the lead time*". The lead time begins once the car is ready at the compound or a sub-order is initiated by either a retailer or general agent from the car brands.

Since the sub orders are initiated at SKT, who uses a different software which is not compatible with MobiLast, additional problems arise. The planners do not see when the sub-orders from general agents or car retailers are initiated due to them being in a different system, the only thing that is visible are the vessels and how many cars that are going to be unloaded in the harbour. In turn, this comes as a surprise for the planners since they suddenly receive huge number of cars that need to be planned for (LTP, 2017). Whenever the cars are gathered, they are planned depending on different parameters. According to LTP (2017), the planners usually need to take the following parameters into consideration;

- The dimensions of the vehicle in order to fit it onto the trucks.
- Additional vehicle information such as; chassis number, fittings and type of car.
- The destination and distance to the customer site in order to estimate the travel time.
- The lead time that needs to be followed according to the agreements with car brands.
- Prioritized vehicles.
- The price for the transport, depending on the parameters above and agreements with car brands.
- Customer, compound and terminal information such as; operating hours, personnel and additional availability information.

With the parameters in mind, the planners make the best out of the situations according to LTP (2017). The goal is to minimize late arrivals as much as possible while making sure that the right vehicle is being transported to the right destination. In order to tell how successfully this is executed, a service level target of 95% is set for each car brand as a minimum, meaning that going below 95% becomes problematic (LTP, 2017).

4.1.4.2 The transportation network

Currently, the transportation planners at Autolink are responsible for their own districts. In detail, this means that each planner takes responsibility for a number of trucks and a certain flow. The planning duty is to make sure that the trucks are planned for in the given flow to satisfy the customer needs (LTP, 2017). As mentioned before, Autolink is executing their planning in 4 different ports in Sweden. Below is a list for all transportation planners and their districts, including the number of trucks that is in their responsibility.

Traffic A and C (District A and C) - Deliveries from Södertälje to Stockholm and Mälardalen-area.

Traffic B and N (District B and N) - Deliveries from Södertälje to Dalarna and Norrland, including boat.

Traffic D and F (District D and F) - Deliveries made from Malmö and Halmstad up to Dalarna and Stockholm-area. Approximately 59 trucks.

Traffic E (District E) - Scania chassis to Nynäshamn, Stockholm and Gotland from Gothenburg. 2 Trucks.

Traffic S (District S) - Deliveries between Halmstad, Södertälje and Malmö. Approximately 23 trucks.

Traffic V (District V) - Direct transports between Gothenburg and Södertälje. Approximately 37 trucks.

Traffic T (District T) - Transportations around Northern Götaland and Dalarna from Gothenburg. Approximately 17 trucks.

4.1.4.3 The Price Model

In order to decide a price for the above districts, Autolink uses a price model that is based on postal codes (LTP, 2017) (LM, 2017) and the dimensions of that vehicle. This means that each postal code has a different price assigned to it, depending on where it was sent from. If any given vehicle from Gothenburg is sent to Stockholm, there is a fixed price set for that transported vehicle depending on the postal code it is sent to in Stockholm and the size of the vehicle. According to LTP (2017), it makes it very hard to optimize transportation from a cost perspective since it is more feasible to send cars in a direct flow rather than a route with several destinations. LTP (2017) says that "*Visiting several destinations means that there is additional loading and unloading time at destinations we do not get paid to transport to, it's a waste*" and continues by explaining why the direct district flows are more feasible, "*Driving directly to the retailers means that we get paid for that postal code while retailers can dispatch the cars to the customers in a later stage -- with the drawback of having the trucks returning back with an empty load.*". As a result, it becomes hard to achieve a full truck load (FTL) both ways.

4.1.4.4 Requirements on future software implementation

As a result, LTP (2017) has concluded that MobiLast is not sufficient enough for the planners to plan optimally currently. The need for an optimization software is significant according to LTP, since the process needs to become simplified and more effective. With this in mind, the following requirements were set by LTP (2017) on a future software implementation from a planner perspective;

- Better integration with customers and their order flow. All information needs to be visible and clearly displayed in the software.
- Better integration with Microsoft AX so that information from SKT becomes visible in an earlier stage.
- System support to effectively manage time - to see when the truck leaves the gate, how long time it would take and when it arrives at customer destination.
- System support to iterate plans if unexpected changes or events would take place.
- Being able to gather and store statistical data to form performance metrics.
- Give a price estimation based on the distance in kilometres, instead of districts.

In principle, LTP (2017) wants to see a software implementation that is relevant for the company and the brand. Furthermore, it should be user friendly for the transportation planners and aid them in their daily job. "*The planners need all information that is possible and available to them in order to perform their job*", according to LTP (2017). This is why LTP (2017) feels that they are not getting the information necessary from all ends, "*Some of the orders don't have all the information -- we do not see the sub-orders initiated from SKT -- we can utilize the full availability of the drivers*". The latter is explained by having requirements on the hauliers which are not met. The planners want to be able to fully utilize the driving hours of the drivers while having the possibility to plan for 600 kilometres per day.

4.1.4.5 Trends

According to LTP (2017), the Swedish vehicle transportation industry is going to experience some development. The belief is that the lead time are going to become shorter and shorter to the point where customers are going to ask for deliveries to be made in specific time windows. LTP (2017) further argues that as the industry develops, customers are going to ask more of it. As a result, customers are going to look for more qualitative offerings with more services. One of those services, according to LTP (2017) is tracking and tracing which needs to be developed further in order to have a higher transparency towards customers.

So, based on these four interviews with COO (2017) and other senior level managers in the company, the needs from them are collected and concluded in Table 4.1 which will be used in the next chapter for further discussion.

Table 4.1 - Managerial Requirements on the Software selection

Summary of the managerial requirements	
Bart Steijert	**Magnus Karlsson**
Manually Work Reduction Multi-distribution Flow Management Automation and Digitalisation Optimization on LTL Delivery Real Time Data Update	Agreement-base Lead Time Consideration Transportation Flows Consideration Service Quality and Reliability Enhancement Better Integration and Capability Price Focus Capacity and Volume Restriction Track and Trace
Patrick Magnusson	**Roger Malmros**
System Support Maximum Data Input Real time updates Handle Vehicle Information Parameter Dependent Route Planning Order Pirority Iterative Planning Statistical Transportation Data Gathering Capability to the Current ERP System	Basic Data Consideration Integration with Internal and External Customers Lead Time Focus Cargo Vehicles Prioritisation Achieve Higher Service Reliability Automatic Planning System Support Iterative Planning Price and Time Illustration Statistical Data Gathering and Reporting Capacity and Volume Consideration

4.1.5 Transportation Planner Autolink (TPA)

Besides the view from the management perspective, the points from the front-line planners are also very important since they are the person who gets the practical experience on the current route planning software. Therefore, the interview with one of the eight transportation planners, TPA, is conducted to get detailed information into the system.

4.1.5.1 The Working Flow

Currently, Autolink is working with route planning in a manual way in a single system based on the data from the ERP system they already have. Different transportation planners work in different version of system and work individually. Each of the eight planners takes charge of a single route and deals with all the orders occur on this route i.e. From Gothenburg to Stockholm. The following flowchart shows the working procedure of the transportation planner TPA we interviewed, but as said by TPA, this flow is quite different for different planners since they working individually based on experiences and habit.

As shown in Figure 4.1, the main procedure can be mainly divided into 4 steps, which can be concluded as:

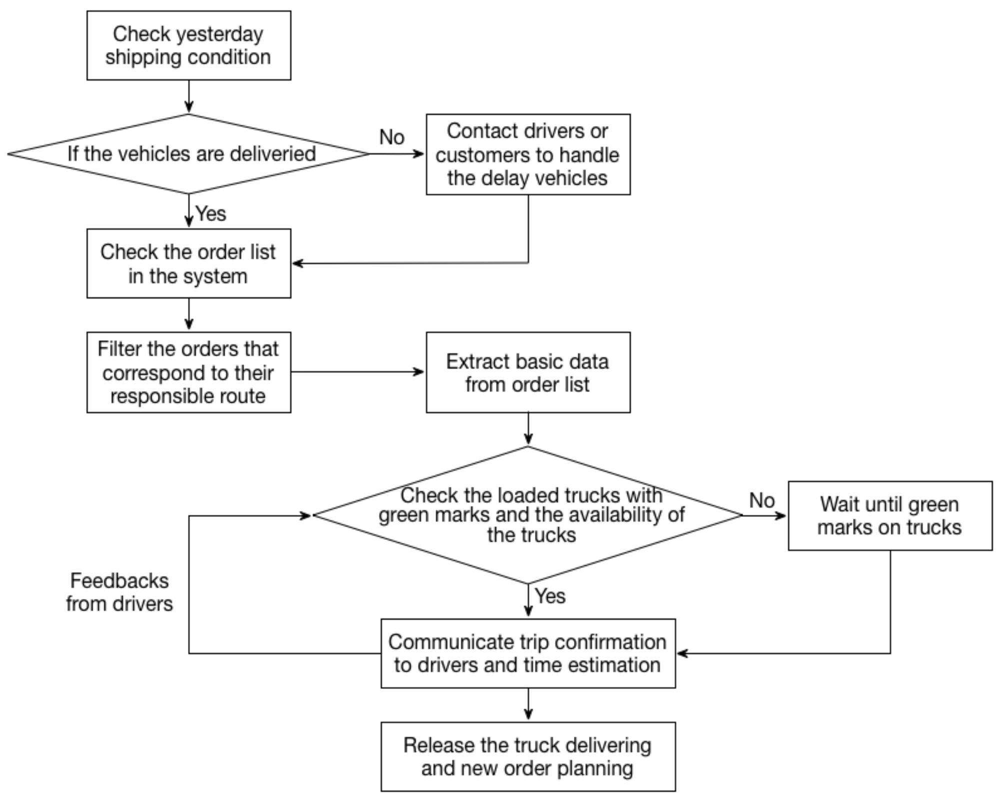

Figure 4.1 - Transport Planner Working Procedure

Step 1: Check yesterday shipping condition

The first step of TPA's daily work is started with the information checking for the yesterday's order delivery like if the vehicles are delivered on time, how long the car is delayed or if there is anything important that driver mentioned in the system. As told by TPA, currently, there are around 10 trucks can show how long the drivers drove and it also displays how long the drivers has left to drive in terms of hours and availability. But in terms of trucks without this equipment, the planner can only call to the drivers to know the time for them the arrive.

Step 2: Check the order list in the system

Then, TPA will start looking the new orders in the system which are inputted to the system manually. With this information in mind, she has to match the different size of the vehicles with different types of truck based on the experience. This is quite important for the load planning, some big vehicles need to be handled first with specific kind of trucks since other trucks are not able to deliver such vehicles. This is done manually and totally depend on the planner's' experience. The demand is also matched with truck capacity manually, and in some scenarios, some chassis (trucks, vans) cannot be loaded due to capacity restrictions which require the planners to work out a specialized solution with the driver.

Step 3: Check the loaded trucks as well as the trucks which is ready to be loaded

After the following works, TPA need to check the loaded trucks which are marked with Green and the truck which prepared to be loaded. (The planner should know if this truck is fully loaded since they planned it in the beginning based on the experience)

Step 4: Release the truck delivering and new order planning

The final step is to release the trucks with the green mark, while the routes for these trucks have been told to the trucks drivers by transportation planners one day ahead. The new orders will also be allocated in this step.

4.1.5.2 Current delivery situation

As mentioned before, NCL serves over 90 percent of car input delivery in Sweden which means they need to handle different requirement from different companies or individuals. The following points were mentioned during the interview with TPA:

Lead Time

The lead time has appeared a lot during the whole interview session. Different customers will have different requirements on the lead time which will directly influence the release time of the trucks as well as the route planning. For example, according to the experience, the orders from Gothenburg to Stockholm is three days which means if a customer’s requirement of lead time of delivery is five days, then Autolink have two more days to arrange the trucks to make it fully used. The time that release the trucks depends on the requirement of delivery time windows of the customers, so sometimes the car can deliver at daytime while others have to deliver at night. But if it is not mentioned on the agreement, Autolink will set the default timeframe as five days since they want to be the best on the market.

Priority of Orders

MM (2017) said Autolink have different level of agreements with the customers which determine the different service levels as well as different price. The order priority is one of the differences in the different agreements. For example, the higher priority orders will have a specific procedure when the planners allocate the orders to ensure a higher service. While the timeframe for different level customers to order to vehicles are also different, some customers cannot order cars after two p.m. every day but some higher-level customers can do this depend on different priorities stated in the contract.

Experience-Based Manually Work

Nowadays, Autolink has its own ERP system for the order input as well as some data collection which is in charge by several data analysts to show how the order quantity changed of each brand as well as other statistical analysis regarding the delays or the detailed information regarding each order like pick-up time, arrival time etc. But besides these, many jobs are done by manually work which based on experience. The following areas are identified as manually works based on planners' experience:

- The planners need to match the vehicles with different types truck manually based on the experience. Allocation of capacity is therefore done manually and aims toward achieving the highest load all the time. But as TPA said "*Issues arise when new vehicle orders arrive*".
- Some orders require Autolink to delivery vehicles from the dealer's location to another branch which also need to be manually planned.
- The estimated lead time of each order is based on planner's experience without considering weather, congestion etc. which leads to a high possibility for the delayed delivery. And since different drivers will have different extent of route experience which also creates communication problems between planners and drivers when they estimated travel time through callings.
- As mentioned above, the planner need to send the route plan to the drivers one day ahead while these route plans are determined by planner's personal experience, previous existed route as well as learning by doing which may miss the optimized route and lower the working efficiency.
- Depending on experience of drivers, different drivers can load different number of vehicles onto the same truck, so the planners should also take this into consideration when they allocate the orders to different drivers.
- Iterated route planning is needed since some sudden information or changes may updated by drivers or customers via phone calls with planners. The job is also done manually which could lead to a higher working complexity or increase the fault rate.
- All the orders in the system are input to the Autolink's system manually except some internal orders from SKT.

As said by TPA, "*The first year is quite tough since you have to remember everything in mind.*" The learning curve can also differ a lot depend on different planners until they feel completely comfortable with the current system. And this is not good for the company's long-term development.

4.1.5.3 Existing problems regarding current system

Based on the frontline experience of operating the current route planning system, several points are stated by TPA to illustrate the issues which occurs in her daily work.

First of all, which is also one of the most common issues during TPA's work is the vehicles are not where they are supposed to be when they should be picked up by the driver. Drivers has to spend additional time searching for them and sometimes it also occupies the planner's time to help drivers find the right vehicles. Secondly, the communication is limited, as said above, currently there are only around 10 trucks can stimulate information in the system. For the other trucks, since there is no way to send data or updates to the vehicle GPS, the transportation planners can only communicate with drivers through phone calls. Thirdly, the delay of the delivery. As stated by all the interviewees, the delay is quite common because of lots of uncertainty. Sometimes the drivers even need to drop the vehicle in a terminal and go back to do the other tasks (Because the planners should push the time usage of the driver to the limit, and if the drivers are not going back on time, the next delivery will be influenced), and the vehicles will be picked up by the local company in the second day. TPA also stated the main factors which influence the route planning is the time windows and the customer's location. As she said "*Time is everything and everything is negotiable only if the delivery time meets the requirement. Once the delivery is delayed, calls and emails will come.*" Finally, the low level of integration between the suppliers and customers lead to a bad communication in terms of the order handling which is concluded as "*Systems do not 'speak' to each other*."

4.1.5.4 Conclusion about the current system

To sum up, TPA concluded the current system as good enough as a user-friendly system and it is easy for her to access the data and information she needs to plan the route. The current system is matched with some other companies, but not with some companies like CB 1. For example, when CB 1 orders a batch of cars, Autolink have to make a schedule first and send to CB 1 to let them know the quantity as well as let them have time to prepare the space for putting the cars in order to handle the orders.

When talking about the potential improvement, a similar point as MM (2017) is given as the fluctuation of orders before or after the holidays. There is a seasonal variation exist while there is no any solution to solve this problem through i.e. a flexible contract with transportation company and it will be great if the orders come continuously and in a flat rate (levelled rate) in order to achieve the ultimate goal "*The right vehicles on the right trucks.*". And it is also needed to improve on dealing with the orders from the single customer, as LM and MM (2017) mentioned, the trend toward more customized orders are increasing and some dealerships also start the direct delivery to the customer site. Which means it will not be enough to contact every individual by calling as what they did now in the future just to know the delivery time and place etc.

4.2 Customer Interviews

As a part of the thesis empirical findings, the following sub-chapter will focus on the interviews and data gathered from customer car brands that are co-operating with Autolink. More specifically, five different car brands have been chosen, which are going to be presented in 3 different interviews. The aim is to present information about the customer requirements, demands and opinions so that it's taken into consideration when choosing the software provider.

4.2.1 CB 1: Transportation Manager 1 (TM 1)

CB 1, with its headquarter in Gothenburg, is the first customer to conduct the interview since the production plant is located in Gothenburg. All the orders are delivered from Gothenburg to all around the Sweden which might cause huge differences from other car brands which need to be imported.

Currently, there are two types of distributions exist in the collaboration between CB 1 and Autolink which named "Port Distribution" and "Dealership Distribution", while the "Port Distribution" refers to the direct delivery for vehicles to transfer from factory to the port and the "Dealership distribution" means the vehicles need to be picked up in different places or combined with other brands to increase the filling rate. Since majority of problems occurs in the

"Dealership Distribution", the interview was conducted with the focus on this segment.

4.2.1.1 Background

TM 1, with 5 years' experience in CB 1 Outbound Logistics and responsible for Carriers Planning and Performance. He has a close relationship with factories, dealerships as well as logistic service providers and emphasis on the road transportation issues follow-up and evaluation. Sweden is his main focus market but also business in other Scandinavia countries.

4.2.1.2 Information Sharing

Currently, CB 1 is working with a Transport Management System to follow up the whole transport process according to the different models while this system is only partly integrated with Autolink. The extent is limited to each phase of the transportation like "loaded", "transporting" and "arrival" etc. which means both sides can only see the status of the vehicles rather than detailed delivery information.

As TM 1 said "*We provide everything they (Autolink) want*." Information like expected volume, car models, orders destination, dimensions, the produce date of the car. The cars are able to be picked up around 1.5 days after the production, and CB 1 will contact Autolink to pick up the car and start calculate the lead time which will show automatically based on different orders and destination in CB 1's Transport Management System.

Besides this, information like delivery volume forecast is also shared with Autolink in different time periods. According to TM 1, the forecast can be divided into three levels on the basis of 10 days, monthly and yearly from CB 1 and the forecast based on each destination and country is generated every Monday and it is also updated in a regular term. All of these forecasts are shared with Autolink through Excel sheet.

When comes to the methods of sharing information, CB 1 shares the information like orders forecast with Autolink through Excel sheets and for other data like orders information, they use Electronic Data Interchange (EDI), Figure 4.2 shows their process:

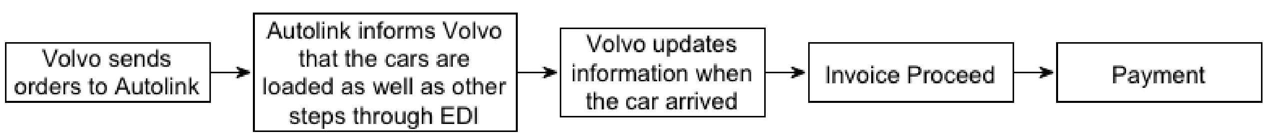

Figure 4.2 - The Process for Orders from CB 1

4.2.1.3 Requirements

TM 1 named four points of the most important requirements from CB 1 which will be elaborated in the following chapter:

Lead Time

First and foremost, lead time of the vehicles is in the highest priority, TM 1 need to check if there are any cars need to arrive each dealership and contact them to see if the car is arrived. As concluded by TM 1 "*If the vehicles can be delivered on time, there will not be any problems occur and everyone is happy. Otherwise, the delay will lead to a lot more working load for both myself and Autolink.*"

As shown in the Figure 4.3 below, the employees in the dealerships will start planning the workshop once the arrival date of vehicles is told by the company, this will be a problem when the vehicles are delayed, which means it is hard for the job to be processed and will cause customers complains and dissatisfaction. When the vehicles cannot arrive on time, the dealership will ask TM 1 where is the car since the customers will be here to pick up the vehicles tomorrow and it still needs time to do some preparation of the car etc.

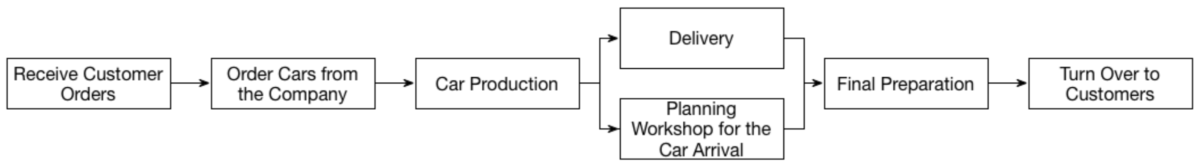

Figure 4.3 - Working Process in Dealership

Once the delay occurs, CB 1 will try their best to give customers a new estimated delivery time to the customers which may probably remain the customer satisfied. But if nothing is updated to the customers when the delay happened, that will cause a big dissatisfaction in the customer's side. What is more, when the delayed time exceed the limit which stated in the agreement with customers, CB 1 will need to pay additional fee to the customers which will increase the cost even one step further.

The good news for Autolink is CB 1 have no penalty for Autolink regarding the delay yet since this may lead to the penalty from Autolink due to the inaccurate car volume prediction and lead to reversed result to both companies. As TM 1 said, CB 1 wants to have a healthy long-term relationship with Autolink rather than the reverse effect caused by the penalty from both side which may turn to the higher price in the end.

Capacity

Besides the lead time, capacity is also one of the TM 1's main focuses, as he said "*It will be good if Autolink have enough capacity to achieve certain lead time even in the high-volume time period.*" The reason why the capacity so important is due to the order fluctuation which is also mentioned by MM (2017), CB 1 wants Autolink have the ability to provide enough capacity during their peak time. The increase on the capacity can solve the problems on both sides of Autolink as well as CB 1 in face of the order fluctuation which increases the additional workload of both CB 1 and planners in Autolink.

However, TM 1 also fully understands why Autolink cannot guarantee the load to them. As he said "The problem does exist but it can be understood since no one wants the capacity stands there as a waste when there is no enough order." But it will be good if Autolink can improve the ability that Autolink follow with enough capacity along with CB 1's orders.

Filled and Damage Rate

Autolink serves around 95% of the car transportation in Sweden, which means there are plenty of customers like CB 1, CB 2, Toyota etc. doing business with them. Most of times, Autolink needs to combine different orders from different customers on the same truck to achieve a higher fill rate. But TM 1 thinks it will be good if it is possible that one truck is filled with only CB 1 cars which aims to reduce the lead time as well as load time at the dealership side. Also, regarding the damage rate, CB 1 have an agreement with Autolink on a certain damage rate, but as TM 1 said, Autolink performs pretty good on the damage rate during the previous working experience.

4.2.1.4 Industry Trends

During TM 1's five-year experience, there is almost no change towards the time window delivery since all the dealerships are available for picking up and loading/unloading 24*7. But when the delay occurs, the time windows delivery may be required in order to minimize the influence to the end customers.

4.2.1.5 Inventory

CB 1 puts a lot of efforts on lean production, the car production is based on orders. When the cars are produced, they will be sold which means there are no inventory for CB 1 in Sweden at least and as TM 1 said "*Currently, we only have one car left in our yard.*" Since CB 1 has its headquarter and production plants in Gothenburg, all the inventory are kept in their own factory instead of Autolink or other dealerships, this might be a big difference comparing with other brands who need inventory as a buffer in Sweden.

4.2.1.6 Evaluation on Autolink

The requirement of CB 1 for Autolink is that 95% of orders should be delivered on time. Basically, CB 1 is satisfied with the collaboration with Autolink, the on-time delivery rate is quite good and the damage rate Autolink achieved is also remain in a high level.

Nowadays, most of orders are delivered on time except several regions in Sweden or some specific issues occur in some months. Regarding the seasonal change of orders, on normally months like February, the requirement is met by Autolink but for months with order fluctuation or backlog like, January and July, Autolink haven't meet the standard and this is their future direction for improvement. As TM 1 said "*We are quite satisfied with the collaboration with Autolink, but the continuous improvement should always be put in the highest level since there is always space to improve the service level.*"

4.2.2 CB 2: Transport Manager 2 (TM 2)

4.2.2.1 Background

The partnership with CB 2 is considered to be the second biggest one for Autolink, with a cooperation lasting 30 years. This is one main point of TM 2 (2017) when talking about how important it is to maintain the relationship with Autolink in order to distribute cars into the Swedish market. To properly manage such a partnership there has to be an information flow, according to TM 2 (2017). In terms of information between CB 2 and Autolink, how the following information is shared is explained by TM 2 (2017) as listed below.

- Order book referring to which type of car that needs to pushed through the chain.
- The inventory levels in Sweden.
- When the cars are delivered by vessel and which models that are on the vessel.
- The weekly or second week production plan, showing the quantities produced.

Even though the flow of information is important, TM 2 (2017) describes how easy it is for the information to be mishandled along the way to Autolink. "*The involvement of many firms is not beneficial for the information flow*" which refers to the forecasting firms, terminal handling firms and others that are involved in the flow. TM 2 (2017) further describes in detail how this leads to having one quantity in the beginning of the information flow to having a completely different by the end of it. TM 2 (2017) reiterates saying "*Our prognosis is not good enough.*" when explaining how qualitative the data sharing is, adding that there is room for improvements. This has led to problems in managing the capacity flow throughout the chain, especially under certain seasons. Under these conditions, when the seasonal variation is high, TM 2 (2017) describes how important it is to get things right when sharing the order books and production schedules in order to eliminate potential problems. While the interview continued, TM 2 concludes that "*We want integration and transparency with Autolink*" putting additional emphasis on the word want.

4.2.2.2 Requirements

TM 2 (2017) continues to describe the agreement between the two firms and which requirements CB 2 has on Autolink. The general idea is that CB 2 wants their produced cars delivered as fast as possible, in the cheapest and best way possible - putting focus on the following aspects;

- **Lead time** - The cars should be delivered according to the agreed lead time depending on port and customer destination.
- **Quality** - CB 2 wants their cars to be delivered in the safest and most reliable way possible with as little damages, mistakes and losses as possible.
- **Price** - The transportation price or cost is a very important aspect, according to TM 2 (2017) stating that "*Price dictates the feasibility and possibility of transportation*". TM 2 (2017) further stated that the annual transportation costs for CB 2 amount up to 90 million SEK with an additional 40 million SEK in terminal costs.
- **Environment -** Due to recent scandals, CB 2 has requested the environmental performances of partner companies in order to measure their total impact according to TM 2 (2017).

These four factors can be considered the core requirements from CB 2 in addition with secondary requirements in the agreement as well. TM 2 (2017) also talks about how CB 2 is engaged into making sure that driver regulations are followed, as well as different vehicle regulations on dimensions, tires and engines. Furthermore, time windows are becoming an increasing demand according to TM 2 (2017) with a projection that more cars are going to be delivered within specific time frames. This is mostly due to the increased demand of leased cars on the European market, where customers are moving towards renting a car for a short period and then buying it. However, TM 2 (2017) reiterates the statement saying that "*It's a growth of an unrealistic market [leasing]*", meaning that it won't have a large future impact.

4.2.2.3 Additional Issues

Throughout the interview with TM 2 (2017), some issues are mentioned. Much of the discussion involves issues regarding the capacity issues that has already mentioned in the previous chapter but also additional lead time issues.

TM 2 (2017) believes himself that these issues are interconnected and that they have to be overcome, whereas they cannot be solved simply by a system implementation. The lead time issues are initiated already at the port in Germany, where the frequency of shipments is too low. Cars that have already been produced and ready 1-2 weeks ago are still waiting for shipment to Sweden. When the cars are shipped, some of them are not according to production and order schedules (TM 2, 2017). This means that the cars are delivered to Sweden in bulk where some of them are late, which puts additional pressure on the NCL brand to handle all the services leading to the planning of transportation. TM 2 (2017) explains how everyone is aware of this, put it is hard to change since the benefits of potential changes do not outweigh the costs that are included.

4.2.3 Distribution Manager (DM)

The interview with the distribution manager (DM) at CB 3, 4 and 5 (CB 345) started off with explaining how the integration was set up with Autolink. Whenever an order is submitted to Autolink, CB 3 makes sure to include information such as;

- The unique customer number and order number
- The volume for that order
- Type of car and corresponding chassis number
- Additional fitting jobs if necessary

In turn, the orders are based on forecasts that are done on a monthly and yearly basis. Usually, the forecasts are based on volume agreements made with Autolink. This means that CB345 has an agreement with Autolink on how many cars that are supposed to be handled (DM, 2017). According to DM (2017), this is one of the most important aspects for CB 345 to measure and Autolink needs to make sure to send confirmations on how many cars that have been handled. The main point for this procedure is to measure the time it takes for the car to arrive to the retailer when initiated by the suborder from the general agent, i.e. the lead time.

In this case, the lead time should be agreed upon already and corresponds to the information stated in Chapter 4.2. In addition, CB 345 wants to know how long time each process for the car takes, from scanning the car to eventually delivering it (DM, 2017). This is done so that it can be measured towards the agreement and the desired customer lead time, which is measured in days. Some commercial cars have to be fitted with certain equipment, which affects the overall lead time, but not the delivery lead time. However, according to DM (2017), it is hard to obtain an expected finish date from Autolink and SKT on some of the vehicles. Furthermore, DM (2017) explains how it would be fantastic to have the delivery lead time correspond to hourly time windows but that it’s not something that the customers have expressed as a fundamental desire. The biggest concern expressed by the DM (2017) seemed to be that a portion of the cars were still delivered on a late date, with delays in several days and weeks.

Ultimately, CB345 measures how well Autolink and SKT does on the successfully transported vehicles (DM, 2017). “The result is dependable on whether the vehicles show up or not” (DM, 2017). In order to make sure that vehicles are on their way, daily contact is held with the customer support in order to gather the data of the whereabouts of the vehicles. The contact with customer support is dependable on the need from the end customers (DM, 2017). The more the customer's query about the vehicles, the more contact is established. In situations where the customer's query about status information or when CB345 asks for data, DM (2017) explains how important it is to give the right information rather than doing it fast. In certain situations, some of the information or data cannot be obtained since Autolink is unable to extract it. “The statistics are not received back, which makes is more difficult” DM (2017) explains regarding the gathering of results. DM (2017) continues to explain that even though there is little support for statistical data, the integration and communication between CB 345 and Autolink is satisfactory, whereas DM (2017) believes that contact can be established rather easily within a short time interval.

4.3 Haulers

The following chapter aims to outline information gained from Autolink's two biggest hauler partners. The haulers are the companies responsible for the availability of the transportation trucks and drivers. In this report, the two haulers are going to be referred to Hauler 1 and Hauler 2, where both of the haulers are responsible for 60% of the road transport carried out by Autolink.

4.3.1 Hauler 1

Hauler 1 is located in the eastern part of Sweden and is mostly responsible for the transports started in that area. The company has approximately 100 trucks available for transportation duties, with 52 drivers operating the trucks. For this report, the interview was held with the company CEO. Throughout the report, the CEO for Hauler 1 will be presented as CEO H1.

4.3.1.1 Operations

As mentioned above, the hauler companies are responsible for providing trucks and drivers as a transportation resource for the cars handled by Autolink. According to CEO H1 (2017), Hauler 1 is a contractor to Autolink with the objective of handling transportation assignments given to them. As a result, Hauler 1 works closely together with the transportation planners to make sure that their plans are executed as good as possible. To do this, Hauler 1 has to assure that all the necessary processes are in place and done correctly while having the full support from the transportation planners (CEO H1, 2017). CEO H1 expresses that "our drivers have to drive according to the plans made by the transportation planners".

Along with driving, the drivers have additional working obligations to load, unload and perform quick damage inspections. Furthermore, the drivers have the responsibility to update their travel tablets, which are connected to a database portal in Autolink, depending on the type of trip that has been made (CEO H1, 2017).

4.3.1.2 Information Technology and Communication

Most of the contact and communication is done through the travel tablet whereas the planned route is displayed on the tablet for the driver. Whenever the driver has reached the customer destination, the tablet needs to be updated. This is also done for every loading and unloading activity throughout the route to gather as much information about the trip (CEO H1, 2017). The information is then sent back to the transportation planners as route status updates. The information is supposed to serve as indicator of how the trip is looking in real time, while gaining an overlook of how many driving hours the driver has driven and has left to drive depending on the rules established by the Swedish Road Administration (2015).

From a company point of view, CEO H1 (2017) wants to make sure that the primary communication is done through the travel tablet. The logic is that there is enough information available on the tablets for the drivers to conduct their driving, while the transportation planners are able to receive updates. On this platform, the drivers have information about the vehicle, where it is place in the yard, the VIN-number, the customer destinations and other instructions (CEO H1, 2017). However, in case of emergencies and unexpected events, the drivers have to conduct telephone calls with the transportation planners to solve the problem. This type of communication is considered secondary and should be used in specific situations (CAO H1, 2017).

The discussion with CEO H1 (2017) moved on to the information that Hauler 1 receives from Autolink. In terms of capacity planning, in order to allocate the transportation trucks, Hauler 1 does not receive any information that would indicate of how much capacity is needed for any given time (CEO H1, 2017). Instead, the capacity is more or less fully utilized every day with the whole fleet being constantly in motion due to the pressure on the market.

In addition, CEO H1 (2017) is very keen on expanding the company's vision on digitalisation. Currently, the trucks are equipped with GPS tracking devices which are connected a system called VEHCO, which connects the drivers, transportation planners and trucks into one system. In this tool, statistical and real-time data can be gathered and stored for later use. Currently, the system is able to track the fuel consumption, driving hours and economic driving. CEO H1 (2017), wants to expand this further by saying "*The system is going to be fully implemented (on a larger scale) July 1st, and we want it!*" and continuing with "*We want the control and to be integrated in a common system to support the transportation planners as much as possible*". The desire from Hauler 1 is to support the transportation planners enough so that their trucks can be planned and used optimally.

CEO H1 (2017) further discusses how important it is to utilize the full capacity of the fleet in terms of driving hour regulations. In that aspect, Hauler 1 wants to be able to plan schedules so that every driver is fully utilized and according to regulations. Furthermore, CEO H1 (2017) is noticing that drivers want to work less and less which has caused additional problems in recruiting drivers. By fully utilizing the driving hour regulations, it would solve a portion of the problem (CEO H1, 2017).

4.3.2 Hauler 2

Hauler 2 is a well-known hauler company in Sweden, who carries out transportation duties in Halmstad, Malmö, Helsingborg and Sundsvall for the NCL-brand. The company is predominantly focused on the vehicle transportation market. Hauler 2 has approximately 75-76 transportation trucks available for duty, with 150 licensed drivers operating the trucks which equates to dealing with 40% of the truck transportations made within NCL brand. In this master thesis report, the interview was held with the company hauling manager which will be referred to as HM H2 (2017) throughout the report.

4.3.2.1 Operations

The main activities carried out by Hauler 2 is to manage the trucks and drivers and operate them. This has been the company's aim for the last 50 years, with the goal of doing it as effectively, economically and environmentally as possible. According to HM H2 (2017), the driver and truck availability has to be present between Monday and Friday between the times 07:00 to 22:00 for all given customer destinations as a minimum. Furthermore, Hauler 2 is very careful to follow the rules set by the Swedish Road Administration regarding driving hours and driver breaks. According to HM H2 (2017), this is important from a regulative perspective as well as from a resource utilization perspective.

In order to do this, Hauler 2 makes sure to give all possibilities and information to the transportation planners at Autolink. The drivers would in this case receive information about the route (the time it takes, distance and destinations), vehicles (VIN-number, yard position, volume) and additional instructions. The information that is submitted by the transportation planners is later used by the drivers though a web application. This means that the drivers are able to see the planned route and how they are supposed to drive over their devices. In turn, the drivers have the responsibility to update the transportation planners along the way when a destination has been reached along with the loading and unloading activities (HM H2, 2017). This is performed so that the transportation planners receive all information necessary to optimize the transports.

4.3.2.2 Information Technology and Communication

As mentioned above, much of the information that the drivers receive comes from the web applications that are connected to the travel devices. This should be considered to be the primary way of communication between driver and transportation planner according to HM H2 (2017). The current software that is in place to make this possible is called VEHCO, which is installed in 72 trucks of the total 75. VEHCO is able to receive information about orders and assignments and convey it to the driver in a way that helps the driver navigate the route through GPS. Furthermore, the driver is able to check real time statistical data about eco-driving and estimated travel time/delays. One remark from HM H2 (2017) that stands out is that the drivers are able to make route updates in the system, but it is not done very often since the transportation planners do not check the information.

Otherwise, the communication is done through phone communication (HM H2, 2017). This is mainly conducted if unexpected events happen or when the driver requests for more routes or assignments. However, this is believed to be somewhat troublesome for some drivers due to unanswered calls from the transportation planners (HM H2, 2017). This leads to drivers not being able to fully utilize their driving hours and eventually a loss in capacity. The drivers then need to make a decision on whether they might get their next load, and might drive to a destination where there are no assignment loads. According to HM H2 (2017), 90% of the time when such issues occur, the drivers receive the information about a new load when they have reached the gates. As a result of that, a lot of time is wasted by just waiting at the gate while receiving assignments.

This is not considered optimal from the perspective of Hauler 2 and its drivers since most of the control wants to be given to the transportation planners (HM H2, 2017). According to HM H2 (2017), the biggest issues are believed to be “the utilization of resources, which is not optimal” and that “the transportation planners do not have a holistic view of the planning”.

4.3.2.3 Information Flow

HM H2 (2017) puts additional emphasis on gathering as much information from partnering companies, suppliers and customers. Every week, HM H2 make sure to hold meetings with production managers in Sweden to get an overview of how each week is going to look like depending on scheduling and additional issues. However, this does not include weekly or monthly projections on what needs to be transported. “Usually a projection of that kind is done on Sunday, for Monday and continues like that the whole week” according to HM H2 (2017). This makes it difficult to allocate and plan capacity in advance or for a long period. Usually it is not a problem according to HM H2, due to the reason that the trucks are fully utilized most of the time. It becomes a problem when the seasonal transportation demand is low, while at the same time having overcapacity.

4.3.2.4 Trends

HM H2 believes that Hauler 2 is going to be subjected to a couple of changes in the future which will put further pressure on the allocation of capacity. The main reason behind the concern is the new flow of leased cars which is subjected to heavy increases in demand. According to HM H2, the increase in volume could be so huge that running the operations would be economically unfeasible. "*The increase would mean that we need more capacity and probably extend the working days by one, which is simply something we can't afford from a cost perspective at the moment*" is said by HM H2 (2017). The difficulties with allocating additional capacity is further troubled by the requirement of drivers, wh. HM H2 explains how "*there are less and less drivers to recruit, and they don't want to work as long as they used to, there has been a change*". This has in turn created challenges in creating optimal schedules for the drivers.

Even though there are many challenges to overcome, HM H2 feels confident about the digitalisation of the automotive market. HM H2 is fully aware that IT is involved in the future business models and that there are many benefits having advanced IT infrastructure. HM H2 (2017) further discusses how "*we have been looking into barcode technology to make it easier loading vehicles and further developing the communication and GPS systems in the trucks*", and that more effort is going to be put towards expanding the IT capabilities.

4.4 Statistical Data Collection

Statistical data will be used to present the current situation of Autolink and how well the current route planning software, MobiLast, is performing. Delivery precision has been identified as a prime performance metric that states how well a company is able to complete any given service towards its customers.

The agreement with car brands also specifies a certain delivery precision which underlines how well Autolink is able to deliver their cars to the intended destinations. In the numbers and graphs below, it is presented the average delivery precision base on the previous month's data (the number of months is different for each brands) for 18 customers including different brands as well as retailer A all around the Sweden. The time periods for every single brand has shown in Table 4.2.

Table 4.2 - Data Collection Period for Different Car Brands

Brands	A	B	C	D	E	F
Periods	2017.01-2017.05	2017.03-2017.04	2016.01-2016.12	2016.10-2017.04	2016.10-2017.04	2016.10-2017.04
Total Volume	2136	130	24965	3237	1813	5904
On time Delivery	1459	101	19829	2645	1520	4979
Delayed Delivery	677	29	5136	592	293	925
Brands	G	H	I	J	K	L
Periods	2016.10-2017.04	2016.01-2017.04	2016.10-2017.04	2016.05-2016.10 2017.01-2017.02	2016.10-2017.03	2016.01-2017.04
Total Volume	7221	6607	9956	6030	3653	8461
On time Delivery	6146	5651	8617	5224	3174	7378
Delayed Delivery	1075	956	1339	806	479	1083
Brands	M	N	O	P	Q	R
Periods	2016.07-2017.04	2016.10-2016.12	2016.01-2017.04	2016.01-2016.12	2016.10-2017.01	2016.11-2017.01
Total Volume	15708	1380	5327	20339	18445	147
On time Delivery	13930	1224	4738	18122	17475	140
Delayed Delivery	1778	156	589	2217	970	7

The Figure 4.4 is showing the delivery precision for every single brand during the time frame states in Table 4.2. One thing need to be mentioned is the accuracy of precision is set as one day which is the current scale used in MobiLast. This means if the vehicles are arrived before 6 p.m., then there are not delayed but if later than 6 p.m., the vehicles will be concluded as delay. If a more accurate scale is used here i.e. hour, the precision might be even lower. As stated by managers in Autolink during the previous interview, the requirement or future vision of Autolink regarding the transport precision is 95%. However, as we can see, only the delivery of brand R and Q can reach around 95% of on time delivery. While for retailer like A, the number dropped significantly to only around 65%-70% and can be considered as a huge issue for Autolink as well as customers in their daily work. For other car brands, the percentage ranges from 75% to 90% which is not a good result for both Autolink and customers. Based on the information above, the current working situation can be considered to have a huge space for improvement.

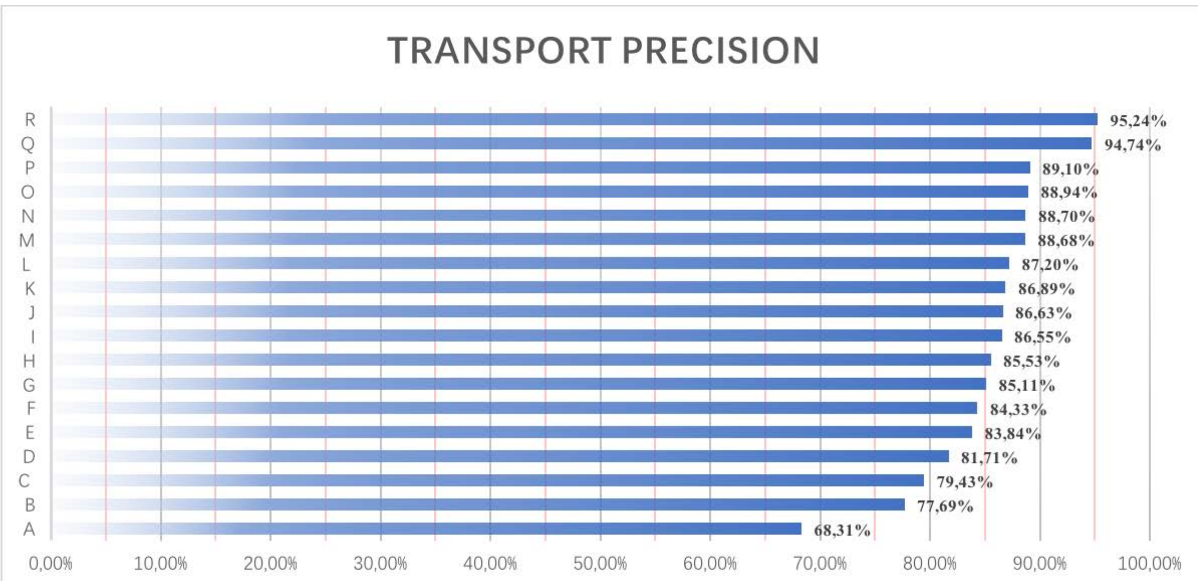

Figure 4.4 - Transport Precision for Each Car Brand

4.5 Software Providers

The last part of the empirical findings is assigned to the software providers since the purpose is to give suggestions on the future route planning system investigation. Around nine software providers were selected in the very beginning and filtered down to three providers in term of the function of optimization. In this part, the features of each software provider will be stated along with the solution they proposed.

4.5.1 Software Provider 1 (SP1)

Software supplier 1 is a tech provider established 1989 in Denmark within a company group. The company group has four different departments where one of them encompasses transportation solutions. The company has had experience with transportation solutions since 1989 and a wide range of services for their customers in terms of integrating, managing and supporting. The contact person for Software Provider 1 (SP1) is the Product Manager, and will be abbreviated as PM SP1 (2017) throughout the report.

4.5.1.1 The Software Solution

The main objective of the transportation management system (TSM) software solution is to optimize the administrative and transformational functions of logistics companies that handle land and sea transports (SP1, 2017). The software includes solutions for assignment bookings, transportation documents, customer agreements, route planning, communication and invoicing. The SP1-TMS solution connects the logistics service provider to a set of basic data. Data such as; haulers, hauler vehicles, expeditors, terminals, county registry (to obtain zip codes), price lists and customer agreements are considered as basic data (PM SP1, 2017). Furthermore, SP1 offers the ability to pick specific functions of their TMS solution to best accommodate its customer. For instance, potential customers are able to choose only the optimization tool if that is their only preference. This means that the product and service offering of SP1 is highly customizable (PM SP1, 2017).

The software solution provided by SP1 encompasses TMS (PM SP1, 2017) with the following main functions can be concluded in Figure 4.5:

- Scanning
- WMS
- Planning
- Optimization
- Customer Integration
- Document Management
- Reporting Tools
- Mapping
- Data Warehouse
- ERP

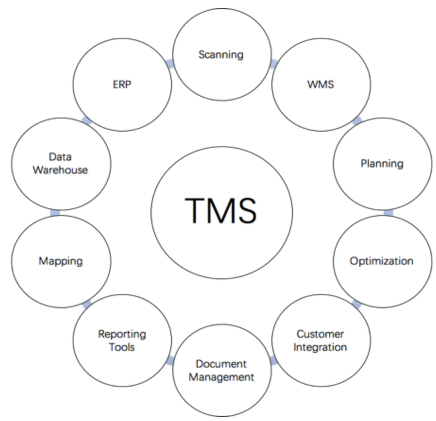

Figure 4.5 - Functions of SP1

4.5.1.2 Software Functions

The TSM/solution provided by SP1 has pre-assigned steps when booking a transportation assignment. In Figure 4.6, the process flow is shown and what is included in every step in terms of data and actions. When initiating the first process step, assignment bookings, the software needs support from an existing order management extension that can provide the order information. According to PM SP1 (2017), integration can be assured with Microsoft AX due to its ERP capabilities, which enables order handling for the TSM-solution.

Assignment	Loading	Transport	Unloading	Distribution	Invoicing and Reporting
Assignment booking - Start\End Dates\Time - Start\End Destination - Customer number - Transportation Mode - Car VIN-nr, model - Fitting requirements -	- Optimization is done here, based on previous basic and real time data - Routes are then suggested to the planner. - Drivers able to update status.	- Send trip confirmation to driver to follow up. - Overlooking each transportation assignment and determening its status.	Scan and Update - Arrival - Damages - Losses - Unloading - Control the assignments		- Invoicing to customer - Managing invoices in journals - Price lists and models - Statstical data reports

Figure 4.6 - Data Utilization in Each Step

When the information is gathered, transportation planners are able to generate optimization suggestions depending on the customer demand at every destination and the capacity of the transportation mode. Transportation planners are then able to overlook trucks as the transportation assignments are in initiated and completed. Furthermore, within the optimization step, planners are able to drag and drop transportation orders depending on how the schedule for each driver and vehicle looks like, as well as getting access to mapping tools that show the route on geographic display (PM SP1, 2017). If the planners decide to, they are also able to make changes in the plan if new data or updates have been submitted into the system.

The software solution provides telematics capabilities that sets up communication between the transportation planners and drivers. In that way, the system is able to send out trip plans and drivers are able to make updates along the way through travel devices (PM SP1, 2017). The solutions offered by SP1 also comes with scanning capabilities, meaning that as the drivers scans and updates along the road, the software is able convey that information to the transportation planners. With the inclusion of data warehouses, real time data can be stored and then used by the transportation planners as they manage the route planning.

In terms of invoicing, SP1 has a long history of developing economic software capabilities. According to PM SP1 (2017), SP1 TSM-solution is able to integrated price lists that are dependent on current agreements with customers. Depending on the transportation plans and when assignments have been completed, customers are billed depending on the specific agreements with Autolink. Furthermore, the software has a reporting function that is able to generate statistical data reports on transportation metrics as long as the data is available in the system (PM SP1, 2017).

4.5.1.3 Price

The calculated implementation price for SP1 software proposal includes designing the solution for Autolink, configuration of the system, assuring functionality, integration, data migration, pilot testing, education and support (SP1, 2017). The cost for all the above services account for 1.554.780 SEK and is considered to be the initial implementation cost.

Excluded from the initial implementation costs are the annual operation costs and cost for maintenance. The operation costs cover the costs for support, IT operations (hardware, middleware, software) and further development.

4.5.2 Software Provider 2 (SP2)

SP2 Denmark, which is a subsidiary of the Irish-based Group, has established in 1975 and currently comes as one of the biggest companies in the industry. The main focus area of SP2 is developing the latest transport planning and optimization solutions to enhance the performance of the clients. The clients of SP2 come from a wide range of industries such as; fast-moving consumer goods and logistics service providers. The contact person from SP 2 was the company director of sales and will be abbreviated as SP2 DS throughout the report for confidentiality reasons.

4.5.2.1 The Software Solution

As shown in the company presentation, SP2 has a full-covering suite of transport administration and planning systems. The product portfolio spans from advanced route planning system, complete real-time-based planning systems, mobile solutions to advanced web portals for transport management.

All the modules are standard which means the ability to combine modules, to configure the software and to make customization based on the requirement from clients. The cloud solution is also available for SP2 products. According to the proposal from SP2, the following modules are included for NCL as shown in Figure 4.7.

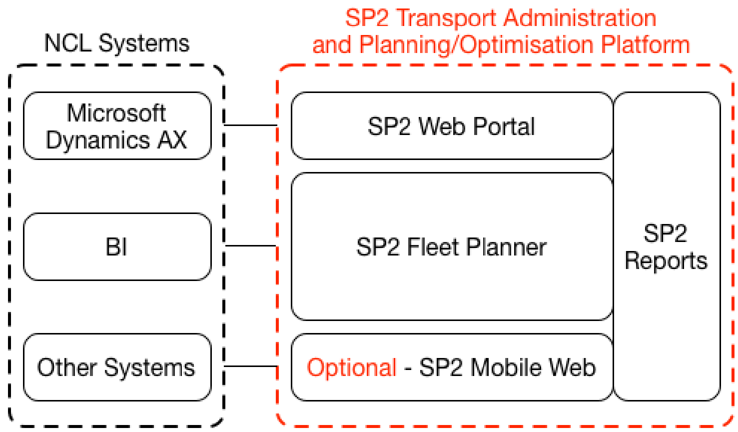

Figure 4.7 - Proposal Solution from SP2

4.5.2.2 Software Functions

Throughout the investigation of SP2, different functions are displayed through different modules the company provides, the following three main modules are introduced while the first module give the core planning and optimization function and the last two modules are optional to Autolink.

SP2 Fleet Planner

SP2 Fleet Planner serves as the core of the platform, as SP2 Fleet Planner is the engine that links all system parts, forming the integrated solution. Figure 4.8 below shows the planning horizon of the SP2 Fleet Planner.

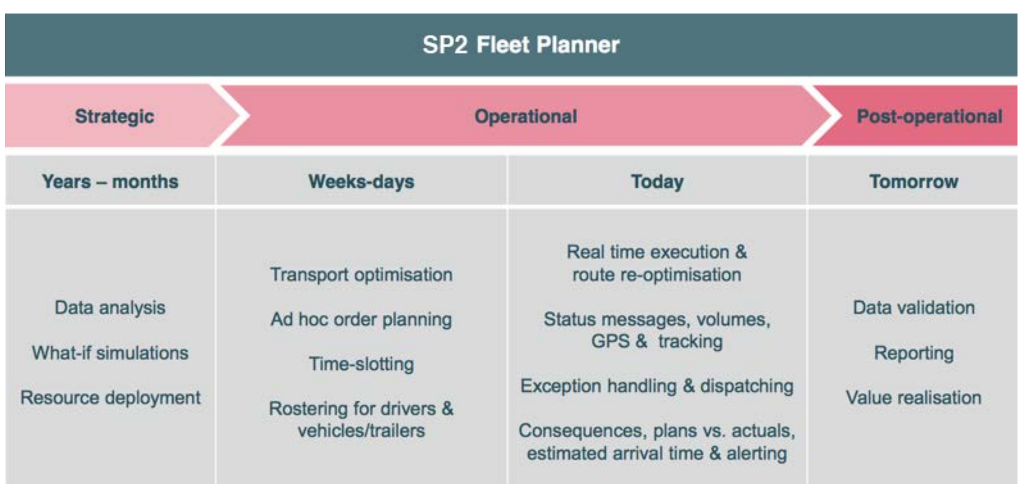

Figure 4.8 - SP2 Fleet Planner Introduction

The Fleet Planner can enable clients to have a dynamic, rolling and operational planning system, a real-time and event-based resource scheduling and re-optimisation platform while reach automatic optimisation of fleet, routes, sequence, order insertion and bookings/time slots. The key features of this module are listed below:

- Real-time optimisation
- Agile optimisation
- Rolling optimisation
- Automatic time-slotting
- Drag and drop features
- Terminal and transport integration
- Resource scheduling/rostering/tracking
- Ad hoc planning
- Changeable algorithm configuration
- Load planning
- Route inspection
- Advanced fleet management
- Haulier self-billing
- Geographical capabilities

The core of the optimization function lies in the algorithm and its ability to make use of various data (SP2 DS, 2017). Transportation planners are able to manage data folders on orders, vehicles, terminals and areas. The optimization algorithm is integrated with Google Map capabilities so that transportation planners can overview most planning elements such as; routes, vehicles, terminals, cargo, driver regulations and travel time to mention a few (SP2 DS, 2017).

SP2 Web Portal/SP2 Mobile Web (Optional)
The SP2 Web Portal serves as a platform for different entities like transport planners, customers as well as drivers to get access the fleet planner. It enables NCL to have portal spaces for e.g. monitoring and reporting, warehouse interaction, drivers and hauliers and developing framework for creating customised spaces.

The web portal direct coupled with the SP2 Fleet Planner and it can also be used as an independent web-portal or be integrated with an existing internal/external webpage. Different entities have different authority level to access the data in different spaces like internal space, driver and haulier space as well as customer space.

The function of the web portal can be divided into four parts: standard functionality, managing and assigning resources, order taking, adjustments and time slotting as well as execution, validation, self-billing and reporting which is shown in Figure 4.9 with details of each function.

Besides the regular web portal, SP2 also provide clients with SP2 Mobile Web system as an optional choice which aims to improve the customer experience especially for the drivers and enable easier access for drivers to the route lists, status messages, GPS, data correction, etc.

The SP2 Mobile Web is a part of the SP2 Web Portal, where the two modules are the same but provide a more portable way for some internal customers by using a normal smartphone that most drivers regular and existing phone can be used. The Web Portal is able to be accessed by the drivers as well as external customers (SP2 DS, 2017). The drivers are able to use the portal through a phone application to see their driving assignments for the day. The routes are displayed and show stops, breaks and returns that driver will make while the driver is able to update along the way. External customers have the same possibilities by tracking and tracing their cargo or orders according to agreements (SP2 DS, 2017).

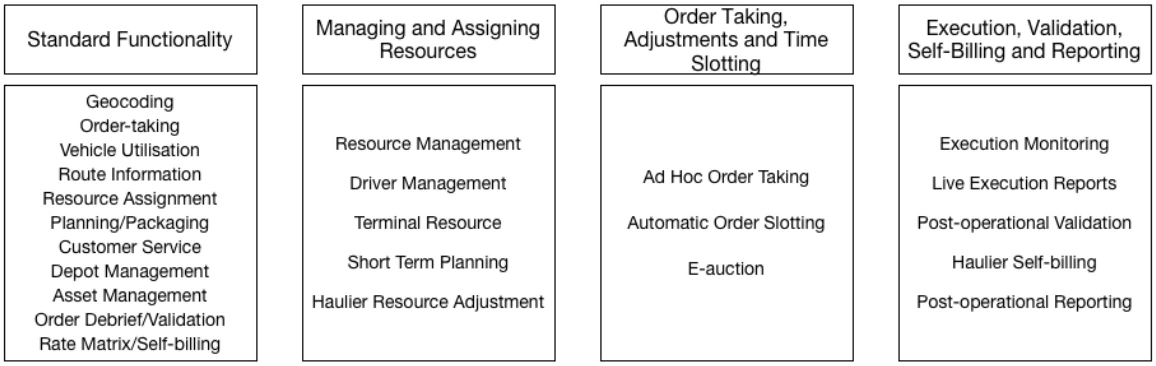

Figure 4.9 - Detail of Each Functions

SP2 Cloud Solution (Optional)
Besides all the functional units stated above, SP2 also contains a cloud solution option which means the SP2 solutions can works in a secure data centre in combination with a range of services and maintenance at the agreed service levels in face to situations like disruptions or disasters etc.

4.4.2.3 Price

The price for SP2 Fleet Planner can be classified into three main parts: implementation cost, license cost and maintenance cost which is 2 751 091,2 SEK, 1 037 037,8 SEK/year and 88 586,7 SEK/year respectively as shown in Figure 4.10. (Currency rate: 12-05-2017)

SP2 Fleet Planner		
Implementation Cost	2 751 091,2 SEK	One time costs
License Cost	1 037 037,8 SEK	Yearly Cost
Maintenance cost	88 586,7 SEK	Yearly Cost

Figure 4.10 - Price for SP2

4.5.3 Software Provider 3 (SP3)

SP3 Gmbh, with its headquarter in Aachen, Germany, established in 1969 with its focus on advanced optimization and supporting Business Intelligence (BI). The company has always been profitable since 1985 and it is the first company ever to receive Enterprise Award by German Operations Research (GOR). The contact person at SP3 that was interviewed for this master thesis project worked as the Director of Business Development and will be referred to as DBD SP3 throughout the report.

4.5.3.1 The Software Solution

The SP3 Solution Portfolio has been implemented across 7 areas including Logistics, Aviation, Inventory & Supply Chain, Risk & Fraud, Manufacturing Logistics, Workforce Management as well as Production. While the proposed solution for NCL is classified in Manufacturing Logistics as Automotive Logistics with a fully integrated operational IT system starts from network planning to performance management with two core subsystems named Transport Management System (TMS) Solution and Compound Management System (CMS) Solution as shown in Figure 4.11.

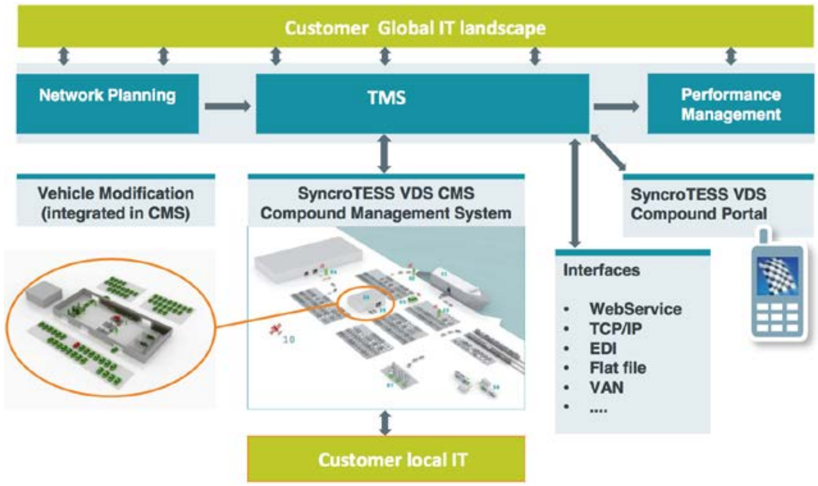

Figure 4.11 - Proposed Solution from SP3

4.5.3.2 Software Functions

As stated above, SP3 has two main products named TMS Solution and CMS Solution, while TMS is the mandatory part of the system and CMS is optional to the clients. While instead of providing separate module for Autolink, the proposed solution from SP3 is a one station solution which contains every module from order handling to the final payment as well as reporting which leads to the higher implementation cost and better system integration.

TMS

TMS, as the core to SP3's solution, is specifically designed for Finished Vehicle Logistics includes modules like Truck/Driver planning and management, contract management for prices, costs and SLA, order management like 4PL and 3PL orders and Estimated Time of Arrival (ETA) calculation etc.

One key system in TMS is the Vehicle Distribution System (VDS) which focuses on optimizing Finished Vehicle Distribution by least cost Network and ensures efficient VIN-management in the outbound Supply Chain. SP4 describes it as the most complete solution for Finished Vehicle Logistics with the process shown in Figure 4.12:

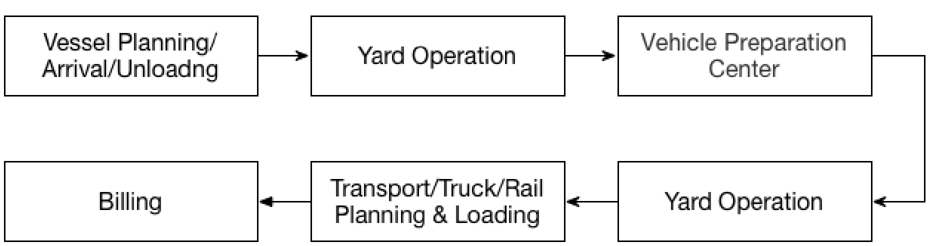

Figure 4.12 - Process for Finished Vehicle Logistics

Transportation Planning and Billing
DBD SP3 (2017) explains how the planning process is able to handle all data elements received from orders, trucks, drivers, GPS-data and real-time data to compute the most optimal route and the estimated travel time. The transportation planners have access to the same data and are able to track the driver, truck and cargo through a planning board with drag and drop features. Through the planning board, real time data can be accessed and iterations can be made if needed (DBD SP3, 2017).

Furthermore, the TMS-solution is able to give support to telematics communication between planner and driver. However, the telematics service is not fully expanded and completed according to DBD SP3 (2017). Internal parties and customers are able to access web based portals to retrieve report based information. This means that the software is able to generate statistical transportation data for whomever needs it.

In the billing process, information is gathered on which transportation assignments and cargo has been completed. Depending on integrated price structures and agreements with customers, invoices are created and later distributed to the paying entity (DBD SP3, 2017).

CMS
As a supplement to the TMS Solution, CMS solution covers all processes within a compound including yard planning, receiving of vehicles, optimized parking, damage recording, management of holds, resource planning and optimized task allocation ot yard workers and load preparation etc.

It also contains a fully integrated workshop/VPC management including service orders Generation, stock levels control, resource planning, Vehicle Identification Number (VIN) prioritization and detailed real-time progress reporting.

4.5.3.3 Price
SP3 proposes a pay-per-use license which is based on the number of processed vehicles per year. There are no additional licenses per user, per mobile device, for other system environments (PROD, QA, DEV, etc.) as shown in Figure 4.13. (Currency rate: 12-05-2017)

SP3 TMS Solution		
Implementation	4 389 053,0 SEK	System implementation for NCL
Modification	1 127 206,1 SEK	Estimate for Customisation and Interfaces
Service	**5 516 259,1 SEK**	**One time costs**
Maintenance	2 802 787,4 SEK	Yearly support and maintenance fee
License	2 325 185,8 SEK	Yearly license fee
Maintenance & License	**5 127 973,2 SEK**	**Yearly Cost**
Option (7/24 Support)	1 162 593,4 SEK	Yearly Cost (for optional 24/7 Support)

Figure 4.13 - Price for SP3

5. Analysis

In this chapter, the analysis of this thesis report will be conducted based on the theoretical framework and findings made throughout the data collection phase. The analysis will serve as a base and main source for answering the research questions in chapter 1.3. This chapter will be divided into eight parts where managerial views, customer needs, optimization, working flow and system integrations is obtained from conceptual model 3.10. Furthermore, the authors of this report will put additional emphasis on analysing the findings obtained from the hauliers and the case studies to obtain a richer base for the research questions. In the end of the chapter, the benchmarking model will be presented and analysed to show the differences of the software providers.

5.1 Managerial Views

According to Selmat. A et. al. (2012), a route planning system can and should be strategically aligned depending on managerial policies and goals. The managers working at Autolink have insights, experience and knowledge into the operations, logistics services, planning and marketing aspects of the company that are of importance to determine the company's strategy and requirements on a future RPS. The aim of this chapter is to analyse the information obtained from logistics manager, marketing manager, operations manager and lead transportation planner.

5.1.1 Vision

The managers all share a common vision that the whole NCL-brand should move away from offering logistics services as separate entities (LM et. al., 2017). Instead, the focus should be on offering complete logistics solutions as one common LSP. COO (2017) describes how important it is for the NCL-brand to become specified within their field in order to compete in the market in the future. LM et. al. (2017) are therefore adamant that the future direction of the company is becoming a 4PL that is able to offer complete logistics solutions for supply chains. In 1996, Arthur Andersen (now Accenture Consulting) described a 4PL as an "integrator that assembles its own resources, capabilities and technology and those of other service providers to design and manage complex supply chains". LM et. al. (2017) have been clear in their quest to merge the whole NCL-brand into digitalisation as the future lies in the technology. Therefore, in order for Autolink to be able to offer specialized logistic services, the technological capabilities need to be developed further. As of now, the brand top management has identified that the current route and load planning system is not satisfactory (LM, LTP, 2017).

5.1.2 Managerial Requirements

In order to make a decision on which software provider to choose, the managerial requirements have to be studied further. As shown in Figure 4.1, all the managerial requirements and needs from each manager have been recorded. As shown in the Figure 5.1, the managers do have the same needs and requirements regarding a new software implementation.

Each manager is convinced that optimized route plans are necessary in some way or another. Steijaert. B (2017) states how important it is to achieve optimized transportation to fully utilize internal and external resources. Furthermore, Steijaert. B believes that optimization is necessary in order for the NCL brand to stay competitive and ready for digitisation in the future. LTP (2017) goes into detail how that optimization would be necessary and welcomed as it would be able to solve problems. LTP (2017) feels that the current system setup is does not offer system features such as taking all data under consideration, allowing iterative planning, planning based on price and time, capacity considerations and vehicle prioritization. Basically, LTP (2017) is able to identify that Autolink is currently missing optimization features that are needed. Most of the features are mentioned by Selmat A et.al (2012) and Berhan. E et.al (2014) are needed in order to effectively make optimized plans.

LM P et.al (2017) put emphasis on the data that is being used to construct the plans and express that support for basic data and real-time data is necessary for Autolink and their ability to offer great service quality and reliability. As mentioned in previous chapters, vehicle routing problems are very much affected by random data parameters, and if controlled they yield better planning schedules in terms of quality and reliability (Denos. C et. al., 1997). The marketing manager MM (2017) explicitly expressed the importance of having a high serviceability and understanding towards the customers in order to keep them, mentioning that high service quality makes the customer even more satisfied.

Additional focus is also requested on the integration with other systems, both internal and external. LM. P, LTP and MM (2017) are all clear on their requirement of needing to have integration with all internal systems such as VEHCO and MS AX, while also ensuring that customer systems can also communicate with the in-house system. This is considered as one of the most important aspects when investing and implementing an RPS (Lee. J et.al, 2007) (Denos. C et. al., 1997) (Selmat. A et. al., 2012). In this case, the communication through customer systems to own systems and later out to the drivers is deemed crucial for a transportation plan to succeed.

From the managerial interviews with LM and LTP (2017) it was concluded that there currently was minimal support for statistical data gathering. In terms of gathering data about truck fill rates, travel times or late arrivals in minutes or hours, MobiLast was not able to present the data effectively. This is problematic in the sense that managers and employees are unable to track the performance of their work and operations (Coredination, 2015). Therefore, it should be considered as a requirement for the system that statistical data reports can be gathered.

The most positive outcome of this analysis is that it is evident from a tactical and strategical point of view that the managers at Autolink and the NCL-brand are aware of the shortcomings in transportation planning. As seen above, each manager remarks on the missing optimization capabilities within the brand. It is believed that that it could potentially hurt the NCL-brand in the future and how customer perceive the service quality. Furthermore, some questions surfaced regarding external factors such as integration, system support and reporting which implies that the managers are not only focused on optimizing the planning aspect, but also other areas of whole system. What this would mean is that Autolink may not only be looking at an optimization tool, but also additional services to help in other areas where system supports missing as well. This will be further discussed in the coming chapters of the thesis report.

As a result of the managerial requirements analysis, Figure 5.1 provides a shortlist of the needs from the managers.

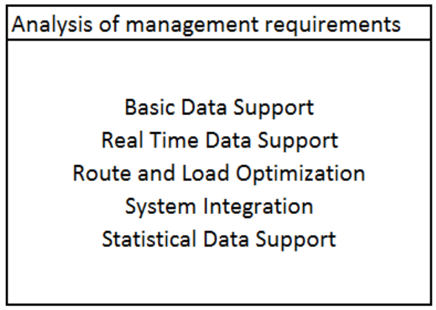

Figure 5.1 - Analysis of management requirements

5.2 Customer Needs

As mentioned in the first chapter, NCL currently takes over 90% of market share in the vehicle logistics industry in Sweden which means there is a large amount of car brands are delivered by NCL. Since the aim of this study is to improve the operational performance of Autolink with the aim to improve the customer satisfaction, there is a need to collect the voice of customers to see what are these brands really need like the requirements or demands they imposed on the company.

In this section, the analysis will be based on interviews with five different car brands (CB1-5) around the world to identify the key demands that need to be fulfilled by the final solutions.

5.2.1 Customer and interviewees selection

As described before, 5 brands were chosen to conduct the interview while each brand is chosen with the aim to represent the potential difference between different brands in different culture to ensure a good representative. CB1, which is the local brand of Sweden with its headquarter in Gothenburg, is chosen not only because it is one of the biggest customers of Autolink but also, through the comparison between CB1 and other brands, the differences of delivery between local brand and other brands which needs to be imported can be shown. The second chosen brand is CB2, one of the biggest vehicle manufacturers in the world and it is also the second biggest customer for Autolink (TM 2, 2017). The rest of brands CB3, CB4 and CB5 are from different cultural background i.e. Japan, Korea and France respectively. Through the investigation, the derivative different focus points can be revealed.

In addition to the brand selection, all the interviewees have a rich experience in their field regarding logistics i.e. TM 1 from CB1, TM 2 from CB2 and Distribution Manager (DM) for CB3, CB4 and CB5 which are believed can show the right information and constructive insight on the future trends.

5.2.2 Demand

With the information from Chapter 4.3 in mind, different customer demands or requirements were got from TM 1, TM 2 and DM as shown in Table 5.1 (TM 1; TM 2; DM, 2017).

As shown in Table 5.1, the lead time of the delivery becomes the first and foremost factor for all customers to evaluate Autolink. As long as the lead time is reached according to the contract with customers, which means that the vehicles are delivered on time to the customers, the complaint will be diminished and Autolink will have a good customer evaluation.

Table 5.1 - Demands from Customers

CB 1	CB 2	CB 3,4,5
Lead Time Filled and Damage Rate Capacity Allocation	Lead Time Price Quality Environment	Detailed Lead Time Better Communication

At the same time, the vehicles should be delivered in the safest and most reliable way with as little damages or mistakes as possible (TM 1, TM 2, 2017). Price, which is one of the most important elements in CB2's strategy (TM 2, 2017), but also relevant to other car brands, as stated by TM 2 (2017) and Berhan. E et. al. (2014), the price decides if a route is possible and feasible, with the end goal of minimizing the price as much as possible is the ultimate goal for each company.

Besides these, DM (2017) pointed out a better communication is also needed to enable a better route planning solution. The right information is more important to do the things fast and a good information transparency and integration can lead to eliminate potential problems (TM 2, DM, 2017).

In addition, capacity during the order fluctuation period is mentioned by TM 1 as they want Autolink could be able to allocate enough capacity to them every time they need, not only for the transport volume but also for the inventory space and time frame they needed. Besides, environmental impact for the transport are stated as the demand by TM 2 solely.

Through the analysis of these three interviews, it is found that the current route plan is not the optimized one which leads to the delay for all five car brands as well as others as shown in Figure 4.4. Therefore, the problem exists in Autolink can be confirmed one step further as the VRP that defined by Kumar. S. N. & Panneerselvam. R. (2012) and Berhan. E et. al. (2014). RPS can serve as a suitable way to find the optimized route with the use of data and information to determine optimal routes and later communicate the decision to the vehicles (Denos. C et. al., 1997). As shown in Figure 3.10, the demand from the customers can be communicated well in the first step during the order handling to ensure a good route and load planning based on all the factors named by Selamat A et. al. (2012) with the influence on the final time estimation. As Berhan. E et. al. (2014) concluded, the more data feeded into the RPS, the better route planning can be achieved.

However, to ensure the order handling get the correct input from customers, Autolink needs to have a good CRM solution, as Bhat and Darzi (2016) claimed, the CRM is considered as one of the most important key factors which influences the success of the organization. With the use of CRM focuses on the demand side (Mohan and Deshmukh, 2013), Autolink can work closely and cooperatively with customers. The long-term relationship within the supply chain can lead to a more efficient, truth-sharing outcome (Ren, Z.J. et. al., 2010) while MM (2017) also emphasized on the need to work closely with customer to offer a better service is the most important trend in the future market.

The RPS solution here works as a platform which integrates the ICT and CRM at the same time. The customer demand data as well as other parameters which impact the route and load planning can be considered thoroughly and automatically. Through the implementation of RPS, benefits like cost reduction, enhanced service level and better time estimation for delivery etc. can be achieved (Audy, J. F. et. al., 2012; Berhan E. et. al., 2014).

5.3 Optimization

From the interviews with the internal employees and managers, it is found that the current software solution, MobiLast, is not capable enough to optimally plan the transportation assignments (LM et. al., 2017). LTP (2017) points out how the current software, MobiLast, is only a tool for booking transportation assignments and overlooking order information. The transportation planners working with MobiLast are performing their planning tasks manually, which means that the current planning does not consider all relevant data parameters and constraints, resulting in no optimization of the route and load planning. According to Kumar. S.N, Panneerselvam. R (2012) and Berhan. E et. al. (2014), this is considered as a typical vehicle routing problem.

Both LTP (2017) and LM (2017) express that transportation planners are not able to process all basic data through manual work. Therefore, the complexity of VRP becomes monumental, since the planners are unable to control stochastic parameters that affect the route and load planning (Berhan E. et. al., 2017). In this case, the transportation planners are having difficulties handling basic data parameters. As a result, Autolink is unable to service their customers in the most satisfactory way possible. Karlsson M. (2017) points out how customers are subjected to delays, and that Autolink receives complaints that the reliability of service is not up to par with the agreements.

By taking the data presented in Chapter 4.2.1 into consideration, Figure 4.3 shows how well Autolink is able to service their customers based on the delivery precision for 18 car brands, showing that only one car brand (R) was above the 95% precision limit. However, the statistical data for car brand R was gathered from November 2016 to January 2017 and does not show recent month data. Similar data is recorded for brand Q which had reached 94.74% delivery precision under a three-month period and a huge volume compare to others. Between October 2016 and April 2017, the delivery precision data was gathered for five car brands (D, E, F, G and I) with a raging delivery precision from 81.71% to 86.55%, all below the promised 95% mark. January 2016 to April 2017 showed that data was collected from 3 different car brands (H, L and O) to have a raging delivery precision from 85,53% to 88.94%, also below the 95% mark. Car brand P, which has data recorded for whole 2016 shows a delivery precision of 89.10%, still below the 95% mark as well. The percentage rises along with how many periods data periods are recorded, suggesting that seasonal variation affects the delivery precision. Even though the percentage increases, it is clearly visible that the current transportation service is affected by delays by not fulfilling the 95% service level requirement. The main reason for the low delivery precision might not only be caused by the transportation planning system, MobiLast. However, the system does not help or provide any subsystem support in the planning aspect of dispatching optimal solutions for Autolink and its customers in the first place.

Moreover, LM P. and LTP R. (2017) both feel that the planners need more support from the system to enhance the overall planning performance. Since the transportation planners are optimizing their own work, they are unable to get a holistic view of the planning. Therefore, all possible options are not considered by the planners which eventually leads to an a not optimized planning flow. Planners intentionally hold cars in inventory for several days in order to fill transportation trucks and achieve a FTL (LM P., 2017). In turn, this puts a delay on the cars that have been waiting for days or even weeks. A route planning system is able to consider the demands of the customers as important information and would assign the cargo depending on a number of factors, delivery dates being one of them (Chandra P., 1994). Another aspect that is considered by the RPS is the demand and each site and available truck capacity, so that the right cargo can be assigned to the right truck (Berhan. E et.al, 2014).

The utilization of the truck capacity is also a common issue in the transportation flow. According to LM P. and LTP R. (2017), many vehicle trips are returned back to their original depot with an empty cargo. The reason is that there are no transportation bookings back from the end destination and Autolink is forced to return the truck in order to handle new transportation bookings at the starting depot. According to Berhan et. al. (2014), this is referred to as having capacitated vehicle routing problems. By having empty trucks on road, the utilization of capacity becomes lessened, resulting in higher costs than necessary (Santen. V, 2016). By considering the customer demand at each customer destination, RPS are able to generate optimal route plans for returning flows and when capacity is needed (Selmat et. al., 2012). According to TPA. P (2017), the data parameters that are considered while planning are:

- Agreed lead times with customer brands
- Start and end destinations
- Car model
- Priority

As seen from the list above, a small quantity of information is considered by the transportation planners. By merely considering other various data parameters as travel time, volumes, vehicle and driver availability, to mention a few, a vehicle route problem is created at the planning phase (Kumar. S. N., Panneerselvam. R, 2012; Berhan. E et. al., 2014). Even though that was the case, TPA P. (2017) still felt that there was enough system support and operational efficiency for her to successfully dispatch transportation vehicles. One interesting observation is how different the view is from LTP R. (2017). According to LTP (2017), MobiLast does not provide enough system support and is nowhere near able to optimize the route and load planning.

It is safe to evaluate that transportation planners have a different view on how the current system, MobiLast, is performing. However, it is equally safe to conclude that the optimization planning at Autolink is not satisfactory. Through observations, gathering of statistical data and interviews, it is shown that there are many different opinions in regards to the route and load optimization. It becomes transparent enough that there are many difficulties in the planning aspect and that Autolink is very much affected by vehicle routing problems in many various ways and that the situation can worsen if nothing is done.

5.4 Working Flow

Taking the working flow as shown in Figure 4.1 as an example, it is obvious that many side-works need to be taken into consideration without the support from the MobiLast before and during the actual route planning. This leads to plenty of time wasted and also increases the uncertainty and accuracy of the planning process. Therefore, the current working flow need to be changed in order to be correspond to the software implementation.

As we can see from Case 1 (Sundling, E., & Mårdfelt, J., 2011), the working process of NCL currently is actually really similar to the one used in the fast-moving consumer goods distributor A before they implemented the route planning software. The large amount of planning work is done by the dispatchers or transport planners manually based on personal experience which leads to a high risk of uncertainty in each step. However, it is also inapplicable to put a fully automatic solution in Autolink since small changes are needed from time to time to adjust orders or changing parameters from the customers as LTP said "*The planning horizon is essentially in seconds, minutes or hours, not days or weeks*."

In this scenario, the solution A used in Figure 3.7 is also believed as a feasible way for Autolink to implement the software through the whole company including Autolink, SKT and SMT. The transport planners will be placed as the central point of the integrated person-software system while the route and load planning system will serve as the main way to optimize the daily orders. The system will work as a unique way for all the subsidiaries with in NCL with a good compatibility with internal and external customers not only contains employees in the NCL-brand and all the customers but also including haulers as well as drivers for updating the real-time information. While the planners will work in a more strategic way which needs their rich personal experience to "approve" or "select" among the plans that made by the RPS. Furthermore, the focus of the planners will shift to handle emergency or do some corrections in order to make the planned route more feasible based on the additional information, i.e. sometimes the customers may adjust the orders after the planned route has been sent to the drivers, or some changes on regulation, constructions or accidents that has not been updated to the system on time, so that the planners will need to plan the additional routes manually before the information are updated on the system database by the software provider (TPA, 2017).

5.5 System Integration

The integration between MobiLast and Microsoft Dynamics AX is another aspect that is considered not being compatible in the current system setup (LM, 2017). As stated by LTP (2017), the picture below shows the current working procedure from the customer orders received by SKT till the payment. Due to the lack of system integration between the customers, SKT and Autolink, the order information need to be converted and this process usually takes hours of a day to completed. What is more, within the NCL itself, the communication is also not smooth enough between SKT and Autolink to enable a good collaboration.

Denos. C et.al. (1997) stated route and load planning has a large amount of constraints and requirements need to be considered and the more data is known, the better decision can be made to enable a higher customer satisfaction and efficiency. The gap exists currently between SKT and Autolink hinder the information delivery to the downstream company Autolink. As shown in Figure 5.2, after the vehicle preparation like PDI etc. which are conducted in SKT, the sub-orders will be made by SKT to inform Autolink to pick up the vehicles and conduct the transport, while in this step, the detail orders information will miss because of the system MobiLast used by Autolink cannot get access to the original order information (LTP, 2017). As we can say, the systems used now in NCL can only be seen as a platform for gathering all the information but not as an assistant to support the planners to make a more efficient route plan decision.

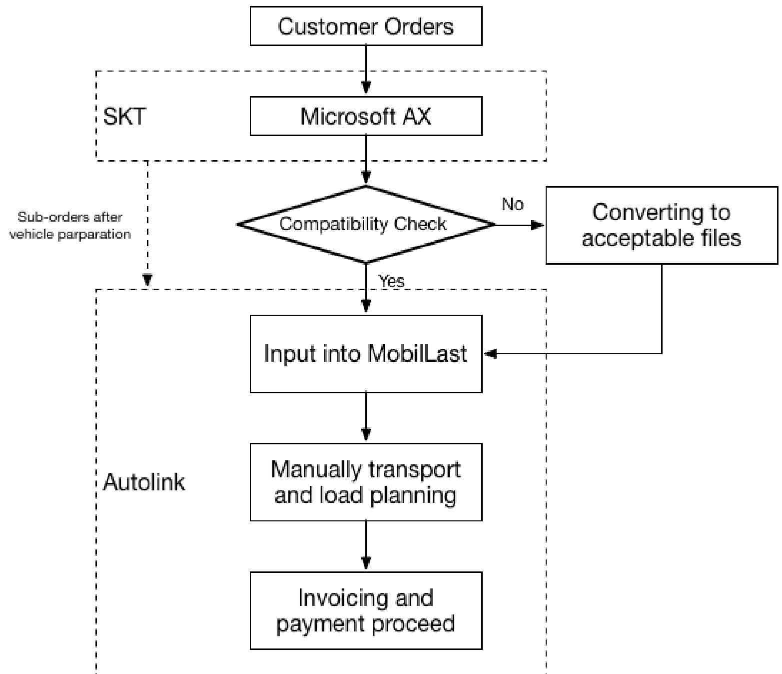

Figure 5.2 - Preparation before planning

Moreover, manual work is still performed to push signals from MS AX to MobiLast. LM et. al. (2017) wants a stronger integration between MS AX and the intended future software solution. By allowing better integration, the step between order handling, planning and optimization allows the RPS to function properly (EECA, 2017). Information is obtained from many data sources, which means that there has to be integration between systems for the RPS to access information that is available externally. The better the integration capabilities are, the easier the access to data becomes, which allows a better planning and optimization process. The issue is visible in the extraction and gathering of statistical data according to LM (2017). With no current structure for gathering statistical data such as fill rates, transit time and cost per freight unit in a systematic way, it becomes increasingly hard to report on the actual firm performance. For an LSP, it is important to be able to track the performance of the transportation activities according to Coredination (2017). Being a core activity for Autolink, it is fundamental for the firm to be able to judge the performance based on KPIs. Therefore, it becomes beneficial to have system support for gathering statistical transportation data through the RPS.

It is worth mention that the current telematics capabilities offered by the software provider VECHO is deemed to be satisfactory and no replacement is needed (LM et. al., 2017). Lee. J et. al. describes that the importance of having telematics support is due to the communication taking place between transportation planners and drivers. Furthermore, this enables the planners to receive more real-time data and updates about the route trips the drivers are driving (Lee. J et. al., 2007), which is the goal of VECHO according to LM (2017).

Therefore, based on the information from the software providers' interviews, the follow structure by implementing different softwares on the basis of the current ERP system and MobiLast is shown in Figure 5.3.

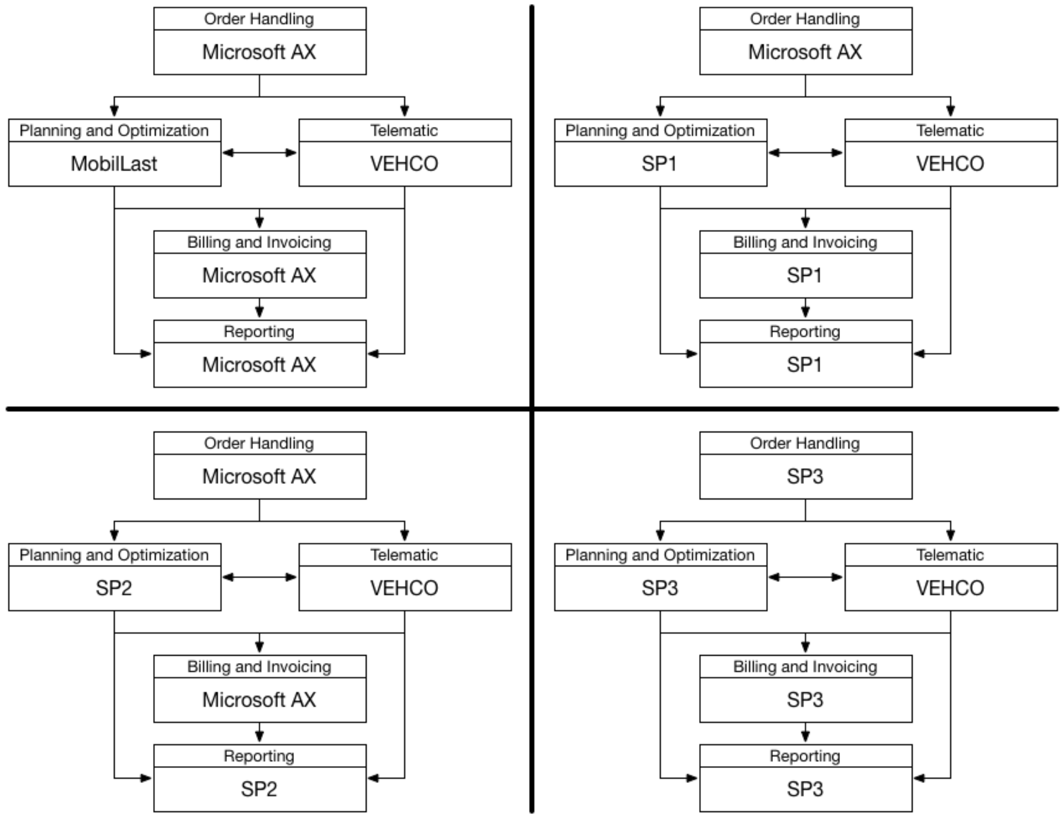

Figure 5.3 - Structure by implementing different softwares

5.6 Haulers

The analysis of the haulers will focus on the interviews with CEO H1 and HM H2 from chapter 4.4. The analysis of haulers is done in order to gather the requirements the haulers have on Autolink to further take their requirements into consideration when choosing a future software providers.

Both haulers work towards optimizing the flow for Autolink by providing capacity in terms of trucks and drivers, while assisting Autolink with various information and data to aid the planning process (CEO H1; HM H2, 2017). According to CEO H1 and HM H2 (2017), the goal is to be as transparent as possible regarding sharing information with the transportation planners. This is in line with the theory described from Selamat. A et. al. (2014) and that the RPS should be able to handle incoming information from external hauler entities regarding trip confirmations and request and in turn send back a trip plan when the planning has been conducted. With the support of the haulers to such extent, Autolink needs to add support for the haulers in their system in order to handle the incoming information flow from them. Being able to collect the necessary information from haulers adds to the accuracy and reliability of the RPS (Selamat. A et. al., 2012). Both CEO H1 and HM H2 (2017) mentions how both hauler companies want to give complete control to the transportation planners when planning, which means that it is of utter importance to give as much support to the transportation planners.

Furthermore, both hauler 1 and 2 have invested in digitalization of the transportation trucks driven by them. Investments have been made in a telematics system by both hauler companies in order to add support for real time data (CEO H1; HM H2, 2017). The intended purpose of the telematics system is to be able to oversee the drivers, GPS tracking, add support for real time data and tracking performance. Lee. J et. al. (2007) describes how this is the exact purpose of telematics systems in transportation systems, and that there should be system support for such initiatives. By adding the support of telematics systems, additional data flows can be enabled for the RPS and improve the planning process (Lee. J et.al., 2007). Real time data flows help with the management of stochastic parameters, which are random by nature. Much of the complexity in SVRP is caused by stochastic parameters according to Denos C. et. al. (1997). The desired outcome when planning and optimizing route and load planning is to have control of the random parameters (Berhan E. et. al., 2014). This is why it important to for Autolink to have telematics support within their RPS, so that it enables the support of real time data and tracking.

The tracking is another aspect of why both haulers have further invested in digitalised systems. CEO H1 and HM H2 (2017) both remarked on how important it was for them to follow the regulations regarding driving hours, breaks and rest set by the Swedish Road Administration (2015). By having control of the driving hours, breaks and rests, the haulers can assign capacity more effectively, and thus make improved driver schedules. HM H2 (2017) remarked how the distribution of driving hours in uneven since some drivers have their driving hours fully utilized, while others are having several hours left. By having support for tracking within the telematics capabilities, the RPS can use the data to construct more optimal trip plans. This is another parameter to consider in order of overcoming the vehicle routing problem, as it adds an hourly constraint on the system (Berhan E. et. al., 2017).

To conclude the analysis, it is evident that the haulers have requirements that affect the optimization of route and load planning. These requirements heavily affect Autolink in the way trip plans are constructed and dispatched. Autolink is only able to dispatch customer vehicles depending on the utilization of trucks and drivers that are operated and hired by haulers. This is why the requirements of the haulers matter greatly when implementing an RPS and optimizing route and load plans.

5.7 Benefits

With the implementation of the RPS to the whole NCL-brand, both integration and optimization issue can be largely improved. The SKT and Autolink can be seen as one organization and get access to the same database at the same time while enhance the information transparency between. All the information regarding orders as well as other factors which may influence the route choose will be collected and stored in the route planning system as shown in the Figure 3.2. The RPS can use all data like including specific customer orders, cost, vehicles and drivers and even policy into the route and load planning process (Berhan et. al., 2014). As shown in the Figure 3.11 (Dhara S. et. al., 2016), the working process of RPS works on an iterative and continuous way, every single change in the whole environment will lead to the new optimal solution in the real-time background.

To sum up, with the use of a good route and load planning system, along with other devices installed on the trucks or customers, a network can be formed between different entities within this transport chain. The transport planners can get an overview of the current delivery situation through the system dashboard which monitoring the four main areas of ITS as described by Wikipedia (2017). While based on the communication through the system works from the managerial level between NCL and customers down to the information change between truck drivers or planners. A so called CTM as shown in Chapter 3.4.2 can be achieved by bringing all the parties together to solve the route and load planning problem. The web portal of RPS which illustrates the real-time information of the vehicles can be accessed by customers and enable customers to be integrated into the system as they want (MM, 2017). The better collaboration also enables NCL have a better image of what each customer wants from the order handling process in the very beginning, as MM (2017) said "*Better offering should be based on the customer needs*".

The NCL can largely reduce the working load of the planners as well as reduce the total costs up to 5% to 20% as stated by Sundling, E., & Mårdfelt, J. (2011), while other benefits by implementing ITS and CTM like increasing asset utilization, improve service level etc. can also be gained by NCL (Audy, J. F. et. al., 2012). The extra administration working time like preparation of orders information and extra time spending on the inter-communication etc. can be minimized. The RPS can also provide the planners with more support for a better planning (Berhan E. et. al., 2014) during the work while the most of orders can be planned by the system automatically in a rapid speed (As the example in Case 1, the system can solve the route problem with 1,000 orders in about 5 minutes) instead of manually work that contains plenty of risk and extra working time.

5.8 Software Benchmarking

As shown in the Table 5.2, the requirement or points which need to be evaluated are classified as five categories named "Core Needs", "Additional Needs", "Serviceability", "Others" and "Price". These five categories are basically coming from the former template which was did by Autolink. However, it is worth to mention or can be seen as one of the biggest differences from the original template is that all the sub-criteria here are based on the needs from Autolink as well as its customers rather than with the aim of evaluating a RPS. After consider all the information above, the scores are discussed based on the Likert Scale while 1 represents the worst while 5 represents the best. The following part will be assigned to describe the contents for each criterion.

5.8.1 Core Needs

The Core Needs here is defined as the essential needs for NCL with the implementation of the whole RPS. This part has taken ideas from interviews with managers, planners as well as customers in order to find points which are needed for the company in the high priority. All the points are chosen based on the company's actual needs instead of criteria to evaluating a good RPS.

Basic Data Support
The basic data support here means the RPS should be able to handle essential information input like capacity, demand, vehicles and drivers as well as cost which is shown in the Figure 3.10. With the use of these data, the RPS can deliver a better route planning and time estimation to enhance the service level and reduce the working load for the transport planners.

Order Handling Support
One current issue from TPA P. and LTP R. (2017) is the bad integration within the orders input process. With this in mind, the order handling support is identified as one of the most important

factors of the RPS. The RPS should not only have the ability to fully consider the customer demands including volume, lead time as well as the configuration of vehicles, but also need to have a good integration with the customers side to facilitate a smooth information flow.

Transportation Bookings
The transportation booking is chosen to be the core needs for Autolink is due to its intensive correlation with the capacity issues for a long-term RPS implementation. Both managers in Autolink and the customers stated the order frustration or capacity issues in the peak time period is one of their considerations in the future. In this case, a good transportation booking can serve as a foundation to support a better order prediction. This function lets planners to booking trucks or drivers with hauliers in advance to make the hauliers have more time to arrange or allocate capacity to Autolink in the earlier step with the aim to improve flexibility.

Planning and Optimization
The route planning and optimization is the No.1 priority for Autolink to choose a RPS. Based on the data collection in the empirical findings, manually working is the main part for the planners in terms of the route plan. What is more important, the optimization process is missing in Autolink and plenty of works were done based on personal experience currently without considering all the information needed for a good route plan. And it is also impossible for planners to access to real time data and optimize the route and load planning continuously and iteratively. Based on this fact, the planning and optimization ability of the RPS is chosen to be the core needs to implement the RPS.

System Integration
Instead of the integration with the customer's system as described in the order handling, the system integration here refers to the integration within the NCL brand. As stated by LM P. (2017), the current focus for the company is to implement a route planning and optimization software which is only a module of the company's long-term vision. This requirement lead to the demand for RPS to have ability to be integrated with current working environment with the use of Microsoft AX as well as VEHCO (Telematics). Besides the compatibility with current systems, it is also needed for the software to be able to be further extended with potential other systems in the value chain as shown in Figure 1.3.

Statistical Data Support
The final core need is identified as statistical data support which means the RPS should be able to generate quantitative data instead of manually work currently be done by the data analysts. The data is used to show to the company how the fact is regarding the transport including delivery precision based on regions, brands or other criteria and other performance evaluation in different timeframes.

5.8.2 Additional Needs

Beside the core needs for Autolink, several additional needs are selected as criterions for Autolink to evaluate the RPS. The additional needs are defined as points which can improve the service level, enhance working efficiency or reduce the working load but not being stated as the essential needs for the company in this moment from the interviews. Autolink will glad if the system can provide with these feature, but if these features are missing, it will not influence the final decision so much.

Reporting Support
The reporting support is seen as one complement to the statistical data support which is a build-in feature of the RPS. The aim of it is to generate brief report for the data analysts or managers to have a basic image of the working information in different manner like figures, tables or even texts etc.

Invoicing Support
The invoicing and payment phase is the final step for Autolink in dealing with the delivery. Instead of the currently way of invoicing with the use of Microsoft AX, the invoicing support refers to the feature that the system can send the invoice information to the customers automatically. And this feature can be seen as one step further for the integration with customers' system as identified in the core needs.

Telematics Support
The real-time information sharing between transport planners and driver was stated by both TPA P. and LTP R. (2017). With a good support for telematics modules in the system, lots of time can be saved due to the reduce of additional communication time through phone calls among planners, drivers and customers. Although currently Autolink is quite satisfied with the current telematics system VEHCO, but in order to be fully integrated in the future, the telematics support of the RPS is chosen to be the additional need.

Tracking and Tracing
Kaelsson M. and several customers (2017) states one of the most important trends in the future market is the need by customers to have more and more detailed real-time delivery information of the vehicles they need. With this in mind, it is required that the RPS can provide real-time updated vehicle information to the customers through customer portal or other manners.

Language Options
As mentioned by LM P. (2017), the language options can be considered as one advantage of choosing the RPS. Since Autolink conducts business in Norway and Sweden currently, the support for Norwegian and Swedish can minimize the potential risk for further recruitment.

Security
The confidentiality of the company information including orders, customer data etc. is critical to both NCL brand as well as their customers. But as mentioned, since the original requirement of Autolink to implement the RPS is to improve the operation performance, so the security is put in this segment.

User Friendly Interface
The user-friendly interface existed in all the interviews within the company regardless of levels in the company. A good user-friendly interface can reduce the learning cost as well as show the information in a clearer way to the customer. But as concluded in the last points, since this is not extensive linked with the original goal of implementing the RPS, this feature is also put in the additional need.

5.8.3 Serviceability

The serviceability of the software providers is determined through their ability to offer support for their services. The NCL brand will become dependent on the knowledge and experience that each software provider has on the after sales procedures in order for the software to work as intended (LM, 2017). Software providers will, as a result, be judged on their inclusion of support, maintenance, expertise sharing and plans for implementation.

Support

The support feature here refers to the customer support provided by the software providers including software and hardware support professionals who provide supports via email, telephone across the whole solution that the company provide to enable the optimal performance.

Maintenance

Maintenance is the service that the software providers should be able to offer promptly update on the system in a regular basis and prevent the database from breaching while it is facing emergencies.

Expertise

It is important that the software providers have the experience in the logistic industry or in the related areas like transport management or route planning. Based on the experience of the software providers, knowledge can be transferred to Autolink through the training process by the software providers. With the proper education, Autolink can gain a deeper understanding of the systems and reporting capabilities as well as gaining a deeper knowledge of industry best practice to fully master the system.

Implementation

The implementation feature represents how good the proposed project plan of each software provider to implement the system in the Autolink. While this process starts from the software and hardware installation until the final customized system starts working based on the customer's requirement and actual situation.

5.8.4 Others

Other criteria that do not affect the decision as much as the previous ones will be listed in the Others-category. These criteria are considered important to an extent, and would play a much larger role in the future. According to LM et.al (2017), the direction of the NCL brand is moving towards becoming a 4PL, and it is in the interest of the managers to see how the software can be developed further. Considering this, the software providers will be judged on two points including their 4PL capabilities along with the future possibility.

4PL Capabilities

The 4PL capabilities means the system can be used as a one station solution through the whole value chain of Autolink or NCL brand as shown in Figure 1.2. This criterion is used to see how the current 4PL capabilities of each software and how is it to integrate with other platforms that currently used in the company.

Future Possibilities

As mentioned, the company is planning to move forward as a 4PL step by step in the car logistic industry. Therefore, the future possibilities or the extensibility is selected as one parameter to evaluate the software. This parameter aims to see if it is possible for current module to be extend or connected with other potential modules to enable a total solution in the future market.

5.8.5 Price

The price of the software and all its included services determines how feasible the implementation becomes for the NCL brand. LM P. (2017) wants to make sure that the return on investment is greater than the cost of it, saying that "the cost needs to make sense depending on the needs". The price criteria will therefore be reviewed in the end of the benchmark model as two separate parts, when all other criteria have been reviewed already.

Implementation Cost
The implementation cost is the one-time cost which will happen in the beginning of the project including solution design, data migration, hardware and software investment as well as project management and education etc.

Annual Cost
Beside the implementation cost, the annual cost refers to the yearly cost for the solution maintenance and services fee as well as the cost for further development.

5.8.6 Benchmark Analysis

As mentioned above, the benchmark model was constructed using different criteria obtained from the theoretical framework, empirical data collection and observations. The Table 5.2 below shows the benchmark of the different software providers; SP1, SP2 and SP3 based on the criteria above. In order to show how well each software provider was rated on each criterion, a Likert scale from 1-5 will be used, where 1 indicates unsatisfactory fulfilment and 5 extraordinary fulfilment.

Table 5.2 - Software Provider Benchmark

		SP 1	SP 2	SP 3
Core Needs	Basic Data Support	4	4	4
	Order Handling Support	4	4	4
	Transportation Bookings	4	4	4
	Planning and Optimization	3	5	2
	System Integration	4	5	2
	Real Time Data Support	4	4	4
	Statistical Data Support	4	4	4
Additional Needs	Reporting Support	4	4	4
	Invocing Support	5	4	4
	Telematics Support	3	4	5
	Tracking and Tracing	3	4	5
	Language Options	2	2	4
	Security	4	4	4
	User Friendly Interface	3	5	4
Serviceability	Support	4	5	5
	Maintenance	3	5	5
	Expertise	4	3	4
	Implementation	4	5	5
Others	4 PL Capabilities	2	2	5
	Future Possibilities	4	4	4
Price	Implementation Cost	5	4	2
	Annual Cost	4	4	2

Core Needs
Looking at the core needs and criteria of each software provider it is shown that each provider is able to fulfil most of the core needs. Basic data support, order handling support, transportation bookings, real time data support and statistical data support was able to be provided by each supplier in a satisfactory way. Each provider was able to ensure that their product offerings were able to gather and store data so that optimal plans could be created. The usage of data is fundamentally important for a RPS in order to solve a VRP (Kumar S. N., Panneerselvam R., 2012; Berhan E. et. al., 2014) Furthermore, all of the product offerings from the software providers had the necessary functions such as order handling, booking, optimization and statistical data support. In order to generate an optimized plan, certain functions need to be present in the RPS as shown in Figure 3.10. SP2 is offering a specific portal solution for its customers that are tailored to improve the order handling and transportation booking aspect of the RPS. A similar solution is found in the product offering of SP3, while SP1 does not offer a specific solution for order handling.

The software providers mostly differ in the optimization aspect of their product offering as shown in the benchmark model. SP2 scored the highest in its ability to offer the best optimization for Autolink. This is due to being able to generate optimal plans for several routes, vehicles and load by using basic and real-time data. In other words, the optimization process of SP2 would be able to solve regular VRP and Stochastic VRP. Furthermore, the optimization tool of SP2 was able to take classifications of different vehicles into consideration. Autolink is currently dealing with many different cars with varying dimensions and weight, which puts additional pressure on the allocation of capacity and loading. While SP1 and SP3 were able to offer similar optimization setups, they were unable to offer the same sophistication as SP2. Similar to SP1, SP2 offered a modularized solution that put more focus on achieving the purpose of offering an optimization tool. Even though SP3 did offer a optimization tool, it was not best applicable to Autolink and its industry. The optimization tool was more suited for parcel cargo transportation rather than vehicle transportation. SP3 on the other hand can be viewed as a total transportation system solution focusing on all operations in the supply chain. All from yard operations, to inspections and planning is covered by SP3 product offering.

In that regard, SP3 falls behind in the integration criteria since it would require a new system implementation across the whole NCL-brand. This implies that the current system setup with Microsoft AX and VEHCO would be dismissed in favour of SP3's solution. Autolink is currently more focused on a optimization module rather than a complete solution (LM, 2017). The reason being is that a new complete implementation would require a high amount of resources, knowledge and funds to implement properly. The risk and cost of such implementation does not outweigh the benefits. Instead, it is more beneficial for Autolink to ease and carefully implement a module so that more experience and expertise is gained along the way. Currently, the firm and its employees, mainly the transportation planners have very little to none exposure in optimization tools. By putting focus and funds into a big and comprehensive solution, the result could end up being costly for the NCL-brand. A successful implementation of SP3's offering would allow a high level of integration since the software functions are connected to one system. SP2 and SP1 on the other hand would both be able to integrate their product to Microsoft AX and VEHCO.

In the end, SP2 ends up being the provider most able to fulfil the core needs of Autolink by offering satisfactory functions in their product offering with the addition of an effective optimization and planning tool. While SP1 would be able to improve the current situation of Autolink, it’s sophistication does not match SP2s more suitable product offering. SP3 would be able to solve the VRP for Autolink, but is considered a more large-scale implementation and solution. As a result, SP2 ended up with the highest average score out of the three providers with a score of 4,28, while the SP1 had 3,85 and SP3 3,43 in the benchmark analysis.

Additional Needs
Figure 3.10 is once again used to display the importance of certain additional needs such as reporting, invoicing and telematics. Coredination (2017) describes how important is to be able to track the performance of operations, including the planning while also having support for effective billing and invoicing. Each software provider was able to delivery most of the additional needs in a satisfactory way. While all the providers were able to provide support for most additional functions such as; reporting, invoicing, telematics, tracking and tracking, some excelled more than others in different aspects.

Regarding the reporting, invoicing, telematics, tracking and tracing it is shown that SP2 and SP3 excel the most. While SP1 would provide a satisfactory fulfilment of the functions mentioned above, SP2 and SP3 provide additional application support for their reporting, tracking and tracing. However, SP1 ended up having the best invoicing support due to the company’s vast experience with economic systems and billing procedures. While telematics support is enabled for all the software providers, Autolink still remains adamant to keep VEHCO as their main provider of telematics system (LM, 2017). In regards to that, each provider is able to integrate with VEHCO if necessary. SP3 was however able to use its own telematics, tracking and tracing tools to successfully identify where cargo was located at each of their steps in the supply chain. However, this is an independent system, which means that the integration with VEHCO became unclear.

Big differences were spotted in the language options of the service providers, where SP3 is the only provider able to offer translations in all the Nordic countries. However, all the providers were able to run their software in English. In addition to English, SP2 was able to run its application in the Danish language and SP1 was able to run in the Norwegian language. Each provider was able to offer satisfactory security by protecting sensitive data and the users using the system.

Each software provider was able to at least offer a more user-friendly interface for the users compared to MobiLast. The UIs where customizable depending on the preferences of the transportation planners, meaning that the planners could choose what to display in the software. However, SP2 offered a UI that was aesthetically pleasing and easy to navigate. The software could easily display relevant basic data, real time data, driver and vehicle availability while the transportation planner was able to generate optimal route plans. Additional features such as drag and drop allowed the transportation planners to manually drag and drop orders onto truck in a visible way. SP3 had a similar structure of their UI while also offering additional features.

In conclusion of the additional needs, SP3 comes out as the provider who is most likely to fulfil the needs in a satisfactory way with an average score of 4,14. SP2 falls shortly behind with an average score of 4 due to its language options falling short. SP1 ends up with a score of 3,42 meaning that their product offering would be satisfactory for Autolink, but not as sophisticated as

SP2 and SP3.

Serviceability
In the ability to service customers in regards to support, maintenance, expertise and the implementation process, each provider was able to give at least satisfactory support as shown in Figure 5.5.1. A huge cost and clear implementation process made SP3 very likely to effectively support Autolink in the implementation. SP3 allocated funds for system configuration, tests, education and go-live support in order to make sure that the implementation goes as intended. However, the huge cost is due to the comprehensive solutions that is offered by SP3, as it focuses on all actions from yard management to transportation planning and follow-up. Both SP2 and SP1 have lower prices assigned to their support and maintenance due to their modularized solution. SP1 has 252 260 SEK (June 30, 2017) assigned for education and test, while SP2 has 885 000 SEK (June 30, 2017) assigned to support, test, educate and run projects to aid Autolink.

While the companies are specialized at creating planning softwares, their experience is more focused on route planning for cargo that is different from cars. In that regard, each provider could not score above 4. To conclude the serviceability criteria, SP3 averaged a score of 4,75 with SP2 tracking behind at 4,5 and SP1 at 4.

Others
LM et. al (2017) stated that the direction of the NCL brand is moving to a more solution oriented business with 4PL capabilities. With that i mind, the only provider to be able to offer a solution that would suit such plans would be SP3. By overviewing all the operations taking place from the harbour and yard to the planning of transports, SP3 TMS solution is able to gain control tower view of the supply chain and assist when needed.

In terms of future possibilities with the softwares, each service provider is able to develop their software further if that is the case. Autolink is valuing a close relationship with its provider and being able to develop that relationship further (LM, 2017).

To summarize, SP3 is the most likely decision in regards to moving towards 4PL oriented software. They offer a TMS solution that is able to be further developed if needs change in the future, which is why the scored the highest in this category (4.5). While SP1 and SP2 do offer same development capabilities, they are heavily dependent on other softwares independent softwares that Autolink is working with (Microsoft AX and VEHCO), which is why both scored 3.

Price
Looking at the prices for each software provider, SP3 comes out as the most expensive one with an initial potential implementation cost of 5,489 MSEK and additional annual costs of 5,127 MSEK yearly in license and maintenance cost for 5 years. The license costs are influenced by the volume handled by Autolink and could very well rise depending on how large the volume actually is. As stated numerous times above, the high price is mostly influenced by the magnitude of the solution, being a TMS solution and not only a optimization tool. This is one of the main reasons why SP3 product offering could become a financial burden with costs reaching 26 million SEK over 5 years. In turn, Autolink gets a solution that might not be beneficial for their business at this given time period. In turn, the feasibility of SP3 is not deemed satisfactory for Autolink, which is why the average score for the price is 2.

The two more cheaper options are SP1 and SP2, which focus on a modularized optimization tool. SP1 have calculated a 1,5 MSEK implementation cost and a total service and maintenance cost of 4,708 MSEK over 5 years. In total, the costs amount to 6,2 MSEK over the 5-year period for the software solution. This makes SP1 the cheapest alternative and affordable for Autolink. However, considering that SP1 rated lower than both SP2 and SP3 in all the benchmark-categories, the solutions might not be the best for Autolink. Due to SP1s' affordability and suiting Autolink better than SP3, their score is 4.5.

SP2 comes in as the second most expensive solution with 2,75M SEK in implementation costs including annual license and maintenance cost of 1,125M SEK for 5 years. In total, SP2 offers a solution that costs 8,375M SEK over a five-year period, which is almost 18 million SEK cheaper than SP3 and 1,8M SEK more expensive than SP1. This can still be considered as an affordable software option which is why the score is 4 for SP2.

6. Result

This study aims to find a way to improve the current route planning operations of Autolink based on their needs and market demands with a purpose of establishing sufficient information for Autolink to make a decision regarding a potential IT-software investment in the future. With this in mind, the thesis put focus on answering the three research questions mentioned in chapter 1.3 to find the necessary results for the study. These research questions will be answered below, based on the information presented in this report.

RQ1: What requirements and parameters have an impact on the planning and optimization of routes and cargo for Autolink?

Throughout the literature study, data collection and observations made at Autolink on transportation planning, several parameters and requirements were found to impact the route and load planning. Presented below is a list of which requirements impact the transportation planning processes. For these questions, the conceptual model 3.10 will be used which parameters affect the planning as seen below.

Travel Time: Distance, road conditions, traffic conditions, weather and loading/unloading times.

Management Input: Strategies, policies, goals and vision.

Capacity: Truck capacity, cargo dimensions and depot capacity.

Customer Demand: Volume, lead/windows time and cargo types.

Vehicles and Drivers: Vehicle availability, driver availability, vehicle condition, drive regulations and fuel consumption/driving patterns.

Cost: Price model/structure and parameter dependent.

Further data collection and analysis showed that the exclusion of different software feature capabilities was impactful on the planning process. The additions of invoicing, reporting and real-time data support through telematics would be necessary and enhance the quality of the service offered by Autolink. The integration between internal and external system impacted the planning process of Autolink in terms of optimization and functionality. In addition, the hauler companies stated the importance of satisfactory communication with drivers and vehicles to be a necessity. The report also showed that regulations imposed by the Swedish Road Administration (2015) impacted the planning of the truck in terms of driving hours, breaks and rests.

RQ2: In terms of customer requirements, which needs do they impose on the route planning and how does it affect Autolink?

During the process of three interviews with five car brands from different backgrounds, different demands are identified by the end customers. There is no doubt that the most important requirement is stated as lead time or even detailed lead time (Time-windows delivery) by all the customers. Beside lead time, other demands are also pointed out i.e. fill and damage rate (quality), price, communication, environmental performance as well as capacity issues.

As believed by the authors of this study, the focus on the lead time or the delivery precision in the planning phase can enable Autolink to have a more precise route and load planning since these are the most important criteria for customers to evaluate the service level. A more efficient resource and capacity usage as well as a better integration internally within NCL brand and externally with customers are needed to reduce the time waste, working load and complexity. In this scenario, a well-organized route and load planning system is suggested by the authors for Autolink to reach better performance to replace the intensive manual work that is used in the company currently.

RQ3: How does a software implementation benefit Autolink to improve their planning process? And which kind of solution is most suitable for Autolink?

This thesis report shows that Autolink is able to reach a more beneficial situation by implementing an RPS solution for their transportation planning. With no or limited optimization taking place at the moment, improvements would be able to be made in different areas in the planning of routes and cargo. Autolink can expect shortages in administration time due to a decrease in manual working time. With more optimized plans, transportation vehicles would be assigned the most optimal route for its cargo, reducing the total distance. This could help eliminate the issue of empty return goods flow from end destinations, which in the end reduces the cost. With more accurate time estimations generated by the RPS, improvements could be made in the current unsatisfactory delivery precisions to customers. Furthermore, as shown through the case studies, Autolink would be able to improve the environmental performance of the trucks through reductions of emissions. As a result, the authors of this report believe that Autolink have a lot of potential for improvement within their planning process.

Through the usage of benchmarking in chapter 5.5 of this thesis report, it was found that the best suitor for a software solution would be SP2. SP2 was able to satisfy Autolink’s core needs the best out of the three providers. The optimization tool is able to compute multiple geographical depot spots while taking multiple data types into consideration. Due to its simplicity, being a modularized optimization tool, it is most beneficial for Autolink’s current IT structure. Outside of the core needs, SP2 was able to fulfil the rest of the categorical needs in a satisfactory way. Therefore, it is strongly believed that SP2s product offering is able to give Autolink all the benefits that come with an optimization tool as mentioned above. The only doubt on SP2s product offering are the future software development possibilities and 4PL capabilities. Autolink if it’s needed.

7. Discussion

Since the scope of this study is limited to solving the route and load planning as well as optimization problem within the distribution phase of the whole value chain, the report has only put emphasis on this field and ignored several points aside of this goal. However, the following questions are considered as interesting areas which could become the potential fields that worth the company to look into in the future.

7.1 Total transportation solution

During the study, it is found that Autolink or NCL-brand is working forward with a long-term version to be a total solution provider or so called 4PL. Both LM and COO (2017) recognize the synergistic benefits and a need as being a 4PL in the vehicle logistic industry in the future market. However, as shown in Figure 1.2, the scope of this study is limited within the NCL-brand itself from terminal handling in Sweden until the vehicles arrive to the end customers as requested by the company. In this perspective, the suggested implementation of the route planning system in this study can be seen as the first step for Autolink moving forward to a 4PL in the future.

Therefore, after six-month study, it is suggested by authors that the need of a well-chosen total transportation solution is gradually increase along with the degree of the integration of the whole value chain. The final system should not only provide a full view of the current scope as state before but also needs to take the processes like factory to harbour delivery, harbour/terminal handling and sea freight into consideration which is out of the current scope. The control tower view of the whole value chain can be shown in a better way with the use of a total transportation solution, and Autolink can centrally monitoring the whole working procedure as well as the single module within the process.

The reason for choosing the total transportation solution in the future instead of extend each module step by step as what is doing now can be concluded as three points. First of all, since the RPS is the first time that Autolink introduces the computer-aid system into the organization, it is better for them to learn by doing and extend the modules gradually from Autolink to the whole brand in the beginning. This action aims to avoid the risks of the huge operational and managerial differences by implementing a one-station system in the beginning. Besides, with the growing number of modules, the system integration issues between different systems or even different platforms will become more and more complex. With this in mind, a total solution provider could be a better idea in rid of the integration or compatibility problems. Last but not least, with the implementation of a total transportation solution in the future, some knowledges which beyond the current scope of Autolink or NCL-brand can be obtained from the solution providers. The training and support services and help the company accelerate to transfer to a 4PL.

7.2 Capacity constraint

The capacity constraint issue was mentioned many times during the data collection process, not only from the internal employees but also from customers. According to the theory (Berhan. E, et. al., 2014) as well as the RPS providers, it is assumed that this problem can be concluded as a whole supply chain problem as TM 1 and TM 2 (2017) said, the capacity issues starts in every step of the supply chain including the sea transport, freight transport or even in the inventory.

This cannot be solved only by Autolink itself at least for now since it is beyond the scope of the distribution phase that Autolink focuses on.

As mentioned in the previous chapter, benefits like maximized load volume and higher utilization of the current resources including drivers and trucks can be reached by the use of RPS. But this action can only enhance the operational performance by improving the planning efficiency when the order quantity is under the maximum capacity.

However, the order fluctuation for the Sweden market is the more serious issue that is facing by the company as shown in Figure 7.1 which comes from the order quantity over the 2016. It is found that the order quantity ranges from around 4500 to 10000 cars each month with a average of around 8000 per month.

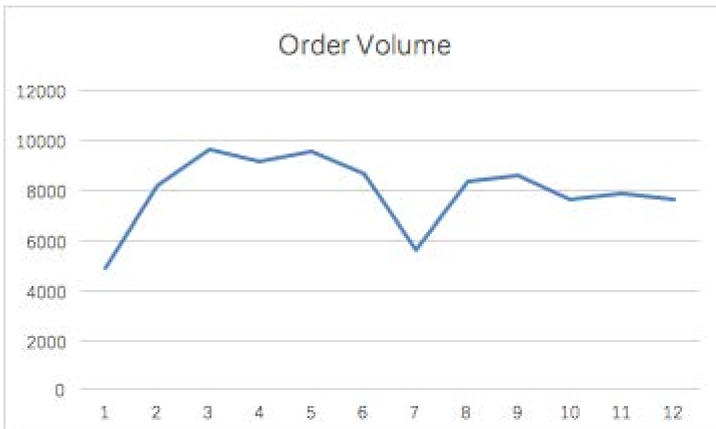

Figure 7.1 - Order Volume for Sweden market in 2016

As told by the employees of Autolink, the order fluctuation usually will reach the peak before or after the holiday due to the high volume of rented cars delivery, sometimes it also happens because of the sales push by the car brands before the end of the financial year. Such a big difference on the volume leads to lots of troubles for both Autolink as well as customers. On the one side, the customers wanted Autolink to provide enough capacity as they needed for the car delivery especially during the peak time period. Otherwise, either customers or Autolink will need to hold these vehicles in the limited inventory space and the customer satisfaction of consumers will drop due to the delivery delay. But on the other hand, it is unrealistic for Autolink to keep the spare capacity during the slack season if they hold a fixed contract with the hauliers.

To sum up, the capacity issue is definitely a field that Autolink should look into in the future if Autolink wants to be a 4PL in this industry as their future vision not only because it is actually one of the demands requested by the customers, but also because it is an existing problem that Autolink is currently facing in the daily operation. A possible solution for this could be seeking for a flexible contract with hauliers in terms of the capacity based on a better information sharing and prediction from the customer side.

7.3 Centralized or decentralized route planning

Choosing which strategy to implement when planning everyday business operation is fundamental for companies. The same principles affect Autolink in terms of how the route planning is conducted. At the moment, the firm is dividing its transportation planners on different geographical locations. As shown in chapter 4.1.4.2 planners are assigned to one of the main ports in either Gothenburg, Södertälje, Malmö and Halmstad with the responsibility of planning their own districts.

This can be considered as a decentralized route planning strategy according to Portatour (2015). With transportation planners allocated at several destinations, they are able to react more effectively to short term changes in the planning phases. Transportation planner then has specific port, route and load information depending on the port location and district. However, in an environment where there is no or limited optimization and low system support, which is the case of Autolink, decentralized planning becomes rather ineffective. According to Portatour (2015), more time is then needed to construct optimal route plans when working in a decentralized manner. Even then the quality of the route plan cannot be guaranteed since much of the time has been wasted on actually finding a solution that is not optimal. As shown in this master thesis, Autolink is currently not able to guarantee optimal route plans due to no or limited system support for optimization. Consequently, this would imply that the current decentralized planning setup is not beneficial for Autolink and its route and load planning.

Centralized planning on the other hand would give Autolink the opportunity to plan in-house at one location (Portatour, 2015). Compared to decentralized, all the planning decision will not be taken at a local level. Instead, they are taken at a central level with a holistic view of the routes and cargo. This is more effective for a multiple depot strategy, which is the case for Autolink (Chapter 4.1.4.2) (Ortec, 2017). The reasoning behind this is that planners can apply synergies when optimizing over multiple locations. It is considerably easier for transportation planners to exchange expertise, experiences and best practice while located at a central location (Ortec, 2017). As a result, the planning unit can obtain more control over the flow of trucks and goods.

The focus is to create a control tower unit that takes all the planning decisions while having a supply chain overview. Certain capabilities need to be in place for this to become operational. According to Ortec (2017), there has to be technology, organization and process support for a control tower concept to function properly. It has to be assured that qualitative data can be captured in the system and later used to make planning decisions with high transparency. As long as the data is of high quality, the need for planners at local sites decreases. A centralized control tower unit would use the qualitative data to manage transportation, inventory, measure and monitor the supply chain operations.

For Autolink, this could mean that several improvements can already be made at this very moment. By slowly realizing that a central control tower unit is more effective for the transportation planning, Autolink could change the current planning strategy. Being able to gather all the transportation planners centrally or to a centralized schedule, more knowledge could be exchange between the planners. This creates a system where decision is made centrally for several depots with the inclusion of more qualitative data (Ortec, 2017). This would result in taking much better decisions for the route and cargo network. Newly recruited planners would also benefit greatly from the centralized strategy, as the learning curve becomes shorter. According to LTP (2017), planners have to spend a lot of time figuring out how even start planning and finding their own best practical way. By including them in a new unit or team, it becomes easier for them to get into the working environment and logic. Furthermore, Autolink would also reduce costs by assigning people to one location rather than having overcapacity in other locations.

With the focus on implementing a new route planning system, Autolink would add technological support for their transportation planners. As mentioned by Ortec (2017), a centralized planning strategy benefits greatly by having relevant technological support. This adds further support towards the decision to invest into a new RPS, with the main reasoning that Autolink could further develop their business and planning strategy to become more efficient.

7.4 Leased cars trend

Along with the capacity issues that are affecting Autolink, a new distribution flow of cars might soon be introduced. According to MM (2017), the whole NCL-brand is going to be heavily affected by the increase in leased cars. Such advances in the marketplace puts additional pressure and needs on the NCL-brand to deliver better performance. MM (2017) has identified that time windows deliveries and pickups are going to be one of the few additional needs that the customers are going to ask for when leasing cars. This is also confirmed as a potential change by the transportation managers at two of the car brands, adding that customer are going to want more time specific deliveries (TM 1; TM 2, 2017).

Selmat. A et.al (2012) talks briefly how specific time windows puts additional constraints on the travel time estimation for route and load planning. Rather than preparing the transportation trucks and its vehicle cargo accordingly to agreed lead times, there has to be a adjustment towards delivering on a specific time. This means that once the car is ready for transportation, Autolink will no longer have the usual 48 hours to deliver to the end destination. Instead there will be a fixed time when the car needs to be delivered, independent on when the car is ready for transportation. Shortened lead times is something LTP (2017) believes will affect Autolink in the future and is thus inevitable. Considering that the current software planning setup with MobiLast gives little support towards estimating the travel time (LTP, 2017), transportation planners are going to face an even harder task to accommodate leased cars to customers in time. In chapter 4.2.2, the current delivery precision without time windows is shown, and only one car brand was able to receive their cars at a satisfactory precision level. By accounting time windows into the equation, delivery precision becomes even further constrained, adding more difficulties into the transportation planners task.

To manage such situation both Selmat. A et.al (2012) and Berhan. E et.al (2014) describe that time windows can be managed by RPS and their algorithms. Time estimation calculations will be regulated to the time window parameter, and transports will be dispatched accordingly. Transportation planners then get the necessary system support to dispatch transportation trips successfully. Basically, an RPS investment would also be beneficial for Autolink in the future when taking leased cars into consideration as well. This should also be considered when investing into a new system, as it affects future business plans. One aspect of the RPS is that managerial requirements, policies and strategies are taken into consideration in order to work as intended (Selmat. A et.al, 2012).

8. Conclusion

This chapter presents the conclusion of this study in terms of the three research questions, as well summarize authors' recommendation of the software selection and the potential field that may be attractive for Autolink to look into in the future.

Throughout this master thesis study and its empirical findings, the current situation of the logistics service provider Autolink has been observed. The findings have shown that it is evident that Autolink would benefit from implementing a route planning software with the aim of optimizing and improve the current route and load plans. Due to this, there is a clear gap between the firm's current transportation planning compared to what is recommended and needed. As a result, the transportation planning is not executed in the best and most optimal way possible.

The study has shown the effect of considering both basic and real-time data into the planning phases of transportation. By including more relevant data and data that is gathered in real time into the planning phase, the reliability of the planning as well as the quality of the service is enhanced. This provides help in the quest of delivering within lead times specified together with customer car brands. The findings showed that lead times was most of the highest concern for the customers, which was something Autolink could not fulfil in a satisfactory manner. By addressing the customers and their needs, it became evident that there were issues in managing the lead times and that a planning solution was necessary. By implementing a route planning software, Autolink would be able to regain more control of their transportation planning compared to the current system in place. Several other benefits were also possible for Autolink, such as; reduced administrative time, reduced total travel time, reduction in emissions and cost reduction. As a result of this, the authors of this report managed to benchmark three software providers against each other. The results of the benchmark showed favour for software provider 2 (SP2) mainly due to fulfilling the core needs of delivering a modularize planning tool with strong optimization capabilities that fits the current system setup.

Even though there are clear benefits of implementing a route planning system at the firm, additional supply chain issues were recorded that might affect the investment decision. With the continuous increase of cars imported, Autolink is heavily subjected to a capacity issue that affected the availability of inventory spaces. This is something a route planning system will not solve entirely by itself, whereas its geared more towards demand planning from customer car brands and port operators. With the influx and increase of leased cars on the market, the issues is going to become even larger due to a higher car turnover in inventories. Instead, the authors of this report suggest that a total transportation or supply chain system solution might be beneficial. This allows Autolink to gain control of the whole chain, but would require additional IT and personnel capabilities. Furthermore, it is suggested by the authors of this report that Autolink should look into the possibilities of centralizing their business further so that additional business benefits from the planning perspective can be gained.

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Appendix A - Questionnaires

Interview Questions (COO)

What is the short-term, mid-term and long-term vision of Autolink and NCL?

How does the NCL companies work together? How are the operations coordinated?

Which barriers are you seeing in the transportation aspect of the firm?

How do you feel about the current level of integration with your suppliers and customers?

At which level do you want to collaborate with the software providers or customers?

How do you make sure your services are coordinated with customers?

Are you aware of certain requirements or complaints from customers concerning transportation?

What do customers find satisfying, what do they find unsatisfying?

Are there any trends that you are aware of that might affect NCL in the future and how is it taken into consideration when planning?

Interview Questions (LM)

What is the short-term, mid-term and long-term vision of Autolink and NCL?

How is NCL structured today and how do you collaborate together?

How is transportation managed today?

How does the relationship with car brands and dealerships work?

Is each dealer responsible for one specific brand or more than one brand?

How do you collaborate between the 4 ports around the Sweden?

Is the decision made only in Gothenburg or individual at each site?

Do you prefer to develop a centralized strategy?

What is the vision with the distribution of cars?

What is your opinion on the current route planning system?

What are the objectives and goals when planning and optimizing routes?

What are your requirements for the software?

Which kind of problems are you experiencing with you route planning currently?

Interview Questions (MM)

What is the short-term, mid-term and long-term vision of Autolink and NCL?

Which needs and demands are imposed by customers?

Are there any KPIs that you monitor and control in order to fulfil the customer desires?

Which future trends are you starting to see within your customer base and market?

Could you tell us more about how you develop potential customers through marketing?

Which aspects do you think is the most urgent to improve in order to meet the demand from the marketing perspective?

How do you deal with the customer’s complaints regarding the delayed deliveries caused by planning?

Interview Questions (LTP)

What is the short term, mid-term and long-term vision of Autolink and NCL?

Is there a specific working description for the planners that they need to follow?

What parameters or factors will you consider when you decide the route planning?

How is transportation planning managed and executed currently?

How do you evaluate the current software system?

Do you feel that the current software setup is user-friendly or do you think it provides enough support when the planners make decisions on the order and truck planning?

When you received an order, how is it fed into the system so you can plan the transport?

Which requirements do you have on hauliers?

What are your requirements on a future RPS?

How important is a reliable time estimation for the customers?

Which trends are you seeing being developed in the future of transportation?

Interview Questions (TPA)

What are the objectives when you plan routes?

How are you currently working with route and load planning?

How does the process look like?

Which kind of data and parameters are you working with when planning routes?

Which issues do you experience regarding route planning during your daily work?

Do you feel that the current software setup is user-friendly?

Is it easy to access the data and make use of it to plan optimal routes?

Do you feel that any particular data is missing for you to plan routes more effectively?

How do you ensure the highest possible load factor for each transport?

How do you make sure that the travel time estimations are reliable?

Do you feel that the system gives enough support?

Do you get sufficient information from customers/suppliers regarding customer orders?

Do you do any monthly or seasonal report to summarize the work?

Interview Questions (Hauliers)

Which activities are carried out by your company?

What information do you need from Autolink to be able to conduct your business effectively?

What information do you send back to Autolink?

How do you communicate with Autolink to make sure the sufficient communication is achieved?

How do you as a hauler manage transportation plans from Autolink?

How the price for your service settled?

What is the fixed price agreement based on?

Which issues do you face the most?

How do you feel about expanding your current IT structure?

Which regulation do you have for your drivers?

Which trends are you seeing in the future on the road transport?

Interview Questions (Customers)

What information will you send to Autolink in terms of orders?

How are the order schedules distributed?

Do you have any prediction on the orders in the future?

Are you sharing this with Autolink?

Which communication is conducted between you and Autolink?

What do you think is the biggest issue when you working or communicating with logistic service providers?

What do you expect from Autolink in terms of your demand and requirements in transporting cars?

How do you evaluate Autolink in terms of transportation according to your requirement?

Do you see a trend in time windows delivery or the car deliver to the customers directly?

Which issue do you think actually influence most to you, the delayed delivery itself or the inconvenience that caused by the wrong estimated lead time?

What is your view on the system integration with other companies?

Do you keep an inventory in the dealership in terms to face the order fluctuation?

Interview Questions (Software Providers)

In terms of order handling, how are the orders handled into the system?

How well is order handling integrated with other systems?

How is the route and load planning optimized in the software?

Which parameters are taken into consideration by the software?

How would travel time be estimated by the software?

In which way can updates and changes be made in the planning process?

Are iterations possible while planning?

Is the software able to prioritize orders depending on their urgency?

How the planners are able to communicate and update drivers along the planning process?

Does the software gather statistical data?

How is the invoicing executed?

Appendix B - Route Allocation

Figure 1 - Route T

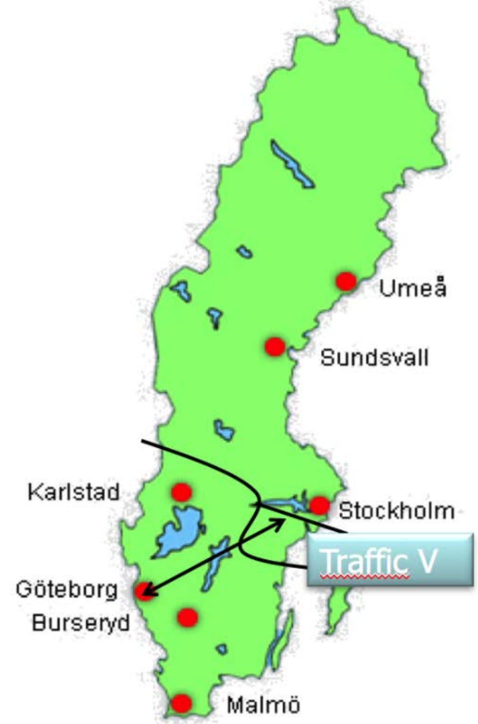

Figure 2 - Route V

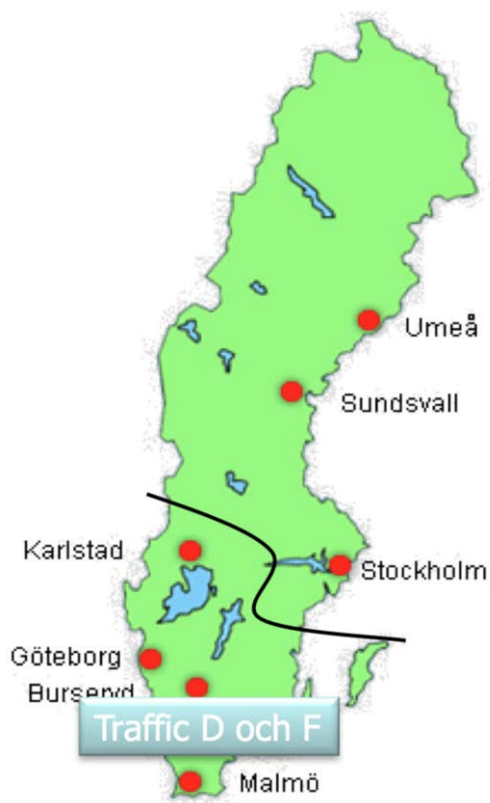

Figure 3 - Route D/F

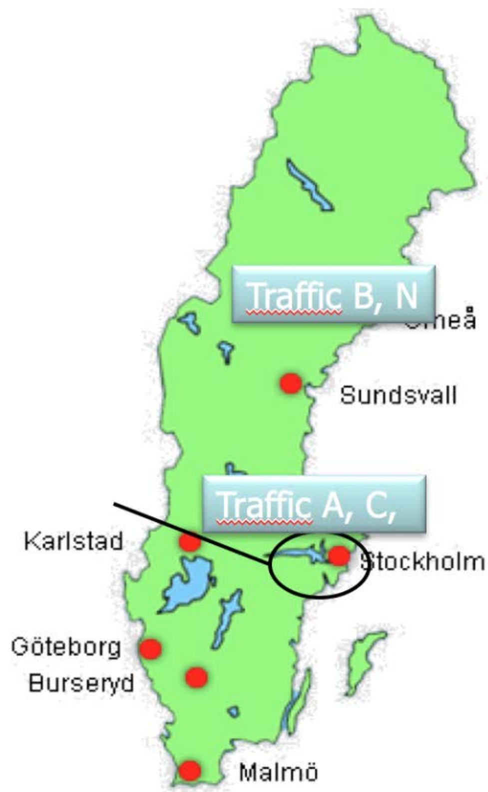

Figure 4 - Route A/B/C/N

Figure 5 - Route S/E/W