Future impacts of self-driving vehicles
A case study on the supply chain of e-commerce to identify important factors for the transport administrators of Sweden

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Abstract

The rapid pace of the development of the transport and vehicle industry in combination with megatrends such as digitalization, automation, and electrification can have huge effects on how transport planning and the society evolves. In order to meet goals such as increased traffic safety, improved environment, and reduced congestions a lot needs to be done. Two tools expected to be of significance when creating a more transport efficient society are automation and digitalization, whereby self-driving vehicles (SDVs) is an important area.

The race towards fully autonomous vehicles is ongoing and scholars argue that the implementation of SDVs can be faster within in freight transportation than passenger transportation. Higher cost-savings, as well as decreasing availability on the labor market, are two arguments for why freight transportation can be autonomous faster. Depending on how ambitious or slow the policy and planning are as well as the development of shared solutions, different future scenarios, as well as penetration rates of SDVs, can come through. One certain trend argued to continue to grow as well as having an impact on the development of SDVs is the rapid growth of e-commerce.

This study addresses the uncertainty concerning SDVs from a transport administrator’s perspective by identifying important factors for Trafikverket regarding the implementation of SDVs within freight transportation. Four already developed future plausible scenarios for the year 2030 lay the ground for this study and a case study concerning the supply chain of e-commerce in Sweden is used to delimitate the study. Interviews with distributors were held to conduct the case and two workshops with experts within the transport sector, academia, and authorities, as well as a meeting with a reference group with representatives from Trafikverket were held to collect data. In the workshops, the experts identified trends and system impacts within the four future scenarios.

A key insight gained in this study is that SDVs is an area with a lot of insecurity and thus, it needs to be investigated further. One solution to study the subject further is to implement restricted lanes for SDVs to test the technique properly. The results of this study clearly show that even though SDVs is a topical issue, it should not be studied as a solitary subject but rather in a larger context together with other significant factors. Nighttime transports and deliveries, platooning, and electric roads and electric vehicles are three factors that are likely to be implemented very soon and should, therefore, be studied together with SDVs. Moreover, the result from the workshops implies that there will be an increased number of vehicles as well as vehicle kilometers within the distribution of e-commerce packages in the future. In addition, the experts expect SDVs to be present in the year 2030, but the number of SDVs depend on multiple factors.
Preface

We have had the luck to have three supervisors throughout this journey and we would like to give our sincerest thanks to all of them for their valuable input and comments. Our supervisor at Luleå University of Technology, Athanasios Migdalas, for his appreciated feedback and support; our supervisor at Trafikverket, Peter Smeds, for always being very helpful, giving us significant contacts, and introducing us to Trafikverket even though you have been located in another city; and last but not least, our supervisor at ITRL, KTH, Albin Engholm, for always prioritizing us, giving us the time we need to discuss and being the best at coming up with innovative and smart ideas.

In addition, we would also like to express our gratefulness to Olof Johansson at Trafikverket for helping us to get started as well as giving us valuable input. Moreover, we would like to thank Anders Forsberg at ITRL for his expertise and helping us with contacts to the workshops. Furthermore, we would like to thank all the people who have lent us their time through interviews, workshops, and meetings. Your skills have contributed greatly to our study and we would not have been able to conduct this study without your support and input.

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Dictionary

**Charge on the move** - Electric charging of a vehicle when it is moving. Overhead catenary systems and inductive power transfer are two types of charge on the move (CoM) techniques.

**Curb space** – Publicly owned real estate accommodating pedestrians, parked vehicles, retailers, and much more.

**Gamification** – The use of game elements in areas that traditionally don’t belong with gaming, for example, commerce and transportation. A way to increase user interaction and engagement.

**Inductive Power Transfer** - Electric charging of vehicles using inductive technology.

**Overhead Catenary system** - Electric charging of trucks using electric overhead cables.

**Platooning** – Several vehicles are connected and communicating with each other.

**Self-driving vehicles (SDVs)** - A vehicle which uses technology to drive without human interference. This is equivalent to Society of Automobile Engineers (SAE) level 4 and 5\(^1\).

**Shared solutions** - Sharing of products and data such as vehicles, clothes, and location.

\(^1\) [https://www.sae.org/standards/content/j3016_201609/](https://www.sae.org/standards/content/j3016_201609/)
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1 Introduction

The following chapter presents a brief background of self-driving vehicles. Furthermore, the problem background is explained as well as the research object which lay the ground for the research questions. Thereafter, the scope and delimitations of the study are presented.

1.1 Background

The development of the vehicle and transport industry is rapid and megatrends such as digitalization, automation, and electrification are expected to have huge impacts on the society and how the transport planning will evolve (Trafikverket, 2018). The Swedish Government (2017) states that Sweden needs to be more transport efficient and use transports in a smarter way to reach goals such as increasing traffic safety and capacity, reducing congestion, and improving the environment. However, the development of new transport solutions is not enough to be able to reach these goals, it is also essential to adopt the right prerequisites regarding the infrastructure. Electrification and electric roads were vehicles can charge while on the move, is an example of solutions that is progressively evolving in line with the more ambitious goals and the constant development of the vehicle industry (Motion 2017/18:1248). Moreover, automation and digitalization are tools expected to be of significance when creating a more transport efficient society and an area that the government focuses on is self-driving vehicles (SDVs) (The Swedish Government, 2017).

Scholars argue that SDVs cannot be seen as science fiction any longer (Guerra, 2016; Muddhar, Valantasis-Kanellos, & Plant, 2016). Today, most of the car manufacturers produce vehicles with automatic features such as automated braking, self-parking, and variable-speed cruise control (Guerra, 2016) and the race towards fully autonomous vehicles is ongoing. The first shipment ever done by a self-driving truck (with monitoring by a driver though) was conducted in the United States already in the year of 2016 (Davies, 2016).

SDVs is a topical issue for both cars and trucks. However, some truck companies believe the development of SDVs to be faster within freight transportation than passenger transportation due to the demand for transportation and the decreasing availability of drivers on the labor market (Davies, 2017). In addition, Wadud (2017) conducted a study of the total cost of ownership for SDVs. The result showed that freight transportation achieves higher financial returns when adapting the self-driving technology compared to passenger transport, which also motivates the faster development. Moreover, freight transport is likely to be early adopters of SDVs due to the possibility to reduce costs as the higher costs for the vehicle will be offset by lower labor costs (Guerra, 2016).
Freight transportation in Sweden includes four types of transportation modes, namely road, rail, sea, and air transportation (Trafikanalys, 2016). The by far most dominating mode is by road and 86 percent of the total transportation mass is delivered by trucks (WSP, 2016). Transportation by road is often divided into long-distance transportation and last mile logistics whereby last mile logistics is argued by Lim, Jin, and Srai (2018) to be a critical factor for market differentiation. Furthermore, the authors discuss that due to its flexibility, last mile logistics offers a convenience that customers care about and same-day and on-demand delivery services are gaining traction for retail purchases.

McKinnon (2006) argues that when it comes to finished products, and in particular retail supplies, road transport has an almost monopoly in the distribution. An area within retail supplies that is completely dominated by the transportation mode of trucks is electronic commerce (Trafikanalys, 2017). Electronic commerce (e-commerce), which refers to when a shopper makes an order online through a website (Anderson, Chatterjee, & Lakshmanan, 2003), is compared to other areas very transport intensive. Partly because it is boundless per definition as customers can buy from all over the world and partly because the delivery points are widely spread throughout the globe (Trafikanalys, 2017). Another reason for why e-commerce is transport intensive is the high levels of returns, which are due to the simplicity as well as the service having a low price or being free (PostNord, 2017b). The development of e-commerce is rapid and the area was expanding with 16 percent during 2017 according to PostNord’s annual report e-barometern (2018). In addition, e-commerce is increasing much faster than any other retailing area (Trafikanalys 2017).

1.2 Problem background

Trafikverket, the Swedish Transport Administration, is responsible for the overall long-term planning of the transport system in Sweden, which includes road, rail, sea, and air transport. Their responsibilities include the maintenance, operation, and building of state roads and railways as well as ensuring effective use of the infrastructure. Furthermore, Trafikverket needs to guarantee that the infrastructure contributes to a transportation that is safe and environmentally sound. Another important task for Trafikverket is to create the prerequisites for a robust and efficient transport system. (Trafikverket, 2017b)

The current literature regarding SDVs focuses mostly on passenger transport (Kristofferson & Pernestål Brenden 2018; Wadud, 2017). However, scholars argue that freight transportation might implement SDVs earlier than passenger transport. It is therefore of importance to study the impact of the implementation of SDVs in freight transportation. One common way to handle the uncertainty regarding the future is to apply a scenario analysis (Börjeson, Höjer, Dreborg, Ekvall, Finnvelden, 2006; Milakis, Snelder, Arem, Wee, Correia, 2015; Van Notten, Rotmans, Van Asselt, & Rothman, 2003). A scenario analysis gives possible future states of the world (Mahmoud et al.,
2009) and the method has for instance been used when developing strategic plans for transport investments (Milakis et al., 2015). Therefore, a scenario analysis for SDVs conducted in Sweden by Pernestål Brenden, Kristoffersson, and Mattson (2017) will lay the ground for this study. The study distinguishes from similar international studies due to the involvement of 23 different transport organizations and as it is developed from a Swedish perspective. In the scenario analysis, the authors have, in collaboration with experts, identified certain and uncertain trends with impact on the development of SDVs. Two of the uncertain trends were then used as axes to create the four scenarios which this study will be based on. The trends used are shared solutions breakthrough and how ambitious and proactive policy and planning is. In figure 1, the four scenarios and the two uncertain trends are illustrated.

![Figure 1: The four scenarios and two uncertain trends developed by Pernestål Brenden et al. (2017).](image)

Another area that most likely will have an impact on the future needs of freight transportation and transport administrators is e-commerce since it is very transport-intensive in combination with that it is increasing much faster than any other retailing area. Moreover, one of the certain trends identified in the workshops held by Pernestål Brenden et al. (2017) was e-commerce. In the report, the authors state that e-commerce will most likely continue to grow and that that it will have a high impact on the development of SDVs, which makes the combination of SDVs and e-commerce of relevance. As it is of great significance that Trafikverket is well-informed about how the transport
system can evolve, it is therefore of relevance to study the possible impacts of SDVs on freight transportation within e-commerce in the future.

1.3 Research objective

The aim of this report is to identify important factors for the transport administrators regarding the implementation of SDVs within freight transportation. The research is focusing on a case study regarding the supply chain of e-commerce and how the transportation can change in this particular area. The four possible future scenarios developed by Pernestål Brenden et al. (2017) will lay the foundation for the study.

1.4 Research questions

To achieve the objective, two research questions have been constructed.

*RQ1: How will the distribution of e-commerce packages be affected by the implementation of SDVs in each of the four possible future scenarios?*

The purpose of the first research question is to gain an understanding of how the distribution of e-commerce packages could change with the implementation of SDVs. This understanding will be acquired by workshops with experts in the transportation field whom will identify important factors and estimate system impacts such as number of vehicles and number of vehicles kilometers traveled. A case of how the current situation within e-commerce distribution will be used as a reference point of the situation today and the four scenarios developed by Pernestål Brenden et al. (2017) will be applied to predict the impacts of SDVs on freight transportation in each scenario.

*RQ2: What impacts can the implementation of SDVs have on the transport administrators considering the identified factors and system impacts in research question one?*

The purpose of the second research question is to gain and generate knowledge of how the implementation of SDVs can affect transport administrators in Sweden. To answer the research question, an analysis of the identified factors and system impacts from research question one will be executed. In addition, a reference group of experts within Trafikverket will discuss the identified factors which in turn will generate important knowledge in the subject for Trafikverket.

Figure 2 illustrates how the research questions are connected and how they together fulfill the research objective.
1.5 Scope and delimitations

The research is limited to the geographic area of Sweden. This is due to the aim of developing useful information for the Swedish authority, Trafikverket. The supply chain in the case study is therefore limited as illustrated in figure 3 below and hence, the report will focus on the last part of the supply chain. This part includes the distribution of e-commerce packages from that the packages arrive in Sweden until it reaches a collecting point where the customer will be picking up the package. As visible in figure 3, the production and warehouse are located abroad due to the increased trend of online shopping from a foreign country (PostNord, 2018). Production and warehouses also exist in Sweden but will not be a part of this case study.

Furthermore, the study is limited to road transportation and it focuses on e-commerce as it is an area that is predicted to grow as well as it will have an impact on the implementation of SDVs. In addition, the report is written under the assumption that SDVs will be implemented in the future and the focus is thus on the possible effects. If it is realistic to introduce SDVs or not is therefore not a part of this study.
2 Method

In this section the disposition of the study is presented followed by the selected methods regarding research purpose, research approach, and research strategy. Thereafter, follows the data collection and the data analysis. Moreover, the validity and the reliability of the study is discussed.

2.1 Study disposition

This study included four phases, which are shown in figure 4 below. The phases were started in numerical order, but not accomplished in the same order. Phase one was not fully completed before the start of both phase two and three. Moreover, the research questions are mapped out in the image to highlight when each question was answered.

The initial phase of the study included a literature study. Current research was collected and important concepts explained. SDVs, as well as the current situation of freight transportation and e-commerce in Sweden, was examined. Furthermore, other concepts that most likely will impact the transport administrators of Sweden, such as electric roads, are also discussed in this section. The literature study was then used as a starting point for the next phase, the current situation analysis. In the second phase, interviews with a distributor in the e-commerce industry were held to gather information for the specific case study. The distributor is an expert within the field and for the second interview the expert was told to describe a general e-commerce case in order to obtain a representative case. The interview guides for the two interviews are presented in Appendix A and Appendix B. Moreover, literature regarding the specific area of handling packages within e-commerce was studied as well to collect useful information for the case study.

Figure 4: The four phases of the study and were in the process each RQ was answered.
Phase three, which main goal was to contribute to RQ1, started after the completion of the current situation analysis. In this phase, two workshops with experts within the areas of freight transportation and SDVs were held. The workshops included discussions about the impacts of SDVs on freight transportation within the four future scenarios and the case of how the distribution of e-commerce packages is handled today was used as a reference point in the discussions. In between the workshops, the outcome of the discussions from the first workshop was compiled and analyzed. The result from workshop 1 was presented to the experts at workshop 2 to validate the analysis. A more detailed description of the dispositions of the workshops is presented in section 2.3.1.1 Workshops.

To answer RQ2, phase number four was conducted. In phase four, a comparison of the case study of the current situation and results of the workshops was done. In addition, a reference group of experts within Trafikverket were gathered to discuss the results and further invest the possible impacts on the transport administrators of Sweden. A more detailed description of the disposition of the reference group meeting is presented in section 2.3.1.2 Reference group.

2.2 Research methods

Table 1 below illustrates the used methods in the study and thereafter a more detailed explanation of the research purpose, research approach and research strategy are presented.

<table>
<thead>
<tr>
<th>Area</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research purpose</td>
<td>Exploratory</td>
</tr>
<tr>
<td>Research approach</td>
<td>Abductive</td>
</tr>
<tr>
<td>Research strategy</td>
<td>Case study</td>
</tr>
</tbody>
</table>

2.2.1 Research purpose

There exist four types of research purposes namely exploratory, descriptive, explanatory, and evaluative. A study with an exploratory purpose seeks to find out what is happening, new insights, ask questions and assess phenomena in a new light. Descriptive research is used to describe a profile of events, persons, or situations while the purpose of an explanatory research is to explain the relationships between variables. Lastly, evaluative studies involve finding out the performance of the studied object or situation. (Saunders, Lewis & Traynor, 2016)

In this research, an exploratory purpose will be used as this study includes the searching for new insights and exploring of the future for SDVs. Furthermore, this study is well aligned with exploratory research as it relies on the three possible ways of conducting an exploratory research stated by Saunders et al. (2016), which are a search of the literature, interviewing experts in the
subject, and conducting focus groups interviews. In addition, the area of e-commerce and SDVs are currently relatively unexplored in the literature, which further motivates the choice of having an exploratory research purpose.

2.2.2 Research approach
There are three different research approaches namely deductive, inductive, and abductive approach. A deductive approach involves testing of existing theories while an inductive approach includes the development of theories from collected data. Lastly, an abductive research approach is a combination of deductive and inductive. (Saunders et al., 2016)

The research approach for this study is defined as abductive. Kovàcs and Spens (2005) explain the abductive approach as an iterative process of observations and theory matching, which is the set-up for this study. Furthermore, an abductive approach is suitable when having a case study as a strategy (Dubois & Gadde, 2002), which therefore further motivates the choice.

2.2.3 Research strategy
A case study will be used as the research strategy and the motivation for this is that, according to Saunders et al. (2016), a case study strategy is appropriate when having an exploratory research and when “How?” and “What?” questions are used as research questions. Furthermore, Bell and Waters (2014) state that case studies can be suitable to use as pilot studies which in turn will make it possible to generate important variables that will benefit the research. Different methods can be used to collect information to case studies but interviews are among the most useful (Bell & Waters, 2014). As this study will generate most of its data from interviews and workshops, a case strategy is chosen. In this study, a case regarding freight transportation within e-commerce and the implementation of SDVs will be studied.

2.3 Data methods
A summary of the chosen data collection methods as well as data analysis is presented in table 2 below.

<table>
<thead>
<tr>
<th>Area</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data collection</td>
<td>Primary and secondary Qualitative</td>
</tr>
<tr>
<td>Data analysis</td>
<td>Thematic analysis Quantitative analysis Summarizing of meanings</td>
</tr>
</tbody>
</table>

Table 2: The chosen data collection areas and its applied methods.
2.3.1 Data collection

The collected data consists of both primary and secondary data. Primary data, which is new data generated during the study (David & Sutton, 2011), was gathered through interviews, workshops, and discussions with a reference group. The secondary data, which is existing data (David & Sutton, 2011), included articles and research on SDVs, freight transportation, and e-commerce. Keywords used in the search engines Google Scholar and Scopus included for example: “E-commerce”, “Freight transportation”, “Self-driving vehicles” and “Autonomous vehicles”. Meetings with relevant people were held at the beginning of the project to collect useful information and gain knowledge to further investigate the area. These meetings were then used as starting points for the primary data collection and laid the foundation for the interviews.

There exist different kinds of qualitative methods to collect data and two common ones are interviews and workshops. Qualitative methods are according to Mack, Woodsong, MacQueen, Guest, and Namey (2005) beneficial when having an exploratory research purpose as they consist of open-ended questions which are rich and explanatory in nature. In addition, qualitative methods allow the researcher to further engage with the respondents as it gives the flexibility to probe the initial responses by adding “why?” or “how?” to previously asked questions (Mack et al., 2005). Due to this, interviews and workshops were held to gather qualitative data. Moreover, interviews and workshops are known to be flexible methods that generate rich materials (Bell & Waters, 2014), which further motivates the choice of using qualitative methods.

Two semi-structured interviews were held with a distribution company and the reason for choosing semi-structured interviews is that the interviewer can be more flexible and does not need to follow the interview guide strictly. This makes it easier to obtain the desired outcome. The purpose of the interviews was to gain insights of the current situation of e-commerce distribution.

Moreover, data was collected through two workshops and one reference group meeting. The workshops’ main goal was to discuss the role of SDVs in the future scenarios regarding freight transportation of e-commerce while the purpose of the reference group was to elaborate with how the results from the workshops can influence Trafikverket. The workshops consisted of experts in the fields of logistics, freight transportation, and e-commerce as well as truck manufacturers, scholars, and authorities. The reference group involved three persons from Trafikverket. The two workshops and the reference group are connected as shown in figure 5 below.
The black underlined, italic, and bold X’s in figure 5 illustrates the scenario descriptions developed by Pernestål Brenden et al., (2017) that lay the foundation for the workshops. The result developed in workshop 1 was of qualitative nature and is illustrated as Y’s in the figure. This was then validated during workshop 2 and Y’s are therefore now underlined, italic, and bold in workshop 2. Furthermore, the result of workshop 2 were quantitative, which the black %’s in the picture symbolizes. The result from workshop 2 was then validated after the workshop, which is why the %’s are underlined, italic, and bold in the reference group meeting. This validation was done before the reference group, which is shown in the figure with a little box between the two data collection instances. The validated results from workshop 1 and 2 were then used and discussed during the reference group meeting.

The method of selection was non-probability as it is suitable for case studies (Saunders et al. 2016). Furthermore, the technique snowball sampling was used to invite experts to the workshops and respondents to the current analysis. The technique was appropriate since both Trafikverket and Integrated Transport Research Lab\(^2\) have contact with many experts in the area who in their turn knew other experts for us to contact. A list of which types of organizations the experts represented in the workshops as well as the represents from Trafikverket in the reference group is viable in Appendix C.

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\(^2\)Integrated Transport Research Lab is a multidisciplinary and multi-stakeholder arena that assembles experts in areas concerning transports solutions, transport systems areas to improve and implementation and barriers regarding these areas. It is funded by KTH, Scania and Ericsson.
2.3.1.1 Workshops

The third phase of the study included the conduction of two workshops. Before the workshops, a document with relevant material and information about the workshops was sent out to the participants in order for them to prepare, see Appendix D for the material for workshop 1 and Appendix E for the material for workshop 2. However, the preparations were not necessary but favorable for gaining an understanding of the workshops and a short introduction was held at the beginning of each workshop. These introductions contained more detailed explanations of the same material that was sent out in advance so that participants who had not been able to prepare would still be able to understand the context and participate as well. Furthermore, the introductions also included a short presentation of the agenda and the general goal of the workshop.

Workshop 1 had 15 participants and workshop 2 had 13 participants as 8-15 people is an ideal size (Community Tool Box, 2017). The groups were small enough for everyone to be able to participate and get some individual attention from the presenter but at the same time large enough to yield discussions and enough opinions (Community Tool Box, 2017). The participants had in advanced been assigned one out of four smaller groups and the reason for this is that it generates a better atmosphere where the participants can feel safe in the “smaller format” before they feel comfortable to discuss in the bigger group (Westling, 2011). In order to generate good and interesting discussions, the groups were constructed to include a variety of people representing different actors and companies.

Each of the four groups had in advance also been assigned two diagonal scenarios to focus on in the discussions. This implied that everyone only discussed two scenarios. Group 1 and 2 discussed scenario sharing is the new black and follow the path and group 3 and 4 discussed scenario what you need is what you get and same, same, but different. The reason for this set-up was due to limited time. However, as two groups worked with the same scenarios, different thoughts and opinions were still gathered and the results from each group were compared and analyzed in the common discussion at the end of each workshop.

Both workshops were two hours long and each workshop was divided into a number of sections. People cannot keep their concentration for two hours, so changing activities and having short pauses is a good way to keep the participants interested (Community Tool Box, 2017). The first workshop included four sections and the first section was the short introduction described above. The second section started directly after the introduction and the participants gathered in their pre-defined groups to carry out the first part of the workshop. Each group had been assigned to start with one of the four scenarios and their goal was to identify trends and how long-distance transportation and last mile logistics of the given case, which is explained in 4.2 Case study – e-commerce, might be carried out in the year of 2030 in a specific scenario. The procedure of the identification of the trends was as following, first, the participants had five minutes to individually
brainstorm their ideas of trends and write it down on post-it notes. Thereafter, the participants discussed their ideas with the rest of the group and clustered their notes. According to Lacinai (2015), these methods are often used in workshops and make the participants feel involved. Afterward, a short break was held and then the same procedure as in the previous section was done once again. However, this time, the other scenario that was pre-assigned to the group was discussed and analyzed. In the fourth and last section, all participants were gathered to commonly discuss the results from the two previously sections.

Similarly, to the first workshop, the second workshop contained four sections. The first section was the short introduction explained earlier and the last section involved all the participants and common discussions, just as in workshop 1. The two middle sections were, however, structured differently than in the first workshop. In the second section, the participants were, in their assigned groups, discussing and validating the results from workshop 1. Each group had in advance been assigned two scenarios which they were to validate. After the validation, a short break was held before section three started. This time, the section involved three smaller exercises. Each group had in advance been assigned two scenarios to analyze throughout the whole workshop, so all of the exercises involved these two scenarios. The first exercise was to discuss and estimate what kind of vehicles that will exist in long-distance transportation and last mile logistics in the year 2030 for the specific case explained in 4.2 Case study – e-commerce. The participants were to fill in their estimations in a template, which can be seen in Appendix F. In the template, three categories for each of the two transportations where pre-defined, namely SAE level 0-3, SAE level 4-5, and other. Once this was done, the participants moved on to exercise two. In this exercise, the participants estimated the size of the fleet for both long-distance transportations and last-mile logistics in the year of 2030 for the given case. Two templates were constructed in advance for the participants to fill in for this exercise. In the first template, Appendix G, the participants needed to estimate the total size of the vehicle fleet for each of the two transportations. The year 2018 with index 100 was used as a reference point to estimate the future size of the fleets. Once this was done, the participants filled in how the vehicle fleet for each long-distance transportation and last mile will be composed in the year 2030. The template in Appendix H was used to estimate that. Lastly, the third and final exercise of section three involved the estimation of future vehicle kilometers. By using the same principle as in the previous exercise, the participants where to start by using index 100 for the year 2018 and estimate if the vehicle kilometers traveled is expected to increase or decrease in comparison (see Appendix I). Once this was done, each of the three categories (SAE 0-3, SAE 4-5, and others) was assigned their share of the total vehicle kilometers

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3 SAE International (Society of Automobile Engineers International) is a global association which distributes knowledge about autonomous vehicles and systems. The organization has implemented a five-level standard for autonomous driving.
traveled in each of the two means of transport for the case. For this exercise, the template in Appendix J was used.

2.3.1.2 Reference group
The last phase of the study was the meeting with a Reference group at Trafikverket. The group consisted of three experts in the area of freight transportation and digitalization and a list of the participants can be seen in Appendix C. Similarly, to the workshops, information was sent out in beforehand for the participants to be able to prepare. In this case, the results from the two workshops were presented as well as descriptions of the different scenarios. It was important to send out the information in beforehand to give the participants better insights as the data collected from the workshops have been vast. The meeting, which lasted for two hours, first had an introduction and the results were presented in greater detail. Thereafter, Trafikverket where to distinguish three trends (out of seven) that will affect them the most. The seven trends were a mix of general trends and scenario specific trends that were identified to have an impact on Trafikverket and a list of the trends is presented in table 3 below.

Table 3: Seven trends identified to have an impact on Trafikverket.

<table>
<thead>
<tr>
<th>The seven trends</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Nighttime transports and deliveries.</td>
</tr>
<tr>
<td>• Platooning for long-distance transports.</td>
</tr>
<tr>
<td>• A bigger breakthrough of SDVs for long-distance transport compared to city logistics.</td>
</tr>
<tr>
<td>• Other modes and vehicles for freight transportations are getting larger market shares.</td>
</tr>
<tr>
<td>• Continued development of electric vehicles and electric roads.</td>
</tr>
<tr>
<td>• International direct delivery.</td>
</tr>
<tr>
<td>• Increased requirements for co-loading.</td>
</tr>
<tr>
<td>• Restricted lanes for SDVs.</td>
</tr>
</tbody>
</table>

Afterwards, the general trends which are expected to occur regardless scenario were discussed since these trends are most likely to occur. Thereafter, trends in each of the four scenarios were discussed in relation to Trafikverket.

2.3.2 Data analysis
The collected data was analyzed with three different methods. A thematic analysis was used for workshop 1, a quantitative analysis for workshop 2, and summarizing of meanings for the reference group meeting. Thematic analysis is a suitable tool for analyzing the gathered data when conducting qualitative research (Alhojailan, 2002). The method is used to analyze themes (patterns) of the collected data. Since the first workshop consisted of four different groups, is it
possible to find patterns within the groups and analyze which trends that are most common. According to Braun and Clarke (2006), the method has the advantage of highlighting similarities and differences across the data set. By using this approach, general trends which occurred in all four scenarios for the three areas last mile logistics, long-distance transport, and others were identified. Thereafter, specific trends for each scenario were further analyzed. The analysis of workshop 1 was adjusted after being validated at workshop 2 and thereafter compared with the studied literature.

The second workshop had a quantitative focus and therefore, a quantitative analysis method was used. According to David & Sutton (2011) the method includes identifying trends by using statistical tools, graphical illustrations, and comparing similarities as well as dissimilarities. When analyzing the data, the statistical software program Microsoft Office Excel was used. The data was compiled in tables in Excel and thereafter validated by a person from each of the four groups from the workshop. After the validation the result was visualized in graphs were each bar represent the average value. However, since the average number only consist of two estimations, the estimations are illustrated in the graphs as well. The graphs are found in chapter 5.2 Workshop 2 and consist of four graphs for long-distance transport and four graphs for last mile logistics. After creating the graphs, similarities and dissimilarities was identified in the different scenarios as well as a comparison of long-distance transport and last mile logistics. The result was also compared with the first workshop and the studied literature.

When analyzing the reference group meeting the method summarizing of meanings was used. The method is applicable when analyzing qualitative data and summarizing the key points from an activity (Saunders, Lewis & Thornhill, 2016). The first step of the analysis was to transcribe the meeting. Thereafter, summarizing of the key points was made. The key points were related to the identified trends from the two workshops to be able to know which recommendations to focus on for the transport administrator.

2.4 Validity and reliability

In general, there exist two types of measurements to ensure the quality of a study and these are called reliability and validity (Carmines & Zeller, 1979). The reliability and validity of a study are important to evaluate and consider in order for the results to be trustworthy (Roberts, Priest & Traynor, 2006). In this section, the validity and reliability of the study will be discussed.

2.4.1 Validity

Validity can in general be described as if we measure what we intend to do (Roberts et al., 2006). The validity of this study can have been negatively affected by possible misunderstandings during interviews and discussion. Both misunderstandings when it comes to the respondents and how they have interpreted the questions but also misunderstandings and misinterpretations of the responses.
To increase the validity of the study information from different sources have been collected, compared, and analyzed. In addition, every person has been contacted in consultation with supervisors from ITRL in order to ensure that every involved person is of relevance and will most likely contribute with useful information. Furthermore, the results from both the interviews as well as workshops have been validated by different actors. The case study and the current analysis have been validated by the respondent to ensure that the information is correct. Workshop 1 was validated at the beginning of workshop 2 to assure that the summarized information was correct. The second workshop was validated and clarified by one person from each of the four groups. Lastly, the results from workshop 1 and 2 were then discussed with the reference group from Trafikverket, which could be seen as a validation control. Moreover, the validity is increased by having the representation of different actors in the workshop such as truck manufacturers, authorities, logistics companies, and scholars.

2.4.2 Reliability

Reliability can be described as the extent any measuring procedure will yield the same result again when repeated (Carmines & Zeller, 1979). This means, that for a study to have high reliability, the same results should be obtained if the measuring process is repeated. As this study involves prediction of the future as well as it is a quite unexplored area, it will affect the reliability of the study. The collected data will most likely not be the same if it were to be collected in a similar study in the future, as the area studied is fast changing and quickly evolving. In addition, all of the collected primary data have been collected with qualitative methods were the agenda and discussion have been semi-structured. The same interview questions, as well as overall agenda and topics discussed in both the workshops and with the reference group, can, of course, be re-used, but possible attendant questions or deviations are not documented which makes it almost impossible to yield exactly the same results again. Moreover, the result of this study is strongly depending on which participants that attended. Subjectivity is, therefore, another factor that will have a negative impact on the reliability. David & Sutton (2011) state that a way to improve the reliability is to have well-constructed questions and to use pilot studies. To obtain a higher degree of reliability has the presentation of the workshop been discussed and revised together with a supervisor from ITRL and master students in the program sociotechnical systems engineering.
3 Literature review

The following section includes literature regarding freight transportation, self-driving vehicles, the future scenarios which lay the foundation for this study, other technologies that has an impact on the infrastructure as well as possible solutions for last mile logistics, and e-commerce.

3.1 Freight transportation

The demand for freight transportation derives from the distance that separate producers and consumers (Crainic, 2003) and there exists a lot of evidence that the distances will continue to increase (Figueroa, Lah, Fulton, McKinnon, & Tiwari, 2014). Psaraki-Kalouptsidi and Pagoni (2011) argue that the increasing trend for goods transported on road will continue, which implies that there will be both longer distances as well as more goods on the roads in the future. The increased demand for road freight transportation has led to many challenges including the need for more efficient transport on congested roads, less dependency on fossil fuels, and the need for a better safety on roads (Psaraki-Kalouptsidi & Pagoni, 2011).

Technology and the evolution of it is a major factor that determines how freight transportation is organized (Crainic, 2003). Moreover, the sector is continuously changing due to the growth and transformation of the economy (Gonzalez-Feliu, 2012). Some argue that technology advancements will involve an increase in road freight transportation as technology has created opportunities for customers to shop online from anywhere in the world while others argue that technology will have positive effects due to efficient joint delivery systems which rely on systems that share information to prevent increase in traffic (Yoshimoto & Nemoto, 2005). In both cases, freight transportation must adapt to and perform within the rapid changes in technology (Crainic, 2003). Some major technology changes and innovations that will have an impact on freight transportation are the development of SDVs.

3.2 Self driving vehicles

In the literature, different terms are used for the concept of automated road transport vehicles (Lutin, Kornhauser & Masce, 2013; Madigan et al., 2016; Milakis, Van Arem, & Van Wee, 2017; Rios-Torres & Malikopoulos, 2017). These are Autonomous Vehicles (AV), Connected Automated Vehicles (CAV), Automated Road Transport Systems (ARTS), and Self-Driving Vehicles (SDVs). According to Pernestål Brenden et al. (2017), the names indicate more than just automated vehicles. An example is that autonomous implies that no external support system is used, while external systems are used to support vehicles under the categories of CAV and ARTS (Pernestål Brenden et al., 2017). The term self-driving vehicles will be used as the distinction between the different types of automated vehicles is not necessary for this work.
SAE International (2016) has conducted a classification system of driving automation. The lowest classification, level 0, equals no driving automation while the highest classification, level 5, means full driving automation (SAE International, 2016). The driving environment is monitored by the human driver for level 0-2 and is monitored by an automated driving system for level 3-5. Table 4 illustrates the levels of driving automation with a clarification of each level.

**Table 4: SAE’s levels of automation.**

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0: No driving automation</td>
<td>Human driver controls and performs everything.</td>
</tr>
<tr>
<td>1: Driver assistance</td>
<td>Human driver performs everything but driver assistance of either steering or acceleration/deceleration is possible by an assistance system which uses information about the driving environment.</td>
</tr>
<tr>
<td>2: Partial driving automation</td>
<td>Human driver performs everything but one or more driver assistances such as steering or acceleration/deceleration is possible from an assistance system which uses information about the driving environment.</td>
</tr>
<tr>
<td>3: Conditional driving automation</td>
<td>An automated driving system performs all aspects of driving with the expectation that human driver appropriately will respond when requested to intervene.</td>
</tr>
<tr>
<td>4: High driving automation</td>
<td>An automated driving system performs all aspects of driving even if human driver does not respond appropriately when asked to intervene.</td>
</tr>
<tr>
<td>5: Full driving automation</td>
<td>An automated driving system performs all aspects of driving full time and under all conditions that a human driver can manage.</td>
</tr>
</tbody>
</table>

In this work, the SDVs referred to is from level 4 and above as the literature is mostly considering level 5 (Pernestål Brenden et al., 2017) as well as it is level 5 of automation that has most potential to be released according to Litman (2017).

There is a growing literature on the possible effects of SDVs and the potential effects are most often depending on the level of implementation, cooperation as well as the level of penetration rate of SDVs (Milakis et al., 2017). This results in some of the potential effects being contradictory as the possible outcomes could vary. In this study, the effects of SDVs on freight transportation will be divided into two categories; advantages and disadvantages. This report will only cover a small portion of all aspects regarding SDVs. Milakis et al. (2017) have written an extensive literature review discussing potential effects of automated driving for those who are interested in reading more, however, the focus of the study is passenger transportation.
3.2.1 Advantages of SDVs

One major positive, potential impact of SDVs, in general, is that it can enhance traffic safety (Dresner & Stone, 2008; Khondaker & Kattan, 2015; Fagnant & Kockelman, 2015) as the majority of accidents are attributed to human errors (Milakis et al., 2017). Trucks are involved in most of the fatal road accidents and the human error is accountable for 90 percent of the accidents (Fagnant & Kockelman, 2015). By gradually removing the control from the driver’s hands, traffic accidents caused by human errors can be avoided (Kristoffersson & Pernestål Brenden, 2018). Furthermore, SDVs can better sense and anticipate the vehicles’ braking and acceleration decisions which allow for smoother braking, better speed control, and a steadier acceleration, which in turn reduces the fuel consumption (Fagnant & Kockelman, 2015). Other advantages are reduced driver cost and the possibility to assist drivers in narrow streets (Kristoffersson & Pernestål Brenden, 2018).

3.2.2 Disadvantages of SDVs

Papa and Ferreira (2018) argue that the benefits of SDVs are often highlighted and that it is important to also discuss the potential problems. Litman (2018) states that SDVs might lead to increased costs due to the need for additional vehicle equipment and services. In addition, other negative implications are that the implementation of SDVs could generate new risks such as cybersecurity and keeping the information of the trucks safe from hackers as well as the risk of system failures (Kristoffersson & Pernestål Brenden, 2018; Litman, 2018). Moreover, Sivak and Schoettle (2015) argue that even though SDVs could increase traffic safety, there are still some situations where SDVs might be disadvantageous regarding safety. These situations include recognizing and dealing with unusual road users such as ridden horses and large non-automotive farm equipment, conditions such as flooded roadways or a sudden snowstorm as well as situations where direct traffic is required for the police or construction crews. Furthermore, the authors discuss the transition period and the expectations that conventional drivers have on other vehicles actions. Today, many interactions and decisions are made with eye contact and drivers proceed according to the feedback received from other drivers. The consequences regarding this problem still remain to be ascertained (Sivak & Schoettle, 2015).

3.3 Future scenarios

In this section, the four scenarios explained in the problem background is described in more detail. The four possible future scenarios for SDVs in the year 2030 were developed by Pernestål Brenden et al. (2017). The scenarios can be used as a foundation for further work regarding how the society will develop in accordance with SDVs. In these scenarios, two uncertain trends were used as axes to generate four scenarios. The uncertain trends are shared solutions breakthrough and how ambitious and proactive policy and planning is. The four scenarios are illustrated in figure 6 below.
Common for all scenarios are certain trends that during the study were identified to be included in all of the scenarios. These certain trends include a high technology development, increased urbanization which leads to a competition of street space, growing e-commerce, more ambitious sustainability goals, increased automation, that most vehicles are going towards level 2 SAE, and a shift from product focus to a service and solution focus. Below, each scenario is described further and the descriptions can be found in even greater detail in the report by Pernestål Brenden et al. (2017). The descriptions below were found to be most relevant for this study and lay the ground for the workshops.

*Same, same, but different*

In this scenario, an ambitious, proactive and innovative policy and planning are assumed in combination with no breakthrough for shared solutions. The government is actively encouraging the social structure and takes a great responsibility for it, however, shared solutions have not gotten any penetration in either data or things. This has resulted in a society that is similar to today but with a fast-moving technology advancement. There is a great focus on sustainability and most vehicles are powered by electricity instead of fossil fuels. In addition, there is an extended network of electric charging stations.
Sharing is the new black

Here, an ambitious and proactive policy and planning are assumed and there is a breakthrough of shared solutions. The government is actively encouraging the social structure and takes a great responsibility for it and the combination of that together with people’s willingness to share data and solutions has implied in the government being responsible for the majority of the data. Furthermore, the structure of the government is different as well as the culture in general which has resulted in a great focus on sustainability. Sweden is a well-known test-site for new solutions and all vehicles are connected and powered by electricity or biofuel.

What you need is what you get

The policy and planning by the government are slow and careful which has resulted in commercial actors taking the lead when it comes to social structures and infrastructure. However, people are willing to share data and solutions. The winners in this scenario are the companies with a lot of customer insights and personal data is the new currency. Only a few, big companies are controlling the market as they have bought most of the smaller companies and innovative start-ups. The bigger companies are among others financing infrastructure in their services.

Follow the path

This scenario is most similar to how the situation is today in Sweden, but with a much more severe congestion situation. Follow the path assumes a slow policy and planning situation where there is no or little breakthrough for shared solutions. Even though Sweden is cutting edges when it comes to renewable energy, the majority of cars are still powered by diesel or petrol as electric cars have a much lower second-hand value. In general, this scenario is very similar to how it is today, only with smarter solutions for the everyday life.

3.4 Other technologies to facilitate freight transportation

Other technologies and concepts that do not necessarily involve SDVs will be presented in this section. Here, other up and coming concepts will be discussed. Most of the technologies are being developed and tested right now as well as these are mentioned on the website of Trafikverket, which implies that these concepts are important to study as well as they most likely will affect the transport administrators. Moreover, a combination of these techniques together with SDVs could also be possible.

3.4.1 Platooning

Platooning, road trains, and car convoys are all used similarly to describe the same concept. They refer to the technology where each vehicle in a platoon autonomously is following the one in front of it and the first vehicle, which is leading the platoon, is controlled by a human driver (Kamali, Dennis, McAree, Fisher, & Veres, 2017). Generally, a vehicle platoon consists of a leader and a
number of followers, whereby the leader controls all the platoon members and takes all the decisions on behalf of the whole platoon (Maiti, Winter, & Kulik, 2017). The level of automation for a platoon can vary from SAE level 2 to level 5 depending on technique and how much driver interaction that is needed (Shladover, 2017) which indicates that automation is needed, but not particularly the same level as for SDVs.

The vehicles in a platoon travel together and are actively coordinated in a formation, which requires communication between the vehicles (Bergenhem, Shladover, Coelingh, Englund, & Tsugawa 2012). Vehicle-to-vehicle (V2V) communication is used for continuous control such as adjusting each vehicle’s position in the lanes and keeping the space between the vehicles but also for more complicated tasks such as joining and leaving requests or dissolving the platoon (Kamali et al., 2017). Vehicle platooning reduces the gap between the vehicles which reduces traffic congestion and aerodynamic drag (Maiti et al., 2017) and the reduced aerodynamic drag enables fuel and emissions savings (Larsson, Sennton, & Larson, 2015). However, the concept of platooning is not visible on the streets today except for pilot tests due to regulations and legalization barriers. For example, countries have slightly different rules which make it challenging to come up with solutions that fit every country as well to drive truck platoons across borders (Alkim, 2018).

3.4.2 Electric roads
A critical factor for enabling electric vehicles (EVs) on long-distance travel in a larger spectrum is the concept of dynamic charging, charge-on-the-move (CoM). The concept is based on the idea of road infrastructure being able to transfer energy to EVs while they are moving. One major advantage of CoM is that it eliminates range anxiety as it reduces the need for an installed battery with high capacity since EVs automatically will be charged while on the move. Furthermore, the technology offers the opportunity to reduce the purchase price and mass of the vehicles, which will further benefit the widespread of EVs. The benefits and cost of implementing CoM infrastructure depend on the final specifications of the specific CoM technique used, which are drastically advancing. Anyhow, not all roads need to be affected for a well-functioning CoM infrastructure. It would for example not be necessary to implement CoM on urban roads as relative short journeys are undertaken there. (Nicolaides, McMahon, Cebon, & Miles, 2016)

3.4.2.1 Inductive Power Transfer
One of the most promising CoM concepts is inductive power transfer (IPT). The technique has been used in numerous applications for over 25 years including lightning applications, amusement parks, and underwater and mining applications but has more recently been highlighted for EV applications (Nicolaides, Cebon, & Miles, 2017). IPT is dependent on recent developments within magnetic materials such as power electronics and is, therefore, a technology of the time (Covic &
Boys, 2013). IPT is a nonconductive (wireless) system (Nicolaides et al., 2017). Typically, it consists of two different subsystems: road and vehicle charging unit and when the two units are close to each other, energy is wirelessly being transferred between the parts (Nicolaides et al., 2016). Static charging applications can obtain an efficiency over 90 percent (Miller, Jones, Li, & Onar, 2015) and for dynamic charging a similar efficiency is expected (Naberezhnykh, Reed, Ognissanto, Theodoropoulos, & Bludsuzuweit, 2014).

IPTs major advantage is that it is a simple system that is unaffected by weather conditions, as it doesn’t require any plug-in cables. (Nicolaides, Cebon, & Miles, 2017). However, Covic and Boys (2013) argue that one of the biggest challenges for IPT systems today is to implement and ensure IPT roadways for both public and private vehicles all over the world. Vehicles that depend on IPT systems require a widespread implementation of the technique for it to function properly and for the benefits to be applicable.

3.4.2.2 Overhead catenary systems

Another solution for charging electric freight vehicles when on the move is to use a so-called overhead catenary system. The system uses similar technology as trains were trucks can connect to overhead wires to charge the vehicle. Trucks have the possibility to automatically connect and disconnect as the vehicle is traveling on electrified parts of the road. (Nicolaides et al., 2017)

Grünjes & Birkner (2012) lists several advantages of using an overhead catenary system. First of all, it is a proven technology from the railway system. Secondly, the technology does not interfere with the infrastructure of the road. Lastly, it is easier to assure safety for pedestrians since the interaction between the driveway and the power supply infrastructure is reduced compared with the use of IPT. Many of the challenges regarding overhead catenary systems are well-studied and understood, but there still exists technical issue to resolve (Nicolaides et al., 2017). The authors argue that the system is not suitable for cars, which means that the freight industry must bear the cost regarding operations and infrastructure alone. Furthermore, the authors discuss the challenge of maintaining the exposed wiring which is located above the carriageway.

3.5 Solutions for last mile logistics

In addition to the solutions described above, which are more applicable for long-distance transports, there exist different transport solutions for last mile logistics. Some of the possible solutions within the area are discussed in this section, both existing solutions but also future alternatives such as drones and autonomous delivery robots.

3.5.1 Bikes

Using bikes as an alternative to vans, trucks, or cars for the last mile is a solution with variations. There exist different types of bikes, for example, ordinary bikes, electric bikes, and tricycles, but
what they all have in common is that they emit zero emission (Schliwa, Armitage, Aziz, Evans, & Rhoades, 2015). The solution is limited to light goods transportation and shorter distances as it needs to be reasonable for a human to transport the goods on a bike (Slabinac, 2015).

3.5.2 Drones
Delivery drones which are controlled remotely or automatically is a solution for delivery of parcel goods or urgent goods (Slabinac, 2015). Some benefits of using drones are fast and flexible deliveries as well as it can bypass crowds and reach remote locations (Huang, 2017). Compared to bike alternatives, drones are suited for even lighter goods. The range of how much a drone can deliver varies, for example the university Ecole Polytechnique Federale de Lausanne has developed a drone that can deliver parcels up to 500 grams (Science Daily, 2017) while a drone developed by South Korea’s Ministry of Public Safety and Security together with CJ Korea Express, the country’s largest cargo delivery company, has a payload of up to 3kg (Aitken, 2015). In addition to the capacity limitations, other limitations regarding drones are regulatory restrictions and the limited distance capacity (Huang, 2017).

3.5.3 Delivery robots
Robots that travel on the sidewalks is another last mile solution (Pettitt, 2015). It is a fast and flexible delivery method and has a higher capacity compared to drones (Huang, 2017). Some robots do also have microphones to enable two-way communication (Pettitt, 2015). However, some of the limitations with delivery robots are that they cannot operate in crowded areas as it travels on the ground as well as the risk of thefts (Huang, 2017).

3.5.4 Electric vehicles
Another solution for last mile delivery is electric vehicles. As many trucks today spend a lot of time idling, especially in cities, electric vehicles will result in lower fuel consumption and thus, lower fuel economy. In addition, the same route is operated almost every day with a return to a company garage at the end, which makes systematic recharging centrals a feasible solution for these electric vehicles. However, the breakthrough for electric vehicles is not as big as one would hope, as they sometimes tend to be less cost-effective than the traditional options due to purchase price, fuel price, vehicles utilization etc. (Lee, Thomas, & Brown, 2013)

3.6 Transportation within e-commerce
The growing importance of electronic marketplaces and e-commerce and its implications on freight transportation was discussed by Crainic already in 2003. Furthermore, Anderson, Chatterjee, and Lakshmanan also stated in 2003 that the growth in e-commerce will be most obvious when looking at the impacts on transportation. The statements from 2003 are still current today and scholars argue that e-commerce generates a demand for transportation and delivery (Morganti, Seidel, Blanquart, Dablanc, & Lenz, 2014). According to Le and Ukkusuri (2018), the
increased e-commerce has led to new challenges for logistics providers and delivery services such as price, convenience, and speed, which are of high importance for the customers.

The last mile logistics regarding e-commerce is often very inefficient when delivering directly to the customers’ home (Iwan, Kijewska, & Lemke, 2015). For instance, the orders are often very fragmented and the vehicles are not fully loaded due to the combination of small orders and the demand for fast deliveries. In order to improve the last mile delivery in the urban freight transport systems, the European Commission BEST Urban Freight Solutions (BESTUFS) was funded to investigate best practices in the area (Allen, Thorne, & Browne, 2007). One of the best practice solutions is to use so-called collection points which lead to fewer delivery locations. The collection points are often located in post offices, convenience stores, or petrol stations close to the customer’s home (Allen et al., 2007). Goods are delivered to the collection point and the customer is notified when their order is ready for collection. Moreover, Morganti, Dablanc, and Fortin (2014) argue that collection points often are used to satisfy customers demand for flexibility and the need for firms to consolidate shipments.
4 Current situation

In this section, the current situation of e-commerce in Sweden is described as well as e-commerce trends. In addition, the case, which lay the ground for the workshop, is also presented. The case is focusing on the supply chain of e-commerce. An interview with a distributor was held to obtain the fictive case.

E-commerce is a rising trend and 66 percent of the Swedish population buy at least one article online every month (PostNord, 2018). The Swedish e-commerce has according to Trafikanalys (2017) increased its turnover by 106 percent the last five years while the retailers at the same period increased it with 13 percent. As e-commerce is such a fragmented business with different transport actors there is no statistic available today for the number of packages which have been bought online. However, DB Schenker estimated the number of packages in Sweden for business to consumer to be 60 million in 2014 (Trafikanalys, 2017).

The possibility to shop at any time, lower prices, larger supply, and the possibility to choose a delivery mode are among some of the reasons for why customers buy online and regarding the transportation. The three most important factors for the customer are the cost, where the collection point is located, and delivery time (PostNord, 2017a). In the year 2015 were customers satisfied with 4-5 delivery days, today customers demand 2-3 delivery days (Bring, 2017). In addition, several customers request delivery the same day or the day after. According to Trafikanalys (2017), 29 percent of the customers ordering online thinks that delivery the following weekday is important. Trucks are therefore driving long distances during the night and last mile distribution the following morning to be able to deliver within the short time frame (Trafikanalys, 2017).

There are three different transport setups when delivering goods within e-commerce. Firstly, the goods can be delivered to a store, secondly, the goods can be delivered directly to the customer’s home, and lastly the goods can be delivered to a collection point. Today 6 out of 10 orders are delivered to collection points and the packages often pass one or several transshipment points on the way to the delivery point. (Trafikanalys, 2017)

Trucks are the dominated means of transport for e-commerce. Heavy trucks are often used for long distances while light trucks are used for shorter distances and last mile distribution. Heavy trucks are beneficial for long distances as they have a higher maximal capacity and can carry heavier, larger, and more goods. The total maximum loading capacity for a heavy truck is at least 3500 kg while a light truck only is allowed a total weight of 3500 kg. Light trucks are essential in last mile distribution due to their flexibility and the importance of the last mile logistics is expected to expand as a result to the increased e-commerce and urbanization. Moreover, the number of light trucks are increasing and almost 90 percent of the trucks in use are light trucks. However, the light
trucks drive shorter distance and therefore stand for 68 percent of the total distance with trucks. (Trafikanalys, 2017)

4.1 E-commerce trends

The e-commerce expert Patrik Müller argues that the United States is taking the lead regarding digitalization and is 6-7 years ahead of Sweden in the development of e-commerce. Therefore, trends in the United States can be expected to occur in Sweden as well some years later. One of the trends which are likely to come about is the closure of many physical shops and that physical shops will be used as a complement to e-commerce instead of vice versa (DIBS, 2018). Moreover, the turnover for e-commerce is expected to keep rising. In Sweden, there is a digital marketing shift were the frequency of the number of purchases increases and as well as the money spent (PostNord, 2017b).

The delivery is expected to be even more important for the customers in the future. The customer requires flexibility, control of where the product is, and being able to change the location of delivery point once the order has been placed (PostNord, 2017a). In a survey customers got the opportunity to express how they wanted their deliveries to be in the future, 42 percent of the respondents wished for a locked box outside their home and 18 percent wished for delivery by SDVs (PostNord, 2018).

4.2 Case study – e-commerce

The case, which lay the ground for the workshop, will now be presented in a narrative form. This case was acquired through an interview with a distributor and is fictive.

An e-commerce company has three warehouses in Europe. Packages are transported from the warehouses by trucks to a transshipment point in Malmö. The packages which are to be delivered in the area of Stockholm are thereafter transported by heavy trucks to a terminal in Stockholm. When the packages reach the terminal a final separation is done and the packages are sorted in cages to be delivered to the collection points. A light truck then drives a loop to different collection points and deliver the cages. The number of collecting points vary depending on which route and to where customers have ordered their goods. One single collection point can get 200-300 packages each day which require a well-planned supply chain. The overall network described is illustrated in figure 7 below.
As this case is limited to Sweden, the studied area is from Malmö to collecting points in Stockholm. Therefore, the case includes one long-distance transportation between Malmö and Stockholm and last mile distribution within Stockholm where delivery to collecting points are being made. The last mile logistics, in this case, is equivalent to city logistics as it refers to delivery within the city of Stockholm. In addition to the described case above, the workshop participants were informed about future e-commerce trends discussed in the previous section 4.1 E-commerce trends, such as flexibility and increased demand.
5 Empirical findings

The result from both workshops and the reference group is presented in this section. Firstly, the general trends are presented and thereafter follows a narrative description of each of the scenarios. The descriptions are supplements to the future scenarios in section 3.3, which was the reference point for the experts during the workshops. Lastly, the result from workshop 2 and the reference group meeting is presented.

5.1 Workshop 1

In workshop 1, the following general trends were identified, see table 5. These trends are topics that were raised in each of the four scenarios and they have therefore been clustered into general trends.

Table 5: General trends identified by the experts which are applicable for all future scenarios.

<table>
<thead>
<tr>
<th>General trends</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nighttime transports and deliveries</td>
</tr>
<tr>
<td>New types of and more delivery options</td>
</tr>
<tr>
<td>Platooning for long-distance transport</td>
</tr>
<tr>
<td>A bigger breakthrough of SDVs for long-distance transport compared to city logistics</td>
</tr>
<tr>
<td>Other modes and vehicles for freight transportations are getting larger market shares</td>
</tr>
<tr>
<td>Continued development of electric vehicles and electric roads</td>
</tr>
<tr>
<td>International direct delivery</td>
</tr>
<tr>
<td>Increased requirements for co-loading</td>
</tr>
<tr>
<td>Extended congestion taxes and environmental zones</td>
</tr>
</tbody>
</table>

Deliveries can occur at any time which implies that nighttime transports and deliveries are common in the year 2030. There are new types of delivery options as well as a larger number of delivery options. Customers can pick up and get their orders delivered to for example the gym, in smaller “boxes” in their properties, and at work. Automation is more common in long-distance transportation than for city logistics and platooning is a solution that is used for long-distance transportations. Other modes and vehicles for freight transportation are gaining increased market shares and both sea and rails are becoming more popular. However, not all experts agreed to this general trend. Some argued that as trucks are more flexible as well as future technology such as platooning will enable even cheaper transports, the use of trucks will instead increase even more in the future. The development of electric vehicles and electric roads has continued to increase, but to different extents in the different scenarios. The breakthrough of electric roads is for example higher in the two scenarios where the policy and planning is ambitious and proactive than in the other two where it is slow and careful. Nowadays, the distributions centers in Malmö are not
necessary to the same extent as today (the year 2018) since most of the transportation goes directly from warehouses abroad to Stockholm. In addition, there are increased requirements regarding co-loading as well as extended congestion taxes and environmental zones in the cities.

Furthermore, the experts in workshop 1 also discussed specific trends, last mile logistics, and long-distance transportation in each of the four scenarios. In table 6 below, the results from these discussions are compiled and a more detailed and narrative description of each scenario is presented in the sections 5.1.1 Same, same, but different to 5.1.4 Follow the path.

*Table 6: Specific trends and trends for last mile logistics and long-distance transport in each of the four scenarios identified by the experts in workshop 1.*

<table>
<thead>
<tr>
<th></th>
<th>Same, same, but different</th>
<th>Sharing is the new black</th>
<th>What you need is what you get</th>
<th>Follow the path</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Trends</strong></td>
<td>The buying process changes. Restricted lanes for SDVs. A network of governmentally owned electric roads.</td>
<td>Regulations to facilitate for SDVs. Plans to incentivize efficient transports. Dedicated curb space. Electrification requirements.</td>
<td>New actors and types of cooperation. Shift from passenger to freight transportation in cities. Flexible cities, neglected countrysides. Worse traffic situation.</td>
<td>Reduced parking area. Services in the properties. Increased transport costs. Decrease in curb space. Dedicated bike and walk lanes. Electric roads on specific routes.</td>
</tr>
<tr>
<td></td>
<td>Same, same, but different</td>
<td>Sharing is the new black</td>
<td>What you need is what you get</td>
<td>Follow the path</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>------------------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------</td>
<td>---------------------------------------</td>
</tr>
</tbody>
</table>

5.1.1 Same, same, but different
The buying process has developed and customers can use VR technology as well as showrooms when deciding what to order online. The change in the buying process has led to fewer returns as the customer knows what to expect when ordering online. SDVs has restricted lanes as it is difficult for "normal" drivers to function and interact with SDVs. The government owns and maintain a network of electric roads. The transports are co-loaded to some extent but not fully due to limited breakthrough for shared solutions. The co-loading often occurs where there is a lack of space such as in the old city of Stockholm. More actors are operating in the last mile distribution in the urban environment. Coordination of goods to optimize is common. For example, delivery of goods can be combined with pick up of waste and recycling. Packages are often delivered by bikes and light, emission-free vehicles to the end consumer. Fewer actors are competing for long-distance transport due to a price sensitive industry where only the strongest survive. Electric vehicles are common and attractive routes are electrified, but some of the long-distance transports are still powered by fossil fuels. Moreover, the long-distance transport has an increased remote control which makes it possible to control vehicles from a control center.

5.1.2 Sharing is the new black
New regulations to further facilitate the implementation and development of SDVs have been implemented. The state incentivizes efficient transports by for example having dedicated lanes for co-loaded goods. There are dedicated curb spaces which makes it possible for vehicles to load and unload easily in the city. Moreover, there are more requirements to use electric vehicles. There is a total flexibility and visibility - customers can always see where their order is as well as they get a full digital feedback throughout the whole process. Gamification is used to involve customers further and to facilitate for co-loading and better transports. It can, for example, be used to give customers higher credits for better choices and lower credits for options that require separate
deliveries and has a bigger impact on the environment. The pricing setting process is dynamic and depends on factors such as the possibility to co-load, environmental impacts, and how far the goods are traveling. SDVs are partly used as they give support to drivers. However, drivers are still important but their role is more supervising than today. There are new laws and regulations which requires co-loading. New delivery modes are common and different solutions such as electric vehicles, bikes, and robots can operate the transport depending on where the goods are going. Robots can, for example, deliver goods to customers in business environments. During night times, deliveries are made with quiet electric vehicles. When it comes to long-distance transports, longer vehicles are used. One reason for this is the possibility to load more but also to be able to compete with the other modes of freight transportation that are expected to increase. There is a minor decrease in long-distance transport due to co-loading. Moreover, lanes are dedicated for platooning at specific hours and the state has standards for platooning which needs to be used.

5.1.3 What you need is what you get

New actors, types of cooperation, and platforms for sharing of goods and services. Many companies offer subscriptions to their customers, for example, the possibility to subscribe to clean beddings which get changed every week. Due to the many possibilities and innovative solutions, there is a shift from passenger transportation to freight transportation in cities. Instead of doing it themselves, people buy services from companies, like ordering food online instead of going to the supermarket. As the companies want to make a profit, their focus is on cities where the most money is being made. This has resulted in flexible cities but a neglected countryside. The policy and planning are slow due to infrastructure owners not being sure what the requirements and demands are, which has led to an even worse traffic situation. The reason for this is that the data is owned by companies and not by the state, which makes it hard for the policy and planning to predict future demands and needs. Last mile logistics solutions involve smart co-loadings solutions driven by the shared data breakthrough and the cooperative attitude of companies. However, companies only corporate when there is profit in it for them. Delivery to customers’ homes is being made with simpler SDVs, bikes, and pools of electric cars which drive registered loops. The driver transfers from being a driver to a service person whom for example take care of the unloading of the packages at the customer’s home. Large actors have established nodes/distribution centers in the cities where packages are sorted and then taken from there to the customer’s home. There has been a decrease in long-distance transport compared to the scenario follow the path due to more efficient, co-loaded transportation, and shared solutions. There is also a reduced number of drivers which leads to an increased development of platooning technology. Furthermore, different fleets and actors have different solutions and standards for their systems and trucks.
5.1.4 Follow the path

Reduced parking areas due to limited private motoring. Services in properties have increase and solutions such as instaboxes (a type of post box that fit packages) are common. Transport costs such as fuel and driver cost have increased and the increase is mainly the salary of the drivers due to lack of educated drivers. The demand for curb space is high which has resulted in a competition of the space of the road when loading and unloading. More dedicated lanes for bikes and walking has also affected the lack of curb space negatively, as it gives even less room for deliveries. Specific roads and routes are electric and there is a collecting point crisis. Collecting points are not earning any money by offering that type of service and do not have enough space or educated personal which has resulted in fewer collecting points. This has led to last mile delivery to customers' homes and other types of collecting points. Home deliveries are made during specific time slots and new business models are required for this change. Many companies have started to go back to delivering packages to the physical store where customers can pick it up. Bikes and electric cargo bikes are used for last mile delivery and the breakthrough for SDVs is low. Many new startups have established other ways to solve the last mile problem, for example, delivery by taxis. Longer vehicles have been introduced for long-distance transportation and the roads have increased buoyancy to be able to cope with heavier transportations and vehicles. However, the increase of buoyancy is from a longer perspective than 2030 since it is not possible to change the buoyancy in such a short time frame.

5.2 Workshop 2

The results from the first exercise clearly shows that the scenarios do not matter when it comes to which types of vehicles there will be in Sweden in 2030, as the same vehicles were brought up in all scenarios, see table 7 below.

<table>
<thead>
<tr>
<th></th>
<th>SAE 0-3</th>
<th>SAE 4-5</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Last mile logistics</strong></td>
<td>Light trucks</td>
<td>Light trucks</td>
<td>Drones</td>
</tr>
<tr>
<td></td>
<td>Light electric vehicles</td>
<td>Light electric vehicles</td>
<td>Smaller delivery robots</td>
</tr>
<tr>
<td></td>
<td>Electric vans</td>
<td>Electric vans</td>
<td>Bikes</td>
</tr>
<tr>
<td><strong>Long-distance transport</strong></td>
<td>Trucks Platooning</td>
<td>Trucks Platooning</td>
<td>Train</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Boat</td>
</tr>
</tbody>
</table>
In last mile logistics, the following vehicles were listed in the category SAE 0-3: light trucks, light electric vehicles and electric vans. In the category SAE 4-5, the same vehicles where listed, however, this time, either fully automated or automated to a higher level than in the previous category. In the last category, other, vehicles such as drones, smaller delivery robots, and bikes, both electric and ordinary, were listed. For long-distance transport, the categories SAE 0-3 and SAE 4-5 both included trucks. Both “ordinary” trucks and trucks with platooning technology. The difference between the trucks in the two categories is the level of automation and the need (or no need) of a driver. The category other included trains and boats as other possible modes of freight transport.

In the second exercise, the experts estimated the number of vehicles within long-distance transportation in each of the four scenarios, as shown in figure 8 below. In the workshop the reference point 100 was used which is the level of 2018. The blue bars illustrate the mean value of the two estimations and the mean value is written in numbers above each bar. The start and end of the black line illustrate the results from each of the groups. For example, in what you need is what you get did the two groups estimate the same number of vehicles within the long-distance transport, which is why there only exists a start point. In figure 8 below, follow the path has the highest number of vehicles with an increase by 30 percent compared to today.

![Figure 8: Graph illustrating the number of vehicles within the long-distance transport.](image)

Thereafter, the experts were asked to categorize the number of vehicles, figure 9 illustrates the categorization. The categorization is based on the levels of SAE and as viable in the figure, scenario same, same, but different and what you need is what you get have the highest share of SDVs (SAE 4-5), with 35 percent each.
The same procedure was made for last mile logistics and the estimation of the number of vehicles in each scenario is viable in figure 10. The result shows that the scenario same, same, but different has the highest number of vehicles, but also the highest variation among the two estimations as the black line is the longest.

The categorization of the vehicles within the last mile logistics is illustrated in figure 11 below. Compared to the result in figure 9 regarding the categorization of long-distance transport, is it
viable that it is a lower share of SDVs (SAE 4-5) within the last mile logistics when comparing scenario specific numbers. In the scenario same, same, but different for example, 35 percent of the vehicles are SDVs in long-distance transport while for last mile logistics, the number is 20 percent.

![Categorization of the number of vehicles within the last mile logistics in the year 2030](image)

*Figure 11: Graph illustrating the categorization of the number of vehicles within the last mile logistics.*

The last exercise of workshop 2 included the estimation of the number of vehicle kilometers. The graph illustrating the number of vehicle kilometers in the long-distance transport can be seen in figure 12 below. The result shows that what you need is what you get and follow the path has the highest number of vehicle kilometers, with an increase of 30 percent compared to today.

![Number of vehicle kilometers within the long-distance transport in the year 2030](image)

*Figure 12: Graph illustrating the number of vehicle kilometers within the long-distance transport.*
The categorization of the vehicle kilometers within long-distance is presented in figure 13. The result shows that the scenario same, same, but different has the highest level of vehicle kilometers operated by SDVs (45 percent) while follow the path has the lowest, where only 3 percent of all vehicle kilometers are operated by SDVs.

![Graph illustrating the categorization of the number of vehicle kilometers within the long-distance transport.](image)

*Figure 13: Graph illustrating the categorization of the number of vehicles kilometers within the long-distance transport.*

Furthermore, the graph illustrating the number of vehicle kilometers in last mile logistics is presented in graph 14 below. The highest number of vehicle kilometers is expected to be in scenario what you need is what you get, with an increase of 45 percent compared to today.

![Graph illustrating the number of vehicle kilometers within the last mile logistics.](image)

*Figure 14: Graph illustrating the number of vehicle kilometers within the last mile logistics.*
The categorization of the number of vehicle kilometers within last mile logistics is viable in figure 15 below. The graph illustrates that the scenario what you need is what you get has the highest share of vehicle kilometers traveled by SDVs while follow the path has the lowest share.

![Figure 15: Graph illustrating the categorization of the number of vehicle kilometers within the last mile logistics in the year 2030](image)

5.3 Reference group

In the reference group meeting, the participants from Trafikverket were asked to point out the three most important trends for Trafikverket from a list of seven identified trends, both general and scenario specific, that are believed to affect Trafikverket (see table 3 in section 2.3.1.2 Reference group). They all agreed on that nighttime transports and deliveries as well as continued development of electric vehicles and electric roads were two very important trends for Trafikverket. However, they had split views on the third trend. Both platooning for long-distance transports and restricted lanes for SDVs were identified as important trends for Trafikverket. The representatives argued that nighttime transports and deliveries is a way to better distribute the traffic, in order to decrease congestion and reduce the occupancy of the roads. Furthermore, they argued that as Trafikverket is not able to build roads in the same pace as the traffic is increasing, nighttime transports and deliveries are a great way to reduce congestion. Regarding electric vehicles and electric roads, both solutions are important to be able to reach the sustainability goals. Therefore, they are very important for Trafikverket too, as Trafikverket are working and planning for a better future in Sweden. Moreover, Trafikverket, but also other companies and countries, are testing different technologies today which further motivates the importance for Trafikverket. The platooning technology has already gotten very far and is a technology that Trafikverket believe
will be significant in the future. Just as electric vehicles and electric roads, it is an additional solution towards a more sustainable traveling due to the possibility to drive more efficient. Lastly, restricted lanes for SDVs was argued to be an important trend by some of the representatives, as it is, according to the representatives, needed in order to test automation on a larger scale. Already by 2030, Trafikverket argues that it actually is possible that there exist some restricted lanes for SDVs, which is why it is an important aspect for Trafikverket to plan and work towards. However, the representative that did not agree on this trend argued that there will not be restricted lanes, but rather distribution networks with slow SDVs in cities. Another possible solution discussed was shorter, restricted routes for SDVs that also are restricted to a specific type of goods or product.

In the scenario specific discussions, the participants were asked to discuss the results from the workshop in relation to Trafikverket. In same, same, but different, the representatives for Trafikverket argued that there will exist electric roads, but not everywhere. And the same is applicable for restricted lanes for SDVs, they will exist on some routes but it will not be a too common sight. However, the restricted lanes need to cover the whole route for specific goods as the SDVs can or will not be able to operate on “normal” roads. Therefore, the whole route must be restricted from start to end. Furthermore, Trafikverket argued that many new solutions will develop in the last mile. As long-distance is more important for Trafikverket, the discussions did not go any deeper within last mile solutions.

In the scenario sharing is the new black, Trafikverket discussed the topic “Plans to incentivize efficient transports” a lot. They agreed that it is a possible solution for them, however, the incentivize process and how it will be executed, can evolve differently. They discussed dynamic regulations and laws that depend on the traffic situation and the environment. And that incentives can be given to for example cars that are full of people instead of having just one person in the vehicle. Furthermore, Trafikverket discussed the possibility to better control and handle the information in order to better plan and incentivize for efficient transports and the whole road system in general. Specific and lanes for some cars/trucks or other vehicles, traffic signals to better operate traffic, and a dynamic pricing for environmental taxes are some examples of possible solutions discussed. In addition, the representatives argued that dynamic pricing is another important aspect and is something that they are planning for already. Taxes depending on how much you drive and what type of vehicle as well as other effects such as noise and congestion could all be weighed and considered in the taxes in the future. Moreover, Trafikverket agreed that there will be a standard for platooning, but most likely before 2030 as it is something that is already up on the agenda. Furthermore, they agreed that lanes could be dedicated for platooning, but it is important to plan the restrictions well. During peak hours, it is probably more likely that platooning will be prohibited due to already congested roads. So, it is important to dedicate platooning during “right times”.

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When discussing what you need is what you get, the representatives argued that this scenario is not something to aim for or work towards. If the policy and planning are slow, there is a risk that there will be an even worse traffic situation. The public traffic will be affected negatively and people will have the mindset that they rather take their own vehicle instead of using the public transportation, which will increase congestion even more. Therefore, it is very important that Trafikverket works towards an ambitious and proactive policy and planning as a preventive cause. Moreover, they did not agree on that they did not “own” the data in this scenario. Even though private actors own the data, it does not matter as Trafikverket believe that as long as they find a good way to share the data, the owner of it is not important. However, if Trafikverket and the actor owning the data does not come up with an agreement, it could result in a slow policy and planning as they do not know what the demands and trends are. Moreover, they agreed with the experts that there will be a shift from passenger transportation to freight in cities. Though, they argued that this trend also could imply in more traffic, as people will save time when ordering services and goods online and the saved time could, for example, be used to travel.

Lastly, the scenario follow the path was discussed. As the scenario is very similar to how it is today, Trafikverket had nothing to add to this scenario. Trafikverket also discussed the general trends and the scenarios in a more general tone. The platooning discussion about restricting and also prohibiting platooning during different hours was discussed further. When platoons are prohibited, a driver will be needed in every truck which in turn means that one of the huge savings regarding platooning will not be applicable. Furthermore, they discussed different levels of platooning and that it could exist platooning technologies even in the last mile logistics, but most likely in the suburbs or edge of a city. When it comes to SDVs, some were positive towards having restricted lanes in order to properly test the technology, while some argued that it is not a good solution. If SDVs are to be implemented directly in the “normal” traffic, a driver will be needed in the vehicle ready to interact when asked to. This means that some of the benefits regarding SDVs will not be as big as if the driver is absent. In addition, one representative argues that it is hard to simulate more than 5 percent of SDVs in traffic, which means that it is difficult to know the effects of SDVs without testing it. Therefore, the representatives that were positive towards restricted lanes for SDVs argue that in order to find out, one must test the SDVs on restricted lanes before implementing it in real traffic. Moreover, Trafikverket said that if they want to test SDVs on restricted lanes, it is possible. It is just a question of prioritization and money. Trafikverket also said that there is a lot of focus on the technology behind SDVs today, but that the focus also needs to be on the usage and how the transport system might evolve in the future.

Electric roads were one of the trends that the representatives agreed on to be one of the top three most important things for Trafikverket (when choosing from seven specific trends). When discussing this topic later on in the meeting, more information was raised. They discussed the
political importance of electric roads and that it is of interests for the politics, in both Sweden but abroad too, to find a sustainable solution. When discussing which type of technique that most likely will have a breakthrough, the representatives had shared opinions. One argued that overhead catenary systems will not be a good solution while another representative argued that it actually is a good solution. Another representative argued that it will be the cheapest solution that will come through but that many aspects will be important. It is hard to evaluate electric roads solutions by just looking at the price, esthetics or technique. However, all techniques are not applicable everywhere. Overhead catenary systems might not be workable in cities as it will destroy the cityscape, so in cities, inductive power transfers might be more suitable.
6 Analysis

In this section, the result from the study is analyzed. Firstly, general trends will be discussed followed by scenario specific trends. Thereafter follows system impacts and different interpretations of the different scenarios.

6.1 Trends

The general trends developed in workshop 1 are all important to consider as they are common for all scenarios and thus likely to occur regardless how the future will evolve. When Trafikverket were to choose top three trends that most likely will affect them, three trends from the general trends were picked as well as another trend. The fourth trend was not a part of the general trends but will still be presented in this section due to its importance for Trafikverket. The three trends that Trafikverket chose that are general trends are nighttime transports and deliveries, platooning for long-distance transport, and continued development of electric vehicles and roads. Specific lanes for SDVs was the fourth trend that is not a part of general trends.

Nighttime transports and deliveries: Research indicates that both distances (Figueroa et al., 2014) and goods transported on roads will continue to increase (Psaraki-Kalouptsidi & Pagoni, 2011) which is also visible in the estimations made during workshop 2. The results in figure 8 and 12 clearly show that both the number of vehicles and vehicles kilometers traveled for long-distance transports will increase in all scenarios except for the scenario sharing is the new black. Using nighttime transports and deliveries is, therefore, an important tool for transport administrators and, in particular, Trafikverket to better spread out the traffic and thereby reduce the congestion. That this trend was chosen as one of the most important is therefore not surprising, since the congestion is one of many challenges that road freight transport has been struggling with for many years (Psaraki-Kalouptsidi & Pagoni, 2011). Moreover, it goes well in line with the need for smarter and more efficient transports which the Swedish Government is promoting (2017).

Platooning for long-distance transport: Platooning for long-distance transport has been developed for a while and the technology is almost ready to be implemented and used, there are only some regulation and legalization barriers left to overcome (Alkim, 2018). So that this trend was raised in both workshops and stated to be one of the top trends for Trafikverket was expected. Platooning goes well in line with the certain trend identified by Pernestål Brenden et al. (2017) that there will be more focus on sustainability, as platooning gives advantages such as less congestion (Maiti et al., 2017) and enables fuel and emission savings (Larsson et al., 2015). Moreover, another aspect of the technology that makes it likely to implement in the near future, regardless scenario, is that it is a small step towards SDVs. Each truck can still have a driver, but the driver can execute other important tasks while in the platoon. This gives some of the benefits of SDVs without losing the driver, thus implementing platoons is an important step towards fully autonomous trucks in the
future. However, as stated by Trafikverket in the reference group, platoons are not suitable in all situations. During peak hours, when the traffic situation is at its peak, long convoys of trucks will probably only worsen the already congested situation. Therefore, restrictions regarding when to use platooning and to be able to easily dissolve the platoons is an important aspect of the technology to be implemented in a larger scale in Sweden according to Trafikverket. Furthermore, platooning standards are something to strive for as well for the technology to be widespread. Using standards will facilitate the implementation and also make it easier for international freight transports to operate, as one barrier with platoons today is that different countries have different rules which make it challenging to come up with solutions that fit every country as well to drive truck platoons across borders (Alkim, 2018).

**Continued development of electric vehicles and electric roads:** Also, this trend is well aligned with the sustainability focus expected to be a certain trend by Pernestål Brenden et al. (2017), as electric vehicles have a lower fuel consumption and emits less than vehicles powered by fossil fuel (Lee et al., 2013). However, what technique to use is not as certain as that the electric roads will be used and developed. There exist different types of electric roads, but dynamic charging, charge-on-the-move is a promising technique, especially when enabling electric vehicles in a larger spectrum (Nicolaides et al., 2016). In the reference group meeting, Trafikverket discussed both IPT and overhead catenary systems as possible techniques. The advantage with IPT is that any vehicle can use it, while overhead catenary is more applicable for one type of vehicle as it uses an overhead wire and thus, only vehicles with similar height can connect. For freight transport on long-distances, the overhead might be a good solution. But in cities and routes with many cars, IPT is more suitable. The implementation of electric roads requires a lot of work by transport administrators, so, therefore, it is most likely that only the most attractive routes will be electrified by 2030.

**Restricted lanes for SDVs:** The penetration rate of SDVs in each of the scenarios differ, but common for all is that there is a breakthrough for SDVs for long-distance transport. In workshop 1, the experts stated that there will be restricted lanes for SDVs in the scenario same, same, but different, but not in any other scenario. That there is none in follow the path is not surprising as the scenario is the least proactive one with the smallest penetration rate of SDVs, but that this trend did not arise in the other two scenarios is rather unexpected. As discussed in the reference group meeting, restricted lanes for SDVs is almost a must for pilot testing, as it is difficult to simulate and know the effects of SDVs in traffic without trying it in real life. Furthermore, it is a way to partly avoid the interaction problem between conventional drivers and SDVs discussed by Sivak and Schoettle (2015). Therefore, this result is shocking as 2030 only is 12 years ahead, and the gap from having 0 percent SDVs today, to going to about 20 to 35 percent in long-distance transports in the year 2030 for the scenarios sharing is the new black and what you need is what you get, is
pretty big. Even though the goal is to have SDVs that can fully operate with normal traffic, the road towards that will probably involve many tests. One explanation for why only same, same, but different was expected to have restricted lanes could be that the experts believed SDVs to already have gotten through the testing process and when doing the estimations, thinking of a future a bit further away than 12 years.

Except for these four trends mentioned above, whereby three was originally in classified as general trends from workshop 1, the rest of the general trends will now be presented and discussed further.

A bigger breakthrough of SDVs for long-distance transport compared to city logistics: This was highlighted by the experts in both workshop 1 and workshop 2 and was discussed in all four scenarios as it is of general character. The estimations of the system impacts show a higher share of SDVs (SAE 4-5) within long-distance transport compared to last mile logistics (which in the case is equivalent to city logistics, as the last mile is operated in the city of Stockholm). However, the share of SDVs in both long-distance transport and last mile logistics is very similar in the scenario follow the path. The reason for this could be that platooning can be seen as partly SDV. Trucks in the platoon that is following the leader, are basically autonomous. However, when estimating numbers in the scenario, platooning technology could be accounted in the category SAE 0-3 but also in the category SAE 4-5 depending on the platooning technologies. Different technologies and also, interpretations of how the technologies will be used, can have affected the results. Some might argue as since there is a driver in at least the first truck, the trucks are not fully autonomous and therefore not applicable under the SAE 4-5. Other might believe that since the trucks in the platoon are following the ones before, they can be seen as autonomous. Moreover, a reason for a bigger breakthrough of SDVs within long-distance transport could be explained by the less complex environment compared to the city logistics.

Other modes and vehicles for freight transportations are getting larger market shares: This is a trend that was brought up in workshop 1 and confirmed in workshop 2. Both when estimating types of vehicles in each scenario, as they all estimated boat and train in the category “other” for long-distance, but also when estimating kilometers traveled and categorizing the vehicles within long-distance transport, it is clear that other modes of transport are getting larger market shares. This trend was also discussed by the reference group, who said that if that is true, it would be a relief. The roads are already congested and freight transport is struggling with reducing the congestion on roads (Psaraki-Kalouptsidi & Pagoni, 2011), therefore, having a larger share of goods using boat and train instead, would be beneficial in that cause.

Increased requirements for co-loading: An additional way to make the transportations more efficient is to co-load. Obvious effects of this are that it is beneficial for the environment due to fewer emissions as fewer vehicles are needed, which is something that the Swedish Government
(2017) actively encourages. As mentioned before, this goes well in hand with the sustainability focus in all scenarios (Pernestål Brenden et al., 2017), which of course motivates this trend. Furthermore, this trend does not involve the implementation of new roads, infrastructure, vehicles etc., so compared to some of the other trends, it is easier to implement and thus, very likely to occur. The only problem with this is how to coordinate the process and make sure that everyone involved gets their share of the profit. But compared to changing all the roads to electric roads, it should not be that complicated.

Extended congestion taxes and environmental zones: Lastly, this trend is also very important to highlight. It coincides with the certain development of a sustainable focus (Pernestål Brenden et al., 2017) and the agenda of the Swedish Government (2017). How this implementation will occur and what type criteria that will be involved is, however, not as clear. Taxes can vary depending, for example, type of vehicles, number of people in the vehicle, filling degree, how much the vehicle is emitting, different zones etc.

6.2 Same, same, but different

In this scenario, an ambitious, proactive, and innovative policy and planning are assumed in combination with no breakthrough for shared solutions.

Fewer actors: The experts believe it will be fewer actors within long-distance transportation due to a price sensitive industry. It is therefore important for the few actors to have competitive advantages to be able to survive. Kristoffersson and Pernestål Brenden (2018) argue that an advantage with introducing SDVs is the reduced driver cost. To be able to compete in the market it might, therefore, be an incentive to introduce SDVs since some costs related to drivers may be reduced. It is most likely that the driver still is needed in year 2030 due to regulations and the short time frame. The costs in form of salary for the driver can therefore not be removed. However, other costs can be lowered with the self-driving technology. For example, reduced fuel consumption as argued by Fagnant and Kockelman (2015) as well as creating opportunities for the driver to perform other value-adding tasks.

A network of governmentally owned electric roads: As stated earlier, focus on sustainability is a general trend and one way to get a more sustainable transport system is through electric roads. In this scenario, the experts believe the network of electric roads to be owned and governed by the government which is likely due to the ambitious policy and planning. Historically have electric vehicles not been cost-effective in comparison to traditional vehicles regarding for example purchase price and fuel price (Lee, Thomas & Brown, 2013). However, since the focus has shifted even more to sustainability in this scenario, the state might implement more congestion charges and environmental zones, making it more expensive to use fossil fuels. So due to regulations, freight transports that are powered by fossil fuel will be more expensive than electric trucks in the
future. Furthermore, another tool that the state can implement is to prohibit transports using fossil fuels in some areas, resulting in these transports having to take alternatives routes.

6.3 Sharing is the new black

*In this scenario, an ambitious, proactive and innovative policy and planning are assumed in combination with a breakthrough for shared solutions.*

A *decrease of long-distance transports:* The experts in the first workshop predicted a decrease in long-distance transports as a trend in this scenario. Moreover, the result from the second workshop shows that the experts expect a decrease of vehicles. Sharing is the new black is the only scenario which has a decrease of vehicles which can be connected to the combination of an ambitious planning and a breakthrough for shared solutions. Yoshimoto and Nemoto (2005) argue that the technological development can have positive effects such as efficient joint delivery systems to share information and prevent an increase in traffic. And the technological advancements, with combination of an ambitious policy and planning, enables the state to direct the traffic to alternative routes depending on the traffic situation as well as the possibility to co-load which explains the decrease of long-distance transports in this scenario.

*Electrification requirements:* There is a focus on sustainability since the policy and planning are ambitious, which is partly why the transport administrators control the traffic through different incitements. One example discussed during workshop 1 was the requirement to use more electric vehicles and that some routes could even be dedicated to electric vehicles in order to further promote more sustainable transports. This requirement might seem different compared to the network of electric roads in the scenario same, same, but different. However, the trends are similar in their focus on electrification in order to reduce the environmental footprint. The difference is that same, same, but different focuses on electric roads while this scenario focuses on electric vehicles. Both trends are necessary to make electrification possible which makes these trends very similar. As stated earlier is the electrification trend depending of the proactive politic in both of these scenarios.

*Regulations to facilitate for SDVs:* According to the experts in workshop 1 the scenario has regulations to facilitate for SDVs to a larger extent than the other scenarios due to an ambitious politic. The reason for why this scenario has a larger extent than same, same, but different, which also has an ambitious policy and planning, is that the breakthrough of shared solutions further facilitates the development of SDVs. Communication between vehicles, and SDVs in particular, is greatly depending on sharing of data, as it is needed in order for V2V communication. For example, data regarding speed, destination, position etc. are all vital for a better traffic control. Therefore, in comparison with scenario same, same, but different where there is no breakthrough
for shared solutions, the regulation process might have been slowed down due to the lack of shared data.

**Plans to incentivize efficient transports:** As stated earlier is sustainability important in this scenario and one way to achieve higher sustainability is the rewarding of efficient transports. The reference group argued that transport administrators can control the traffic by giving companies which focuses on the environment valuable information of where and when to travel. Moreover, the experts discussed during workshop 1 that customers can choose environmental transports of their goods and also get points when selecting a sustainable transport. Today, there is no focus on how the transport is made when buying online. However, when the supply chain gets more viable and the customer knows which alternative that is most environmentally friendly, it could change.

6.4 What you need is what you get

*In this scenario, an ambitious but slow and careful policy and planning are assumed in combination with a breakthrough for shared solutions.*

**New actors and types of cooperation & shift from passenger to freight transportation in cities:** The possibility to buy services and goods from new actors has created a shift from passenger transport to freight transport in cities. However, as stated by Trafikverket, this might not be the situation. As people get more free-time due to the time saved when being able to order everything online, even food and other services, this time can be spent on traveling and other activities. Therefore, the shift might not be too obvious. Yet, all the extra time spent on traveling is not comparable to the amount of traffic reduced due to the possibility to order everything online instead of privately going to the store, as companies can better plan and co-load in order to optimize their routes.

**Worse traffic situation:** The experts argued that since the transport administrators do not own the data, it is difficult to predict demands and thus, the traffic situation is even worse in this scenario. This argument is based on the scenario analysis by Pernestål Brenden et al., (2017) which states that companies own the data and the policy and planning has a hard time keeping up. When discussing this with Trafikverket, they argued that the owner of the data is not relevant as long as it can be shared with the transport administrators. However, agreements between the owners and the ones who want to use the data, in this case, the transport administrators, need to be made for it to work.

**Distribution centers:** One trend in this scenario was that companies will build distribution centers in or nearby cities. From these centers will last mile solution then be delivered with SDVs, electric bikes, or bikes. However, there is no specific attribute in this scenario that makes this trend to only be applicable in this scenario. Using distribution centers facilitates co-loading and helps to better
plan transports, which just as many other trends are motivated by the sustainability focus. Furthermore, this solution is already used today, so it should be seen as a general trend instead of a scenario specific.

*Reduced number of transports (long-distance transport):* The experts believe the number of transports to be lower compared to the scenario follow the path. This is a reasonable assumption as cooperation among actors, co-loading and effective use of data makes it easier for companies to plan and make the transports more efficient.

*Mix of fleet (and standards) & fewer drivers:* As the companies control the market by owning the data in this scenario, there is a huge focus on profitability and cutting costs, which makes the assumption of having fewer drivers legit. Companies can use platooning to further reduce costs by fuel savings as stated by Larsson et al., (2015). However, the experts stated that there will be a mix of fleet and standards, but that is less likely. Especially different standards for platooning as one barrier with platooning according to Alkim (2018) is to coordinate platoons from different countries as regulations obstruct the process. Moreover, during the reference group meeting, did Trafikverket discuss that companies already work towards a common solution for platooning, which further motivates why a mix of standard would be less likely.

### 6.5 Follow the path

In this scenario, an ambitious but slow and careful policy and planning are assumed in combination with no breakthrough for shared solutions.

This scenario is described by Pernestål Brenden et al., (2017) as most similar to how the situation is today. This clearly shows in the results as both estimations regarding SDVs were low (the lowest penetration number of SDVs in both long-distance transport and last mile) as well as there were no protruding solutions in this scenario. As described in the literature, technological development can affect traffic flow positively (Yoshimoto and Nemoto, 2005), but, as this scenario has the least technological development, the lack of technological development has instead lead to an even worse traffic situation with more congestion.

Another key insight from this scenario is that since the technological development is the slowest, the focus in this scenario is a bit different than the other scenarios. Instead of developing new solutions and services, this scenario focuses more on developing already existing solutions. For example, longer vehicles and increased buoyancy on the roads, which are solutions to meet the increasing demand and requirements.

### 6.6 System impacts

The analysis of the system impacts is divided in three categories following the exercises in workshop 2. These categories are: types of vehicles, number of vehicles, and vehicle kilometers.
6.6.1 Types of vehicles

In the first exercise of workshop 2, the experts estimated types of vehicles in the different scenarios which turned out to not be scenario specific. It was no vehicle or technique that was unexpected, except that smaller delivery robots would be a last mile solution independently of scenario. It might be a surprising result as this solution could be considered to be connected to more futuristic settings. However, delivery robots can be seen as an addition to the existing fleet which differs from for example trucks. Trucks have long lifetimes and can therefore still be available in the SAE 0-3 in the year of 2030 as trucks bought in the recent years will still function properly then. Companies will most likely not be able to change their already existing fleet at the same pace as small delivery robots can be bought, which motivates why robots are independent of any scenario. Furthermore, the production of delivery robots is less complex and less expensive in comparison to trucks. However, delivery robots have the disadvantage that they cannot operate in crowded areas (Huang, 2017), which is why it is important to also consider other last mile solutions such as bikes, drones, and electric vehicles that were discussed in the workshop. Furthermore, these solutions coincide with the literature which recommends such kind of last mile solutions.

6.6.2 Number of vehicles

Long distance transportation: The number of vehicles has increased in all scenarios except for sharing is the new black. The main reason for this increase is the rising e-commerce trends which are expected to increase even more in the future as described by PostNord (2018). Sharing is the new black, on the other hand, is the only scenario with an expected decrease in number of vehicles. This could be argued to be due to the breakthrough of shared solutions in combination with an ambitious policy and planning. In sharing is the new black, the possibilities to co-load as well as the breakthrough for shared solutions has resulted in more efficient transports. This, in turn, has resulted in the need for fewer vehicles. On the contrary, follow the path has the highest number of vehicles in long-distance transportation. The experts, therefore, believe that if we continue at the same pace as we have now, the number of vehicles will continue to increase.

Regarding the categorization of vehicles within long-distance transportation, SDVs are viable in all scenarios. The smallest penetration rate is seen in the scenario follow the path, which means that if we keep the same pace as today, the penetration rate of SDVs will not be as high as it could be. The other scenarios have a penetration rate of 20-35 percent, so if any changes regarding either politics or breakthrough for shared solutions are being made, SDVs will be implemented to a much higher degree. One could argue that it, therefore, is not only one aspect that will affect the rate, but rather many factors, that will determine the outcome of SDVs and the penetration rate within long-distance transportation for e-commerce.

Last mile logistics: The experts estimated an increase in the number of vehicles within last mile logistics in all scenarios. This could be explained by the increased demand for flexibility, the
estimated increased number of home-deliveries, and the increased demand overall described in the literature. However, the smallest increase, was again, in sharing is the new black. As described in long-distance transportation above, this could be described by the attributes of sharing is the new black, which opens up for more co-loading and more efficient transports and thus better sharing solutions for the companies delivering packages in the last mile.

When estimating the categorization of vehicles, the experts argued that SDVs will be implemented in all scenarios. Compared to long-distance transportation, the penetration rate for SDVs was smaller in all scenarios. This was also discussed in workshop 1 and the experts argued that the explanation for this is the more complex environment in cities. The comparison of SDVs is only made for vehicles within the category SAE 4-5. However, in last mile logistics, other vehicles such as drones and small delivery robots are expected in all scenarios. These vehicles are also autonomous, but not in the same “context” as the SDVs referred to in this study. One could, therefore, argue that even though the penetration rate of SDVs is lower in last mile logistics, there is still a high breakthrough of autonomous vehicles. About 30-40 percent of the vehicles used for last mile delivery are autonomous when drones and delivery robots are accounted too. This number of automation in the last mile logistics, which actually gives last mile logistics a higher number of automation compared to long-distance transport (where only SAE 4-5 is accounted), could be explained by the future demands of the customers. In a survey, customers wished for home delivery by SDVs (PostNord, 2018), which implies that customers are demanding SDVs in the last mile.

6.6.3 Vehicle kilometers

When comparing the number of vehicles with the number of vehicle kilometers is it visible that the graphs are coinciding. For example, the scenario follow the path has the highest number of vehicles as well as the highest number of vehicles kilometers traveled in long-distance transport. This result indicates that the vehicles are utilized to the same extent. However, when comparing the categorization of long-distance transport and last mile logistics is it viable that the category others are not used to the same extent within last mile logistics. In the comparison between figure 13 and 15 are the vehicles in the category “others” not used to the same extent as the categories SAE 0-3 and SAE 4-5. One reason for this could be that SAE 0-3 and SAE 4-5 are either driving longer routes, are used more often or a combination of the two. This could be explained by the fact that both drones and bikes have limited distance capacity compared to trucks and cars (Huang 2017; Slabinac, 2015).

6.7 Different interpretations

When analyzing the result is it clear that different groups had varying interpretations and focus of the scenarios. Some groups had a bigger focus on the political aspect while others focused on the breakthrough of shared solutions. The groups that thought that the political view was more
important had estimated lower numbers (for example fewer vehicles and vehicle kilometers) in the
two scenarios were the policy and planning are more ambitious and proactive. These groups
thought that as the politics is ambitious and proactive, the society is actively working with smart
solutions, co-loading etc., which enables more effective transports and thus lower values for the
two scenarios at the top. In contrast, the groups that focused on the breakthrough of shared
solutions, on the other hand, got lower values in the scenarios to the right, where the breakthrough
for shared solutions is higher. These groups argued that shared solutions enable shared
transportation and thus more effective transports which results in lower values. These differences
are especially shown in what you need is what you get and same, same, but different as the two
groups who worked with these diagonal scenarios had contrary focuses. This has resulted in the
result of these two scenarios being very similar in all of the graphs in workshop 2, as the opposite
focuses outweigh each other.

Another interpretation that shows clearly in the graphs is that the groups that worked with the
scenarios sharing is the new black and follow the path, in general, was more skeptical towards
SDVs than the groups that worked with the other two scenarios. This is reflected in the results as
the scenarios sharing is the new black and follow the path overall gets much lower values for SDVs
than the other two scenarios (see figure 9 and 11 in empirical findings). Compared to the scenario
analysis by Pernestål Brenden et al. (2017), the scenario sharing is the new black should have a
higher portion of SDVs than the other scenarios as it has both an ambitious and proactive policy
and planning as well as there is a breakthrough for shared solutions. But due to different
skepticisms in the groups, sharing is the new black has lower values than two of the scenarios.
However, when comparing sharing is the new black with its reference scenario follow the path, it
still has a high degree of SDVs. Therefore, some of the results could be perceived as misleading.
7 Conclusion

The research questions will now be answered one by one.

RQ1: How will the distribution of e-commerce packages be affected by the implementation of SDVs in each of the four possible future scenarios?

In the workshops, other trends which affect the distribution of e-commerce packages than SDVs were discussed as well. These trends are likely to occur in the year 2030 and are therefore of importance for the transport administrators. When answering the research question these trends are discussed as well.

Same, same, but different: General trends in this scenario involves a developed buying process with VR and showrooms, restricted lanes for SDVs, and a network of governmentally owned electric roads. When it comes to last mile logistics, there is co-loading to some extent, more actors operating, and there exists a coordination of goods in order to optimize. Furthermore, last mile deliveries to customers’ homes are made with bikes and there is an increase of light and emission-free vehicles. There are fewer actors in long-distance transport due to a price sensitive industry. Electric vehicles and electric roads on attractive routes exist as well as an increased remote control.

The system impacts for long-distance transportation in this scenario were estimated to:

- A 15 percent increase of vehicles whereby 35 percent of the total vehicle fleet is believed to be SDVs.
- A 25 percent increase in vehicle kilometers whereby 45 percent of the total vehicle kilometers are estimated to be traveled by SDVs.

For last mile logistics, the system impacts were estimated to:

- A 60 percent increase of vehicles whereby 20 percent of the total vehicle fleet is believed to be SDVs.
- A 35 percent increase in vehicle kilometers whereby 20 percent of the total vehicle kilometers are estimated to be traveled by SDVs.

Sharing is the new black: General trends in this scenario involves regulations to facilitate for SDVs, plans to reward efficient transports in different ways, dedicated curb space for loading and unloading as well as electrification requirements. Last mile logistics is more flexible and viable and gamification as well as dynamic price regulations are used to better plan and promote efficient transports. SDVs are used for driver assistance and there are co-loading requirements. Electric vehicles, bikes, and delivery robots are dealing with last mile distribution and during nighttime are quiet electric vehicles used. Trends within long-distance transport involve longer vehicles and dedicated lanes for platooning during specific hours. Furthermore, there exists platooning
standards that must be used in order to use the technique and due to co-loading and an ambitious policy has there only been a minor decrease of long-distance transports.

The system impacts for long-distance transportation in this scenario were estimated to:

- A 2.5 percent decrease of vehicles whereby 20 percent of the total vehicle fleet is believed to be SDVs.
- A 2.5 percent decrease in vehicle kilometers whereby 22.5 percent of the total vehicle kilometers are estimated to be traveled by SDVs. This is the only scenario with a decrease of both vehicles and vehicle kilometers.

For last mile logistics, the system impacts were estimated to:

- A 17.5 percent increase of vehicles whereby 14 percent of the total vehicle fleet is believed to be SDVs.
- A 30 percent increase in vehicle kilometers whereby 16.5 percent of the total vehicle kilometers are estimated to be traveled by SDVs.

What you need is what you get: General trends in this scenario involves new actors and cooperation’s which have resulted in a shift from passenger transportation to freight transportation in cities. As companies control the market, there is a focus on cities which results in flexible cities and a neglected countryside. Moreover, the traffic situation is worse in this scenario than today due to a slow policy and planning. Last mile logistics include co-loading solutions and home deliveries are made by SDVs or bikes. Post boxes and shops are used when home delivery is not an option. Distribution centers are built around cities to better distribute last mile logistics and pools of electric vehicles are used on specific routes. There is a reduced number of long-distance transport due to co-loading and new types of cooperation. Fewer drivers are available as it is a matter of expense. Lastly, different companies use different trucks and techniques.

The system impacts for long-distance transportation in this scenario were estimated to:

- A 20 percent increase of vehicles whereby 35 percent of the total vehicle fleet is believed to be SDVs.
- A 30 percent increase in vehicle kilometers whereby 40 percent of the total vehicle kilometers are estimated to be traveled by SDVs.

For last mile logistics, the system impacts were estimated to:

- A 40 percent increase of vehicles whereby 22.5 percent of the total vehicle fleet is believed to be SDVs.
- A 45 percent increase in vehicle kilometers whereby 27.5 percent of the total vehicle kilometers are estimated to be traveled by SDVs.

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Follow the path: General trends in this scenario involve reduced parking areas to lower the number of vehicles, possibilities to collect e-commerce packages in properties, increased transport costs, decreased curb space, more bike and walk lanes as well as electric roads on specific routes. Last mile logistics include trends such as collecting point crisis, time slots for home delivery, deliveries by taxis, and electric bicycles but almost no SDVs. The long-distance transport is characterized by longer vehicles and increased buoyancy of the roads.

The system impacts for long-distance transportation in this scenario were estimated to be the following:

- A 30 percent increase of vehicles whereby 5,5 percent of the total vehicle fleet is believed to be SDVs.
- A 30 percent increase in vehicle kilometers whereby 3 percent of the total vehicle kilometers are estimated to be traveled by SDVs.

For last mile logistics, the system impacts were estimated to:

- A 37,5 percent increase of vehicles whereby 5 percent of the total vehicle fleet is believed to be SDVs.
- A 40 percent increase in vehicle kilometers whereby 12,5 percent of the total vehicle kilometers are estimated to be traveled by SDVs.

General trends: In addition to the scenario specific trends, did also the workshop result in some general trends that are non-scenario specific. These trends were raised in all scenarios and the following general trends are expected to occur: more nighttime transports and deliveries as well as new types of and more delivery options. The platooning technology is common for long-distance transports and the breakthrough for SDVs is larger for long-distance transports than for city logistics. Other modes and vehicles for freight transportations are getting larger market shares and there is a continued development of electric vehicles and electric roads. Regarding the specific e-commerce case in this study, the transshipment stop in Malmö is not applicable anymore due to international direct deliveries. Due to sustainability goals, there are increased requirements for co-loading and extended congestion taxes and environmental zones. All results are presented in greater detail in the results for workshop 1 in the sections 5.1.1 Same, same, but different to 5.1.4 Follow the path.

**RQ2: What impacts can the implementation of SDVs have on the transport administrators considering the identified factors and system impacts in research question one?**

The impacts are difficult to predict, but the important aspects highlighted in this study is that SDVs and platooning will be implemented in the future regardless scenario. The experts believe that SDVs will be implemented in both long-distance transportation and last mile logistics. The
implementation of SDVs will require a thorough planning and implementation plan, which will have an impact on the transport administrators in Sweden as they need to plan for the implementation. In addition, the platooning technology will require planning too. Both how to implement it but also regarding how to restrict the technology as discussed in the study, since already congested roads can be negatively affected by long truck platoons if these are implemented during peak hours. Therefore, the implementation of SDVs and platooning technology needs to be planned for.

Regarding the system impacts, both the number of vehicles and vehicles kilometers traveled is expected to increase in almost all scenarios and distances, which in turn will result in more traffic. This will, of course, affect the transport administrators as well, as it will require a well-functioning infrastructure to keep up with the increasing demand on efficient roads and transports solutions for the traffic to function properly. The estimated increase is therefore of significance to plan according to, in order for the transport administrators to reduce traffic congestion and other goals identified in this study. Except for these trends and technologies, it is vital to study and further develop the other trends mentioned in the report. Both the two other trends identified to be of major importance for Trafikverket (nighttime transports and deliveries as well as electric roads), but also general trends and scenario specific trends as these are factors of significance identified by experts in the transportation field.

To conclude, the impacts of the implementation of SDVs are hard to predict, but in order to facilitate the implementation, it is vital to plan for the implementation. Furthermore, other trends and technologies are important to consider as well since these trends are discussed in the context of SDVs as well as they are believed to occur regardless.
8 Recommendations

We recommend Trafikverket to focus on the general trends since these are expected to occur in all of the four scenarios. The focus should especially target the four trends that Trafikverket prioritized in the reference group. However, is it of importance to understand the different scenarios and actively work towards the most desirable one. It might be hard for Trafikverket to influence the breakthrough for shared solutions, as it is based on people’s attitude towards how much they are willing to share data and other solutions. On the contrary, the ambitious and proactive policy is easier to affect and something that Trafikverket should strive towards as it in general results in a less congested and better traffic situation in Sweden. We are now going to discuss the four trends further and how Trafikverket can continue their work within these trends.

Electric roads: We recommend Trafikverket to continue the development and testing of electric roads. Trafikverket is already working actively with electric roads and it is important to continue this work and further develop the area. Both as a proactive policy and planning is ideal for future development, but also for Sweden as a country to be able to compete globally and cut edges.

Nighttime transports and deliveries: Trafikverket should consider how to reward companies that are driving during nighttime as this would result in less congested roads. One example of this is to make it favorable for companies to drive during the night by increasing the taxes during peak hours. The money from the taxes can then be used to continue the development of the other discussed trends in the report.

Restricted lanes for SDVs: As the results show, there is a lot of insecurity regarding when and how the breakthrough for SDVs will occur. However, all experts argue that SDVs will be implemented in the near future as all scenarios include SDVs in both long-distance transportation and last mile logistics. Some parts of Trafikverket are arguing for test lanes while others are more keen on having distribution networks, which clearly shows that this is something that Trafikverket need to actively work with. We, therefore, recommend Trafikverket to start the planning of a test distance/lane for SDVs. The lane can be limited to for example the transport between a harbor and a distribution center. It should be an area where there is continuous traffic as well as the possibility to separate the test lane from the rest of the traffic.

Platooning: Trafikverket should consider how to restrict platooning and still be able to obtain the benefits from the technology. A suggestion is to start with approving platooning during specific hours and review the result. For example, allowed it during the night which coincides with the trend to increase nighttime transports and deliveries. In addition, the technology can, of course, be used during other times, as long as the peak times are avoided.
9 Discussion

One representative expressed, after the reference group meeting, that if Trafikverket could choose a “dream” scenario, it would be a more neutral version of the scenario sharing is the new black. The representative said that Trafikverket desire to be closer to the origin than the scenario sharing is the new black but still remain in the quadrant. If this dream scenario represents the whole authority, is it important to continue the development and tests regarding SDVs as well as discussing the usage of the technology. In addition, the insecurity highlighted in the results of the reference group regarding the different mindsets of when and how SDVs will be implemented, clearly shows that SDVs is a topical subject that Trafikverket needs to work with. As Trafikverket is an authority whose main goal is to guarantee a safe and environmental sound infrastructure and transportation, it is vital that they know how to deal with the future transports implications that the implementation of SDVs will generate. Especially since SDVs is a trend that all experts believe to be implemented by the year 2030 as well as it is something that customers within e-commerce are requesting as a delivery method in the future.

The scenario description by Perenestål et al., (2017) indicates that an ambitious policy and planning leads to new transport solutions, technology development, and a prosperous society. However, the experts had varying interpretations of how an ambitious policy and planning could affect the transportation in the workshops. Some experts interpreted it similarly to Pernestål et al., (2017), while others had a different view. Instead of resulting in more solutions and new technology, some argued that proactive politics could result in a better utilization of current vehicles and transport solutions as using the existing vehicles can be more favorable for the environment instead of manufacturing new ones. Therefore, when having this kind of mindset, it could actually mean that a proactive planning not automatically results in a faster development of SDVs but rather the opposite.

9.1 Method

Regarding the method, there are some aspects that could be improved for similar studies in the future. The first aspect that could have affected the results negatively, is that the workshops were short and only two to the number. As the workshops only lasted for two hours each, whereby almost half of that time was spent on introduction and understanding all of the scenarios and exercises, it was very little time left to actually execute the exercises. This could have resulted in that the participants did not have time to fully reflect on their assumptions as well as some assumptions being made in a rush. This is especially applicable for workshop 2, where each exercise was very time consuming and hard to estimate. That we only arranged two workshops can have similar effects on the results, as there was very limited time to get all the information and estimations desired for this study.
Another reflection regarding the method is that it would have been better if all groups discussed all scenarios. Due to the limited time frame discussed above, this was not possible. But for future research, it is probably a better method to use. As we had such diverse groups, the result is not as reliable as we would hope since only two groups worked with each scenario. Furthermore, it makes it hard to compare the different scenarios, as the groups who worked with two diagonal scenarios had a different approach and focus compared to the others groups who worked with the other two scenarios. If all groups would have discussed all scenarios, it would, therefore, be easier to compare and get a more coherent result.

In addition, it was challenging to focus on SDVs in our study, which clearly shows in the results. A lot of other problems and focus areas has been raised and some of them, like electric roads and nighttime transports, are not specific for SDVs. This implies that SDVs is strongly connected to other trends, systems, and concepts regarding freight transportation and that a system perspective is of significance to study. However, it is still important to study SDVs in a larger spectrum but at the same time investigate the effects of SDVs in the smaller context, as the effects regarding “only” SDVs are of significance as well.

9.2 Future research

Our recommendation for future research and how to further develop the studied area is to not apply all four scenarios in the same study. The focus scenario could either be chosen from one of the four develop by Pernestål Brenden et al., (2017), or a combination of the scenarios. One approach could be to first identify and then study the most desirable of the four (or compose a desired scenario) and use that scenario as a reference point. Another approach could be to study the least desirable (or compose a “worst-case-scenario”) and use that scenario to investigate what must be done in order to not end up in that scenario. This could be done from both the perspective of Trafikverket, but also from other actors and companies view. In conclusion, the focus area of the study would be to create a dream scenario or a worst-case scenario and then investigate what must be done in order to reach or avoid that scenario.

Another approach to further work with the results of this study is to not apply the scenarios and instead focus on the most important trends identified by Trafikverket. As concluded in this report, it is of significance to further study the implications of SDVs by implementing restricted lanes for them. However, there is a huge vagueness regarding how the implementation will occur. Therefore, a suggestion is to further look at the implementation process regarding restricted lanes for SDVs. In general, the study should focus on barriers and facilitators and how to overcome and work with the possibilities in order to implement restricted lanes for SDVs in the nearest future. Three topics to further study could be:

- What is required from Trafikverket or any other transport administrator?
- What is the best way to implement restricted lanes for SDVs?
- How is the implementation going to work and where should the lanes be located?

Furthermore, another interesting area to investigate is platooning and how the restriction and implementation of the technology are going to come about. As mentioned in the conclusions, platoons will most likely be restricted during specific times, so questions to further look into are:

- When should platoons be restricted?
- How is the restriction of platoons going to be operated to function in the best possible way?
- What is required for platoons to be operating on the streets today?

9.3 Research contributions

This report can partly be seen as a type of validation of the scenario analysis developed by Pernestål et al., (2017), as some of the insights gained also validates the results in the scenario analysis. Moreover, our conclusions contribute to the knowledge that SDVs cannot be investigated as a solitary subject, but should rather be studied in the context of a larger spectrum. An abundance of factors are just as important as SDVs and the combination of these factors together with SDVs are therefore of huge importance to further study. Our conclusions have also resulted in insights of how significant the general trends are, and that these are important to study apart from SDVs as well, as the general trends are very likely to occur and not as complicated as SDVs to implement, especially legally and ethically. In addition, this study indicates that there will be an increase of vehicles and vehicles kilometers within e-commerce in almost all scenarios and distances, which implies in more traffic and transports on the roads. Also, SDVs are expected to be implemented in all scenarios, which implies that SDVs will deliver e-commerce packages in both long-distance transportation and last mile logistics in the future regardless of scenario.
References


In Electric Vehicle Conference (IEVC), 2014 IEEE International (pp. 1-8). IEEE.


61


Yoshimoto, R., & Nemoto, T. (2005). The impact of information and communication technology on road freight transportation. IATSS research, 29(1), 16-2


Appendix

In this section the different appendixes which are referred to in the report are presented.

Appendix A: Interview guide 1 – distributor

The following questions were used as an interview guide with a distributor within e-commerce. The respondent got the questions before to be able to prepare. The interview was the first of two interviews. It was semi-structured and lasted for 40 minutes.

1. Tell me, shortly, about your profession, your role, and your daily tasks?
2. Could you briefly describe your supply chain? (Actors involved? The flow of goods?)
3. Tell me about the relationship between the different actors.
4. What are the general trends in the industry today? (More or fewer companies? Different tasks? New actors? New focus?)
5. Why do you think that the general trends are the way they are today?
6. How does your company handle work of change?
7. Tell me about your focus when it comes to the future regarding technology and infrastructure? What are your main goals for the year 2030?
8. How do you think the supply chain will change for freight transportation when trucks are self-driving?
Appendix B: Interview guide 2 – distributor

The following questions were used as an interview guide with a distributor within e-commerce. The respondent got the questions before to be able to prepare. The interview was the last out of two interviews and lasted for 65 minutes.

1. How is the value chain of e-commerce company - distributor - collection point/customer structured?
2. How many packages does a specific e-commerce company send every day?
3. What kind of transport modes are used within the value chain? What types of trucks and sizes?
4. Where do you have transshipments points?
5. How many transshipments are usually done for a package?
6. How do you handle returns?
7. Do you cooperate with road carriers to deliver the packages?
8. How is your relationship with the collection points?
9. Do you deliver packages both to collection points and to the home of the customer?
### Appendix C: Workshops and reference group participants

<table>
<thead>
<tr>
<th>Workshop 1</th>
<th>Workshop 2</th>
<th>Reference group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logistics company</td>
<td>Logistics company</td>
<td>Olof Johansson, Digitalization program</td>
</tr>
<tr>
<td>Political and environmental think tank</td>
<td>Municipality representative</td>
<td></td>
</tr>
<tr>
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<td>Postal service</td>
<td></td>
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<td>Trafikverket</td>
<td>Trafikverket</td>
<td></td>
</tr>
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<td>Transport researcher</td>
<td></td>
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<tr>
<td>Transport researcher</td>
<td>Transport researcher</td>
<td></td>
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<tr>
<td>Truck manufacturer</td>
<td>Union for transport workers</td>
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<td>Truck manufacturer</td>
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<tr>
<td>Union for transport workers</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
UNDERLAG FÖR WORKSHOP 1

Syfte, mål och fokus på workshopen
Vad vi vill få ut av workshopen samt beskrivning av framtidsscenarierna

Josephine Hedman & Kajsa Björsell
josephine.hedman@trafikverket.se & kajsa.bjorsell@trafikverket.se
Bakgrund – examensarbete

Syfte: Studera hur infrastrukturen kommer att påverkas vid implementering av självkörande godstransporter.

Mål: Fördjupning inom de fyra scenarierna Integrated Transport Research Lab (ITRL) och Statens väg- och transportforskningsinstitut (VTI) tagit fram för att utforska hur godstransporten ser ut år 2030.

Avgränsningar: Fjärrtransport och last mile logistics till ombud av konsumentvaror beställda online.

Mål med workshop

Identifiera hur godstransporter för e-handel kommer att se ut år 2030 gällande fjärrtransporter samt last mile logistics i fyra framtagna framtidsscenarier. Dessutom vill vi undersöka hur självkörande fordon används i dessa transporter.

Dessa mål kommer att uppnås med hjälp av er expertis och diskussionerna kommer utgå från ett case.

Fyra framtidsscenarier för år 2030


Säkra trender för alla scenarier

- Teknikutvecklingen fortsätter i hög takt
- Urbanisering tilltar vilket leder till ökad konkurrens om gatu- och stadsutrymmet
- E-handeln ökar
- Allt mer ambitiösa hållbarhetsmål
• Automatisering ökar
• Skifte av fokus från produkt till lösning

**Detaljerad beskrivning av scenarierna**

**Same, same, but different**
I detta scenario antas en ambitiös och proaktiv samhällsbyggnadspolitik och litet genomslag för delade lösningar.

**Sharing is the new black**
I detta scenario antas en ambitiös och proaktiv samhällsbyggnadspolitik och genomslag för delade lösningar.

**What you need is what you get**
I detta scenario antas en ambitiös men långsam samhällsbyggnadspolitik och genomslag för delade lösningar.

**Follow the path**
I detta scenario antas en ambitiös men långsam samhällsbyggnadspolitik och litet genomslag för delade lösningar.
VII

Ambition, proactive and nytänkande samhällsbyggnadspolitik och institutioner

Same, same but different
- Välplanerad, statlig samhällsbyggnadspolitik: offentligheten tar ett stort ansvar
- Delade lösningar har inte fått genomslag, varken data eller prylar
- Väldigt likt idag fast teknikutvecklingen har gått framåt
- Fokus på hållbarhet
- Fler fordon drivs av el istället för av fossila bränslen
- Utbrett el-laddningsränt

Sharing is the new black
- Välplanerad, statlig samhällsbyggnadspolitik: offentligheten tar ett stort ansvar
- Delade lösningar har fått genomslag, både data och prylar
- Staton ansvarar för majoriteten av kör- och positionsdata
- Annan nyvåningsstruktur och kultur: stort fokus på att främja miljön
- Sverige = självklar testbädd för nya lösningar
- Fordon är drivna på el eller annat biobränsle samt uppkopplade

Follow the path
- Långsam samhällsbyggnadspolitik
- Delade lösningar har inte fått genomslag, varken data eller prylar
- Väldigt likt 10-talet
- I framtiden när det gäller förnyelsebar energi men de flesta bilär använder trots det bensin/diesel pga högre andrahåndsvärde
- Allvarlig trängselsituation

What you need is what you get
- Långsam statlig samhällsbyggnadspolitik: företag driver samhällsbyggnaden kommersiellt istället
- Delade lösningar har fått genomslag, både data och prylar
- Personlig data = nya velurin
- Vinnare genom kundinsikter
- Endast ett fåtal kommersiella aktörer styr marknaden
- De stora privata aktörerna har köpt upp de flesta småföretagen och finansierar även infrastruktur i deras tjänster

Helhet: samma som förut men med lite smarter vardagslösningar

Ambition, långsam samhällsbyggnadspolitik och institutioner

Figur 2: Detaljerad information om respektive scenario.
Syfte, mål och fokus på workshopen
Vad vi vill få ut av workshopen samt beskrivning av framtidsscenarierna

Josephine Hedman & Kajsa Björsell
josephine.hedman@trafikverket.se & kajsa.bjorsell@trafikverket.se
Bakgrund – examensarbete
Syfte: Studera hur infrastrukturen kommer att påverkas vid implementering av självkörande godstransporter.

Mål: Fördjupning inom de fyra scenarierna Integrated Transport Research Lab (ITRL) och Statens väg- och transportforskningsinstitut (VTI) tagit fram för att utforska hur godstransporten ser ut år 2030.

Avgränsningar: Fjärrtransport och last mile logistics till ombud av konsumentvaror beställda online.

Mål med workshop
Komplettera föregående workshop där deltagarna diskuterade trender för godstransporter inom e-handel för fjärrtransporter samt last mile logistics i de fyra tidigare framtagna scenarierna. Denna workshop vill vi:

- Validera/justera resultat från workshop 1
- Uppskatta systemeffekter från framtidsscenarierna gällande
  - Fordonstyper
  - Effekter på flottstorlek
  - Effekter på fordonskilometer

I följande text ges en kort beskrivning av de framtagna scenarierna och därefter resultatet från workshop 1 där en fördjupning i varje scenario gjordes för ett case inom e-handel.

Fyra framtidsscenarier för år 2030

Säkra trender för alla scenarier

- Teknikutvecklingen fortsätter i hög takt
- Urbanisering tilltar vilket leder till ökad konkurrens om gatu- och stadsutrymmet
- E-handeln ökar
- Allt mer ambitiösa hållbarhetsmål
- Automatisering ökar
- Skifte av fokus från produkt till lösning
**Detaljerad beskrivning av scenarierna**

**Same, same, but different**
I detta scenario antas en ambitiös och proaktiv samhällsbyggnadspolitik och litet genomslag för delade lösningar.

**Sharing is the new black**
I detta scenario antas en ambitiös och proaktiv samhällsbyggnadspolitik och genomslag för delade lösningar.

**What you need is what you get**
I detta scenario antas en ambitiös men långsam samhällsbyggnadspolitik och genomslag för delade lösningar.

**Follow the path**
I detta scenario antas en ambitiös men långsam samhällsbyggnadspolitik och litet genomslag för delade lösningar.

---

**Ambitiös, proaktiv och nytänkande samhällsbyggnadspolitik och institutioner**

**Same, same but different**
- Välplanerad, statlig samhällsbyggnadspolitik: offentligheten tar ett stort ansvar
- Delade lösningar har inte fått genomslag, verken detta eller prylar
- Valdigt litet idag fast teknikutvecklingen har gått framåt
- Fokus på hållbarhet
- Fler fordon drive av el istället för av fossila bränslen
- Utbrett el-laddningsnät

**Sharing is the new black**
- Välplanerad, statlig samhällsbyggnadspolitik: offentligheten tar ett stort ansvar
- Delade lösningar har fått genomslag, både data och prylar
- Staten ansvarar för majoriteten av kör- och positionsdata
- Annan myndighetsstruktur och kultur: stort fokus på att främja miljön
- Sverige = självklar testbädd för nya lösningar
- Fordon är drivna på el eller annat biobränsle samt uppkopplade

**Follow the path**
- Långsamt samhällsbyggnadspolitik
- Delade lösningar har inte fått genomslag, verken detta eller prylar
- Valdigt litet 10-tal
- I framtiden när det gäller förnyelsebar energi men de flesta bilar användar trots det bensin/diesel pga högre andrahandsvärde
- Allvarlig trängsel situation

**What you need is what you get**
- Långsamt statlig samhällsbyggnadspolitik: företag driver samhällsbyggnaden kommersiellt istället
- Delade lösningar har fått genomslag, både data och prylar
- Personlig data = nya valutan
- Vinnere genom kundiäkt
- Endast ett fåtal kommersiella aktörer styr marknaden
- De stora privata aktörerna har köpt upp de flesta småföretagen och finansierar även infrastruktur i deras tjänster

**Figur 3: Detaljerad information om respektive scenario.**
Resultat workshop 1
I föregående workshop identifierade deltagarna generella trender, trender för last mile logistics och trender för fjärrtransporter i samtliga scenarier. Trenderna togs fram utifrån ett e-handels case år 2030 där paket levereras från Malmö till Stockholm (fjärrtransport) och sedan levereras i Stockholm till ombud eller hem till kund (last mile logistics).

Efter att ha sammanställt resultatet från workshopen kunde vi konstatera att det fanns generella trender som gällde för samtliga scenarier, dessa är:

- Nattleveranser och nattkörrning
- Nya och fler typer av utlämningsställen exempelvis gym, instabox, till jobbet
- Platooning för fjärrtransporter
- Inte lika stort genomslag för SDVs i städer som för fjärrtransport
- Andra typer av godstransporter börjar konkurrera mot lastbilar - sjö och tåg får marknadsandelar
- Fortsatt utveckling av elfordon och elvägar, men olika grad i de olika scenarierna
- Internationell direktleverans (ej omlastning i Malmö utan direkt till Sthlm)
- Allt större krav på samlastning
- Utökade trängselskatter och miljözoner

Nedan följer resultatet för respektive scenario:

Same, same, but different

<table>
<thead>
<tr>
<th>Trender</th>
<th>Fjärrtransport</th>
<th>Last mile logistics</th>
</tr>
</thead>
</table>


## Sharing is the new black

### Trender
Lagstiftningar för att förenkla och utveckla för SDVs och samhället i allmänhet. Förare är kvar pga arbetsmiljöskäl. Allt större krav på elektrifiering.

<table>
<thead>
<tr>
<th>Fjärrtransport</th>
<th>Last mile logistics</th>
</tr>
</thead>
</table>

### What you need is what you get

### Trender
Nya plattformar för delning av varor och tjänster, t.ex. abonnera på rena sängkläder som kommer varje vecka så privatpersoner slipper åka till tvätteri. Skifte av persontrafik till godstrafik i städer. Låg transparens och insyn - kunderna bryr sig/är inte medvetna om hur leveranser sker, endast fokus på flexibilitet. Samhällsplaneringen går ej i takt vilket leder till värre trafiksituationer, infraägare kan inte förutspå behoven då de inte äger datan.

<table>
<thead>
<tr>
<th>Fjärrtransport</th>
<th>Last mile logistics</th>
</tr>
</thead>
</table>
**Follow the path**

<table>
<thead>
<tr>
<th><strong>Trender</strong></th>
<th><strong>Last mile logistics</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mindre p-platser.</td>
<td><strong>Ombudskris</strong>- tjänar inte pengar på att erbjuda den servicen och vill inte fortsätta → leder till fler och olika typer av hemleveranser samt andra uthämtningsställen (nya affärsmodeller behövs, går t.ex. tillbaka till att hämta i affärer istället för ombud).</td>
</tr>
<tr>
<td>Mer andra tjänster i fastigheter - ex: instabox.</td>
<td>Start-ups: nya försök till leveranser i städer, ex taxi.</td>
</tr>
<tr>
<td><strong>Fjärrtransport</strong></td>
<td>Last mile sker med el-lastcyklar. Dock knappt SDVs.</td>
</tr>
<tr>
<td>Fler långa fordon.</td>
<td>Tidsfönster för hemleveranser.</td>
</tr>
<tr>
<td>Ökad bärighet på vägarna.</td>
<td></td>
</tr>
</tbody>
</table>

XIII
Appendix F: Template 1 – Workshop 2

Template for exercise one in workshop 2.

**What types of vehicles will be used in e-commerce in the year 2030?**

Last mile logistics

<table>
<thead>
<tr>
<th>Scenario A*</th>
<th>Scenario B*</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAE 0-3</td>
<td>SAE 0-3</td>
</tr>
<tr>
<td>SAE 4-5</td>
<td>SAE 4-5</td>
</tr>
<tr>
<td>Other</td>
<td>Other</td>
</tr>
</tbody>
</table>

Long-distance transports

<table>
<thead>
<tr>
<th>Scenario A*</th>
<th>Scenario B*</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAE 0-3</td>
<td>SAE 0-3</td>
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<tr>
<td>SAE 4-5</td>
<td>SAE 4-5</td>
</tr>
<tr>
<td>Other</td>
<td>Other</td>
</tr>
</tbody>
</table>

*In the workshops, the scenarios were named correctly but to save space in the report, we have named them A and B instead of their real names.*
Appendix G: Template 2 – Workshop 2

Template for the first part of exercise two in workshop 2.

What is the total amount of vehicles in the fleet for e-commerce in the year 2030?

Last mile logistics

<table>
<thead>
<tr>
<th>2018</th>
<th>Scenario A*</th>
<th>Scenario B*</th>
</tr>
</thead>
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<tr>
<td>Index 100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Long-distance transports

<table>
<thead>
<tr>
<th>2018</th>
<th>Scenario A*</th>
<th>Scenario B*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Index 100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*In the workshops, the scenarios were named correctly but to save space in the report, we have named them A and B instead of their real names.
Appendix H: Template 3 – Workshop 2

Template for the second part of exercise two in workshop 2.

**What is the share of vehicles in each of the categories?**

Last mile logistics

<table>
<thead>
<tr>
<th>SAE 0-3</th>
<th>SAE 4-5</th>
<th>Other</th>
<th>SAE 0-3</th>
<th>SAE 4-5</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Long-distance transports

<table>
<thead>
<tr>
<th>SAE 0-3</th>
<th>SAE 4-5</th>
<th>Other</th>
<th>SAE 0-3</th>
<th>SAE 4-5</th>
<th>Other</th>
</tr>
</thead>
<tbody>
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<td></td>
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<td></td>
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</tbody>
</table>

*In the workshops, the scenarios were named correctly but to save space in the report, we have named them A and B instead of their real names.*
Appendix I: Template 4 – Workshop 2

Template for the first part of exercise three in workshop 2.

What is the total amount of vehicle kilometers within e-commerce?

Last mile logistics

<table>
<thead>
<tr>
<th></th>
<th>2018</th>
<th>Scenario A*</th>
<th>Scenario B*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Index 100</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Long-distance transports

<table>
<thead>
<tr>
<th></th>
<th>2018</th>
<th>Scenario A*</th>
<th>Scenario B*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Index 100</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*In the workshops, the scenarios were named correctly but to save space in the report, we have named them A and B instead of their real names.
Appendix J: Template 5 – Workshop 2

Template for the second part of exercise three in workshop 2.

**What is the share of vehicle kilometers traveled for each of the categories?**

Last mile logistics

<table>
<thead>
<tr>
<th>Scenario A*</th>
<th>Scenario B*</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAE 0-3</td>
<td>SAE 0-3</td>
</tr>
<tr>
<td>SAE 4-5</td>
<td>SAE 4-5</td>
</tr>
<tr>
<td>Other</td>
<td>Other</td>
</tr>
</tbody>
</table>

Long-distance transports

<table>
<thead>
<tr>
<th>Scenario A*</th>
<th>Scenario B*</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAE 0-3</td>
<td>SAE 0-3</td>
</tr>
<tr>
<td>SAE 4-5</td>
<td>SAE 4-5</td>
</tr>
<tr>
<td>Other</td>
<td>Other</td>
</tr>
</tbody>
</table>

*In the workshops, the scenarios were named correctly but to save space in the report, we have named them A and B instead of their real names.