UNIVERSITY OF GOTHENBURG
SCHOOL OF BUSINESS, ECONOMICS AND LAW

Master Degree Project in Logistics and Transport Management

Accessibility of Road Infrastructure

The role of the road in the transport systems and the society

Ivar Camenius and Andrew Karlsson

Supervisor: Lars Brigelius
Master Degree Project No. 2014:48
Graduate School

Abstract

The roads in Europe are getting more and more congested, and the effects are a problem for many stakeholders, including the society as a whole. At the same time increasing road capacity is both costly and risks increasing traffic even more which puts demands on utilizing existing infrastructure in better ways. The purpose of this thesis is to identify changes in road accessibility and see how they affect transport companies. The changes will also be analyzed from a societal perspective in order to give recommendations for more efficient use of road infrastructure in Sweden. This is a deductive, qualitative study which has been conducted through in-depth interviews with experts in transport and accessibility as well as respondents at managerial positions in transport companies. The results from this study indicate that real time information has the largest positive effects on transport companies. Real time information can also be used to increase the efficiency of the transport system by combining it with the other presented changes in accessibility.

Keywords: Accessibility, environment, safety, infrastructure, congestion, real time information

Acknowledgements

Firstly, we want to express our gratefulness to Trafikverket for allowing us to write for them and dig deeper into the area of efficiency of road infrastructure which has truly been inspiring. Special thanks to our supervisor Rikard Engström at Trafikverket for all help, inspiration and guidance throughout the master thesis. The time you have spent and the involvement you have shown will not be forgotten. Also thanks to our supervisor from school, Lars Brigelius, for encouragement and guidance throughout the process of writing.

Furthermore, a great thank you to all interviewed persons who have taken your time and helped us with your experience and opinions, without you this study would not have been possible.

Ivar Camenius Andrew Karlsson

Gothenburg, May 15, 2014

Table of Content

List of figures

List of tables

1 Introduction

In this chapter a background of the research topic is presented. The purpose and research questions are stated and the limitations are discussed. An outline of the thesis is also provided.

1.1 The role of the road

Road transports are part of the lifeblood of the European economy and about 44 % of the goods in EU are transported on road. The numbers for the passenger traffic are even higher, 73 % of the people travel with private cars (European Commission, 2012).

Road is the only mode of transport that can provide door-to-door transports and it increases the potential market for goods and services. Road has always been a factor for economic growth of a country (SINTEF, 2007) and some argue that road infrastructure should be seen more as an investment that can boost the economy and less as a mean of transportation. Therefore private investments or collaborations in infrastructure can be effective, however the organizations need to have very large resources and be prepared that the investments do not bear fruit in two years, but rather in 25 years (EBRD, 2013).

Roads have historically been used to boost the economy. One of the reasons for this is the enormous amount of people who are involved and employed in the road sector. The indirect professions related to road are also innumerable, e.g. insurance or logistics professions (SINTEF, 2007). The road also contributes with a lot of economic aspects such as job creation. According to a French study from 1995, the road construction process of a €150 million investment in road created on average 3240 jobs (SINTEF, 2007). American Federal Highways Agency also made a study, stating that a USD 1 billion investment in highway can generate as much as 44709 full-time jobs (FHWA, 2004). The road transports also contribute with large amounts of money to the national budgets through different taxes and insurances. Access to the transport network has dramatically increased through roads, allowing people to access workplaces further from home, hospitals and health care and leisure activities (ibid.).

Today road infrastructure is facing a number of challenges. Drivers are confronted with congested roads at the same time as many vehicles run empty. People expect safer roads while the fuel prices increase and the need to reduce pollution is greater than ever (European Commission, 2012).

Studies made in England and Sweden show the importance of road transports and what would happen if people were to live without trucks. If companies' supply chains would be disturbed it could have devastating consequences for the society. One of the reasons for the possible large consequences is the pressure for faster transports and lower stock levels which have made the whole transport system vulnerable to even short delays or disturbances (McKinnon, 2006).

When looking at statistics for road transports in Sweden, it can be seen that the amount of ton kilometers has increased quite steadily historically. The latest drop came after the economic crises in 2008 but now the transports are recovering (Trafikverket, 2012a). At the same time as more and more road infrastructure are built, the need for traffic control, operation, maintenance and reinvestments grows as well (ibid.).

Prognoses for the future use of the cars and what will happen with the role of road infrastructure differ quite much. Trafikverket has made a prognosis that the use of private cars will increase with 34 % between 2014 and 2025 (Trafikverket, 2013a), while others, such as Christer Ljungberg (CEO at the technic consultant Trivector) mean that the driving of cars has reached its peak and is now decreasing. There are also reports coming from USA and Japan that the use of private cars is already decreasing (GP, 2014). Even VTI (The Swedish National Road and Transport Research Institute) is skeptic about the numbers presented by Trafikverket, and says that if the growth of use of private cars will continue at the same rate as between 2000 and 2010 the growth until 2030 will be around 13 % (VTI, 2013b).

1.2 Challenges in the transport system

'Optimising the performance of existing road networks is a cheap way to reduce the environmental, social, and financial impact of ever increasing volumes of traffic' (Richter, Aberdeen & Yu, 2007, p.1). For the time period 2013-2017, CEDR (Conference of European Directors of Roads) has set up a number of challenges of the road network that need to be handled. Some of these challenges are to reduce congestion, taking a holistic view of transport systems, collaborate better with stakeholders and being aware of innovative finance and funding mechanism (CEDR, 2013b).

When talking about road stakeholders, the list could be made very long. A wide definition describes a stakeholder as '*any identifiable group or individual who can affect the achievement of an organization's objectives or who is affected by the achievement of an organization's objectives*" (Freeman & Reed, 1983, p.91). When defining road stakeholders, this would mean any group or individual who can affect or is affected by road or road infrastructure. This also includes actors concerned with changes in road accessibility, such as road tolls or road maintenance.

Aside from CEDR, there are many other international road conferences which all discuss the most relevant topics related to roads and road transports. They give an overview of what is discussed and what problems are faced by the road industry today. The last two years the focus on these conferences has been on a number of topics but there are some that comes up more often than others (VTI, 2013a; CEDR, 2013a). When comparing the current issues and the different road organizations' future challenges, the topics could be combined into three main areas. These are Accessibility, Environment and Road Safety.

1.3 Accessibility

In order for a transport system to work properly, people and goods need to have access to it. When changing transport infrastructure there is both direct and indirect development effects

(Olsson, 2009). When something is accessible it point towards that it is possible to access or reach (Olsson, 2006). Accessibility can be described as physical access to goods, people, facilities and destinations (Victoria Transport Policy Institute, 2012) or 'the ease with which people/goods can interact with/reach other places and activities, and the ease with which this can be done, in terms of time, cost, passability, connectivity, and transport services provided' (Olsson, 2006, p.28). This includes the grade of freedom for goods and people to move in the transport system. This definition can be used as a starting point for analyzing the effects of improved accessibility (Olsson, 2006).

According to Forsström (1999) aspects like road standard, capacity, connectivity, bearing, passability and trafficability are important when studying accessibility. Trafficability and passability are connected to the speed the vehicles can be conveyed with and if the road can be used at any time. Capacity means how many vehicles can use a road without causing congestion and bearing is the maximum weight a vehicle can have on the road (Forsström, 1999). Connectivity can be defined as the number of places where one can join the transport network (Olsson, 2006). Changing accessibility in one part of the transport network has effects on the overall accessibility (Forsström, 1999).

When people talk about access and efficient use of infrastructure, what often comes first into mind is the congestion on roads. Congestion is not only a problem for the people using the infrastructure; it also costs the society enormous amount of money. The waste of fuel and lost productivity of workers are two of the main effects of the congestion. For EU, congestion costs more than 1 % of its GDP. This waste of resources needs to be handled, and optimizing the infrastructure use is one way of doing it (European Commission, 2012).

What is important to mention is that previous research show that congestion is not only a consequence of bottlenecks or over-use of the road capacity but is actually derived from seven different root causes (Cambridge Systematics Inc., 2005). These can be seen in figure 1 below where the seventh cause, fluctuations in normal traffic, is excluded:

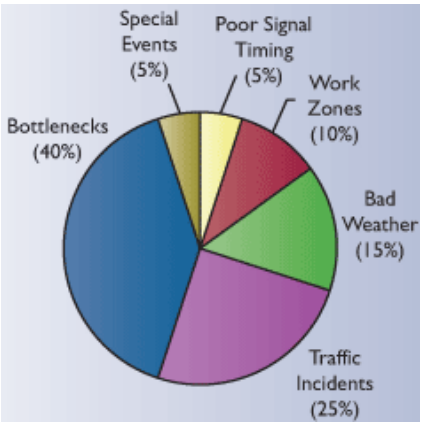

Figure 1: The Sources of Congestion (FHWA, 2002)

1.4 Road safety

Studies by numerous researchers have shown that efficient organization of road safety management system should be one of the main priorities in order to achieve positive safety results (OECD, 2008; WHO, 2009). A comprehensive study has been done on road safety systems in 14 European countries where researchers found out that the best performing countries not always meet 'good practice' characteristics of road safety (Papadimitriou et al., 2012). Various researches have been done in the area of assessing the possible impact of road safety management elements on road safety performance. A good example is a study from 2011, which found out positive effects on road safety performance from road safety management system by estimating the effect of setting quantitative goals for accident reductions (Wong & Sze, 2011). Another study, from 2013, identifies road safety indicators such as mortality and fatality rates and describes their effects on the road safety performance (Papadimitriou & Yannis, 2013).

In May 2013, in China, VTI held a conference where the main themes discussed were road safety, speed management and how to exchange good practices between countries and cities (VTI, 2013a). Sweden is one of the countries in the world with the lowest numbers of traffic incidents, compared to the size of the country. In 2012, the Swedish Parliament changed the target for reducing the number of fatalities by half and the serious injuries by a quarter between 2010 and 2020 (Trafikverket, 2012a). There are different measures that are used and tested to increase the road safety in Sweden. Using Alco locks, divided lanes for cars and pedestrians, Intelligent Speed Adaptation systems and Variable speed limits are just some of the projects that are running at the moment (Trafikverket, 2012b).

The safety targets in Sweden mostly derive from the directives by the European Commission and looking at the development of fatalities in EU shows that even though the safety targets have not been reached, the number of fatalities has been steadily decreasing for the last 20 years (European Commission, 2010).

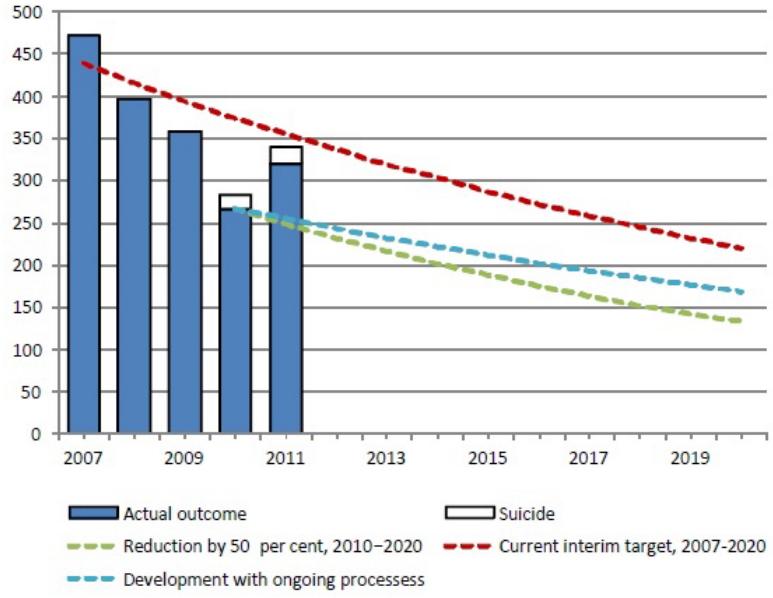

Figure 2: Road traffic fatality trends in 2007-2011, (Trafikverket, 2012a)

As seen in figure 2, three alternative curves can be seen, showing the previously established interim target, the prediction and the trends corresponding to a possible new interim target. Interim target is a target that is ongoing and can change over time.

1.5 Environment

Environment is influenced by changes in road infrastructure as well. Good examples are new road routes, alternative fuels and vehicles, and using tolls and intermodal solutions. All of them have both negative and positive effects. Intermodality reduces pollution by utilizing the advantages of each mode but at the same time new railways and roads have to be built in order to ensure a smooth switch to different transport modes. It offers constant flow of door-to-door services meeting customer requirements and empowering the transport system to be cost-effective (Europa, 2005). Alternative fuels have positive impact on environment because fewer emissions are emitted. Furthermore, alternative vehicles can transport bigger amount of goods thus making less trucks on the roads (Tran et al., 2013). Building new road routes however cost a lot of money and often create more traffic on the roads (Prakash, Oliver & Balcone, 2001).

According to Swedish Government, there are plans for improving the regulation system and financial incentives in order to develop a well-organized transport society. It can be done through policy instruments which can help to succeed in climate goals and environmental quality. It will also give a possibility for people to choose alternatives with minimum impact on climate (Regeringskansliet, 2013).

1.6 Problem description

Today the road struggles with high maintenance and development costs while the road infrastructure in general needs to last for around 40 years to be economically viable (Trafikverket, 2002; O'Flaherty, 2002). At the same time as the transports on road have shown continuous increase the role of the road is questioned. Often road transports are mentioned in a negative way, primarily because of the negative environmental effects but also the corruption that exists in the transport sector as a whole (Transportnet.se, 2014). Another factor is the safety, where rules are often neglected or sidestepped. The immanent contradiction in the increased use of the roads and the ageing of the infrastructure should also not be forgotten.

As mentioned earlier in the paper, accessibility, environment and road safety have been identified as the most important areas for improvement. Among these, accessibility and its effects on different actors in the transport sector seems to be the least researched area. Infrastructure is necessary for developing a society and trade. In order for the trade and transports we have today to work sufficiently, accessibility is also a necessity (Tillväxtverket, 2014). If the transport costs less, more places can be reached within a certain budget and the access will thereby increase (Olsson, 2006). When elaborated on in this research, higher (road) accessibility also means reduction of barriers for people and vehicles, better access for traffic and decreased congestion.

Congestion is a problem that is closely related to the accessibility of the road. What is remarkable is that traffic incidents and bad weather together are roots of congestion in the same extent as bottlenecks. This shows that the problem with congestion is diverse and that different changes can affect different of these roots. Therefore it is important to understand how different changes related to road infrastructure can affect these root causes, and in a larger perspective, how different stakeholders are affected.

A lot of the researches available focus on the effects of infrastructure investments on the drivers or the people living nearby but other actors are often neglected. How is for example a transport company affected by increased road tolls? In city planning, the focus has always been on passenger transport. Freight transport, is however a major problem and even though freight issues have the most negative effects on sustainability of cities; they are not prioritized in urban planning (Behrends, Lindholm & Woxenius, 2008). Public authorities are mostly not concerned with operations of private companies and public-private cooperation is necessary to solve these issues (Crainic et al., 2004). Instead of reducing the negative effects of road infrastructure, this thesis will try to see the effects of managing the traffic through changes in accessibility and thereby give suggestions of how to utilize the infrastructure in a more effective way. Efficiency is a widely discussed concept and is usually 'a comparison between inputs used in a certain activity and produced outputs' (European Commission 2009, p.5). In this research, efficient road use will mean the level of output with the given resources available (the resources in this case are e.g. roads, signs, speed limits, tolls). Higher efficiency will mean higher accessibility in total for the road stakeholders at the same time as decreasing environmental impacts and improving road safety.

1.7 Purpose and research questions

To identify changes in road accessibility and see how they affect transport companies. The changes will also be analyzed from a societal perspective in order to give recommendations for more efficient use of road infrastructure in Sweden.

1. *How are freight transport companies affected by the changes in road accessibility?*
2. *How are the changes in accessibility affecting safety on roads and the environment?*

1.8 Limitations

The focus in this report will be on the Swedish transport market and how certain investments or changes in infrastructure affect freight transport companies. Three main areas for changes are identified and shortly described but only one, the accessibility, will be further investigated. To be more specific, the focus will be on changes affecting accessibility however in the cases that these changes affect environment or safety; these effects will also be discussed. Changes that only affect environment and/or safety will not be handled in this thesis. In order to see the consequences of these changes, different stakeholders are identified and described. The report then concentrates on the effects on transport companies driving heavy trucks (weighting over 3,5 tons) since this stakeholder is often excluded in research on

accessibility of the transport system. The report is not targeting any particular kind of road or length of transports but includes all types of them.

1.9 Disposition

Chapter 1: In this chapter a background of the research topic is presented. The purpose and research questions are stated and the limitations are discussed. An outline of the thesis is also provided.

Chapter 2: This part discusses the different research methods used in the study. The research design is presented and data collection methods as well as a discussion on research quality are provided.

Chapter 3: In this chapter the theoretical framework is handled. The reader will be provided with information about different changes related to road infrastructure. Stakeholders will also be identified.

Chapter 4: Here the results from six different interviews are presented. The collected data has been divided into different topics. Two of the respondents work at Trafikverket, three have managerial positions within transport companies and one works with planning at a car manufacturer.

Chapter 5: In this chapter the results of the theoretical framework and the empirical study are discussed. The changes in accessibility of road are analyzed in depth in order to better understand the potential outcomes and to be able to answer the research questions.

Chapter 6: Answers to the research questions are presented and recommendations for the future are provided.

2 Methodology

This part discusses the different research methods used in the study. The research design is presented and data collection methods as well as a discussion on research quality are provided.

2.1 Research paradigms

In research methodology there are two main paradigms to guide the researcher. Depending on how reality and knowledge are viewed different paths can be taken (Collis & Hussey, 2009). These paths, called positivism and interpretivism, are interlinked.

Positivism is based on the belief that there is only one objective reality which is independent of the researcher and the goal is discovery of theories based on quantitative methods e.g. observations and experiments (Collis & Hussey, 2009). The research is objective and intends to receive generalizable results (Blumberg B, Cooper & Schindler, 2011). Interpretivism is based on the belief that the social reality is shaped by how it is perceived. The researcher interacts with his phenomena and is subjective. Qualitative studies are central in this method (Collis & Hussey, 2009).

In this study interpretivism is the main paradigm because of the features of the research area. This investigation of road infrastructure and its effects will take a holistic view which is also preferred when investigating the research problem as mentioned by Patel & Davidson (2003).

2.2 Research approach and method

A study can be either deductive or inductive depending on the connection between the theory and empirical study (Patel & Davidson, 2003). In an inductive study, observations are the foundation for building a theory. In a deductive study, on the other hand, theories are used to define a theoretical framework that can be tested by empirical studies (Collis & Hussey, 2009). This study is not exploring a new area, thus the study will have deductive characteristics. This also makes an explorative approach suitable since few earlier studies are available (ibid.). Exploratory approach as a phenomenon has the purpose of providing information and assist in research to gain insight in a in a new area (Blumberg B, Cooper & Schindler, 2011). Another good argument for using an exploratory study is the ability to change the study according to the data available (ibid.). The literature review covers different changes in accessibility and the results from the theoretical framework have been compared to the empirical study to see if existing theories can describe the effects on transport companies.

In a study, the data found can be either quantitative, qualitative, or both. Quantitative data is generally data in a numerical form while qualitative data represent data in a nominal form, e.g. words, pictures etc. (Collis & Hussey, 2009). The authors of this research have used qualitative data with an interpretivistic approach since this method emphasizes quality and depth of data collected (ibid.). In this research area, when effects on transport companies are investigated, the effects are often not quantifiable and clear, but rather complex and consisting of many parts such as economical or customer related ones. The target has been to deepen the

knowledge and understanding of infrastructure changes and stakeholders and the qualitative data has been a necessary starting point in order to understand the direct as well as the indirect effects.

2.3 Data collection

2.3.1 Primary data

Primary data are data that are generated from an original source. This could e.g. be own experiments, surveys or focus groups (Collis & Hussey, 2009). In this study the primary data consists of the data collected from the interviews done by the authors.

Interviews

When using qualitative methods in a study, interviews are very common. Individual in-depth interviews are usually divided into three types depending on the role of the interviewer. The three types are: Unstructured, Semi-structured and Standardized interviews (Sreejesh, Mohapatra & Anusree, 2014). There are also two common response formats, namely open-end questions and close-end questions.

Personal interviews have their greatest advantages in the depth and detail of information available and it is also possible to do more things to improve the quality of research than with other methods. The interviewer has a lot of control and can even pre-screen to make sure that the participant replying is the right one. The language can also be adjusted during the interview if the participant seems to be affected negatively by the interview. However, interviews are costly, both in terms of money and time (Blumberg B, Cooper & Schindler, 2011). There is also a risk that the information needed is not provided, since the interviewee might adjust his or her answer to reflect another situation than the one that is actually in place (Patel & Davidson, 2003).

In this case, standardized open-ended questions have been used. These questions have a sequential order and are worded carefully with open-end construction. This has been done in order to reduce the differences in responses due to the effect of the interviewer's choice of words. In this case, the interviews have been conducted by two interviewers, which make it appropriate to use the standardized open-end questions since this decrease the bias through minimizing of variation in the questions. (Sreejesh, Mohapatra & Anusree, 2014). This also facilitates comparison between different respondents (ibid.) which is useful in the authors' case since transport companies with different characteristics have been approached.

The negative aspect is that substitute questioning is limited in order to cope with individual differences. Open ended-questions are also time-consuming to construct and can inflict bias since the researcher or interviewer can misinterpret the answers (ibid.). In this particular case, open-end questions are however still favorable since the respondent has a greater freedom to express him, which is necessary when discussing accessibility and future use of infrastructure, where often no simple answers exist.

In order to gain knowledge about the situation on the roads in Sweden and to see how infrastructure planners are thinking, in depth-interviews were held with two persons at Trafikverket. One of them is a long-term planner and works with preparing material for governmental decisions. The other one is director of accessibility and responsible for making sure the target of accessibility in the Swedish transport system is reached, which made him a perfect candidate for discussing effects of changes in accessibility as well as the future challenges and possibilities. Both interviews lasted for one hour, however, the interview with the director of accessibility was held as a telephone interview at the office of Trafikverket in Gothenburg. The interviews also served to identify differences in thinking between transport planners at Trafikverket and transport planners in the private sector.

Two interviews were also held with managers at the transport company Schenker. One of them was CEO for Schenker Consulting and the other one was CEO for the haulage part of Schenker. These interviews lasted for 90 minutes each and aimed to identify how a transport company is affected by different changes in accessibility. The transport company was chosen due to the strong position it has on the market and the collaboration it has with Trafikverket in different projects. One interview was also conducted with a planner at a family owned transport company in order to get insight from a smaller actor as well. This interview lasted for 60 minutes.

Furthermore, a telephone interview was held with a project planner at Volvo Trucks Technology and lasted for around 60 minutes. This interview was held in order to get the view of a vehicle manufacturer to get input on how to make vehicles and infrastructure more efficient in the future.

All the interviews were recorded in order to strengthen the quality of the interviews and to be able to check the accuracy of the written down notes afterwards. The recorded interviews were transcribed. Before conducting the interviews the questionnaire was sent to the interviewees. The reason for this was to save time for the actual interview sessions but also to prepare the interviewees for what their expectations should be and give them time to think through the topic and the questions stated.

The theoretical framework covers five different changes in accessibility, however in the interviews a couple of more topics have been asked about in order to see if these ones have effects as well. These topics can be seen as topics emerged from the interviews that are later added to the analysis in order to cover all the most important topics. These parts also help to better answer the subsidiary target of this study, to give recommendations for more efficient use of road infrastructure in Sweden.

2.3.2 Secondary data

Secondary data are data that are already existing and collected from sources like publications, newspapers or databases. The data are usually collected by someone else and for another purpose than what the researcher will use it for (Collis & Hussey, 2009). In this study, the theoretical framework has been constructed through a literature review with material from existing sources. A literature review helps to develop the knowledge around a subject and focuses on the most influential research and main theories (Collis & Hussey, 2009). The

intention here has been to get insights from the previous research and thereby construct a simplified framework for changes related to infrastructure.

Secondary data can also help to get insight when identifying potential customers and trends (Sreejesh, Mohapatra & Anusree, 2014) and this has also proven efficient in this case, when identifying changes related to infrastructure and stakeholders in the road transport sector.

When gathering data, various methods can be used to expose different aspects of a problem. By using a multiple method in this study, and collecting data with several methods (Philip, 1998) the research questions have been approached from different perspectives. This also suggests that if the different methods show similar results, it would indicate higher reliability. The first research question, investigating the effects on transport companies, has been studied more thoroughly both with secondary and primary data, through a literature study and several interviews. The second one has been researched primarily through external, secondary sources.

2.4 Quality of data

Validity and reliability are two important concepts to measure quality of data. Validity refers to how well a research study can produce results that are actually relevant to the researcher. Reliability on the other hand is the consistency of the results with comparable studies under the same conditions (Sreejesh, Mohapatra & Anusree, 2014).

2.4.1 Validity

In order for data to be valid, it should consist of representative samples, appropriate research procedures and correct measurements. In an interpretivistic study the data extracted provides rich and detailed explanations. By searching for the knowledge and meaning behind a phenomenon, the validity consequently becomes high (Collis & Hussey, 2009). Furthermore, looking at the match between the information collected and what is the purpose of the research, as well as trying to see what conclusions can be drawn from the results can increase the validity (Herman & Winters, 1992).

The validity in this research has been secured by aiming the research questions as well as the interview questions towards the purpose. Since the purpose has been to primarily provide effects on the transport companies this is reflected in the questions and the respondents have been properly informed about the study and its purpose in order to guide the interviews in the right direction. When establishing validity in a qualitative study, Triangulation is a popular method, which is used through analyzing a research question from different angles (Guion, Diehl & McDonald, 2011). There are different types of triangulation but in this study data triangulation has been used. Using data triangulation means using different sources of information in order to increase the validity. By conducting interviews with several groups in a study, different perspectives can be achieved. In this study, in-depth interviews have been conducted with both transport companies and experts in the road transport sector in order to get different angles as well as get insight into both the companies operating on the roads and the transport planning on a higher, national level. By comparing their answers and feedback,

areas of agreement and divergence have been found, which is also promoted by Guion, Diehl & McDonald (2011).

2.4.2 Reliability

If the outcome of a measuring process is reproducible, it is also reliable (Sreejesh, Mohapatra & Anusree, 2014). Reliability can therefore be defined as the degree to which measurements are free from errors. However if the respondents do not understand the questions properly and give irrelevant answers the quality of the collected data can become poor (ibid.).

In order to ensure reliability and reproducibility in this study, the interview questions have been created as standardized open-end questions, allowing the interviewers to elaborate on the answers at the same time as influencing the actual asking of the question to a minimum extent. The interview questionnaires have also been published in the end of this study, to facilitate the possibility for further research and reproducing of the study (See Appendix A, B, C, D).

2.4.3 Potential weaknesses

There are some potential weaknesses in the thesis. The interview responses can be biased by subjective opinions of the respondents. The questionnaires have however been created to reflect this and are based on the actual subjective opinions. This paper is elaborating on the future of accessibility and road transports and there are no easy right answers that can be tested. Instead subjective opinions and discussions are parts in finding out new ways to think and develop.

This leads to the generalizability of the study. Even though the study aims at giving recommendations for the Swedish market, it is hard to say if the results can be used in other situations or countries. To some extent the issues and possibilities are similar between countries but there are also a lot of differences that can prohibit certain proposed changes in the transport system. As earlier mentioned, even though the study is made in such way to make it reproducible, the responses from the interviews will of course differ if other people are interviewed. However, the overall result of the interviews is believed to be quite similar since it is the mix of interviews that make out the empirical result, not only one person’s opinion in a particular question.

Since the purpose of the study is to see the effects on transport companies, a larger amount of interviews would have been desirable in order to increase the validity of the study. When it comes to the choice of media for the interviews, the target has been to have personal interviews; however this has not been possible in all cases, both due to distance and lack of time for the respondents. This may be a potential weakness; however in all cases the interviewees have received the questions beforehand in order to be able to give detailed answers. The telephone interviews have also been conducted at Trafikverket on a conference phone in order to make it as similar to a face-to-face interview as possible.

3 Theoretical framework

In this chapter the theoretical framework will be treated. The reader will be provided with information about different changes related to road infrastructure. Stakeholders will be identified and discussed shortly.

3.1 Changes related to road infrastructure

When comparing the latest research with the topics discussed at recent road conferences, e.g. by CEDR and VTI it was found that certain topics were repeating. From these topics three main areas have been created: accessibility, environment and safety on the roads. These three areas are interconnected and changes within these will influence the road infrastructure as well as the actors in the road transport network. The topics in table 1 should be seen as examples of changes related to road infrastructure and the authors are well aware that there are many more that could be discussed. Changes in one of these topics are not necessarily affecting only one of the main areas but can sometimes be seen in all of the categories. This is of course a simplification and in which category the topics should be placed can be argued. One example is the road tolls, where increased fees on mornings and afternoons can reduce congestion and thereby increase accessibility. The decreased traffic however also affects the safety on the roads as well as contributes to less environmental effects.

As mentioned in the limitations, this mapping has given insight to the different areas and this paper will focus on the accessibility. Not all the identified accessibility changes will be further researched; instead five of them will be concentrated on in order to find relevant and measurable effects. These topics are Road tolls/Congestion charges, Speed limits, Real time information, Road capacity and Parking & Safety parking. These five topics were chosen by combining previous research with the researchers' hypothesis that these ones would have the highest impact on transport companies. The chapters of findings from interviews and analysis will later show if this is the actual case.

Table 1 has been created both in order show changes in an easy and understandable way, but also to give suggestions for further research in the area. All these three areas will continue to be important and the relations between the presented areas are quite complex, which allows for future investigations with other angles on the topic.

Table 1: Changes related to road infrastructure and the main areas affected

(The highlighted topics are presented with start in 3.3)

Accessibility	Environment	Safety
Road tolls/ congestion charges	New road routes	Real-time information
Speed limits	Intermodality	Road capacity
Real-time information	Alternative vehicles	New signs (information systems)
Road capacity	Digitalization/ Electrification	Speed limits
Parking and Safety parking	Road capacity	Digitalization/Electrification
Terminals	Road tolls/ congestion charges	Roundabouts
Intermodality	Alternative fuels	Park & Ride lot locations
Digitalization/ Electrification	Park & Ride lot locations	Parking and Safety parking
Park & Ride lot locations	Real-time information	
New signs (information systems)		

Source: Authors own construction

3.2 Road stakeholders

According to Dr. Cathy Macharis, the main transport stakeholders in urban areas are Shippers, Receivers, Logistic Service Providers (LSP), Authorities and Citizens (Macharis, 2013). Global Transport Knowledge Practice, an online resource center powered by the International Road Federation (IRF), has another view of road stakeholders. They have identified Transport companies, Private drivers, Public transport, Cyclists & Pedestrians, and Government & Municipality as road stakeholders (GTKP, 2013). A more sophisticated and developed model of the transport actors are given in a study from 2008 where the activities are divided into three areas that are affected but also that affect the actors; Vehicle, Goods and Infrastructure. They are all interrelated in different ways but simply said the actors involved are Transport industry, Vehicle industry, Energy industry, Operators, Forwarders, Shippers, Academies & Universities, Planning agencies & Regulators and Traffic controllers (Behrends, Lindholm & Woxenius, 2008).

Based on these mentioned identifications and classifications of actors, as well as the literature review, a model has been created in order to show the main actors affected by road and changes in road accessibility. These actors are presented in Figure 3 and include Transport companies, Shippers, Receivers, Government/Municipality, Drivers and Vehicle manufacturers. From these, the transport companies have been chosen as a focus for further investigations.

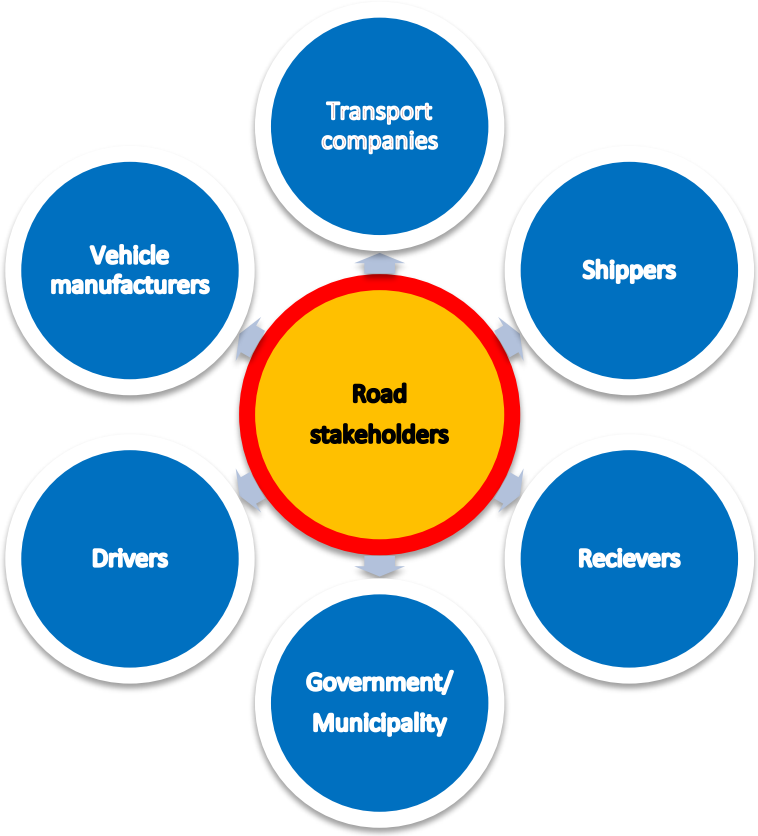

Figure 3: Stakeholders affected by road and changes in road accessibility (Authors' own construction)

3.3 Road tolls/Congestion charges

Road tolls and congestion charges are often mentioned as having the same meaning but there is a slight difference between the two of them. Road tolls are a form of road pricing that primarily helps to recover the cost of road construction and maintenance (FHWA, 2014). Congestion charges on the other hand is another form of road pricing used in order to reduce traffic congestion (Visit London, 2014). Since many researchers use both expressions for the same topic, this study will use them in this way as well, as both are parts in road pricing.

Road pricing is not a new concept and it has quite a long history. Charging tolls has become a very profitable and fast growing business in Europe. The revenues from collecting tolls are increasing from year to year. According to Paolo Ferrari (2002), the gain from collecting tolls can be seen in two ways: Firstly to reduce the transport congestion by increasing the transportation costs of some roads. This would make some road users switch from congested

roads to those which are less congested or with more capacity. Secondly, to regain the maintenance costs since it is hard to depend on public financing (Ferrari, 2002).

Concerning the Swedish market, the first scheme for congestion charges was implemented on 1 August in 2007 in Stockholm after the trial period between January and July in 2006. The main goals of trial period were to diminish the amount of vehicles during the rush hours (morning and afternoon); to improve and develop better traffic flows on the busy roads; to decrease CO2 emissions, NOx and other particles; and to improve urban environment. The results from trial period were better than expected. The summary of the results concludes that the amount of traffic decreased which lead to less damage to the environment in ways of decreased CO2 emissions and other particles. The accessibility was also improved as well as the usage of public transport which increased with 6 %. Road safety was also improved due to reduction of traffic (RDW, 2011). All the consequences of trial period made the government decide to implement congestion tax scheme on permanent base. The main purpose was to improve accessibility on the roads and the environment in order to support financial investments in the road network in the city. It required a lot of money to implement congestion tax scheme and running costs in 2009 were around 200 million SEK. Results have later shown that it was a fruitful investment (Hamilton, 2010). Already in 2009 the traffic levels dropped 24 % (Börjesson et al., 2010). As in the trial period, the quality of environment improved due to reduced amount of CO2 emissions and road safety improved as well (Walker, 2011).

After the successful period of implementing congestion tax schemes in Stockholm, the Swedish government continued the project in Gothenburg. The schemes were implemented in January 2013 (Swedish Transport Agency, 2013). The main incentives for this were to reduce congestion on the roads and to protect transport investment funding from government (Walker, 2011). The results have shown that improvement of access and shorter travel times due to reduced traffic were two of the best achievements in Gothenburg. In total, it represents a reduction of traffic on roads during the morning rush hours by 3 % compared to year before. According to Maria Börjesson, traffic researcher at KTH, it was the same development in Gothenburg as in Stockholm when the congestion tax was new there. The difference was that it stabilized a bit faster in Stockholm compared to Gothenburg (GP, 2013a).

Figure 4: An example of system for road congestion charges in Gothenburg (GP, 2013b)

3.4 Speed limits

One of the main problems in traffic is high speed. Nowadays new developments and improvements of vehicle performance and road standards are growing which leads to higher speed on the roads. High speed usually results in numerous traffic accidents and cruelty of the injuries (Nilsson, 1981). It has also negative effects on the environment in the ways of air pollution and noise from traffic (Fildes & Lee, 1993). Concerning the choice of speed from the driver, it depends on some factors such as environment, driver and vehicle (Shinar, 2007). The driver decides the speed according to his/her own perception of road environment and most of the crashes happen because the driver overestimates the road characteristics and environment (Edquist, Rudin-Brown & Lenné, 2009). For instance, in 2011 a Belgian study was conducted concerning the perception by driver's speed limits conformations. The result showed that a speed limit of 70 km/h was exceeded more often than a speed limit of 90 km/h. This was explained by distraction of the driver (Regan, Lee & Young, 2009, p.4).

The Swedish Road Administration (SRA) carried out trials during 2003-2008 involving variable speed limits. The main purpose was to decrease speeding in bad or unsafe weather conditions. There are three main areas where variable speed limits are applicable: connections with crossing and turning traffic, roads with bad weather conditions such as roads with side winds, and roads with different traffic intensity such as queues and traffic flows. The results from the trial period showed that deaths and injuries were decreased with 40 % with the variable speed limits. Majority of road users were satisfied with the trial system. It helped to decrease the risk of accidents on the roads and the traffic rhythm became calmer. It also slightly improved accessibility and reduced the environmental impact. The setting up of the system on permanent basis was made in 2008 after the trial period was ended by the Swedish Road Administration (Vägverket, 2009).

According to VTI (2010) more than half of the drivers agreed that safety on the road increased when the speed limit was lowered. Nevertheless, the other half of the drivers thought that safety had not changed. Most of the drivers did not believe that a lower speed limit would decrease the accessibility. Moreover, there were no clear differences among men's and women's opinions of speed limits. However, SRA concluded that the younger generation accepts new speed limits better than the older (VTI, 2010).

In 2011, another research was conducted, regarding the views of different road user groups for a new speed system. Groups were presented by two areas: rural and urban. Results showed that users from both areas agreed that changes are good but they did not get the logic behind them. The meaning of changing speed limits was poor for people from rural areas. They claimed that the speed limit system increased safety for vulnerable users but augmented the noise due to adjustment of the drivers speed more often. Moreover, the new speed limits had a negative side as well with traffic jams and refusal of drivers to obey the regulations. Both groups indicated that information should be clearer including the effects of speed on safety, environment and accessibility (VTI, 2011).

Figure 5: Digital road signs at E18 in Sweden (DN.se, 2008)

3.5 Real time information

Real-time data is information that is delivered right after it is collected. The information is provided without delay and is often used for navigation or tracking (Wade & Sommer, 2006). Real time information has developed fast the latest years and there are two main reasons for this. Firstly, the demand for high quality real time information in order to facilitate Intelligent Transportation Systems (ITS) has increased; and secondly, the availability of information in GPS navigators of the location, the speed of the vehicles and where they are heading have developed. These improvements have made easier access to real time traffic information routes and increased the capability of governmental companies to control and manage traffic flows (Sensors & Systems, 2012).

In socio-economic systems like the transport system, information is a main product. It has major impacts on the transport dynamics (Hino & Nagatani, 2014). In traffic, Advanced Traveler Information Systems (ATIS) communicates with the system in the car in order to help drivers in route planning, decrease travel time, minimize travel costs and obtain relevant travel information. ATIS is one type of ITS system and can include e.g. Geographic Information Systems (GIS), Global Positioning Systems (GPS), Dynamic Message Signs (DMS), in-vehicle navigation systems, and television- or radio reports about route conditions (Rong-Chang & Ke-Hong, 2013).

One of the main benefits of ATIS is that it provides real time traffic information for highway drivers before and during their trips. Some of the studies done on real time traffic information conclude that it can help to decrease drivers' travel time and increase service operations in the transport systems (Jou et al., 2005a,b; Srinivasan & Krishnamurthy, 2004). Other researchers figured out that ATIS help to reduce uncertainty during non-present bottlenecks on roads (Levinson, 2003). Today bottlenecks in traffic are very common and studies have shown that if a traffic jam appears it can change quite fast depending on the real time traffic information. This is because drivers using this information can choose another route and thereby the original traffic jam disappears or moves to another route where the cars have moved to (Hino & Nagatani, 2014).

One example of customization of real time traffic information is from Taiwan where research has shown that drivers are willing to pay for this information. The study made observations on traffic information that was priced differently depending on what kind of information it was. This included travel time information, delay information and route navigation information.

The study also showed that if you want to customize real time traffic information it is better to provide drivers with installed navigation devices that can help them to be aware about 'possible problems' on the roads. The customization of real time traffic information and pricing it differently was concluded to be one of the possible methods to solve traffic congestion (Rong-Chang & Ke-Hong, 2013). This tailoring of traffic information will also be more and more important in the future, for example it might be possible to pre-book a parking space and then get the fastest route there. Moreover, the coordination of different modes will improve to make it more efficient to travel or transport goods through different modes of transport (Trafikverket, 2013b).

European Commission is one of the actors that provide real-time traffic information. The information is primarily about road networks, traffic regulations such as speed limits and access restrictions, recommended driving routes, but also live updates with information about congestion, accidents, road works, road closures and weather. The service is primarily targeting road users including private motorists, commercial road transport operators and users of public transports. Indirect the information is also used by transport managers, road operators and traffic managers to optimize the utilization of the roads. The EU Directive 2010/40 (the "ITS Directive), defines the necessary requirements for collection of traffic data and also the requirements for making road, traffic and transport services data accurate and available for digital map producers and service providers (European Commission, 2014).

Using ITS is one way of making the transport system more efficient. The overall aim is to increase accessibility, improve rail and road safety and reduce environmental impact. In Sweden, there are different IT-support systems available during the journey. These include electronic signs, variable speed limits, finding available parking spaces, automatic speed surveillance, smart traffic signals, and electronic congestion charges (Trafikverket, 2013b)

Support can also be offered through IT solutions when driving in a car e.g. seat belt reminders or technology to prevent collisions. If you have an RDS-TMC receiver, you can also receive messages with traffic information relevant for the area you are driving in. Some car manufacturers also provide real time traffic information in private cars during the journey (Trafikverket, 2010a). One of them is BMW that uses satellite information to find the fastest road and avoid road blocks and congested roads. The equipment has an accuracy of 500 meters and calculates alternative road routes (BMW, 2014). Another system is the Intelligent Speed Adaptation (ISA) which displays vehicle speed and compares with local speed limit and reacts immediately when the driver of the vehicle exceeds the speed limit on the road (Karthikeyan & Tamileniyan, 2010). If the speed limit is exceeded, ISA can react in different ways such as warning driver by beeping; the accelerator pulses or offers resistance (Trafikverket, 2010a).

The main positive effects of the ISA system are improved road safety, reduced climate impact and better working environment (Martin, 2002). For instance, road humps can be removed if the majority of cars will be equipped with ISA system. This can lead to reduction of injuries on the roads and to improved access for emergency traffic. ISA also facilitates timetable planning by providing drivers with less stressful working environment (Trafikverket, 2010b).

If you need information before a journey in Sweden, Trafikverket have their own traffic information web site called ”Läget i trafiken” where you can see current traffic conditions on the Swedish roads. The information can also be subscribed to by companies for free in order to develop traffic information services that help the road users. The information is available online, through phone, teletext and radio. All traffic information online is provided in XML-format via a European standard called Datex II and all you have to do is to sign an agreement with Trafikverket (Trafikverket, 2013b).

Trafiken.nu is a Swedish traffic portal with collected information about the traffic in the Gothenburg area (also Skåne and Stockholm in some extent). The site allows for planning a trip or finding out how the traffic situation looks for the moment. Also current disturbances, planned road constructions, events and free parking spaces are possible to see. The site is accessed through internet and is operated by Västtrafik, City of Gothenburg and Trafikverket (Trafiken.nu, 2014)

There are also private alternatives in Sweden like Trafikradion.se where traffic information is sent out daily the whole year in certain areas. The have around 400 traffic cameras that can be seen through the computer, surf pad or in the mobile phone. The information is updated every minute and the ambition is to be the most up to date source that provides the information that is needed by road users. At the same time as the service is developed to be even more local in Sweden, a new European site called TrafficRadio.eu is coming where the same information for European roads will be provided (Trafikradion.se, 2014).

3.6 Road capacity

When designing road and controlling traffic, the road capacity is one of the most important characteristics. The possible time and places of congestion, the number of delays and the capacity for traffic in expected bottlenecks are necessary to forecast (Transport for London, 2013). In order to make everything right it is important to clearly identify the meaning of capacity. As stated in the introduction, capacity means how many vehicles can use a road without causing congestion. Bearing is the maximum weight a vehicle can have on the road (Forsström, 1999). Road capacity is also closely related to weights and measurements of vehicles.

According to European Commission directive 96/53, the members of European Union cannot exceed the limits of transport dimensions and weights within EU (European Commission, 2013). The high-capacity vehicles in Sweden are 60 ton of weight and 24 or 25,25 meters long and have also been developed further for example through the “ETT”-project, where the parameters are 32 meters and 90 tons. These lengths and weights are however by no means extreme in a global comparison. In order to transport a certain amount of goods in a safe and efficient way with low environmental impact, it is important to maintain this use of high-capacity vehicles. The high-capacity vehicles reduce fuel consumption and carbon dioxide emissions by 16 % in Sweden. Calculations show that if Sweden were to reduce the weight

and dimensions of trucks to the EU level, costs would increase with 9 billion per year (Sveriges Åkeriföretag, 2014).

Table 2: Differences in capacity between Swedish vehicles and EU vehicles

	Swedish vehicles	EU vehicles
Max length (m)	25,25	18,75
Max GVW (tonnes)	60	40
Max load (tonnes)	36-42	22-26
Max volume (m3)	130-140	85-96
EURO pallets	51-54	33-36

Source: Ericson (2010)

The effects of changing road capacity to different stakeholders have been studied by different researchers. One study identified three main aspects for extra vehicle travel: arrival of new residents; increased driving by current citizens and extra transport activity. The researchers also concluded that vehicle-kilometers travelled (VKT) demand in the city is elastic thus increasing road capacity or public transport supply is unlikely to decrease congestion (Duranton & Turner, 2011). A Norwegian study has shown that increased investments and maintenance of roads can decrease the environmental impact but just adding extra capacity might instead increase the road traffic and thereby increase the negative effects (SINTEF, 2007). An investigation made of traffic situations in 70 American metropolitan areas shows that cities that financed the extension of road capacity did not progress in reduction of congestion on the road compared to those that spent less (STPP, 1998). Expansion of road capacity can also lead to increased traffic which would lead to congestion in new places (Cervero & Hansen, 2000). An Australian study shows that traffic speed on Melbourne roads not decreased with new urban highway building due to induced traffic. It is however not the expansion of road capacity that generates travel, it is the decrease in congestion delays and travel costs (Odgers, 2009).

Table 3: Cost impacts of roadway capacity expansion

Costs Reduced	Cost Increased		
	Diverted trips	**Longer trips**	**Induced trips**
Travel time	Downstream congestion	Downstream congestion	Downstream congestion
Vehicle operating costs		Road facilities	Road facilities
Per-mile crash rates (if implemented in conjunction with roadway design improvements, but these are often offset if traffic speeds increases)		Traffic services	Parking facilities
Per-mile pollution emissions (if congestion declines, but these may be offset if traffic speeds increase).		Per-capital crash rates	Traffic services
		Pollution emissions	Pollution emissions
		Noise	Noise
		Resource externalities	Resource externalities
		Land use impacts	Land use impacts
		Barrier effect	Barrier effect
			Equity
			Transit efficiency

Source: Litman (2013)

Table 3 shows results from an American study and explains different cost impacts derived from capacity extension. The main positive aspects are reduced travel time and vehicle operating costs. Regarding the negative ones, cost increases in many ways. The cost impacts are mostly related to the society as a whole and not to particular stakeholders. By expanding capacity, accessibility will increase because of improvement of traffic services, road facilities, building new parking facilities and transit efficiency due to putting more money in development of the road capacity. On the other hand, it creates barrier effects for other traffic actors (primarily pedestrians/ cyclists) in a way of limited access to some parts of the road.

When constructing new buildings or developing road capacity, the road safety is often improved. This is due to the implementation of new conditions and laws. Concerning the environment, capacity expansions have negative effects in form of increased pollution, noise and augmented land use. Downstream congestion is also a negative impact which is hard to see, since it has indirect effects on other stakeholders, somewhere else in the transport system (Litman, 2013).

The fast increase in traffic volumes critically affects economic development of the country. In many cases problems arise when traffic increases and capacity of road is limited or without possibility of building additional lanes. Sweden is not an exception and is trying to find effective solutions for accessibility problems. One of the best solutions is using reversible lanes (Trafikverket, 2013c). In USA, for instance, reversible lanes are used on a very large scale. Other countries use reversible lanes in less extent and in many cases it is considered a special solution for capacity and accessibility problems. Bridges are a good example of when using reversible lanes can be efficient. Reversible lanes can always be considered when there are a lot of traffic variations, and can be particularly efficient in urban areas with very high

traffic flows towards the city during the morning hours and from the city during the afternoon (Vägverket, 2004).

Good examples of roads with reversible lanes are the Harbour Bridge in Sydney and the Golden Gate Bridge in San Francisco, but it has also been effectively implemented in Barcelona and Birmingham (GP, 2010). According to the official website of city Phoenix in USA, they have had reversible lanes on 7th Avenue and 7th Street since 1979 and 1982 correspondingly. The Mayor and the City Council were faced with the traffic congestion problems in 1979 in Phoenix. Reversible lanes were one of the solutions in order to solve the traffic issues. The reversible lanes assisted to improve capacity while decreasing cut in traffic congestion. The reversible lanes helped to improve safety, increase capacity and create benefits for other businesses (City of Phoenix, 2011).

In Sweden there is only reversible lane, outside Stockholm in Värmdö (GP, 2013a). The length of this reversible lane is 1,5 km long (Trafikverket, 2013c). A study carried out in Värmdö showed the effects of reversible lanes in order to establish acceptable levels of accessibility. The main critical topics were the pedestrian crossings with traffic islands. According to road user interviews, people were positive regarding the implementation of reversible lanes but cyclists were not satisfied due to less space and fewer possibilities for crossing the road. Moreover, accessibility has improved for drivers but instead the vehicle speed on the road has increased. Even now a lot of drivers are exceeding the speed limit of 50 km/h passing road 222 between Mölnvik and Ålstäket in Värmdö. Compared to building a four lane road which would have cost 140 million SEK, the solution with a reversible lane in Värmdö cost merely 20 million SEK (Vägverket, 2006).

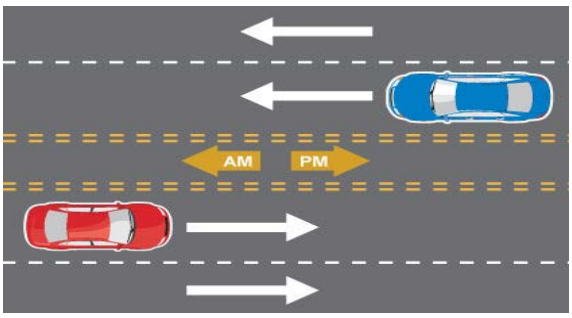

Figure 6: Reversible lane for morning and afternoon traffic (AARP, 2013)

Climbing lanes are another solution and means in this context extra driving lanes on hills. The extra lane is placed in the direction of the climb. The climbing lanes increase the safety and reduce accidents. This is achieved by facilitated bypassing and easier passability by resolving congestion and avoiding long acceleration after the climb (Trafikverket, 2004). This is confirmed by a lot of projects, such as the Interstate 81 Truck climbing lanes in USA where a 12-foot wide climbing lane was added. The result showed that by allowing slower moving vehicles to stay in the right lane, the safety was enhanced. Other benefits were better traffic management as well as the access to an extra travelling lane during traffic incidents (VDOT, 2014).

3.7 Parking and safety parking

Every year the amount of goods transported by road increases and the society is searching for different ways to deal with challenges like safety, congestion and environment. However there are also recent projects with safety parking spots, since the thefts of cargo and diesel from trucks have large effects on the hauling sector. The problem with thefts is increasing and the attacks against trucks have increased with 35 % during the second part of 2013, compared to the same period 2012. Safety parking could be the solution, but who will finance the parking spots are still unclear (Värmlands Folkblad, 2013).

One of the possible solutions that can help in parking matters is Intelligent Truck Parking (ITP) for heavy goods vehicles, which is used in the European countries according to directive 2010/40/EU. Studies have also showed that more than 44 % of the trips within international road freight transport need at least one break (SETPOS, 2009). ITP collects data about parking areas such as security, space availability and services available. The information is then connected to the drivers in real time and assists them with finding the right parking spot. This limits the options for the drivers on when and where to stop (Sochor & Mbiydzenyuy, 2013).

In Sweden, the project "Smarta Lastbilsparkeringar" specifies the potential reduction in time-based costs for heavy goods vehicles and decrease in the cost of delayed and missing goods (Sweco, 2012). Another study, from 2010, has also identified the main benefits of ITP. One advantage was that the search time for parking spots was reduced, another one that parking related thefts and damage was decreased, leading to economic savings as well as reduced number of crimes against the vehicles. ITP also helps to decrease accidents related to fatigue from excessive driving and according to Swedish studies, 38 % of drivers have problems with the rest time regulations (Sochor & Mbiydzenyuy, 2013). Furthermore, 25 % of all Swedish road accidents are related to fatigue accidents (NORDIC, 2008). By using information provided by ITP, drivers lower their stress concerning unknown routes and perceived safety from this application (Sochor & Mbiydzenyuy, 2013). ITP can also offer support for drivers to find recharging stations for environmentally efficient heavy goods vehicles (Baker et al., 2010).

In 2011 the first camera monitored security park for heavy vehicles with online booking was introduced in Sweden. It provides drivers with wireless internet, showers and coffee, all included in the fee of 100 SEK per 24 hours. The security park is located at the E4 between Malmö and Stockholm with the main purpose of providing parking for drivers at the same time as granting safety for them (Security Park Sweden, 2014).

During the last few years in Sweden a lot of safety parking spots have been built, however many of them have been closed due to bankruptcy. For example the safety parking in Värnamo recently closed because of low occupancy rate (Värnamo Nyheter, 2013). Other sources also suggest that the parking in Värnamo was badly placed from the beginning, and that having one closer to Jönköping could have been more beneficial due to higher criminality there (Trailer.se, 2010). A recent study however shows that it is possible to get profits from

the safety parking spots within a couple of years from the investment. There are also some key factors to this success. Location need to be strategic, between central nodes. Supply of services like toilets, restaurants, fuel station and a high security level is also positive. Furthermore, good advertisement and publicity and long-time relations with customers are valuable. ITS- services in real time is also an area for development with high future potential (Sweco, 2013).

4 Findings from interviews

In this chapter, the results from six interviews, conducted on six different occasions, are presented. The information achieved has been divided into themes. Two of the respondents work at Trafikverket, three have managerial positions within a transport company and one works with planning at a car manufacturer.

4.1. Background information on respondents

In order to provide basis for the interviews the respondents are presented with information about who they are, their position at work, how long they have been working on this position and their daily responsibilities.

4.1.1 Respondents at Trafikverket

Bertil Hallman is a long-term planner at Trafikverket in Gothenburg. He works with collecting and presenting decision material for the government and municipalities when it comes to investments in infrastructure. When decisions are taken, he is the one of the people responsible for making sure that the plans are also followed through. He has worked with this for 7,5 years and has contact with a lot of people in his daily work. Most of the people are from within Trafikverket but he also meets municipalities, politicians, municipal corporations, vehicle manufacturers and different representatives for transport companies.

Per Wenner is a director of accessibility at Trafikverket in Borlänge. He is responsible for keeping track and monitor if Trafikverket is obtaining the target for accessibility in the transport system in Sweden. He has been working with this for the last 8 years and handles a lot of questions related to accessibility with much focus on research and science. He collaborates a lot with KTH Royal Institute of Technology, the program for research of vehicles and representatives of the vehicle industry and transport.

4.1.2 Respondents from transport companies and a car manufacturer

Niklas Ward is the CEO of Schenker consulting. He has worked there for 15 years and is involved in all kind of activities but mostly project management and supply chain management. In his daily work he has a lot of contact with people within Schenker but also people connected to different research projects, like people from Trafikverket or Chalmers University of Technology.

Göran Knutsson has had different leading positions within the transport sector since 1996 and is since 2006 the CEO of the haulage part of Schenker. His responsibilities involve setting up goals and targets together with the board of directors, manage audits, reviewing budgets and making sure the organization works properly. He is not very involved with government or municipalities, instead he works more with the car manufacturers in different projects where Volvo, Scania and Mercedes are the large partners.

Linda Lithander works at a small hauler called Pall Cargo. The company is family owned and consists of around 20 trucks and 30 drivers. She has worked in the transport sector for 20 years and works with transport planning and economy.

Anders Berger is responsible for Technology & Project Planning and the Transport Solutions & Services at Volvo Group Trucks Technology. Berger has worked there since 2008 and works a lot with setting up projects together with other actors like transport companies, authorities and shippers. The department only has an indirect influence on political decisions and works more with collecting data and presenting material to relevant persons.

4.2 Changes in accessibility

The following topics are extracted from the interviews and based on the questionnaires. These topics answer the questions of how the transport companies are affected by changes as well as how large the impact is or would be. The effects are also summarized in the end of each part.

The theoretical framework covered five different changes in accessibility, however in the interviews a couple of more topics have been asked about in order to see if these ones have effects as well. These topics are Terminals, Intermodality and Digitalization/ Electrification. The findings in these areas show that they are influential and have therefore been added here, starting with the section of 4.2.6. These three topics will also be discussed further in chapter 5.

4.2.1 Road tolls/Congestion charges

There are quite small negative effects for transport companies, and these are overshadowed by the positive ones since traveling times are shortened. This is especially the case for large cities like Stockholm (Hallman, 2014). Wenner (2014) has the same line and means that the congestion charges are positive for transport companies if the level of traffic decreases. Lithander (2014) however mean that even if the congestion charges had large effects on the traffic, this was mostly in the beginning and now the traffic is basically back at the same level as before (Lithander, 2014).

Schenker, on their hand, are not very affected by congestion charges since the costs of the charges usually are put on the customer instead (Knutsson, 2014). If the situation is pre-competitive and same for everyone (meaning competitively neutral), the congestion charges are not a problem but still the competition with foreign trucks needs to be handled (Ward, 2014). Hallman (2014) agrees that it needs to be handled but also says that this is hard for Trafikverket to affect. Collecting the congestion charges are complex and the cost of collecting the last 5-10 % of the money is almost more expensive than what is collected (Hallman, 2014).

From Schenker's point of view, if the traffic and the congestion decreases it is a good thing, but it needs to be in relation to the increased costs. In the future the congestion problem might affect the office hours, and the congestion charges are one step in this direction. However, more legislation is necessary to make changes; no one will change of their own free will. The roads in Sweden today are enough for the needs; better ways to utilize them are rather needed. In the future, different kind of cargo might be charged in different ways and people who use their cars for free time activities might be charged more than the ones using the cars to and from their workplace (Ward, 2014).

From Volvo's point of view, all fees for using the road infrastructure are costly and in general negative since their customers need to take the costs. However, the accessibility is also increased, and therefore Volvo have a neutral attitude in this matter as long as the money paid for using the roads are coming back to the actual road users through infrastructure investments (Berger, 2014).

Even if the congestion charges are not fully evaluated, they have had clear effects on the transport companies through increased accessibility and faster delivery times. The main problems lie within making it competitively neutral. Even if costs are increased for the transport companies, these are often passed on to the end customers instead.

4.2.2 Speed limits

Speed limits have large effects for the transport companies but much more when it comes to continuity in speed than the actual speed (Hallman, 2014). Lithander (2014) is of the same opinion and adds that the consistency is important in order to keep "drive and stop regulation" (Lithander, 2014). According to Wenner (2014) and Berger (2014) the speed limits are not so influential and only affects marginally.

Today Trafikverket can offer the speed of 80 km/h at most roads (Hallman, 2014; Wenner, 2014) and the speed limits do not influence so much the decision of which road to take for Schenker, since most roads have 80 km/h, which is enough. The transport planners at Schenker calculate with an average speed of 70 km/h (Knutsson, 2014). Ward (2014) has the same opinion and adds that there are rather other factors along the roads that affect the choice of route (Ward, 2014).

Schenker tries to make sure that all drivers keep the speed limits, since almost all agree upon the fact that increased speed also increases the risk of accidents (Ward, 2014). They also work together with NTF (National association for Traffic Safety) and check themselves if the speed limits are kept by installing speed limitation devices in the trucks, allowing a maximum speed of 85 km/h (Knutsson, 2014). The trucks at Pall Cargo are limited to a maximum speed of 90 km/h (Lithander, 2014).

The speed limits affect the transport companies to some extent but to be able to keep the same speed is much more important than the actual speed. The speed limits have also seldom enough effects to influence the choice of road route.

4.2.3 Real time information

Hallman (2014), Knutsson (2014) and Berger (2014) all think that real time information is one of the most important future technologies. Ward (2014) however thinks that real time information is not so important. He agrees that it is an advantage if you know how long time the transport takes with prognoses before the trip to avoid fluctuations but today the information during transport e.g. about queues often comes when it is too late (Ward, 2014). Lithander (2014) also thinks the information comes too late in order to adjust routes.

Ward (2014) and Hallman (2014) both say that real time information can help a lot in order to increase the quality of Schenker's services. Basically, everything that affects the driving

routes and the driving time is interesting for Schenker since it facilitates the work of their transport planners and increases the efficiency of operations. However, Ward (2014) also states that the behavior of the drivers is hard to change since some perhaps have taken a certain route in many years and do not trust the information given from a digital system but rather their own instincts (Ward, 2014).

Many drivers drive different trucks during the same day so most of the real time information used comes to their smart phones and not through equipment in the trucks. The devices in the trucks can collect some data but they are quite low tech and need more development in order to be efficient (Lithander, 2014). Real time information about traffic accidents and such is, as in Pall Cargo's case, mostly handled by the drivers themselves who often achieve updated information through their own mobile phones. Better solutions are needed where fast real time information can be transferred directly to their computers and in turn to the systems of the cars, giving alternative routes much faster than today. Schenker use GPS technology e.g. when loading or discharging and to find the vehicles in order to utilize them in the best possible way (Knutsson, 2014). Hallman (2014) is convinced that real time information technology like navigation systems still needs to be developed. Transport companies use a lot of GPS and the systems often show the shortest road but Trafikverket want them to show the "most suitable road" instead. One problem with road choices is also that the shippers often decide the road route since they are the ones that are receiving the cargo and have a lot of power to affect these decisions (Hallman, 2014).

Most of the respondents agree that real time information is very important for the accessibility. It helps both the planners at the transport companies and the drivers to make decisions on which route to take and to increase the quality of services and efficiency of operations. The information however needs to be even faster in order to gain larger effects. By taking the fastest route or avoiding congested ones, fuel is saved and environmental impact decreased.

4.2.4 Road capacity

Road capacity is not that influential, it is more a question of where and how you can drive or not, with an exception of Stockholm where the capacity is a complex problem and extra fees are added for the city transports because of the longer time it takes due to the congestion (Knutsson, 2014). Wenner (2014) has the same angle and thinks that road capacity does not have so much influence on the accessibility except on certain routes (Wenner, 2014). Ward however (2014) thinks opposite and says that for Schenker the road capacity and dimensions affect the accessibility as well as the road safety (Ward, 2014). The road capacity is important, especially with buoyancy on roads and bridges (Berger, 2014). For Pall Cargo, most of the transports are made on large roads where the road capacity is enough, which makes it less influential (Lithander, 2014).

According to all of the respondents, the congestion problems in Sweden are exaggerated and it is mostly Stockholm and Gothenburg that have any real problems. Lithander (2014) also adds that in Gothenburg a lot of the congestion is caused by vehicles passing through the city since there are no ways around (Lithander, 2014). One effect of the congestion is that you

need to put your terminals on either south or north of a city to optimize your flows since the transports can get stuck in the city center (Wenner, 2014).

Schenker's business is more affected by road constructions and other road blocks rather than daily congestion (Ward, 2014). It is more important to reduce stop times when there are accidents or improving the quality of real time information when something changes in the transport system. The total overtime of the drivers is around five percent and of these percent, one or even more are due to the traffic situations like congestion or accidents that stop the flow (Knutsson, 2014). In Germany the cleaning of roads after accidents is much faster than in Sweden, and the Swedish way where you have to know who pays the insurance of a foreign damaged vehicle before you move it is quite ineffective (Lithander, 2014). Wenner (2014) points out that better ways to measure congestion are needed and says that different projects in the large cities are on the way (Wenner, 2014). To solve the congestion problems larger investments in the rail infrastructure are necessary as well as maintenance work on the existing rails in order to increase the intermodal transports. Schenker is right now working on a project called "Kringfartslogistik" where they try to increase the efficiency of the current infrastructure. This is done by focusing on solving the problems of congestion on the passages outside the cities where transports are driving when arriving or departing from terminals (Ward, 2014).

In order to utilize road capacity better, one way is to develop the use of time windows. There are often municipal restrictions for time windows of deliveries during the rush hours. If different companies like ICA and Coop could co-load their vehicles when they have stores close to each other the amount of transports could decrease (Wenner, 2014). City logistics will also become more important (Ward, 2014). A lot of different other projects are going on with tests of night time deliveries with electric cars and silent loading in order to improve transport efficiency (Wenner, 2014). This is a desirable solution and perhaps a stimulation package is needed for this, since the cars are much more expensive than others. The electric cars are also hard to use during daytime outside the cities since they cannot drive so long distances without recharging the batteries (Knutsson, 2014). Despite the costs of electric vehicles, Hallman (2014) does not expect any reduced fees from government for night time deliveries since the market will adapt to these circumstances if necessary (Hallman, 2014).

Finding a good combination of how to handle the goods and private traffic in the future will also be necessary (Hallman, 2014; Ward, 2014). The home deliveries are increasing and put new demands on the infrastructure. This would mean more goods to transport for the companies but this also means that the private traffic needs to be decreased instead. More services to customers will be needed as well as expanded operations for return handling (Ward, 2014).

Weights and measurements of vehicles have perhaps the largest effects on transport companies since the fuel consumption can be reduced quite much. This would also lead to less emission so there are large potential in these subjects (Wenner, 2014). Before it used to be a problem that the cargo space was not enough in the trucks but today there are more small consignments and the problem has decreased (Knutsson, 2014). For Schenker, the legislation

has large effects; longer and heavier trucks would of course result in more efficient utilization of resources and perhaps also fewer trucks in the transport system. However, even if this is important, the most important factor is that the legislation is pre-competitive and the same for everyone (Ward, 2014).

Longer vehicles reduce the environmental impact, but there is also the question of the need of higher demands for safe over takings in traffic (Hallman, 2014). Berger (2014) states that longer and heavier vehicles increase the accessibility. This, however, also put demands on the buoyancy of the infrastructure, the bridges and also other infrastructure like roundabouts. Increasing the capacity of the trucks also gives fewer vehicles on the roads and increases the accessibility and Volvo is part of a project where the goal is to increase the efficiency of loading and discharging as well as packing better to utilize the capacity of the vehicles (Berger, 2014). Volvo and Pall Cargo have also a project for test driving of longer trucks and Lithander (2014) is generally very positive towards increasing the length and height of the trucks. The weight is however not as easy since it puts more demands on the infrastructure and the legislation is quite favorable already (Lithander, 2014). Knutsson (2014) says that the market talks a lot about longer and heavier trucks but today there are more vehicles in the transport system than ever before, the small vehicles are growing even faster than the large ones (Knutsson, 2014). Ward (2014) mentions the same trend, that in many cases more transports are actually done by smaller trucks since the demand for faster transports is increasing. This instead leads to decreased vehicle capacity utilization rates (Ward, 2014). A lot of data points towards that peak of (private) cars has been reached or at least that the market is more saturated than the prognoses say (Wenner, 2014). Lithander (2014) is also in on the same trail, at least for private cars. The number of trucks will probably increase a while more, both the smaller trucks and the larger ones (Lithander, 2014).

Hallman (2014) does not really see the threat against rail with longer trucks since if the rail is good enough it will be used anyway, and the longer trucks will rather be a complement – and even if it would actually cause more competition between the modes, it would increase the overall efficiency of the transport system (Hallman, 2014). Lithander (2014) also thinks this will gain the overall efficiency with fewer trucks on the roads. The standards between different countries however need to be better harmonized, since it is otherwise hard to utilize larger vehicles if they only can be used in Sweden (Lithander, 2014).

When it comes to standards in the transport system, Knutsson (2014) believes we have enough standards and that most of them work very well e.g. the system with pallets. At Schenker there are a lot of standardized modules for the building of different variants of complete Lorries (Knutsson, 2014). There are however still great differences between different countries in this matter. There are a lot of standards both for vehicles and pallets but more standards are needed on a global level, and if not possible at least on a regional level in Europe. Perhaps the largest need is the standardization of the infrastructure which today allows for different heights of vehicles in different countries and these legislations need to be harmonized both globally and regionally (Berger, 2014).

Hallman (2014) hopes that restrictions in accessibility have large effects, since this makes it a powerful tool to influence decisions in the transport industry. He also suggests certifications of transports like the ones that are used on food products today. Since the end customers need to put higher demands on the transport companies this is one way that could facilitate that. By certifying companies on how they treat their employees/drivers, that they use "green" transport solutions or that the customer can trust that rules and regulations are followed could help in this matter. The customers usually pay quite small amounts for the transports, while having both the money and the power to actually put pressure on making the transport sector more transparent and legal (Hallman, 2014). The receiver must be the one putting pressure on the environmental specifications. There are interesting projects with the buses in Gothenburg; more of these projects need to be evaluated in order to see what solutions that should actually be used in the future or not (Knutsson, 2014).

Hallman (2014) thinks that we have to improve road capacity by fixing the bottlenecks. He says that reversible lanes are not the solution for this in Sweden since they will be too short to be efficient. Moreover, it is more likely to build an extra lane in one direction rather than using reversible ones (Hallman, 2014). Berger (2014) says that reversible lanes are interesting in and out from cities and Volvo have some projects where they try to find technical solutions for better information to the road users. Wenner (2014) is positive towards reversible lanes as well and says that it has worked well in Stockholm. He is also surprised that there have not been more projects for this (Wenner, 2014). In the future a more dynamic way to use the road could be offered and there are also projects going on for e.g. utilizing public transport lanes in better ways. Another example where developments will be seen is that we today have three meters width of the road verges unutilized which is a waste of resources. Today the driving lanes are also defined with painted lines between them which are very static and in the future new solutions that are more dynamic and customizable will probably be used (Berger, 2014).

It should be possible to use high capacity trucks in public transportation lanes or even create an own driving lane for goods transports by reducing e.g. the verges on the road. The wider public transportation lanes may also be used by taxis, two-wheelers or even tourist buses. BRT (Bus Rapid Transit) is a project in Malmö, where high capacity buses are tested and people have to go to the motorway to take the bus, which decreases the amount of stops for the bus. This is one of the examples of improving road capacity in Sweden (Wenner, 2014). Ward (2014) says that infrastructure planners often forget about the goods transport instead of integrating them better in the transport system. Using public transport lanes for goods could potentially help Schenker a lot, primarily by increasing the accessibility of bypasses outside cities (Ward, 2014; Hallman, 2014). If this means that the emission requirements would be sharpened for the trucks using these lanes, it could still be worth it (Ward, 2014). Schenker would probably also gain from using public transport lanes in e.g. Stockholm but at the same time it can make it more chaotic and distract the drivers (Knutsson, 2014). Even if the accessibility for transport companies increase by using the lanes, it will be hard to draw the line of which transports that should be allowed to use these (Lithander, 2014). Moreover a lot of the cargo delivered in cities has a deadline at 8 a.m. which means that even if some transports start at 6 a.m. they will still be caught in the rush hours and using public

transportation lanes at these times is not optimal. An extra lane would in that case be preferable (Knutsson, 2014).

Another way to increase the accessibility is to use more climbing lanes (Hallman (2014). These lanes have also showed very successful both for safety and accessibility (Lithander, 2014) but whether more climbing lanes are needed or not the opinions differs on (Wenner (2014). The most important issues are to solve the stops uphill in winter traffic and to increase the demands on the vehicles to be able to keep the right speed. Apart from the shortages in infrastructure, slow vehicles are also a factor that creates bottlenecks (Wenner, 2014).

Road capacity has generally large effects on the accessibility, but in Sweden the congestion problem is not so widespread which also means that the changes in capacity have smaller effects. Nevertheless, this is a matter which the respondents not entirely agree on. The weights and measurements of vehicles have large effects but even if larger vehicles are preferred from both an accessible and environmental standpoint, the smaller ones seem to increase even more due to increased demand of speed. Using public transport lanes is interesting for transport companies since it directly affects the efficiency of their operations. Climbing lanes is a quite small change with positive effects, but not so important specifically for the transport companies. Reversible lanes could also be positive for the accessibility but it is unclear if the effects are worth the investments needed.

4.2.5 Parking and safety parking

When it comes to parking and safety parking, resting times are very influential. New technological solutions facilitate finding the best parking spot which is important for the overall efficiency of the transport system. To be able to book a loading spot or to see in real time how far it is to the nearest safety parking can help the drivers keep the right speed on the roads and even make them lower their speed in order to time their breaks with the locations of the parking spots (Berger, 2014).

More knowledge is needed about which are the main heavier routes for the trucks. Safe parking spots can be useful to influence transport companies to use certain routes and guide the flow of cars and the market and Trafikverket need to collaborate to make this happen. With better safe parking spots, these can also be used for informing drivers to make them stay there longer if there is e.g. a stop in the traffic, otherwise they will increase the traffic jam even more (Hallman, 2014). Safe parking lots affect transport companies more and more (Ward, 2014; Hallman, 2014) and the parking lots along the roads are to a large extent a cost factor, if it is worth spending money on or not (Ward, 2014). Safe parking can also help to reduce queues in e.g. ports with smart queue systems where the drivers can collect their goods Just In Time when it is ready and not stand in the way of other goods when waiting (Hallman, 2014). Wenner (2014) means that safe parking is good but when it comes to safe parking spots, the willingness to pay is very low from the companies, and therefore this exists in a quite small scale so far. The transport companies simply have insurance on their goods and do not want to pay more for increased safety of the goods/driver (Wenner, 2014).

Knutsson (2014) is positive but the transport sector has low margins on every consignment and paying for a safety parking could potentially take almost all the profit that is made on a

transport. Perhaps this cost should instead be included in the calculated cost of the transport from the beginning, so that the customer pays for the safety of the goods and drivers. This could e.g. be the case if Schenker AB would put pressure on their haulers and say that parking only shall be made on safety parking spots. The safety parking has had a bit bad timing and structure so far and the transport time affects the choice of route so much more than the access of safety parking (Knutsson, 2014). Since the willingness to pay is quite small, new smart solutions need to be found to increase the supply of safety parking. One example is the safety parking in Brändåsen, outside Öreboro, where you can park for free if you buy or refuel for at least 150 SEK. This is a win-win situation since the restaurant and the store get more customers and transport companies like Pall Cargo can refuel their trucks there in order to utilize the safety parking (Lithander, 2014).

Influencing the choice of routes only by offering parking is hard since costs are prioritized over "service" along the roads. Nevertheless, Trafikverket is working on a digital record for all parking spots along the main roads in Sweden which can hopefully help in this matter (Wenner, 2014).

Safety parking has positive effects primarily on the safety, but can also help the accessibility to a small extent. The problem is that the transport companies not prioritize this, since it costs too much and the goods often are insured anyway. The positive effects are clear and the interest is there, but who will pay for the safety of the goods and drivers is still uncertain.

4.2.6 Terminals

With terminals, the authors mean loading and unloading facilities inside or outside of a city.

Terminals can increase the accessibility for the transport companies and it is important with good strategic locations with easy access and where goods do not have to pass through cities unless necessary (Wenner, 2014; Hallman, 2014). However, the municipalities and government will rather support other initiatives like smart city logistics and the actors on the market will probably have to solve this by themselves (Hallman, 2014). Lithander (2014) underlines the same point as earlier respondents, that placement of the terminals is most important. There is however often queues to the terminals, especially in Gothenburg and using more real time information could help in this matter as the trucks could be used for other activities if they would know that all terminal slots are full at the moment (Lithander, 2014). Not only is the location important but also the flows in and out of the terminal. Better notifications for trucks are needed and would help to adapt the arrival times of trucks to match the free capacity in the terminal (Berger, 2014). Being efficient in the terminals also creates margins and shorter loading and unloading times help Schenker, since they are paid for each transshipment they make (Knutsson, 2014).

Ward (2014) states that Schenker today uses their own terminals and want to continue to use them. According to him, there are initiatives taken politically to make municipal terminals and make everyone use it and thereby increase efficiency. He is however critical towards this since all big transport companies are already using their own terminals and creating new ones would only be a waste of resources when there are good terminals already in place. However, in cities where they do not have any terminal it could perhaps be a good alternative to buy the

service of using a municipal terminal instead. When it comes to combi- terminals, the case would be different since the responsibility of the transport shifts between the modes which might make it more suitable for municipal ownership (Ward, 2014). Lithander (2014) does not believe in the shared terminals either. There has been a similar project in Norrköping which did not succeed since the trucks actually travelled more kilometers with that terminal than by going directly to the customer (Lithander, 2014).

The most important factor with terminals is the location and it has large effects on the transport companies where choosing wrong location could mean unnecessary trips through cities. Easy access and possibilities for fast loading and discharging are also vital since the marginal both in terms of time and money are low. Efficiency could also be increased by managing flows better through utilization of real time information.

4.2.7 Intermodality

Intermodality in this case, means using different transport modes during the transport. This includes road, rail and sea transports.

Wenner (2014) wishes to use more intermodal transports than are used today. He says that it has to work on shorter distances, it is simply too easy and cheap to just take a truck door to door where the intermodal solutions are seldom competitive (Wenner, 2014). Hallman (2014) thinks that the rail will continue to grow, and he hopes more short sea routes can be established since the "infrastructure" for it already exists. In some cases cargo need to be moved from rail to sea in order to utilize the rail better and use it to regions where sea transports are not possible (Hallman, 2014). Lithander (2014) thinks opposite in this matter and does not believe the market share of rail will increase. The railway is too unreliable and does not go the locations where the goods are heading (Lithander, 2014). Knutsson (2014) also thinks the railway needs to be improved. Today the transports on rail are far too slow and since Schenker are under time pressure, often that delivery should be made within two days; the rail cannot meet these demands. Not only is the accessibility to the rail necessary, but also the time management, both with easy loading/unloading and times of departure for the trains to match the need of the customers (Knutsson, 2014). It also needs to become more cost efficient to use the rail, with better combi terminals and increased connection points between road and rail (Berger, 2014).

Ward (2014) says that people are worried about the risk of goods moving from rail to road transport if legislation would allow 32 meter vehicles in Sweden. According to him, the intermodal transports between Sweden and Norway should be developed and make rail transport more competitive. A lot of trailers travel to and through Sweden and in Norway they are instead using a lot of swap body vehicles to move trailers on rail wagons. Increased capacity of the rail system in Sweden could help this development of moving trailers on rail (Ward, 2014). Investigations that Volvo has made on increasing intermodality have shown that very little depends on the vehicles and that it is more a question of the technology available in the terminals. However, more efficient vehicle combinations could make rail cheaper in future by e.g. being able to load more units or trucks onto the rail wagons (Berger, 2014). More terminals, more containerization and increased use of unit loaded goods are also preferable to help the development of intermodality (Hallman, 2014).

Hallman (2014) also says that the transport modes need to be used more effectively; and one way to do this is to develop the slow-steaming, meaning that ships use a lower speed in their transports and thereby decrease their emissions and costs of fuel. This should be possible for many transports that are not under time-pressure. The problem today is that the transport from the port to the customer instead often is done under time-pressure. He questions this and says

that it should not be such hurry when it has already taken quite long time on the sea (Hallman, 2014).

Intermodal solutions are wanted by many, but there are different views on the potential since primarily the railway is not competitive enough. As the situation is right now, the intermodal solutions still have quite low effects on the transport companies since the demands on delivery time and number of departures can seldom be met by the railway. The respondents therefore call for more investments to drive the development.

4.2.8 Digitalization/ Electrification

When this topic was introduced in the interviews, the authors mean following: Digitalization is the trend of more and more digital solutions and assistance connected to transports (e.g. in cars, on roads, information or data). Electrification is related to this development and means in this case electrified vehicles and roads.

Digitalization is very interesting and coming more and more. Today there are basically three threats against this progress. Firstly, the safety on the roads that needs to be maintained. Secondly, the threat of data, there is always someone who wants to steal or corrupt data which could be a problem and thirdly, the sensitivity of interference. If the systems go down, will the traffic stop completely on the roads then (Berger, 2014)? One of the projects in this area is platooning where trucks move in long caravans on the highways. This is coming more and more and is tested by Scania and Volvo but will probably take around five years before seen in larger scale in the market (Wenner, 2014).

Knutsson (2014) is positive towards digitalization. If the Eastern-European countries compete with low-wage drivers, why not meet this with "non-driver systems" instead (Knutsson, 2014)? The digitalized cars coming will probably increase the safety of driving, which would also mean that there could be a possibility to reduce the width of the driving lanes in the future (Wenner, 2014). Digitalization is however also dangerous and what happens when you get used to that the car breaks by automatically and suddenly you should drive a car without this system (Lithander, 2014)? Hallman (2014) says that the safety always comes first and decoupling the driver too much is dangerous since the systems not are fool-proof and the driver may lose concentration instead. He is also skeptic to the "platooning" (Hallman, 2014). Lithander (2014) believes that self-steering vehicles is very far away, mostly since there is an issue with who is responsible if something happens when there is no driver to hold responsible. When it comes to electrical roads, this is probably going to be too expensive and just because it is electrified does not mean that the electricity is green (Lithander, 2014).

Since the road transports have large emissions, new fuels are coming and the fossil fuels will decrease in favor of hybrid cars and electricity (Wenner, 2014; Berger, 2014). This also put demands on e.g. having enough refueling stations for new fuels which is not the case today (Berger, 2014; Lithander, 2014). The electrification is however coming fast, and even if the vehicles will probably not be totally electrified, they will be able to recover and reuse a lot more of the energy that is used to power them today (Berger, 2014). For goods transports electric roads are required and in 20 years we will probably ask ourselves how we could allow people to drive cars when computers do it better. The infrastructure will rather be adjusted to

handle the self-steering cars (Wenner, 2014). When it comes to electrification of the roads, this is more of a question for the society since it is a huge investment. Electrified roads can however also decrease the accessibility since the vehicles used will not be able to go very far away from the electric trails (Berger, 2014).

For Schenker, electrification would be positive since it would increase their efficiency. If vehicles without drivers could be used it would increase safety and drivers would not have to sit and become irritated when the traffic is slow. Today the drivers do almost all the work involved in the transport, in the future it would be preferable if the driver only maneuvers the vehicle and someone else does loading and similar activities, both to increase safety but also to better utilize the drivers' time. The fewer decisions the driver needs to take, the better it is, and the safer the working environment will be (Ward, 2014). One risk, however, with digitalization is also that the drivers are forgotten and that the profession is neglected. This could lead to a lack of drivers since the profession will be less stimulating and also that the legislation gets harder and harder to understand as well as the technology putting demands on the drivers. The safety will however continue to increase with the digitalization (Knutsson, 2014).

Knutsson (2014) is confident that the internet will increase as a tool for people who want transports. It will be more and smaller consignments and Schenker will probably have to analyze the purchasing behavior better than today (Knutsson, 2014). People perceive having their own car as freedom and they want mobility. This induces the need to find new transport solutions e.g. like the spotify model – to perhaps "stream a car" and use car pools more effectively. We cannot all have our own cars in the future (Wenner, 2014).

Digitalization is increasing fast and decreases costs for transport companies and increases safety of drivers. Safer vehicles also mean that infrastructure can be better utilized since lower safety is demanded of the road itself. Too much equipment however risks decoupling the drivers and make it harder to make someone accountable for accidents. The development of electrification of vehicles and roads are going fast but still not so much technology is seen in traffic. The electrification is generally positive for environment but is very expensive and can potentially also decrease the accessibility. This is due to lack of refueling/recharging stations and limited area of use for vehicles.

5 Analysis

In this chapter the results of the theoretical framework and the empirical findings are discussed. The changes in accessibility are analyzed in depth in order to better understand the potential outcomes and to be able to answer the research questions.

5.1 Accessibility changes

The proposed changes in accessibility can all have positive and negative aspects depending on how they are implemented and what actors that are studied. The idea is that the changes will create opportunities for transport companies to increase their accessibility, at the same time as hopefully improving safety and reducing environmental impact. The general direction (positive or negative impact) of the effects are summarized after each part and also concluded in a table in the end. Also the direction of the effects on transport companies are provided. Below an example is displayed of how the tables look like, and explanations of the effects are provided as well.

Change	Accessibility	Environment	Safety	Transport companies
Example of change in accessibility	↑	↑↓	↗	→

↑ The change has mainly positive effects on the presented area

↓ The change has mainly negative effects on the presented area

↗ Small or indirect positive effects on the presented area

↑↓ The change can be either positive or negative depending on the situation.

→ The change only has small or no effects on the presented area.

5.1.1 Road tolls/congestion charges

When doing the interviews, the expectation was to receive quite widespread opinions. This was however not the case. All respondents were somewhat positive to congestion charges which is very interesting. Using congestion charges has led to reduction of traffic as well as decreased CO2 emissions and improved road safety (RDW, 2011). Since the travelling times have been reduced, this has also made the transports faster for the transport companies (Hallman, 2014). The largest problem with the congestion charges is the fact that they are not pre-competitive since foreign transport companies do not need to pay the charges in Sweden (Ward, 2014). The respondents did not really have any answers on how this situation should be solved and there seems to be a problem also of who is supposed to handle this. According to Hallman (2014) Trafikverket has no real influence in this matter and it is quite expensive to collect the last percentages of the congestion charges compared to the money that is actually collected. The authors would argue that this needs to be resolved but it also shows the complexity of the problem with pre-competitiveness and that just collecting the money might

make it better for the Swedish transport companies but not necessarily make the transport system more efficient.

It should be noted that in most cases it is actually not the transport companies that pay the congestion charges, instead these are passed on to the consumers or shippers of the products (Knutsson, 2014). If the faster travelling time is the main positive aspect, the authors would argue that the increased costs, even if these are passed on, has to be seen as a negative one since the competitiveness is affected negatively when the transport companies have to charge higher prices from their customers. Even if the traffic levels dropped 3 % the first year of the congestion charges in Gothenburg (GP, 2013a), it should also not be forgotten what Lithander (2014) said; that the traffic levels in Gothenburg now is back at the same level as before the congestion charges were implemented.

One thing mentioned by the respondents was the development of flexibility. Today the transport system is very static (Berger, 2014). This is on the way of changing, e.g. by managing traffic flows with different congestion charges on different times on the day. The congestion charges are managing the traffic by categorizing them into different time-spans in order to get more people to use the roads on times when the congestion is low. This is one way of categorizing the traffic but in the future it might very well be other ways to categorize the traffic. The transports could instead be categorized by type of cargo or by destination, making it different price levels depending on the cargo. Another way to differentiate is if you are doing a trip for leisure or for going to or from work (Ward, 2014).

Another idea to increase efficiency could be to instead of looking into the future and try to foresee what changes and investments will be successful, to look more at the projects going on at the moment. These projects need to be properly evaluated and the results will show whether these projects like congestion charges, platooning or goods transports in public transport lanes are suitable. The pilot projects are therefore of great importance since these show what potential different new technologies and changes are bringing (Knutsson, 2014).

Change	Accessibility	Environment	Safety	Transport companies
Road tolls/congestion charges	↑	↑	↗	↗

Road tolls and congestion charges decrease the traffic and thereby increase accessibility, decrease environmental impact and as an indirect effect, the safety can be increased. Decreased travelling times are positive for transport companies but the effects are quite small and can even out in the longer perspective.

5.1.2 Speed limits

As presented in the theoretical framework, several studies have shown that increased speed on the roads also increases the number of traffic accidents and injuries. Furthermore the increased speed has negative effects on the environment with air pollution and noise (Fildes & Lee, 1993). According to the previous studies one major factor affecting the implementation of changed speed limits is that people understand the logic behind the change. In one case, people perceived that lowering the speed limits increased the safety but instead made drivers

adjust their speed more often and with a negative effect on the traffic jams (VTI, 2010). People wanted the information to be clearer why a certain speed limit was set, as well as the actual effects of the speed on safety, environment and accessibility (VTI, 2011). The authors think that this shows a quite common situation when implementing new systems, and providing drivers with sufficient information in this case can make even the hardest changes easier to implement.

Speed limits have shown to be influential for transport companies but mostly when it comes to consistency of speed. To be able to keep the same speed throughout the route is prioritized much higher than the actual speed limits (Hallman, 2014; Lithander, 2014). The authors would therefore also argue that even if the speed limits were reduced the negative impact on the transport companies in form of longer delivery times would not be very large anyway. This is since it would rather increase the potential for consistency in speed due to better flow in traffic. Spontaneously, one could believe that speed limits would be quite influential in which road route to take since it affects the total transport time. The interviews have however showed that there are other factors that influence this decision (Ward, 2014), showing again that the speed limits have lower effects than one may have thought initially.

As Ward and Knutsson (2014) mentions, whether the speed limits are kept or not depend mostly on the drivers. Since most crashes happen due to an overestimation of e.g. road characteristics by the drivers (Edquist, Rudin-Brown, & Lenné, 2009), the authors would also argue that devices in the cars are likely to have positive effects on the speeds and to be used more frequently in the future.

Change	Accessibility	Environment	Safety	Transport companies
Speed limits	↗	↑	↑	↗

Speed limits have large positive effects on safety. Limiting speed decreases emissions and lower speed also improves flow in traffic, thereby increasing accessibility. For transport companies the consistency in speed is influential, while the speed in itself is quite low prioritized.

5.1.3 Real time information

The demand for real time information seems to increase more and more and the quality is increasing (Sensors & Systems, 2012). This fact is also strengthened by three of the six respondents. The other two still think the information is too slow and reaches the drivers when they are already in a queue but also admit that there is potential in this area (Ward, 2014; Lithander, 2014). There are a lot of information sources for avoiding congestion (Trafikverket, 2013b) however most of the information is needed during the trip and not before it (Ward, 2014). Route planning is one of the most common areas but real time information also helps to decrease the travelling time and to utilize vehicles better (Knutsson, 2014). However, the behavior of the drivers also needs to be taken into consideration and it can be hard to make drivers trust information provided by different digital systems over their own experience (Ward, 2014).

The theoretical framework has showed that one trend on the market is the growing of customization and a study from 2013 has showed that customization of real time traffic information is one of the possible methods for solving traffic congestion and that drivers are willing to pay more for customized real time information (Rong-Chang & Ke-Hong, 2013). The authors would like to add that this trend of customization can be observed in other areas in the transport sector as well, with customized vehicles and actually customized infrastructure. Customizable driving lanes are e.g. mentioned by Berger (2014).

Systems like ATIS help to reduce uncertainty during non-present bottlenecks in road (Levinson, 2003) and the authors would argue that just by getting the right information that concern you as a driver or planner, it would facilitate the working conditions and reduce stress by gaining knowledge about e.g. why the traffic is standing still. This reasoning is also strengthened by Ward (2014), saying that the fewer decisions a driver needs to take, and the safer the working environment will be.

The real time information can take away congestion quite fast since the drivers can choose another route and thereby the original traffic jam disappears or moves to another route where the cars have moved to (Hino & Nagatani, 2014). The authors would like to continue on this reasoning and add that even if real time information helps to avoid bottlenecks, it also spreads the cars, sometimes with the effect that the bottlenecks are moved to another route instead. Spreading the cars would however utilize the existing roads more efficiently.

The road safety is increased both directly and indirectly through better flow of traffic as well as systems like ISA (Martin, 2002). The ISA system is quite interesting when talking about the root causes of congestion since it potentially could be used in the future for replacing road humps as the driver is warned about the speed limit. This would mean that the access for emergency vehicles is increased (Trafikverket, 2010e) and since the congestion due to road accidents is an important matter (FHWA, 2002; Ward, 2014), the authors would argue that this could also help in decreasing the congestion to some extent by shortening the travelling time of the rescue vehicles.

The information that is provided today is based on finding the shortest or fastest route available, but what if this is not the “best route”? What if there are more suitable roads from a societal point of view? If the information provided could be affected by Trafikverket in this way, to e.g. show the most suitable route, there is also potential here for them to be able to manage the traffic on the Swedish roads in a larger extent than today (Hallman, 2014). When it comes to goods transports these are however also affected by the shippers who own the goods (Ward, 2014). The shippers often have quite high influence over delivery times and sometimes also transport routes.

Change	Accessibility	Environment	Safety	Transport companies
Real-time information	↑	↑	↑	↑

Smart systems can help drivers and planners taking shorter routes and keeping the right speed, thus lowering emissions and risk of accidents. Better information also helps to decrease congestion on roads, meaning higher access for vehicles. These effects are also positive for the transport companies.

5.1.4 Road capacity

When talking about road capacity, the road congestion often also comes to mind. Several studies have shown that increasing capacity not really solve the congestion problems and instead increase the total travelling (Duranton & Turner, 2011; SINTEF, 2007; Cervero & Hansen, 2000). As can be seen in Table 3 in the theoretical framework, both travelling time and vehicle operating costs decrease with expanded road capacity. However the effects do not seem to be very large in reality since none of the respondents really perceive the road congestion as a large problem. The question of road capacity also becomes less influential for the transport companies, since they are fairly satisfied with the most of the capacity today (Knutsson, 2014; Lithander, 2014).

Another interesting fact that has been discovered is that the problems for the transport companies primarily not lie within the Swedish cities, but rather just outside of them (Ward, 2014). This is because their terminals usually are located outside the city center and the problem is the traffic in and out of the city. This has also led to new projects for solving the congestion in these areas (Ward, 2014).

Previous research shows that congestion is not only a consequence of bottlenecks or over-use of the road capacity but is actually derived from seven different root causes (Cambridge Systematics Inc., 2005). This was also mentioned by Ward (2014), that congestion is not only the consequence of bottlenecks. Schenker's business is actually affected more by road constructions and other road blocks rather than daily congestion (Ward, 2014). When looking at the earlier presented figure 1 in the introduction chapter, it can be seen that bad weather and traffic incidents are also very influential as sources of congestion (Cambridge Systematics Inc., 2005). This leads the authors to question the measures taken for decreasing congestion. As mentioned in the part about speed limits, the transport companies care mostly about variety in speed, generally not so much the exact speed. Without having real sources on this, the authors' hypothesis is that private road users reason in the same way, that e.g. being able to know that a certain route takes 60 minutes every time is preferable over that the route takes between 30 and 90 minutes and you cannot know how long time it will take each time you drive. Therefore a suggestion could be to increase the actions taken to quickly solve road accidents and plan road maintenance in better ways. This would not solve the daily congestion but increase the accessibility and safety and chances are that this is valued higher than reducing congestion by both private and professional drivers.

When talking about road capacity, the legislative side of it is also worth mentioning. Sweden already allows longer and heavier vehicles than many other parts of Europe which gives benefits in different aspects e.g. by utilizing the existing infrastructure better reduces the total fuel consumption (Sveriges Åkeriföretag, 2014). Generally, all the respondents are positive towards this development, with a reservation from Hallman (2014) that the larger vehicles

also bring greater risks in traffic. However, the authors would also argue that larger and fewer vehicles on the roads would mean fewer accidents. An observation made with support from table 3 in the theoretical framework, is that it shows very positive effects for the transport companies of increasing road capacity, but the inherent negative effects only seem to affect the society, not the transport companies. Arguably this could be the case for introducing larger vehicles on the market as well.

So if the vehicles are allowed to increase in size and weight this should mean more large vehicles on the roads? Well, not entirely true. According to e.g. Ward (2014) the demand for faster transports is increasing and the small trucks are actually growing faster than the larger ones. This is a problematic development, since it will mean lower vehicle capacity utilization rates and more emissions instead (Ward, 2014).

When it comes to standards of vehicles, pallets, infrastructure and other related equipment, this is a complex matter. There seems to be as many opinions about this as there are standards. The knowledge about whether we need more or less standards seem to be limited and what Wenner (2014) says about this matter seems to be the closest one can get to an answer in this question. He means that more standards are not needed, but rather more expertise and more people that are actually working the standards through more systematically. Since there are different levels of standardization the interviewees at least agree upon that there is a need for more harmonization of the legislation, mostly between different countries (Lithander, 2014; Berger, 2014). However, at the same time the standardization risks to lock us into a system that is not optional (Ward, 2014) and that is where the authors believe the improved expertise needs to come in.

Managing driving lanes in different ways is one approach related to road capacity that can affect the accessibility. One way of trying to manage uneven traffic flows on certain road routes, usually during mornings and evenings, is the reversible lanes (Vägverket, 2004). The authors think the discussion about this is very interesting since previous documents show that it has been a part of the plans of Trafikverket since at least 2004 (Vägverket, 2004) and still there is only one reversible lane to be found in Sweden (Vägverket, 2006). So for 10 years the plan has been to add more driving lanes without results, while most projects in other countries have shown it to be a successful tool for managing traffic. In USA, for instance, the reversible lanes are used on a lot of roads and especially bridges and have helped to improve capacity as well as decreasing congestion and increasing road safety (Vägverket, 2004). This leads the authors to ask the question of why this has not been implemented more in Sweden. Hallman (2014) has part of the answer when he says that there are too few locations where the reversible lanes can be built long enough to be worth the investment. However, since others, like Wenner (2014), are surprised that the reversible lanes have not been developed more in Sweden, the authors wonder if the reversible lanes perhaps are not so well evaluated after all and that there might be more potential locations in Sweden where reversible lanes are suitable. When the Värmdö project seems to be such a success both economically and for accessibility (Vägverket, 2006), one starts to wonder if it is not possible to base new projects on this one. Especially when looking at the comparison made for the reversible lane in Värmdö compared to building a four lane road. The reversible lane cost 20 million SEK while

a four lane road would have cost 140 million SEK as mentioned by Trafikverket themselves (Vägverket, 2006).

Another way to increase accessibility is to use climbing lanes. This has very positive effects on both the safety due to easier passability as well as the accessibility, especially during traffic incidents (VDOT, 2014). The effects on the transport companies have however showed to be small, and the effects can mostly be seen when looking at the societal level. Public transport lanes utilized by goods transports is also one possible future solution on the capacity problems. The transport companies see the potential in increased accessibility (Ward, 2014), but it will most likely be best utilized outside cities as it may be chaotic for trucks to use them in central areas as Knutsson (2014) mentions. He also adds that another issue which needs to be resolved is the fact that many of the city deliveries from the terminals are made in the mornings and afternoons, and quite often overlap with the rush hours for public transports and private road users (Knutsson, 2014).

The home deliveries are increasing and put new demands on the infrastructure. For Schenker, this also increases the need of return handling (Ward, 2014). This development naturally also raises the question of night deliveries in cities in order to utilize the infrastructure better. Here is however a problem that the electric vehicles for night traffic are much more expensive than regular cars (Knutsson, 2014) and while the transport companies see this as a societal standpoint, the authorities do not see the incentives to start the projects but rather that the transport industry will start this if they perceive the problems with day deliveries too large (Hallman, 2014).

Changes	Accessibility	Environment	Safety	Transport companies
Road capacity	↑	↑↓	↑↓	↗

Increasing capacity leads to increased access. However, it also increases the traffic, meaning more vehicles and emissions, thereby lowering safety. Increasing capacity can also help environment by decreasing congestion and more space on the roads can mean increased safety. In Sweden, the capacity is not so influential for the transport companies since the capacity is already good, however, increased capacity improve their efficiency and can reduce travelling times.

5.1.5 Parking and safety parking

When starting analyzing the actual importance of safety parking, what comes first into mind is whether the transport companies are prepared to pay extra money for safety parking or not. Previous research has shown that plenty of safety parking spots were introduced in Sweden a couple of years ago, however today many of them have gone into bankruptcy. The most common problem seems to be that the occupancy rate not is enough or that they were placed in the wrong locations (Trailer.se, 2010). Closer collaboration between the transport companies and Trafikverket is needed and more data about where to put the parking spots need to be collected (Hallman, 2014).

The authors still see potential in using safety parking in the future even if many parking spots are closing in Sweden at the moment. Not all parking spots are closing and there are also positive reports as Lithander (2014) mentions with the parking in Brändåsen where you can park for free if you purchase food or refuel for at least 150 SEK (Lithander, 2014). This is also strengthened by recent research stating that profits can be made on safety parking (Sweco, 2013). More criminality will also mean increased demand for safety parking and recent reports show that this is actually the case with increasing number of attacks against trucks during 2013 (Värmlands Folkblad, 2013).

The transport companies generally have insurance on their goods, which makes the safety of the goods a lower priority for them and reduces the willingness to pay (Wenner, 2014). One solution for this could be to include the cost of the safety parking in the customers' bill instead (Knutsson, 2014). The authors mean that safety parking is important for the safety of the drivers as well as the goods and at least the safety of the drivers should be taken into consideration when discussing this topic. However, following Knutssons (2014) advice, could lead to loss of customers, and therefore one solution could instead be to legislate when safe parking spots must be used or at least putting pressure on the companies to use them, otherwise there is a risk that the motivation does not exist. One factor speaking in favor of this argument is that a lot of drivers have problems with the rules for stop and pauses (Sochor & Mbiydzenyuy, 2013) which mean that legislation can have large effects in this area.

Looking at the previous research and the interviews, the authors suggest that the development of parking and safety parking also is closely connected to development of real time information. One example of the potential connections is what Knutsson (2014) says; that technological systems can help the drivers to keep the right speed on the roads in order to time the arrival to parking spots according to their schedule (Knutsson, 2014). This is also strengthened by Hallman (2014) stating that information could help to increase both safety and accessibility for trucks by letting them wait at a parking spot instead of in the queues on the roads (Hallman, 2014).

Change	**Accessibility**	**Environment**	**Safety**	**Transport companies**
Parking and safety parking	↗	→	↑	↗

Parking and safety parking decrease risk of thefts along the roads and the accessibility can be indirectly improved if speeds can be lowered to time arrival to the parking spots. The environmental effects are indirect and negligible. The parking spots are not so important for the transport companies, since they are still too expensive. However, the parking spots bring many positive aspects and the demand for increased safety will increase the use in the future.

5.1.6 Terminals

When talking about terminals, it is not the terminal in itself that is most interesting, but rather the placement of it and the access to loading points, which are important aspects when it comes to accessibility. The terminals also help a lot to avoid flows of goods to pass through city centers (Wenner, 2014). One factor that is important is the fact that a company like

Schenker earns more money when they do more transshipment. Therefore it is necessary to constantly try to improve the loading and unloading times in order to keep the system efficient (Knutsson, 2014). In order to get more efficient terminals the digitalization seems to play an important role, as also Berger (2014) says. If the trucks can get better notifications they can also adjust their arrival time to match free capacity in the terminals (Berger, 2014). The authors believe that better notifications have high potential since the transport companies have much to gain on this. They want to be able to plan for loading and unloading of goods as mentioned by Knutsson (2014). Moreover, if the time management of trucks could be improved the waiting times could be reduced (Lithander, 2014). The authors mean that this would also lead to improved accessibility of the terminals.

When it comes to collaborative terminals between municipalities and transport companies, Ward (2014) and Lithander (2014) are for example skeptic if other terminals already exist since it would be a waste of resources. However, in cities where there are no terminals, these collaborative terminals could be an alternative that is worth looking more into (Ward, 2014). Even if the respondents do not believe in collaborative terminals, the authors believe that other collaborative solutions could be used. For instance, co-loading of cargo between two companies as mentioned by Wenner (2014) could help transport companies to utilize time windows better. This of course has to be structured in such way that the competition on the market is not threatened. The authors also mean that having such terminals could potentially save money for transport companies and reduce congestion and land use. This is due to economies of scale and reduced amount of trucks and terminals.

Change	**Accessibility**	**Environment**	**Safety**	**Transport companies**
Terminals	↑	↑↓	→	↑

Strategic location of terminals and loading areas affect the accessibility. The location also can cause either longer or shorter transports, possibly affecting environment. The safety is however not really affected. For transport companies the location of terminals are very important and can help to reduce both traveling times and costs.

5.1.7 Intermodality

Intermodal solutions are something that people want to see more of and according to most of the respondents this will also likely develop. Lithander (2014) however is a bit skeptic and does not believe the share of railway transports will increase (Lithander, 2014). The railway in Sweden needs to be developed and there is railway available on too few distances, too few routes with double-tracks and the connection with road has to be improved. Another problem seems to be the speed and time-table of the trains. For Schenker, the railway simply does not meet the demands that the customers have on the transport speed which lowers the incitement to use the railway (Knutsson, 2014).

Some people are worried that increasing the maximum allowed size of the trucks will move goods from rail to trucks instead but the views are differing. It is interesting what Hallman

(2014) and Lithander (2014) says about this development. They mean that the total efficiency will be increased which is more important than if the cargo moves from rail to road or not. If the railway is competitive enough the cargo will be transported by rail.

Another issue is that the transport sector needs to be put under pressure from the end customers (Hallman, 2014). The problem is that demands from customers today rather are to get the goods at the shortest delivery time possible (Ward, 2014). This demand for high speed is problematic and aggravates the use of more intermodal solutions (Hallman (2014; Knutsson, 2014). Solutions like slow steaming are interesting to develop and there is probably much kind of goods that do not need to be under such time pressure in the transports (Hallman, 2014). The authors think this reasoning is interesting and argue that not only would this decrease emission and increase the filling rates but also make more capacity available for the goods that really need to be delivered quickly.

When looking at the responses in the interviews there seems to be a gap between the expected development of intermodality and the conditions of the intermodal industry. The general understanding seems to be that the railway will increase its market share, however what is also clear is that the railway in Sweden needs huge investments, both for increasing capacity and for maintenance work. This is a bit contradictory and a challenge that has to be overcome in order for railway to develop in the expected way.

Change	**Accessibility**	**Environment**	**Safety**	**Transport companies**
Intermodality	↑↓	↑	↗	→

Intermodality can increase accessibility of the road since transports are moved from road to rail or sea but on the other hand, it can possibly also decrease it since the switching of transport modes takes time and needs proper equipment. Authors would also argue that moving transports away from road decrease total emissions and fewer transports on road with fewer drivers could indirectly mean lower risks of accidents. Since intermodality is not used in any larger extent, the effects on transport companies are still quite small.

5.1.8 Digitalization/ Electrification

There are many projects going on in the area of digitalization and one, done by Volvo, is the project of platooning where trucks move in long caravans on highways (Wenner, 2014). The new technology with platooning will probably be seen on the roads in a near future, but the safety is the problem (Berger, 2014). Most issues with digitalization are within the safety area, and the systems that are introduced on the market need to be reliable and safe. By digitalizing the vehicles more and more, there is a large chance that they will drive safer in the future than they do today. If this is the case, it also opens up opportunities for example to reduce the width of the driving lanes (Wenner, 2014).

With all systems that are coming, the drivers will also be more and more disconnected from the actual driving of the vehicle. This also raises the question of the driver profession in the future. Will we not have drivers at all? Will anyone want to be a driver if the actual driving is

not needed (Knutsson, 2014)? Lithander (2014) brings up the point that the matter of self-steering cars is complex since if something happens it will be hard to decide who is responsible (Lithander, 2014).

The development of electrification is leading towards more and more electrified vehicles and even if they will probably not be fully electrified in the near future, they will at least be more efficient (Berger, 2014). One should be aware of though, that even if the safety and environmental aspects are enhanced by greener fuels, electrification can decrease the accessibility since the vehicles will be less flexible to move away far from the main roads (Berger, 2014). The authors would also argue that electrification of roads and vehicles can decrease the accessibility through the fact that not all vehicles will be compatible with electric roads or with new legislations for electrified vehicles. Even if the respondents mean that electric roads are still many years away the authors have knowledge that the concept is already tried out in e.g. South Korea and Japan and believe there could be possibilities here for more collaboration between countries.

There are different sources pointing towards that the peak of cars has been reached (GP, 2014; Wenner, 2014). However, even if that is true, and the market is getting saturated, there is still the problem that Wenner (2014) mentioned, that people perceive it as freedom to own their own car. According to the authors this also means that at the same time as the urbanization is continuing (Ward, 2014) there is a risk that we get more cars in the cities as consequence. New solutions to not only use the infrastructure more efficiently but also the cars are perhaps necessary for the future. Car pools are still not so large and it needs to be easier to use the cars. Per Wenner (2014) talked about the "Spotify model" and that it might be possible in future to stream a car the same way that you stream music today. This has similarities with the car pooling and the authors believe it to be an exciting solution for road users in the large cities where you perhaps live close to your workplace and only need to use the car a couple of times every week.

Change	**Accessibility**	**Environment**	**Safety**	**Transport companies**
Digitalization/ Electrification	↑↓	↑	↑↓	↑↓

Digitalization increase access and safety through systems helping the drivers to avoid congestion and supporting them with safety equipment like ISA. Safety is however also at risk if the driver gets too disconnected. The systems can also help to keep consistency in speed, thereby decreasing emissions. Electrification of roads and vehicles help to increase the use of green fuels but the effects on safety aspects are minor. Electrification can also decrease accessibility due to less flexibility to move away far from the main roads. For transport companies the mentioned effects on accessibility and safety are the same and both positive and negative.

5.1.9 Summary - Effects of changes in accessibility

The general effects on accessibility, environment and safety are presented in the table below. The directions represent the overall results from the discussions in the analysis.

Table 4: Effects of changes in accessibility

Changes	Accessibility	Environment	Safety	Transport companies
Road tolls/congestion charges	↑	↑	↗	↗
Speed limits	↗	↑	↑	↗
Real-time information	↑	↑	↑	↑
Road capacity	↑	↑↓	↑↓	↗
Parking and safety parking	↗	→	↑	↗
Terminals	↑	↑↓	→	↑
Intermodality	↑↓	↑	↗	→
Digitalization/ Electrification	↑↓	↑	↑↓	↑↓

Source: Authors own construction

6 Conclusions

Here the results from the study are presented and the research questions are answered. Furthermore, recommendations for future and further research are suggested.

The purpose in this study was to identify changes in road accessibility and see how these affect transport companies. This was also a part in giving recommendations in a wider, societal perspective how to utilize the road infrastructure better in the future.

6.1 Research question 1

How are freight transport companies affected by the changes in road accessibility?

The proposed changes have shown interesting effects on the transport companies, however not all of them positive. Road tolls or congestion charges are reducing the travelling times and the transport companies are quite positive to this, since the costs are passed on to the end customers anyway. There is however a risk that charging higher prices from customers can have negative effects in the long run. Speed limits are mostly influential for the transport companies when it comes to the consistency of speed, and avoiding accelerating and breaking. However, even if the speed limits can lead to longer delivery times, they hardly affect the choice of route at all. Real time information is the factor that can help transport companies in most ways compared to the other discussed changes. The positive aspects include choosing fastest route, avoiding road blocks and reducing uncertainties. This leads to decreased travelling times and costs. There is however still potential for faster and more customized information since it often comes too late for the planner or driver to react.

Road capacity is influential for transport companies since it affects the accessibility. However, the transport companies also admit that more capacity should not be prioritized, but rather more efficient ways to utilize it. Increasing sizes of vehicles can improve the efficiency in operations while lowering negative effects on environment and accessibility. Congestion problems are largest outside large cities rather than within them due to that the terminals usually are located there. This also means that the road capacity is most critical around these locations. Safety parking spots are not very influential since too few exist and they are not used in any larger extent. This is mostly due to the costs, and that transport companies already have insurance on their goods. The demand is however increasing, partly due to increased criminality.

Terminals help to avoid flows of goods to pass through city centers and by improving time management of trucks, waiting times at terminals could be reduced. By using real time information, the loading and unloading of cargo can be faster and the trucks can time their arrival to match free capacity in the terminals. Intermodality is not used in any larger extent, and will not increase very much if the railway in Sweden does not develop. Digitalization helps the transport companies to improve safety of their trucks and drivers. However there are still risks to implement too much equipment that decouples the driver. Electrification is not so large yet but together with digitalization, this can reduce environmental effects. However, due

to that the infrastructure is not ready for electrified vehicles and roads, the accessibility risks to be reduced instead.

6.2 Research question 2

How are the changes in accessibility affecting safety on roads and the environment?

Almost all of the investigated changes affect the areas of accessibility, safety and environment either direct or indirect. Road tolls or congestion charges have positive effects primarily on the environment. This is mostly due to decreased traffic which means lower emissions and thereby cleaner air. The decreased traffic has also small positive effects on the safety, both for drivers and pedestrians. Depending on what is included in the term; road capacity, it can be either positive or negative for the environment. Generally increased capacity will induce more travelling and thereby also increase environmental impact. However, other capacity increases, like reversible lanes, can decrease the congestion and instead decrease the impact, at least in a shorter time frame. Increasing capacity usually also helps the safety on the roads, either through more space or through safety related measures that are often implemented at the same time. Other changes like climbing lanes have very large positive effects on the safety, but basically no effects on the environment except land use. Using larger or heavier trucks mean that fewer vehicles can be used. This would lead to lower emissions, but it also puts demands on the safety since larger trucks usually are harder to maneuver and to bypass by other cars.

Real time information can be used in many ways with positive effects. Smart systems can e.g. help the drivers (and transport planners) to keep the right speed, take the faster route, and avoid congested roads and road blocks with improved traffic flow as a result. All this have positive effects for safety and environment. Speed limits are also very influential for the safety, as higher speeds dramatically increase the risk of serious injuries. Higher speed also means more emissions from the vehicles. Parking and Safety parking logically increase the safety along the roads by decreasing thefts as well as accidents with wrongly parked vehicles. The effects on the environment are however negligible, the only effect seen is if the driver decrease his speed in order to time a certain parking spot that matches his driving schedule.

Terminals are mostly influencing environment through their placement causing either longer or shorter transports depending on location. Safety is however not really affected. Intermodality has very positive effects on the environment since sea- and rail transports generally have less emissions and intermodal transports utilize the advantages of each mode. The effects on safety can be discussed but if cargo moves from roads to rail and sea, chances are that the accidents also decrease due to less traffic and fewer drivers involved in the transport. Digitalization can increase safety through digital systems that relieve the driver from some duties, however there is also a risk that the driver gets too disconnected, risking the safety instead. When it comes to environmental effects, the systems can help e.g. by choosing shortest route or decreasing accelerating and breaking and thereby the emissions. Electrification helps the environment to the very highest degree, since it reduces the use of fossil fuels. The safety aspects are however small or negligible.

6.3 Recommendations for Trafikverket

Looking at the proposed changes in accessibility has showed some concrete improvement areas for better efficiency in the transport system. One observation is that real time information seems to be a related to many of the changes in accessibility. The authors recommend to look at the potential of increasing efficiency by combining real time information with other changes in accessibility, e.g. safety parking. Since the demand for faster and more customized information is increasing, the supply also needs to keep up with the development and information should be presented to drivers even faster than today. The demand for customization is also related to the trend of flexibility. In order to utilize the roads in better ways, flexibility plays a central role. There are many interesting projects for this where e.g. reversible lanes, public transport lanes and congestion charges should be further researched, to better manage fluctuating traffic. Since all respondents have different target areas for future, the current projects can serve as a yardstick for what the future will bring and what changes and technologies are worth investing in.

The matter of legislating more or not also needs to be further researched. This research has shown that it seems to be a difference in opinions in this matter which could be problematic. If Trafkverket thinks that many issues will be solved by the market itself and the transport companies say that they only will change with new legislation, it is clear that this gap needs to be overbridged to make sure that the expectations are on the same level. At the same time, the end customers have large power and need to use this to influence the transport companies, but this also demands better instruments like certain criteria or certifications to facilitate comparison of transport companies.

Another observation is that faster “cleaning” after road accidents should be prioritized to a larger extent than today. Since the transport companies need to be able to plan their deliveries, unpredictable stops influence almost more than daily congestion, and removing e.g. blocking vehicles would have positive effects on the accessibility.

6.4 Further research

This study has identified a lot of possible research areas, as presented in table 1 in the theoretical framework. However not all of them were included in the research and this leaves it for someone else to continue and investigating the remaining subjects or add more topics to develop the table. Since this study focus only on effects on transport companies, and most of the changes in accessibility have widespread effects, it would also be interesting to find out how the particular changes would affect other stakeholders in the transport system. The three areas of Terminals, Intermodality and Digitalization/ Electrification that came up during the interviews would also be interesting to develop more and compare to previous research in order to give an extra dimension to the discussion of these topics.

7 References

AARP (2013). Reversible lanes, Retrieved 2014-02-21 at: http://www.aarp.org/home-family/getting-around/driving-resource-center/info-08-2013/pavement-markings-know-the-road-and-stay-safe.html

Baker H., Cornwell R., Koehler E. & Pattersson J. (2010). Review of Low Carbon Technologies for Heavy Goods Vehicles, Prepared for DfT by Ricardo, RD.09/182601.7, March 2010.

Behrends S., Lindholm M. & Woxenius J. (2008). The Impact of Urban Freight Transport: A Definition of Sustainability from an Actor's Perspective, Transportation Planning and Technology, 31:6, 693-713, DOI,
Retrieved at: http://dx.doi.org/10.1080/03081060802493247

Berger A. (2014). Technology & Project Planning at Volvo Group Trucks Technology, Gothenburg, Telephone interview 2014-04-10

Blumberg B., Cooper D. & Schindler P. S. (2011). Business Research Methods, 3rd European edition, McGraw-Hill.

BMW (2014). Ta dig fram snabbare- real time traffic information,
Retrieved 2014-03-24 at:
http://www.bmw.se/se/sv/insights/technology/connecteddrive/2013/services_apps/rtti.html

Börjesson M., Eliasson J., Hugosson M.B. & Brundell-Frel K. (2010). The Stockholm congestion charges - four years on: effects, acceptability and lessons learnt. In 12th World Conference on Transport Research, Lisbon, Portugal, July 11-15, 2010.

Cambridge Systematics Inc. (2005). Traffic Congestion and Reliability, Trends and Advanced Strategies for Congestion Mitigation,
Retrieved at: http://ops.fhwa.dot.gov/congestion_report/congestion_report_05.pdf

CEDR (2013a). CEDR Road Research,
Retrieved 2014-02-05 at: http://www.cedr.fr/home/index.php?id=226

CEDR (2013b). Strategic Plan 3 2013-2017,
Retrieved 2014-02-05 at: http://www.cedr.fr/home/index.php?id=130

Cervero R. & Hansen M. (2000). Road Supply-Demand Relationships: Sorting Out Casual Linkages, Institute of Transportation Studies, University of California.

City of Phoenix (2011). 7th Street and 7th Avenue Reverse Lanes, Retrieved 2014-02-05 at: http://phoenix.gov/streets/reverselanes.html

Collis J. & Hussey R. (2009). Business Research: A practical guide for undergraduate & postgraduate students, Palgrave Macmillan Press, NY.

Crainic T. G., Ricciardi N. & Storchi G. (2004). Advanced freight transportation systems for congested urban areas, Transportation Research Part C: Emerging Technologies, 12(2), pp. 119_137

DN.se (2008). Digitala hastighetsskyltar en succé, Retrieved 2014-03-04 at: http://www.dn.se/nyheter/sverige/digitala-hastighetsskyltar-en-succe/

Duranton G. & Turner M.A. (2011). "The Fundamental Law of Road Congestion: Evidence from US Cities," American Economic Review, American Economic Association, vol. 101(6), pages 2616-52, October.

EBRD (2013). The road to success for infrastructure projects, Retrieved 2014-02-04 at: http://ebrd2013.com/features/the-road-to-success-for-infrastructure-projects/

Edquist J., Rudin-Brown C. M. & Lenné M. G. (2009). Road design factors and their interactions with speed and speed limits. Melbourne: Monash University, Accident Research Centre.

Ericson J. (2010). The costs and benefits of longer and heavier vehicles, VTI – Swedish National Road and Transport Research Institute, ELMIA, Jönköping

Europa (2005). Intermodal transport: intermodality of goods transport,
Retrieved 2014-02-13 at: http://europa.eu/legislation_summaries/other/l24179_en.htm

European Commission (2009). European Economy,
Retrieved at: http://ec.europa.eu/economy_finance/publications/publication16267_en.pdf

European Commission (2010). Towards a European road safety area: policy orientations on road safety 2011-2020,
Retrieved at: http://www.swedishroadsafety.se/document/pdf//EU/COM-2010-389-final.pdf

European Commission (2012). Road Transport - A change of gear,
Retrieved at: http://ec.europa.eu/transport/modes/road/doc/broch-road-transport_en.pdf

European Commission (2013). Mobility and transport: Road – weights and dimensions,
Retrieved 2014-02-27 at: http://ec.europa.eu/transport/modes/road/weights-and-dimensions_en.htm

European Commission (2014). Intelligent transport systems,
Retrieved 2014-03-24 at:
http://ec.europa.eu/transport/themes/its/consultations/2014-03-14-rtti_en.htm

Ferrari P. (2002). Road network toll pricing and social welfare. University School of Engineering of Pisa, Italy. Transportation Research Part B 36 (2002) 471–483.

FHWA (2002). Traffic Congestion and Reliability: Trends and Advanced Strategies for Congestion Mitigation,
Retrieved at: http://www.ops.fhwa.dot.gov/congestion_report/chapter2.htm#footer11

FHWA (2004). Traffic Congestion and Reliability: Linking Solutions to Problems - Executive Summary. Publication Number: FHWA-HOP-05-004. July 2004, Retrieved at: http://www.ops.fhwa.dot.gov/congestion_report_04/executive_summary.htm

FHWA (2014). Road Pricing Defined,
Retrieved 2014-05-03 at: http://www.fhwa.dot.gov/ipd/revenue/road_pricing/defined/

Fildes B., & Lee S. (1993). The speed review: Road environment, behaviour, speed limits, enforcement and crashes. Federal Office of Road Safety, Report CR127, Canberra: Department of Transport and Communications.

Forsström Å. (1999). Bygd och befolkning, vägnät och förändring; arbetsrapport för delprojektet 'Analys av rumsliga processer i region och vägnät' ingående i projektet Oslovägen: infrastrukturer och transportsystem. Occasional Papers No. 12. Kulturgeografiska Institutionen, Göteborgs Universitet.

Freeman R.E. & Reed D.L. (1983). Stockholders and Stakeholders: A New Perspective on Corporate Governance. California Management Review 25, pp. 88–106

GP (2010). Vändbart körfält på Älvsborgsbron,
Retreved 2014-02-05 at: http://www.gp.se/nyheter/goteborg/1.397630-vandbart-korfalt-pa-alvsborgsbron

GP (2013a). Effekterna av trängselskatten minskar,
Retrieved 2014-01-30 at: http://www.gp.se/nyheter/goteborg/1.1683509-effekterna-av-trangselskatten-minskar

GP (2013b). Högre kommunalskatt utan trängselskatt,
Retrieved 2014-03-03 at: http://www.gp.se/nyheter/goteborg/1.1209938-hogre-kommunalskatt-utan-trangselskatt

GP (2014). Bilen har gjort sitt – nu tar vi tåget, Retrieved 2014-02-03 at: http://www.gp.se/nyheter/goteborg/1.2263589-bilen-har-gjort-sitt-nu-tar-vi-taget

GTKP (2013). Stakeholders – business and civil society, Retrieved 2014-02-16 at: http://www.gtkp.com/themepage.php&themepgid=159

Guion L.A., Diehl D.C. & McDonald D. (2011). Triangulation: Establishing the Validity of Qualitative Studies, Retrieved at: https://edis.ifas.ufl.edu/pdffiles/FY/FY39400.pdf

Hallman B. (2014). Long-term planner at Trafikverket, Gothenburg
Personal interview 2014-03-28

Hamilton C. (2010). Revisiting the cost of the Stockholm congestion charging system. OECD/ITF Joint Transport Research Centre Discussion Paper No. 2010/5. International Transport Forum/OECD round table on Implementing Congestion charging.

Herman J. L. & Winters L. (1992). Tracking Your School's Success: A Guide to Sensible Evaluation. Thousand Oaks, CA, Corwin Press

Hino Y. & Nagatani T. (2014). Effect of bottleneck on route choice in two-route traffic system with real-time information. Physica A 395, 425-433.

Jou R.C., Lam S.H., Liu Y.H. & Chen K.H. (2005a). Route switching behavior on freeways with the provision of different types of real-time traffic information. Transportation Research Part A 39 (5), 445–461.

Jou R.C., Lam S.H., Weng M.C. & Chen C.C. (2005b). Real time traffic information and ITS impacts on route switching behavior of expressway drivers. Journal of Advanced Transportation 39 (2), 169–192.

Karthikeyan B. & Tamileniyan M. (2010). Dynamic Data update for Intelligent Speed Adaptation (ISA System). International Journal of Computer Applications (0975-8887) Volume 11 –No.1, December 2010.

Knutsson G. (2014). CEO Schenker Åkeri AB, Gothenburg
Personal interview 2014-04-09

Levinson D. (2003). The value of advanced traveler information system for route choice. Transportation Research Part C 11, 75–87.

Lithander L. (2014). Planner at Pall Cargo, Gothenburg
Personal interview 2014-05-08

Litman T. (2013). Generated traffic and induced travel: Implications for transport planning, ITE Journal, Vol. 71, No. 4, Institute of Transportation Engineers, April 2001, pp. 38-47.

Macharis C. (2013). October,11th, Decision-making and policy in the city: the MAMCA methodology [PowerPoint slides]. Presented at GM0519 lecture at Gothenburg University

Martin J. (2002). After a 4 year trial – what the Swedes think of ISA. Traffic Engineering & Control 43(10): 376–379.

McKinnon A. (2006). Life without trucks: The impact of a temporary disruption of road freight transport on a national economy, JOURNAL OF BUSINESS LOGISTICS, Vol. 27, No. 2, 2006

Nilsson G. (1981). The effects of speed limits on traffic accidents in Sweden. In Proceedings of the International Symposium on the Effects of Speed Limits on Traffic Accidents & Transport Energy Use. Ireland: Road Research Programme of the Organisation for Economic Co-operation and Development (OECD).

NORDIC (2008). Traffic Safety Research Saves Lives, Road and transport research No 2, 2008, Retrieved 2014-04-29 at:
http://www.nordicroads.com/wp-content/uploads/2012/10/2-2008.pdf

NTF (2014). Rätt fart, Retrieved 2014-03-03 at:
http://www.appannie.com/apps/ios/app/447191868/

Odgers J. (2009). Have All The Travel Time Savings On Melbourne' Road Network Been Achieved?, A GAMUT Discussion Paper, School of Management, RMIT University; Retrieved 2014-02-27 at: http://www.abp.unimelb.edu.au/files/miabp/news%26mediahave-all-the-time-savings-been-achieved.pdf

OECD (2008). Towards Zero: Ambitious Road Safety Targets and the Safe System Approach. Organisation for Economic Co-operation and Development, Paris.

O'Flaherty C.A. (2002). Highways, The Location, Design, Construction and Maintenance of Pavements, 4th edition, Butterworth-Heinemann, Oxford

Olsson J. (2006). Responses to change in accessibility, Socio-economic impacts of road investment: the distributive outcomes in two rural peripheral Philippine municipalities Retrieved at: https://gupea.ub.gu.se/bitstream/2077/16991/2/gupea_2077_16991_2.pdf

Olsson J. (2009). Improved road accessibility and indirect development effects: evidence from rural Philippines, Journal of Transport Geography 17 (2009) 476–483 Retrieved at: http://ac.els-cdn.com/S0966692308000884/1-s2.0-S0966692308000884-main.pdf?_tid=206a1cea-94a4-11e3-8942-00000aacb35f&acdnat=1392292019_20d9d69498101fe2e0c1c728036bff3e

Papadimitriou E., Yannis G., Muhlrad N., Gitelman V., Butler I. & Dupont E. (Eds.) (2012). Analysis of Road Safety Management in the European Countries, Deliverable 1.5 Vol. II of the EC FP7 Project DaCoTA

Papadimitriou E. & Yannis G. (2013). Is road safety management linked to road safety performance. Accident Analysis and Prevention 59 (2013) 593-603

Patel R. & Davidson B. (2003). Forskningsmetodikens Grunder: Att Planera, Genomföra och Rapportera en Undersökning, 3rd edition, Studentlitteratur

Philip L.J. (1998). Combining quantitative and qualitative approaches to social research in human geography – an impossible mixture, Environment and Planning A, Vol. 30, No. 2. pp. 261-276.

Prakash A. B., Oliver E. H. & Balcone K. (2001). Does building new roads really create extra traffic? Some new evidence, Applied Economics, 33:12, 1579-1585

RDW (2011). Road Pricing in Europe, Retrieved 2014-01-30 at: https://www.ereg-association.eu/downloads/public/subjects/Other%20subjects/Road%20Pricing/Road%20pricing%20in%20Europe.pdf

Regan M. A., Lee J. D. & Young K. L. (2009). Driver distraction: Theory, effects, and mitigation. Boca Raton, FL: CRC Press

Regeringskansliet (2013). Investing for a strong and sustainable transport system, Retrieved 2014-02-13 at: http://www.government.se/sb/d/11941/a/207460

Richter S., Aberdeen D. & Yu, J. (2007). Natural Actor-Critic for Road Traffic Optimisation Retrieved at: https://papers.nips.cc/paper/3087-natural-actor-critic-for-road-traffic-optimisation.pdf

Rong-Chang J. & Ke-Hong C. (2013). A study of freeway drivers' demand for real-time traffic information along main freeways and alternative routes. Transportation Research Part C 31, 62-72.

Security Park Sweden (2014). Security Park - Om oss, Retrieved 2014-05-03 at: http://www.secpark.se/www/live/security%20park/startsida.aspx?TreeID=365

Sensors & Systems (2012). Traffic data hits on real time needs, Retrieved 2014-02-25 at: http://www.sensorsandsystems.com/article/features/27489-traffic-data-hits-on-real-time-needs.html

SETPOS (2009). Secure European Truck Parking Best Practice Handbook, Retrieved 2014-04-29 at: http://www.setpos.eu/handbook/SETPOS-project-handbook.pdf

Shinar D. (2007). Traffic safety and human behavior. Bingley, UK: Emerald Group.

SINTEF (2007). Miljømessige konsekvenser av bedre veier, Retrieved at: http://www.sintef.no/upload/Teknologi_og_samfunn/Veg%20og%20samferdsel/Rapporter/A07034_Milj%C3%B8konsekvenser-sluttrapport-ver6.pdf

Sochor J. & Mbiydzenyuyu G. (2013). Assessing the benefits of intelligent truck parking Int. J. ITS Res. (2013) 11:43-53

Sreejesh S., Mohapatra S. & Anusree M. R. (2014). Business Research Methods: An Applied Orientation. London:Springer International Publishing AG

Srinivasan K.K. & Krishnamurthy A. (2004). Investigating the role of mixed real-time information strategies in network performance. Transportation Research Board, 83rd Annual Meeting, Washington, D.C.

STPP (1998). An Analysis of the Relationship Between Highway Expansion and Congestion in Metropolitan Areas, Surface Transportation Policy Project.

Sveriges Åkeriföretag (2014). Optimala fordon – ett klimatsmart val, Retrieved 2014-02-27 at: http://www.akeri.se/opinion/optimala-fordon

Sweco (2012). Smarta Lastbilsparkeringar, Retrieved 2014-04-29 at: http://www.bth.se/com/intelligent_truck_parking.nsf/attachments/Del_1_Deltj%C3%A4nster%20och%20Informationsfl%C3%B6den_ver1_0_pdf/$file/Del_1_Deltj%C3%A4nster%20och%20Informationsfl%C3%B6den_ver1.0.pdf

Sweco (2013). Business models for secure (and smart) truck parking - Key aspects for sustainable economic operation of secure truck parking areas

Swedish Transport Agency (2013). Congestion Tax in Gothenburg, Retrieved 2014-01-20 at: http://www.transportstyrelsen.se/en/road/Congestion-tax/Congestion-tax-in-gothenburg/

Tillväxtverket (2014). Access to infrastructure, Retrieved 2014-02-04 at: http://www.tillvaxtverket.se/nyawebbenforeuprogram/artighetsmeny/englishpages/results/accesstoinfrastructure.4.73323bf613f1e97c6a01233.html

Trafiken.nu (2014). Om Trafiken.nu, Retrieved 2014-03-24 at: http://www.trafiken.nu/goteborg/TopMeny/Om-Trafikennu/

Trafikradion.se (2014). Trafikradion.se, Retrieved: 2014-03-24 at: http://www.trafikradion.se/v5/start/index.php#.UzB1Lvl5MXt

Trafikverket (2002). Livslängd och Trafikanalys, Retrieved at: http://www.trafikverket.se/PageFiles/30482/d4_02_livslangd_och_trafikanalys.pdf

Trafikverket (2004). Stigningsfält och omkörningsfält, Retrieved 2014-04-07 at: http://www.trafikverket.se/TrvSeFiler/Foretag/Bygga_och_underhalla/Vag/Vagutformning/Dokument_vag_och_gatuutformning/Vagar_och_gators_utformning/Linjeforing/13_stigningsfalt_och_omkorningsfalt.pdf

Trafikverket (2010a). ISA – Intelligent Speed Adaptation, Retrieved 2014-02-20 at: http://www.trafikverket.se/Om-Trafikverket/Andra-sprak/English-Engelska/Railway-and-Road/Road-Safety/ISA--Intelligent-Speed-Adaptation/

Trafikverket (2010b). Working environment, Retrieved 2014-02-09 at: http://www.trafikverket.se/Om-Trafikverket/Andra-sprak/English-Engelska/Railway-and-Road/Road-Safety/ISA--Intelligent-Speed-Adaptation/Effects-and-Benefits/Working-Environment/

Trafikverket (2012a). Transportsystemets behov av kapacitetshöjande åtgärder – förslag på lösningar till år 2025 och utblick mot år 2050, Retrieved at: http://publikationswebbutik.vv.se/upload/6691/2012_101_transportsystemets_behov_av_kapacitetshojande_atgarder_sammanfattning.pdf

Trafikverket (2012b). Analytic report Review of Interim Targets and Indicators for Road Safety in 2010–2020, Retrieved at: http://publikationswebbutik.vv.se/upload/6816/2012_162_review_of_interim_targets_and_indicators_for_road_safety_in_2010_2020.pdf

Trafikverket (2013a). Prognoser för arbetet med nationell transportplan 2014-2025, Persontransporters utveckling fram till 2030, Retrieved at: http://publikationswebbutik.vv.se/upload/7038/2013_055_prognoser_for_arbetet_med_nationell_transportplan_2014_2025_persontransporters_utveckling_fram_till_2030.pdf

Trafikverket (2013b). Traffic information, Retrieved 2014-03-24 at: http://www.trafikverket.se/Om-Trafikverket/Andra-sprak/English-Engelska/The-Traffic-Information-Web-Site-Laget-i-trafiken/

Trafikverket (2013c). Reversibla körfält, Retrieved 2014-02-06 at: http://www.trafikverket.se/Foretag/Trafikera-och-transportera/Trafikera-vag/Teknikstod-i-trafiken---ITS/ITS-pa-vag/Styra-och-leda-trafik/Reversibla-korfalt/

Trailer.se (2010). Lågt intresse för säkerhetsparkering, Retrieved 2014-04-10 at: http://www.trailer.se/news.php?id=6224

Tran M., Banister D., Bishop J. D.K. & McCulloch M.D. (2013). Simulating early adoption of alternative fuel vehicles for sustainability. Technological forecasting & Social change 80 (2013) 865-875.

Transportnet (2014). Utan transporter stannar samhället, Retrieved 2014-02-04 at: http://transportnet.se/ledare/utan-transporter-stannar-samhallet/

Transport for London (2013). Roads task force – Thematic analysis, Retrieved 2014-02-27 at: http://www.tfl.gov.uk/assets/downloads/corporate/technical-note-10-what-is-the-capacity-of-the-road-network-for-private-motorised-traffic.pdf

VDOT (2014). Interstate 81 Truck Climbing Lanes - Montgomery County, Retrieved 2014-04-07 at: http://www.virginiadot.org/projects/salem/interstate_81_truck_climbing_lanes_-_montgomery_county.asp

Victoria Transport Policy Institute (2012). Evaluating Accessibility for Transportation Planning, Measuring People's Ability To Reach Desired Goods and Activities, Retrieved at: http://www.vtpi.org/access.pdf

Visit London (2014). London's Congestion Charge, Retrieved 2014-05-03 at: http://www.visitlondon.com/traveller-information/getting-around-london/congestion-charge

VTI (2010). Nya hastighetsgränser i Sverige, Retrieved at: http://www.vti.se/en/publications/pdf/new-speed-limits-in-sweden--how-do-motorists-perceive-this.pdf

VTI (2011). Det nya hastighetssystemet, Fokusgruppsintervjuer på landsbygd och i tätort, Retrieved at: http://www.vti.se/en/publications/the-new-speed-limit-system-in-sweden--focus-group-interviews-in-rural-and-urban-areas/

VTI (2013a). Road Safety on Four Continents in Beijing, China 2013, Retrieved at: http://www.vti.se/RS4C

VTI (2013b). Förslag till Nationell plan för transportsystemet 2014–2025, Retrieved at: http://www.vti.se/sv/publikationer/pdf/forslag-till-nationell-plan-for-transportsystemet-20142025.pdf

Vägverket (2004). Vägar och gators utformning, Retrieved 2014-02-06 at: http://www.trafikverket.se/PageFiles/117572/vagars_och_gators_utformning_utformningsrad_reversibla_korfalt.pdf

Vägverket (2006). Väg 222 Delen Mölnvik – Ålstäket. Utvärdering tre körfält, Publikation: 2006:134, Retrieved 2014-05-01 at: http://publikationswebbutik.vv.se/upload/658/2006_134_utvardering_av_reversibelt_korfalt_pa_vag_222_mellan_molnvik_och_alstaket.pdf

Vägverket (2009). The road to ITS, Retrieved 2014-02-06 at: http://www.trafikverket.se/PageFiles/48747/the_road_to_its.pdf

Värmlands Folkblad VF (2013). Säkerhetsparkeringar mot lastbilsstölder, Retrieved 2014-04-30 at: http://www.vf.se/nyheter/allman/sakerhetsparkeringar-mot-lastbilsstolder

Värnamo Nyheter (2013). Säkerhetsparkering i konkurs, Retrived 2014-04-10 at: http://www.varnamonyheter.se/artikel/7621/sakerhetsparkering-i-konkurs

Wade T. & Sommer S. (2006). A to Z GIS: An Illustrated Dictionary of Geographic Information Systems Environmental Systems Research Institute Inc.,U.S.

Walker, J. (2011). The Acceptability of Road Pricing RAC Foundation, London, Retrieved 2014-01-30 at: http://www.racfoundation.org/assets/rac_foundation/content/downloadables/the%20acceptability%20of%20road%20pricing%20-%20walker%20-%20main%20report%20%28may%2011%29.pdf

Ward N. (2014). CEO Schenker Consulting, Gothenburg
Personal interview 2014-03-26

Wenner P. (2014). Director of accessibility at Trafikverket, Borlänge
Telephone interview 2014-04-01

WHO (2009). European Status Report on Road Safety: Towards Safer Roads and Healthier Transport Choices. WHO Regional Office for Europe, Copenhagen.

Wong S.C. & Sze N.N. (2011). Is the effect of quantified road safety targets sustainable? Safety Science 48 (9), 1182–1188.

Appendix A - Introduktion till intervju

När det gäller investeringar och förändringar av infrastruktur, prioriteras ofta persontrafikanter medan effekterna för privata företag sällan analyseras lika väl. Det finns dock mycket forskning som tyder på att ett tätare samarbete mellan företagen och myndigheter är ett måste för att lösa problem inom vägnätet. Den information som sprids om vägtransporter fokuserar ofta på de negativa effekterna och det glöms bort de positiva effekter som finns och hur beroende vi faktiskt är av våra vägar. Vägtransporterna skapar nytta för individer och företag.

Syftet med den här studien är att belysa vägens roll i samhället genom att undersöka vilka typer av förändringar i vägens tillgänglighet och i trafikeringen i Sverige som kan genomföras och hur dessa förändringar påverkar olika aktörer. Resultaten kommer att användas för att ge rekommendationer bland annat om hur trafiken kan styras och hur vägnätet kan utnyttjas effektivare i framtiden. Studien utförs på uppdrag av Trafikverket och är en del i en internationell studie som utförs av Trafikverket för att presenteras på CEDR (Conference of European Directors of Roads).

Appendix B - Questionnaire for transport companies

Bakgrund/Background

- Vilken position har du på företaget? Hur länge har du arbetat med det här? *(What's your profession? How long have you been working with this?*)
- Vilka är dina dagliga ansvarsområden? *(What are your daily responsibilities?)*
- Vilka personer och andra aktörer har du kontakt med i ditt yrke? – Chaufförer, transportföretag, myndigheter/kommuner *(What people and other actors are you in contact with in your profession? – Drivers, transport companies, municipalities….?)*

Tillgänglighet/Accessibility

Tycker du att Trafikverket tar lika stor hänsyn till effekter på transportföretagen som för privata trafikanter? Vilket inflytande har ni på politiska beslut relaterade till infrastruktur? *(Do you think Trafikverket is considering effects on transport companies in the same extent as for private road users? Can you influence political decisions concerning infrastructure in some way?)*

Vilken typ av förändringar i väginfrastruktur har påverkan på ert företag? *(What kind of changes in road infrastructure affect your company?)*

Vilka av följande förändringar i vägnätet har/skulle ha störst påverkan för ert företag? (What changes in accessibility do you think would have the highest impact on your company?)

- Vägtullar *(Road tolls/congestion charges?)*
- Hastighetsgränser *(Speed limits?)*
- Realtidsinformation, ex genom skyltar om köer *(Real time information?)*
- Vägkapacitet, bredd och bärighet av vägar, extra- eller reversibla körfält, lastbilar med vissa karaktäristika tillåtna I kollektivtrafikfält *(Road capacity e.g. driving lanes, clim bing lanes, width of the road?)*
- Terminalförbättringar *(Improvement of terminals?)*
- Förändrade vikt/mått-regler *(Changed weight/measurement legislation?)*
- Parkeringsplatser utmed vägarna/säkerhetsparkeringar *(parking and safety parking?)*
- Något annat du tänkt på? *(Something else?)*

Är trängsel på vägarna i Sverige ett stort problem eller ej? Hur arbetar ni för att lösa/undvika detta problem? *(Is congestion a large problem in Sweden or just a minor one? How are you working with solving this issue?)*

Vet du om ni har gjort några analyser av förändringar i tillgänglighet av vägar och hur detta harpåverkat ert företag? Vilka positiva eller negativa effekter har ni i så fall sett?

(Have you made any analyses on the changes in accessibility and how they affect your business? Can you give any positive and negative effects with these changes?)

Hur ser ni på vägens roll I det multimodala perspektivet (använder ni annat än väg, hur kan kopplingen effektiviseras för ökat användning av jvg/sjö) *(How do you percieve the role of the road in the intermodal perspective, do you use other modes than road, how can the connection between the modes be made more effective?)*

Vilken roll spelar internationell standardisering (av tex fordon och infrastruktur, samt lastbärare) för att tillgängligheten och funktionen i godstransportsystemet ska bli god? Utveckla *(What role does the international standardization have for the accessibility and function of the transport system for goods?)*

Vilka nya möjligheter och hot ser du i en framtid där vi kan räkna med att digitaliseringen spelar en större roll? (ex självkörande lastbilar) *(What are the possibilities and threats of the future where digitalization will play a larger part, e.g. self-driving vehicles)*

Har du några förslag på hur vägens roll i transportsystemet kan utvecklas och väginfrastrukturen utnyttjas på ett effektivare sätt i framtiden? *(How do you think roads in Sweden can be used more efficiently in the future?)*

Vilka framtida förändringar förväntar du dig kommer att ske och hur kommer ni att hantera dem? *(What future changes are you expecting to appear and how will you cope with them?)*

Appendix C - Questionnaire for transport experts

Bakgrund/Background

- Vilken position har du på företaget? Hur länge har du arbetat med det här?
  (What's your profession? How long have you been working with this?)
- Vilka är dina dagliga ansvarsområden?
  (What are your daily responsibilities?)
- Vilka personer och andra aktörer har du kontakt med I ditt yrke? – Chaufförer, transpo rtföretag, myndigheter/kommuner
  (What people and other actors are you in contact with in your profession? – Drivers, transport companies, municipalities….?)

Tillgänglighet/Accessibility

Tycker du att Trafikverket tar lika stor hänsyn till effekter på transportföretagen som för priva ta trafikanter? Vilket inflytande har ni på politiska beslut relaterade till infrastruktur?
(Do you think Trafikverket is considering effects on transport companies in the same extent as for private road users? Can you influence political decisions concerning infrastructure in some way?)

Vilken typ av förändringar i väginfrastruktur har påverkan på ert företag? *(What kind of changes in road infrastructure affect your company?)*

Vilka av följande förändringar i vägnätet har/skulle ha störst påverkan på ett transportföretag som DHL eller Schenker *(What changes in accessibility do you think would have the highest impact on a transport company like DHL or Schenker?)*

- Vägtullar *(Road tolls/congestion charges?)*
- Hastighetsgränser *(Speed limits?)*
- Realtidsinformation, ex genom skyltar om köer *(Real time information?)*
- Vägkapacitet, bredd och bärighet av vägar, extra- eller reversibla körfält, lastbilar med vissa karaktäristika tillåtna I kollektivtrafikfält *(Road capacity e.g. driving lanes, clim bing lanes, width of the road?)*
- Terminalförbättringar *(Improvement of terminals?)*
- Förändrade vikt/mått-regler *(Changed weight/measurement legislation?)*
- Parkeringsplatser utmed vägarna/säkerhetsparkeringar *(parking and safety parking?)*
- Något annat du tänkt på? *(Something else?)*

Är trängsel på vägarna i Sverige ett stort problem eller ej? Hur arbetar ni för att lösa/undvika detta problem? *(Is congestion a large problem in Sweden or just a minor one? How are you working with solving this issue?)*

Hur ser ni på vägens roll I det multimodala perspektivet (hur kan kopplingen mellan transportsättern effektiviseras?) *(How do you percieve the role of the road in the intermodal perspectiv, how can the connection between the modes be made more effective?)*

Vilken roll spelar internationell standardisering (av tex fordon och infrastruktur, samt lastbärare) för att tillgängligheten och funktionen i godstransportsystemet ska bli god? Utveckla *(What role does the international standardization have for the accessibility and function of the transport system for goods?)*

Vilka nya möjligheter och hot ser du i en framtid där vi kan räkna med att digitaliseringen spelar en större roll? (ex självkörande lastbilar) *(What are the possibilities and threats of the future where digitalization will play a larger part, e.g. self-driving vehicles)*

Har du några förslag på hur vägens roll i transportsystemet kan utvecklas och väginfrastrukturen utnyttjas på ett effektivare sätt i framtiden? *(How do you think roads in Sweden can be used more efficiently in the future?)*

Vilka framtida förändringar förväntar du dig kommer att ske och hur tror du det kommer påverka transportföretag och andra aktörer? *(What future changes are you expecting to appear and how will these affect different road stakeholders?)*

Appendix D - Questionnaire for VOLVO

Bakgrund/Background

- Vilken position har du på företaget? Hur länge har du arbetat med det här? *(What's your profession? How long have you been working with this?*)
- Vilka är dina dagliga ansvarsområden? *(What are your daily responsibilities?)*
- Vilka personer och andra aktörer har du kontakt med I ditt yrke? – Chaufförer, transpo rtföretag, myndigheter/kommuner *(What people and other actors are you in contact with in your profession? – Drivers, transport companies, municipalities….?)*

Tillgänglighet/Accessibility

Tycker du att Trafikverket tar lika stor hänsyn till effekter på transportföretagen som för priva ta trafikanter? Vilket inflytande har ni på politiska beslut relaterade till infrastruktur? *(Do you think Trafikverket is considering effects on transport companies in the same extent as for private road users? Can you influence political decisions concerning infrastructure in some way?)*

Vilken typ av förändringar i väginfrastruktur har påverkan på ert företag? *(What kind of changes in road infrastructure affect your company?)*

Vilka av följande förändringar i vägnätet har/skulle ha störst påverkan för ert företag? (What changes in accessibility do you think would have the highest impact on your company?)

- Vägtullar *(Road tolls/congestion charges?)*
- Hastighetsgränser *(Speed limits?)*
- Realtidsinformation, ex genom skyltar om köer *(Real time information?)*
- Vägkapacitet, bredd och bärighet av vägar, extra- eller reversibla körfält, lastbilar med vissa karaktäristika tillåtna I kollektivtrafikfält *(Road capacity e.g. driving lanes, clim bing lanes, width of the road?)*
- Terminalförbättringar *(Improvement of terminals?)*
- Förändrade vikt/mått-regler *(Changed weight/measurement legislation?)*
- Parkeringsplatser utmed vägarna/säkerhetsparkeringar *(parking and safety parking?)*
- Något annat du tänkt på? *(Something else?)*

Är trängsel på vägarna i Sverige ett stort problem eller ej? Hur arbetar ni för att lösa/undvika detta problem? *(Is congestion a large problem in Sweden or just a minor one? How are you working with solving this issue?)*

Vet du om ni har gjort några analyser av förändringar i tillgänglighet av vägar och hur detta harpåverkat ert företag? Vilka positiva eller negativa effekter har ni i så fall sett?

(Have you made any analyses on the changes in accessibility and how they affect your business? Can you give any positive and negative effects with these changes?)

Hur ser ni på vägens roll I det multimodala perspektivet (använder ni annat än väg, hur kan kopplingen effektiviseras för ökat användning av jvg/sjö) *(How do you percieve the role of the road in the intermodal perspective, do you use other modes than road, how can the connection between the modes be made more effective?)*

Vilken roll spelar internationell standardisering (av tex fordon och infrastruktur, samt lastbärare) för att tillgängligheten och funktionen i godstransportsystemet ska bli god? Utveckla *(What role does the international standardization have for the accessibility and function of the transport system for goods?)*

Vilka nya möjligheter och hot ser du i en framtid där vi kan räkna med att digitaliseringen spelar en större roll? (ex självkörande lastbilar) *(What are the possibilities and threats of the future where digitalization will play a larger part, e.g. self-driving vehicles)*

Vad kan du berätta om nya informationssystem som V2V som Volvo har utvecklat? Hur det kan påverka tillgänglighet? (finns det andra sätt att förändra bilarna så att "tillgängligheten" i transportsystemet förbättras? *(What can you tell us about the V2V system that Volvo have developed? How can it affect the accessibility? (Are there other ways to change the vehicles to increase the accessibility of the transport system?)*

Har du några förslag på hur vägens roll i transportsystemet kan utvecklas och väginfrastrukturen utnyttjas på ett effektivare sätt i framtiden? *(How do you think roads in Sweden can be used more efficiently in the future?)*

Vilka framtida förändringar förväntar du dig kommer att ske och hur kommer ni att hantera dem? *(What future changes are you expecting to appear and how will you cope with them?)*