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Mapping Smart Mobility

Preferences, trends, and problems in the current way of working

Master's Thesis in the Master's Program Quality and Operations Management

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Abstract

The society is changing with increased urbanization and populations, and a lack of sustainability in the construction of today's society, which leads to more efficient and connected mobility being essential for the survival of the society.

This thesis evaluates the preferences that the society has on smart mobility, and the society in this thesis represent the university, industry, local government and the citizens. Moreover, it will evaluate which trends that will affect the development of smart mobility, and lastly the problems in the way to working with smart mobility.

The study is qualitative, consisting of a literature review and 18 interviews within the triple helix. The triple helix consists of three actor categories; local government, industry and university, which is used to get a broad understanding of the situation by combining the views of the different actors, compare and explain current research systems in a social context.

The concluding preferences that were found on smart mobility are; efficient mobility system, robustness, affordability, sustainability, and simplicity for the end user. The efficient mobility system is divided into three parts: area efficient transport, infrastructural investment, and optimization of logistics. However, infrastructural investment and optimization of logistics were found to be more of necessary solutions than preferences.

The identified trends for smart mobility are; electrification, autonomous technologies, digitalization, and servitization. These trends will likely permeate the future development of smart mobility, especially servitization as the society is changing to be more service focused than product focused.

We also found that the current way of working is not aligned across the triple helix with a need for coordination and collaboration as well as lack of a vision for the mobility system. The lack of coordination and collaboration increases the difficulty in creating relevant solutions for the mobility system. The coordination and collaboration can be solved by achieving adequate knowledge transfer, and the creation of a consensus and innovation space. Lastly, the requirement setting is an issue, as there is a conflict of interest between the industry and the local government in who should set the requirements on how the future mobility system should look.

Keywords: *Smart Mobility, Smart City, Intelligent Transport System, Triple Helix, Mobility as a Service, Public-Private Partnerships, Connectivity, Future Mobility.*

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1. Introduction

This chapter is an introduction to the master thesis. The chapter includes the background to the subject, purpose, delimitations, research question, and finally the outline of the study.

1.1 Background

There are major challenges that cities and communities face; an increased population, the increase of the populations' life span (Alm, et al., 2016), polarized economic growth (Falconer & Mitchell, 2012), increased greenhouse-gas emission, and an increased budget constraint for the urban development on the cities (Falconer & Mitchell, 2012). United Nations (2018) estimated that 55,3% of the population lived in urbanized areas in 2018 and that the share will increase to approximately 70% by the year 2050. The concentration of population has led to an increased need to be more resource efficient in urban environments (European Environmental Agency, 2015). As the environmental sustainability is becoming more important have the governments around Europe addressed the increasing importance of the environment by imposing strict environmental goals to reduce the footprint of today's society, meaning that a change of how the society is constructed is needed (European Commission, 2014). The citizens' requirements to be able to live according to the same standards as they do today which results in the need to maintain their life quality while still increasing the resource efficiency in the cities as the world is urbanizing (Manville, et al., 2014), also the customers has an increased focus on environmental sustainability (Assadourian, 2010). One way of achieving resource efficiency is with urbanization, which is already an ongoing trend (Shamming, Herendeen, Hanson, & Wilson, 2010). A smart city makes it possible to increase the resource efficiency of society even further (European Environmental Agency, 2015).

Smart cities are an academic subject that has grown rapidly in the last years (Letaifa, 2015). It is a new way of thinking, intending to offer the highest possible quality of urban life for its citizens and environment by integrating Information and Communication Technologies (ICT) and digitalization with the society (Bakici, Almirall, & Wareham, 2013). Both the society and the academics are starting to explore a variety of dimensions and practicalities related to its functions and what it would mean to adopt the concept. Therefore, there is no agreed definition of a smart city (Letaifa, 2015).

There are several definitions of what a smart city is (Fromhold-Eisebith, 2017). Angelidou (2014) says that a smart city is an entity where it is needed to balance social, economic, and environmental factors. One definition of the smart city is to adopt the use of information and communication technologies to increase the efficiency, reduce cost, and to increase the quality of life for the inhabitants (Falconer & Mitchell, 2012). The European Commission defines smart cities as the application of technology to achieve better management of and more efficient urban environment, and higher quality of life by implementing more sustainable solutions addressing

the challenges present in a city (European Commission, n.d.). This thesis will use a definition that consists of all of the presented definitions of a smart city.

The smart city consists of a physical and a digital layer, see Figure 1 (Sidewalk Labs, 2017). The digital layer is a network integrating with the physical layer and tying the different components together to create a basis for a smart city (Sidewalk Labs, 2017). In the physical layer is mobility one of the most important parts of smart cities (Sidewalk Labs, 2017). Mobility is described as moving people or goods from one place to another and with varying needs depending on the nature of the mobility in place (Costa, Morais Neto, & Bertolde, 2017).

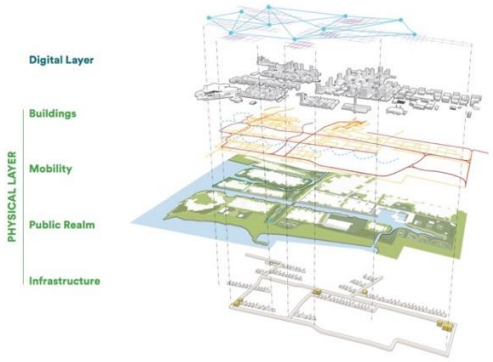

Figure 1 - Smart City Layers (Sidewalk Labs, 2017). Vision Sections of RFP Submission. Adopted with permission.

There has been a substantial significant increase in the transport of goods during the last thirty years of which the road transportation stands for the most significant portion of the increase (European Environment Agency, 2016). Not only the transportation of goods is increasing, between the year 2000 and 2013 was there an 8 % increase in the EU in passenger kilometers (European Environment Agency, 2016). In the year 2013 did the car stand for approximately 70% of the travelled passenger kilometers (European Environment Agency, 2016). There is a need for smart mobility in order to achieve more efficiency within mobility (Van Audenhove, et al., 2018). The interest in the topic of smart mobility has increased a lot during the past year, which can be seen in figure 2, which shows the number of documents published on the subject of smart mobility in the Scopus database.

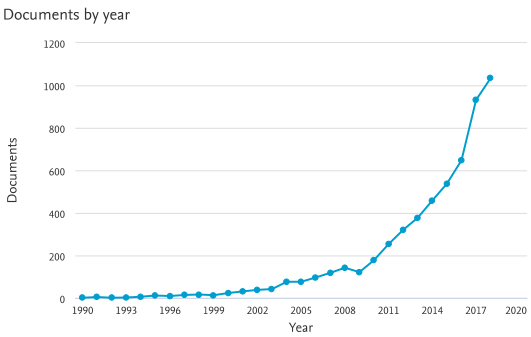

Figure 2 - Number of documents published on the topic smart mobility from Scopus Database, https://www.scopus.com

Smart mobility is a key aspect of smart cities (Benevolo, Dameri, & D'Auria, 2014). Smart mobility refers to a smarter use of the mobility that includes more than just moving people and goods (Benevolo, Dameri, & D'Auria, 2014). Through the creation of a more efficient and connected mobility system does smart mobility aim at reducing the environmental and noise pollution, easing the congestions on the roads, increasing the safety, and improving the system's speed and capacity, whilst reducing the overall costs related to the transportation (Benevolo, Dameri, & D'Auria, 2014). Smart mobility can also have positive impacts on the overall quality of life for the inhabitants of the city (Benevolo, Dameri, & D'Auria, 2014).

There are efforts in the EU to create a joint strategy for the countries in the EU regarding smart mobility (Dutch Government, 2016), and what the governmental actors in the EU have to do to create a situation benefiting the development of technologies related to the future mobility (Swedish Government, 2018). However, there are still unclarities on smart cities, and smart mobility, which led to that the smart mobility field has to be evaluated in order to create an understanding of the situation (Chourabi, et al., 2012), which is what this master thesis is about.

1.2 Purpose and research question

The purpose of this master thesis is to create an understanding of how the conditions can be improved for developing more relevant solutions for a smart mobility system. To do so, society's preferences of the mobility system will be identified together with a number of trends affecting the development, and the current way of developing smart mobility solutions will be evaluated.

Different actors might have different views of what smart mobility is and how to create smart mobility. The preferences represent society’s view, which consists of the local government, customer, industry, and university.

The complexity of the smart mobility development, together with the uncertainties of the preferences on smart mobility and the trends of smart mobility implies that there is a need to fully understand how the current way of working for developing the smart mobility solutions and where the improvement areas lie.

Therefore, the research question is:

What are the preferences, trends, and problems in the way of working for smart mobility from a societal perspective?

1.3 Delimitations

The master thesis project is limited to revolve around only ground-based smart mobility technologies relevant to an urban area. The study will primarily concern a high-level analysis of the technology and its application. From the triple helix will only the relationship

between the local governmental and industrial actors be analyzed when evaluating the ways of working. The study will only focus on urbanized areas in a European context by analyzing the situation primarily from the point of view of Gothenburg but also of the European Union.

2. Theoretical Framework

This section aims at mapping previous literature related to the studied topic, as well as providing an adequate analytical framework to be able to address the subjects that are identified in the empirical findings and the analysis. The theoretical framework will start by addressing the preferences for smart mobility and then continue with the trends affecting smart mobility, lastly describing the current way of working when developing smart mobility.

2.1 Preferences within Smart Mobility

Mobility is a large part of smart cities (Sidewalk Labs, 2017), and it is necessary to know the societies' preferences on smart mobility in order for the industry to develop relevant solutions. The society represents the local government, industry, university, and citizens. The preferences represent the key factors these key actors sought after.

The term mobility describes the concept of moving people or goods from one place to another and with varying needs depending on the nature of the mobility in place (Costa, Morais Neto, & Bertolde, 2017).

Smart mobility refers to the use of more efficient and connected mobility than today within the context of a smart city (Benevolo, Dameri, & D'Auria, 2014). The overall goals of the smart mobility are to reduce the environmental and noise pollution, easing the congestions on the roads, increase in efficiency, increasing the safety, and improving the system's speed and capacity, while reducing the overall costs related to the transportation (Benevolo, Dameri, & D'Auria, 2014). Smart mobility can have positive impacts on the overall quality of life for the inhabitants of the city (Benevolo, Dameri, & D'Auria, 2014). The application of smart mobility can contribute to the overall economic growth of the society by removing the bottlenecks of the current mobility system by creating a more efficient system (Arbib & Seba, 2017). According to the European Parliament (2010), the use of smart mobility with advanced applications can lower the energy consumption of the mobility system.

Based on the definitions and goals of smart mobility presented above can the preferences divided into the following sub-preferences:

2.1.1 Efficiency

An efficient smart mobility system is crucial in order to achieve a smart city (Van Audenhove, et al., 2018). The overall goal of the society is to ease congestion and increase the overall efficiency of the mobility system (Monzon, 2015). However, what is considered efficient of mobility depends on the goal of the specific transport (Götz & Ohnmacht, 2012). According to Van Audenhove et al. (2018), overall efficiency for multiple applications can be achieved by creating a multimodal system. A more multimodal system is often more efficient than a less multimodal mobility system (Avila-Torres, Caballero, Litvinchev, Lopez-Irarragorri, & Vasant,

2018). The different modes range from manual, physical transportation to the motorized transportation using vehicles (Karim, 2017), meaning a developed society has to take into account all modes of transportation when developing the infrastructure and mobility (Litman, 2003). In order for the different modes to coexist, is there a need for integration (Raghunathan, Bergman, Hooker, Serra, & Kobori, 2018). The integration has increased the importance for the case of shared mobility which has a higher demand on the system as a whole rather than on the ingoing parts of it (Raghunathan, Bergman, Hooker, Serra, & Kobori, 2018).

Area efficiency

The mobility of an urban environment is limited by the low availability of land and needs to be area efficient (Wulfhorst, Kenworthy, Kesselring, & Lanzendorf, 2013).

Different types of transportation modes have different capacity and energy efficiency (Firth, 2014). The modes that have the highest capacity have the potential to transport the highest amount of people on the smallest surface in the most energy efficient way (Firth, 2014). Figure 3 shows that pedestrian and bicycle-based mobility have the highest capacity per square meter, while private cars have the lowest capacity (Firth, 2014). The modes that have a high area efficiency should be prioritized when using the area and developing the infrastructure (Wulfhorst, Kenworthy, Kesselring, & Lanzendorf, 2013).

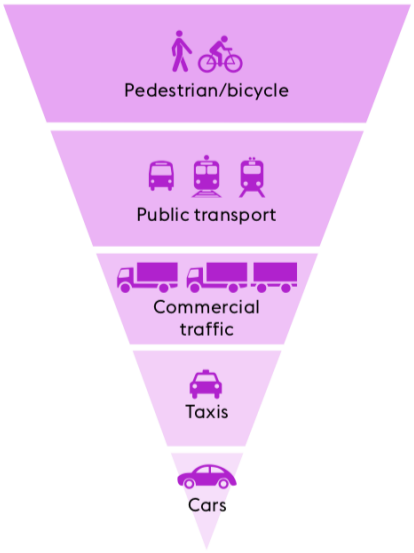

Figure 3 - High capacity and energy efficient modes - Urban Mobility Strategy Retrieved from: The city of Stockholm Traffic Administration (2012)

Shared mobility can consist of travels in public transport or private vehicles (Fulton, Mason, & Meroux, 2017). The shared resources can lead to more efficient use of urban areas, a decrease in traffic congestions, and support an increase in the higher capacity walking and biking (Fulton, Mason, & Meroux, 2017). A joint pool of vehicles, instead of individually owned vehicles, has been proven to fulfill the different needs for mobility in an urban area more efficiently (Alonso-Mora, Samaranayake, Wallar, Frazzoli, & Rus, 2017). The shared vehicles can also reduce energy consumption and emissions from transportation (Alonso-Mora, Samaranayake, Wallar, Frazzoli, & Rus, 2017). However, it would require an increase in the number of passengers per trip and a range of changed policies supporting the transition to shared mobility. However, shared mobility in cars would increase the area efficiency for every car (Fulton, Mason, & Meroux, 2017). The most probable scenario is that that the number of privately-owned vehicles will drop as the shared services increase which together with the technology development will lead to a freeing up of resources for the users, operators, and producers of the vehicles and mobility solutions (Johnson & Walker, 2016).

Infrastructure investments

The infrastructure is essential for achieving efficiency in the mobility system and creating the basis for economic prosperity in a society (Puentes, 2015). It is necessary to have an infrastructure that is compatible with the technology of the smart mobility solution (Department for Business Innovation & Skills, 2013). The existing infrastructure of a city might be incompatible with the smart mobility solutions, which results in a need for updating the infrastructure to a new, compatible one (Bélissent, 2010). Without a compatible infrastructure will the realization of smart mobility be hindered (Bélissent, 2010). Adding up to the need to update the infrastructure is the lacking capacity of today's infrastructure that is present in many of the cities around the world (Bélissent, 2010). By creating incentives to invest in infrastructure, it is possible to continue to drive the transition to a more sustainable society (European Commission, 2014).

Optimization of logistics

In order to create an efficient mobility system, it is important to optimize the logistics of the system (Büscher, Coulton, Efstratiou, Gellersen, & Hemment, 2012). One way of optimizing the logistics is by connecting the ingoing parts of the system and utilizing the data to construct a more optimized system (Büscher, Coulton, Efstratiou, Gellersen, & Hemment, 2012).

Another way of achieving a more optimized logistical flow is to even out the demand on the mobility system on all available hours of the day (Holguín-Veras, et al., 2011). An experiment with off-hour deliveries in New York City shows that not only high-tech solutions are needed to achieve a more optimized logistical apparatus (Holguín-Veras, et al., 2011).

2.1.2 Robustness

One key preference of the society is brought forward as the robustness of the mobility system (Mees, 2005). The robustness is related to the value of the users of the mobility system (Cats & Jenelius, 2015a) and is necessary for an efficient mobility system (Cats & Jenelius, 2015b). The robustness is reached either by creating a system that is resistant to unexpected events or able to cope with the events by having an easy to mobilize overcapacity (Cats & Jenelius, 2015b). The resistance to unexpected events can be reached through flexibility by the diversification of the modes of the mobility system (Mees, 2005).

2.1.3 Affordability

The affordability has different meanings for actors with different costs (Nicolas, Pochet, & Poimboeuf, 2003). The affordability is important to consider when developing new solutions for a smart city, according to Stålstad and Williander (2013). Without a financial benefit with a new solution in comparison to an old one, the adoption will never occur (Stålstad & Williander, 2013). Without adequate affordability for the users and actors of the mobility

system will other solutions be adopted instead, no matter how severe the consequences for the rest of the mobility system is (Hine, 2012).

2.1.4 Sustainability

The World Commission on Environment and Development (1987) defines sustainability in social, economic, and environmental terms. Leiserowitz, Kates, and Parris (2006) present the view that there is a tendency to prioritize environmental sustainability among consumers, the industry, the government, and academia.

The definition of sustainability within mobility is ambiguous (Mihyeon Jeon, Amekudzi, & Guensler, 2013). However, the environmental sustainability of mobility is often focused on the planning of mobility (Litman, 2003). One of the largest effects of the sustainability of mobility is related to the reduction of non-sustainable modes of transport altogether (Litman, 2003). Only changing how the individual vehicles in the mobility system affect the environment will, most likely, not be sufficient for achieving sustainability (Litman, 2003).

The mobility system is closely related to the sustainability of a society (Hine, 2012) in the expression of social, economic, and environmental sustainability (Lyons, 2004). If the mobility system is not constructed sustainably will the overall sustainability of the society be lowered (Hine, 2012). A suboptimal mobility system can influence the social sustainability negatively by hindering certain groups from becoming mobile, which in turn can result in lacking economic sustainability due to people not being able to get employment due to their lack of mobility (Lyons, 2004). A suboptimal mobility system will influence the environmental sustainability by the degree of wasting of resources in the system (Lyons, 2004).

2.1.5 Simplicity for the end user

The essential for the customers is to move from one point to another, the majority see traveling as a must and not the travel itself as the goal (Intermetra business & Market research group AB, 2018). The travelers' goal is to arrive on time in a simple way (Intermetra business & Market research group AB, 2018). In order to create a simple and easy daily life travel for the end user, smart mobility could be used (Intermetra business & Market research group AB, 2018). The future solutions should be simple and compelling for the customer (Van Audenhove, et al., 2018). One way of achieving simplicity for the end user is to integrate multiple modes of transports into one mobility system and to integrate multiple mobility systems with each other (Lyons, 2004).

According to Intermetra Business and Market Research Group (2018), customers are willing to switch to a new technology advanced alternative for mobility that benefits the environment as long as it is simple. However, Intermetra Business and Market Research Group (2019) argues that one of the biggest problems with future mobility is trust in the technological development. No matter how much value a solution can potentially give the end user will it not matter if the

solution is not adopted due to a lacking trust towards the new technology (Intermetra Business and Market Research Group, 2019). One way of creating adequate trust is by making the solutions more adoptable by making the solutions simpler for the end users (Intermetra Business and Market Research Group, 2019).

2.2 Trends affecting smart mobility

There has been a shift in the planning of transport systems from being proximity-oriented to being time-oriented, minimizing the time needed to transport oneself or one's goods to the final destination with a broader scope than achieving efficiency for the motorized vehicles (Pettersson, 2014). There is a change in the development of smart mobility as there is a shift ongoing, and therefore there are several trends that support this shift. This section will explain the current trends of smart mobility.

The establishment of new technologies can create increased demand by creating a need at the users' level (Seba, 2014). However, the technologies alone are not sufficient for creating increased demand, it is also important to create a business model utilizing the strengths of the new technology in order to spark a transition (Seba, 2014). The development of new technology and new business models can put the development situation in a spiral-like situation enabling an even faster development than what was previously estimated, leading to drastically changed demand, method, and payment structure than today (Seba, 2014). These trends will permeate future smart mobility and are the motive for why smart mobility is rising as a topic.

2.2.1 Electrification

Electrification is a trend that already has started, and the process of electrifying the fleet of vehicles is ongoing (IRENA, 2017). The global stock of electric vehicles passed the 2 million mark in 2016 (IRENA, 2017).

Electric vehicles contribute to many environmental benefits (IRENA, 2017). Most of the transport takes place in urban areas where also air pollution is significant. Electric vehicles do not release any air pollutants or emissions when driving (IRENA, 2017). However, the consumption of the electricity that the cars use might be produced from fossil fuels releasing air pollutants or greenhouse gases, meaning that the whole life cycle of the energy production and consumption is vital (IRENA, 2017). Many European cities are planning to equip their public transports with electric vehicles in order to provide the same transport service but with reduced pollution and emission levels (Automotive News Europe, 2016).

Stålstad and Williander (2013) describe that if all cars would be electric vehicles would it solve several problems, among many, are the oil dependence, local air pollution, and the emissions of greenhouse gases. Even if the electrification is the best solution for the society do a majority refrain from electric vehicles due to the short-term benefits of other established technologies, like the combustion engine (Stålstad & Williander, 2013).

2.2.2 Autonomation

Autonomation is on the rise everywhere in the world as the research and demonstration of various extents of self-driving vehicles in various extent continues (Trafikanalys, 2015). The expectations are that autonomous vehicles will contribute to an increase in the capacity on the road network, safety, and produce less emission (Trafikanalys, 2015). However, the term autonomation has no clear definition and can include various degrees of maturity and application of the technology (Trafikanalys, 2015). The difficulty related to the autonomation is how to get the solutions to cope with the environment around itself and how to regulate the use of automated and autonomous technologies (Trafikanalys, 2015).

The composition and extent of connected vehicles on public roads with both autonomous and non-autonomous vehicles affect the flow of the road (Mattas, et al., 2018). Certain mixes of the vehicles types can result in a suboptimal flow, possibly worse than in the case with a vehicle fleet consisting of solely one type of vehicles, that is either autonomous or non-autonomous (Mattas, et al., 2018).

2.2.3 Servitization

Increasingly, corporations have switched from being strictly manufacturing firms to being service-based firms providing a service together with a product, or only a service, instead of solely a product to their customers (Baines, Lightfoot, & Smart, 2011). One of the reasons for the shifted focus from products to services is the potential in retaining customers for a longer period of time instead of having a transaction-based relationship (Vandermerwe & Rada, 1988). Another reason is related to the customer value, which often increases due to the decreased responsibility together with the constant benefits of the solution (Vandermerwe & Rada, 1988). However, due to the lack of physical ties between the customers and the sellers must barriers hindering competitors from poaching the customers be created, as well as creating barriers creating lock-in effects on the customers to create a longsighted relationship between the parties (Vandermerwe & Rada, 1988). By transforming the relationship from a transaction-based relationship to a service-based is there a shift in responsibility for the operation of the products from the customer to the selling companies (Vandermerwe & Rada, 1988). The shift in responsibility creates new demands on the selling companies, with them assuming the risk and operation from the customer (Smith, Maull, & Ng, 2012). The servitization of the companies often means that the corporate strategy has to be reshaped in order to fit the new value offering (Vandermerwe & Rada, 1988).

It is a widely accepted belief that the automotive sector will be the next sector where servitization will break through (Wendle, Ljungberg, Fredricsson, & Lund, 2018). However, the servitization will lead to regulatory challenges that have to be taken care of by the governmental actors (Trafikanalys, 2016). The servitization will require the rules and regulations to be adapted to the new way of delivering value due to a lot of regulations being adopted to a product-oriented economy (Trafikanalys, 2016). In order to benefit from the

technologies and their applications, it is also needed to develop and apply new business models shifting the focus towards the circular and sharing economies resulting in lower resource consumption (Perätola & Ahokangas, 2018).

The circular economy can be seen as a sub-component of the servitization (Murray, Skene, & Haynes, 2017). The most common description of the circular economy is a cyclical closed-loop system where no resources are wasted during production, use, and decommissioning of a product or service (Murray, Skene, & Haynes, 2017) and zero effect on the environment (Lieder & Rashid, 2016).

Arguments have proposed that a shift from the current linear economy to a circular economy would increase the overall welfare in the society by more efficiently allocating the resources, creating new job opportunities, and reducing the harm to the citizens by reducing the emissions and waste they are exposed to today (Korhonen, Honkasalo, & Seppälä, 2017). It is necessary to not only look at the effects of the actual operation of a mobility solution (Niero & Irving Olsen, 2016), but also on the effects of the production and the decommissioning of the solution to be able to see the full effect a solution has on the environment (Korhonen, Honkasalo, & Seppälä, 2017).

A way of combining the servitization with the circular economy is through the use of shared mobility. The shared mobility could consist of travels in public transport or private vehicles. The shared resources can lead to more efficient use of urban areas, a decrease in traffic congestions, and support an increase in walking and biking (Fulton, Mason, & Meroux, 2017).

2.2.4 Digitalization

Digitalization has been rapid during the last generations (Bates, 2001) and it provides opportunities for the society, industry, and consumers to use, develop, and sell new solutions enabling more connected and efficient mobility than earlier (Magnusson & Nilsson, 2014). Digitalization can be seen as a catalysis for the entrepreneurship that provides growth (The Swedish Agency for Growth Policy Analysis, 2014). Digitalization investments accounted for 42% of Sweden's productivity growth between the years 2006-2013 and have created opportunities and desires for all of the city's operations (The Swedish Agency for Growth Policy Analysis, 2014).

The development has led to that the applications of the technology have not been able to evolve at the same rate resulting in unrealized potential in the technology pool able to stimulate further innovation (Bates, 2001). If the development of the integrated circuits, which influence the computational capacity of the ICT applications directly, continue to follow Moore's law will the possibilities of the ICT applications continue to follow an exponential development rate leading to a hard-to-predict situation of what the potential of the technology really is (Schaller, 1997).

Digitalization and smart mobility are closely connected (Panagiotopoulos & Dimitrakopoulos, 2018). Smart mobility relies on several ICTs of one is the communications network of vehicular communication (Panagiotopoulos & Dimitrakopoulos, 2018). The communication can be divided into the communication between the vehicles, between the vehicles and the infrastructure, and between the vehicles and everything else (Panagiotopoulos & Dimitrakopoulos, 2018). To be able to have a functioning transport system based on communication technology is it crucial that the communication infrastructure itself is reliable, secure, and efficient to avoid doing more harm than good (Panagiotopoulos & Dimitrakopoulos, 2018). The inter- and intra-vehicular communication is done throughout the use of telecommunications, electronics, and information technologies applied at a transport system (European Parliament, 2010). The intravehicular can communicate the state of the vehicle either to the vehicle itself or to another actor analyzing the vehicle's well-being to increase the reliability of the vehicles and the mobility system by preceding breakdowns (Corazza, et al., 2018). The intravehicular optimization can lead to an overall more energy efficient fleet (Corazza, Guida, Musso, & Tozzi, 2016) and safer transport system by alerting the mobility system of individual vehicles' breakdowns and thereby aiding in the optimizing of the whole system (Kato, Tsugawa, Tokuda, Matsui, & Fujii, 2002). It is possible to reduce the overall size of the vehicle fleet and minimize the environmental impact through the use of inter-vehicular communication (Fulton, Mason, & Meroux, 2017) and increase the social and economic sustainability by enabling a larger group to become mobile than before to a lower cost (Arbib & Seba, 2017). By providing the actors with the information of how the system is being utilized and shifting the focus from the individual driver to the cooperative driving of the whole system, it is possible to enable the system to be optimized (Kato, Tsugawa, Tokuda, Matsui, & Fujii, 2002).

The current degree of connectivity of mobility solutions is that the subcomponents are moderately connected, but the system as a whole is not connected (Skjutare, Dahlén, & Van Rens, 2018). Capable and widely covering solutions connecting all ingoing parts of the system does not exist (Skjutare, Dahlén, & Van Rens, 2018). The lack of solutions can be explained both by the lack of technological maturity but also the unclear situation of how to handle the data (Skjutare, Dahlén, & Van Rens, 2018). However, without a clear benefit for the users of the smart mobility system, serves it no purpose (Williams, 2008). It can be complex to develop a well-functioning smart mobility system due to the complexity of the system and the systems and actors around it (Williams, 2008).

Although the digitalization comes with significant advantages, some risks need to be dealt with (Jansen & Jeschke, 2018). Risks include both organized and non-organized security threats (Jansen & Jeschke, 2018). Lacking data security can affect the performance and well-being of the whole system (Jansen & Jeschke, 2018). A breach in the data security can also result in personal data being compromised with regulatory actions as a consequence (Gahi, Guennoun, & Mouftah, 2016). Due to the novelty of the use of data on a large scale might the regulatory apparatus change to be able to have relevant legislation in the coming years (Gahi, Guennoun,

& Mouftah, 2016). Furthermore, the digitalization comes with consequences to the users (Münchner Kreis e.V., 2017). The use of digital solutions means that more and more data from the users will be uploaded to a system where the users have little or no control over the data nor an understanding why the data is being collected (Münchner Kreis e.V., 2017). The current trend points towards an increase in how much data that will be collected as well as the importance of the data to the actors providing the services that collect the data (Münchner Kreis e.V., 2017).

2.3 Way of working

Van Audenhove et al. (2018) state that is it necessary to update the way or working in order to create a smart mobility system. The industry's and local government's vision do not cover the requirements, as the cities nor the industry does not have any clear vision of the future smart mobility system yet (Van Audenhove, et al., 2018). The lack of coordination and collaboration can also reduce the performance (Van Audenhove, et al., 2018).

2.3.1 Importance of a vision

A cohesive view on the local government's view in the creation of a smart mobility system is missing in many aspects (Van Audenhove, et al., 2018). As stated by Van Aduenhove et al. (2018), mature cities do not have a clear vision of their future smart mobility system nor a strategy, Van Audenhove, et al. (2018) also state that companies and local government should share a common vision in order to work towards the same directs.

In order for aligning the horizontal work and working in accordance to the systems thinking should a common vision be created containing the long-term goals of the organization as well as strategies for how to achieve the goals (Bergman & Klefsjö, 2010).

The development of smart mobility is a highly complex process because of the large number of uncertainties with a long project time (Tzortzopoulos & Formoso, 1999). It is vital for the industries to stay competitive in short term however it is even more vital to stay relevant in long term perspective as the mobility market changes so rapidly (Van Audenhove, et al., 2018). By having a long-term perspective, it helps to create a smart mobility system that is robust (Van Audenhove, et al., 2018).

According to Van Audenhove et al. (2018) should all mobility stakeholders aligning themselves together on a long-term mobility vision, this is necessary in order to develop smart mobility solutions to increase the whole performance of the mobility systems (Van Audenhove, et al., 2018).

2.3.2 Coordination and collaboration

Van Audenhove et al. (2018) mentioned the importance of ecosystem integration by proving the customer with efficient smart mobility. To achieve integration in the ecosystem and smart mobility in a city must collaboration and coordination be increased (Van Audenhove, et al., 2018).

The development of smart mobility solutions is closely related to urban development as well as cross-organizational development projects. The development of a smart city, and in the extension smart mobility, is a complicated matter due to the complexity of the cities themselves (Komninos, Pallot, & Schaffers, 2013), and the complexity is increased even further due to the, often, lacking competence of the technologies of the public sector (Kitchin, Coletta, Evans, & Heaphy, 2018). Each development project is a unique entity with its unique characteristics with a relatively low degree of transferability of knowledge about how to steer and evaluate the project between different projects (Horstman & Witteveen, 2013). The large number of actors needed for an urban project often leads to a higher complexity due to the different priorities proposed by each actor and difficulty to achieve consensus on what to prioritize and how (Horstman & Witteveen, 2013).

The development of a cross-functional entity, like the smart city, requires close cooperation between all actors within the ecosystem in order to fulfill the needs of all actors (Wheelwright & Clark, 1992). A cross-functional development will lead to a better result in the end in terms of, for example, product quality, cost, and time to develop the end product (Wheelwright & Clark, 1992). The development of smart cities is characterized by such a development process due to a large number of actors in the ecosystem coming from both the public and the private sector (Vanolo, 2014).

A success factor in cross-organizational development projects is the utilization of the knowledge coming from all parties (Wheelwright & Clark, 1992). The cross-organizational joint projects are characterized by the partnerships between public and private actors, which are characterized differently depending on the nature of the project and the ingoing organizations (McQuaid, 2000). Each actor has their own responsibility with the public actors often having to create an environment in which the private actors can operate as well as providing the majority of the financial resources needed for completing the project together with the understanding of the area in which the project is active, and with the private sector often being responsible for providing the technical understanding needed for completing the project (Hoon Kwak, Chih, & Ibbs, 2009). The partnership itself can solve resource constraints, achieve efficiency and effectiveness, create a higher level of legitimacy by incorporating the different actors with their respective field of expertise (McQuaid, 2000), as well as creating a situation where the different actors cooperate rather than compete with each other to achieve a common goal (Hoon Kwak, Chih, & Ibbs, 2009). The nature of the partnerships and their projects can revolve around everything from only operating and maintaining a solution to fully developing, building, financing, and operating a solution (Hoon Kwak, Chih, & Ibbs, 2009).

There are several disadvantages, however, namely the effect of an unclear goal which could potentially lead to the partnership's failure, the costs and difficulties related to the partnership (McQuaid, 2000). Due to the need to integrate and coordinate a number of freestanding organizations, how to balance out the power in an efficient way, as well as the difficulties in how to define the long-term consequences of the partnerships (McQuaid, 2000). The transition to working in partnerships for the public and private actors can be difficult due to the difference in the nature of the projects as opposed to how the actors worked previously and might need some time to create a beneficial collaboration between the actors (Hoon Kwak, Chih, & Ibbs, 2009). The difficulties in the public-private partnerships are increased by the legal differences of what applies to a private entity and a public entity respectively (Drewry, 2000).

The development, and operation, of solutions either containing actors from private and public sector or active in the public realm might work towards different goals at the same time: the public benefit and the profitability of the project (Shoji, 2001). The act of balancing between the different objectives can be difficult (Shoji, 2001). One way of creating a process where there is balance is by separating the commercial side and the governance of the development and operation, but the difficulty increases when the same actor develops, operates and governs the operation at the same time (Amos, 2004). Although it is beneficial to separate the operation and governance at different actors might the nature of the solution lead to few actors being willing to invest the necessary resource into either operating or developing the solutions, leading to the government might have to operate and develop as well as govern the solution to various extent (Amos, 2004). Due to the complexity of the development projects can there be a number of reasons for failure with everything between a poor planning process, a bad financial situation, an inadequate mapping of the needs of the customers, to a lack of coordination among the actors (Soomro & Zhang, 2015).

There are efforts in the EU to create a joint strategy regarding smart mobility in order to increase the coordination and collaboration within smart mobility (Dutch Government, 2016). The process of constructing the joint strategies for the EU countries is a cross-functional process involving legal, technical, and governmental actions needed to be taken into account when creating a strategy that is compatible across borders (European Commission, 2017). The compatibility between the different member countries of the EU is identified as a critical factor when developing new mobility (European Commission, 2018). Non-existing compatibility between the countries will lead to an unfocused development effort, a hard to manage mobility system (European Commission, 2018), and difficulty in travelling and transporting people and goods across borders (European Commission, 2016a). The European states are interested in co-creating standards enabling the industry and academia to focus their efforts (European Commission, 2016d).

2.3.3 Requirement setting

By having a clear definition of what the requirements are, it is possible to tailor the solutions to the specific needs efficiently (Ross & Schoman, JR., 1977). The specification of requirements

and deciding who is responsible for it can aid in coordinating the actors taking part in the development effort (Ross & Schoman, JR., 1977). Collaboratory development projects tend to focus on what the involved actors can offer rather than what their customers need (Bäckstrand, 2006). To be able to set requirements for a collaboration project, it is beneficial to share a common problem where all actors are affected (Brouwer, Woodhill, Hemmati, Verhoosel, & van Vugt, 2016). If there is no common understanding of what the problem is or how to address the problem, it is necessary to have one or more actors setting the requirements and defining what is needed (Brouwer, Woodhill, Hemmati, Verhoosel, & van Vugt, 2016). However, the complexity of managing partnerships can lead to the requirement setting is done inadequately (Klijn & Teisman, 2000a).

The management of the partnerships often takes one of three forms: either as the regular project management form, the process management, or the network-society form (Klijn & Teisman, 2000b). The project management format has a focus on the utilization of the joint resources by having a strong actor coordinating the involved parties (Klijn & Teisman, 2000b). The process management forms' focus lies on creating processes enabling coordination (Klijn & Teisman, 2000b). Network-Society management has a focus on achieving coordination throughout the creation of trust between the different actors and thereby creating a system that is more capable of coordinating itself (Klijn & Teisman, 2000b). However, the actual decision making will most likely not follow a detailed nor formal structure, require a high level of cooperation as early as possible, and require the public sector to define the aim as early as possible in the partnership (Klijn & Teisman, 2000a). The nature of the decision-making process of the joint projects means that the public sector provides an overall direction and some resources to facilitate the private sector utilizing its domain-specific knowledge (Klijn & Teisman, 2000a). A key factor to have in mind when structuring the partnerships is the definition of responsibility among the actors to avoid unclear terms possibly reducing the efficiency and effectiveness of the cooperation as well as risking the overall failure of the project (Klijn & Teisman, 2000a).

2.3.4 Rules and regulations

The rules and regulations of the society affect the development of smart mobility heavily (Ojo, Curry, Janowski, & Dzhusupova, 2015). However, there are no specific regulations in place for the smart city or smart mobility concepts (Riva Sanseverino & Orlando, 2014). The rules and regulations that are set by the government can be seen as a drive for innovation for the industry (Van Audenhove, et al., 2018). Without an adequate regulatory framework will the development of smart mobility be hindered and not lead to the needed improvements of the society (Ojo, Curry, Janowski, & Dzhusupova, 2015). However, the regulatory body can be slow to develop new regulations due to the complexity of their domains and might, therefore, be outrun by the developing actors (Ojo, Curry, Janowski, & Dzhusupova, 2015).

Furthermore, Van Audenhove et al. (2018) states that rules and regulations also can benefit the sustainability as it can be seen as a drive for innovation. In recent months and years have government around the world set regulations of sales for combustion engines and wants to

replace them to electric vehicles (Van Audenhove, et al., 2018). The new regulations are example of rules and regulation that drives innovation and development of the society to change towards a more environmentally sustainable society (Van Audenhove, et al., 2018).

The digital single market is a directive aiming at reducing the multiple national digital markets of the EU to one single market for digital products and services (European Commission, 2016b). The goal of the digital single market is to create a less fragmented market which is easier for the regulatory body of the EU to regulate and will enable a more significant growth than before as well as protecting the EU population from being exploited in a greater extent (European Commission, 2016c). By having one single market in the whole EU, it is possible to provide the same products and services for the whole EU population on the same conditions instead of to a fraction of the population (European Commission, 2016c).

2.3.5 Technology utilization

In order to utilize the technology and the resources of the ecosystem in an optimum way, it is needed to apply the right technology on the right application (Oliver, 2002). It is not always necessary to have the most advanced technology on non-advanced applications (Oliver, 2002). If one fails to do so might the resources of one or more actors be wasted due to the overshooting of the delivered value or not reaching the expected value (Oliver, 2002). The establishment of new technologies is related both to the challenge of establishing the new technology and the opportunity the new technology poses for the ecosystem (Adner & Kapoor, 2016). In order to realize the full potential of the ecosystem fully, it is needed to let the different technologies, both the new and old, complement each other to avoid having technological waste due to the performance of the solution is overshooting the need of the application (Adner & Kapoor, 2016).

The current way of evaluating solutions for the public sector tends to give the smart mobility solutions an unfair comparison due to the inability to take into account how the solutions are functioning, the costs related to them, and how to implement the solutions compared to regular mobility solutions (Li, Namaki Raghi, & Kapl, 2017). The difficulties in evaluating and procuring the smart mobility solutions might lead to difficulties in achieving an adequate adaption due to the new solutions are being brought forward as less financially beneficial than the old solutions (Li, Namaki Raghi, & Kapl, 2017).

2.3.6 Working on the verticals

Local governments are responsible for many different activities and departments, which makes it a major challenge to create good opportunities for interoperability between different applications and technologies and to ensure synergies and economies of scale. An essential key to success is to avoid vertical solutions that run the risk of functioning as silos (Elloumi, 2015). In order to achieve this, a horizontal approach and system thinking are required. The term systems thinking refers to a balanced way of working by weighing in the whole situation, short-

and long-term consequences and factors, the dynamic and complexity of the situation, and the measurable and fuzzy factors respectively when constructing a description or when addressing a problem (Anderson & Johnson, 1997). In this thesis does systems thinking refers to working horizontally and working on the verticals is the contrary.

Vertical integration means that a solution is developed solely for a specific purpose and often customized technical solutions, which makes collaboration between different solutions more difficult (Elloumi, 2015). A vertical solution often generates a dependency to a specific supplier and thus has an apparent locking effect, especially the difficulty in revealing and replacing suppliers (Elloumi, 2015). If the solutions are more horizontal could, for example, a device be used for multiple purposes than otherwise. Systems thinking, also referred to as having a horizontal view, is required in complex situations (Arnold & Wade, 2015). Close integration between the market and the developing company leads to a beneficial informational relationship between the two parties which contributes to the creation of a horizontal view and increases the probability of success (Ogden Armour & David, 1980). Closeness to the market can be achieved through various degrees of vertical integration (Acemoglu, Aghion, & Zilibotti, 2003). However, a society with too few established actors with too much vertical integration, reducing the competition between them, can lead to it becoming a less innovative society in general (Acemoglu, Aghion, & Zilibotti, 2003).

A vertical solution is often the initial, both simpler and quicker to implement (Elloumi, 2015), but it does not have to be the most efficient solution in the long-term aspect since the possibility of economies of scale and interoperability with other solutions can be more difficult. If a city has implemented a number of vertical integrations, it will become significantly more challenging to integrate them horizontally in the future, as standards can differ (Elloumi, 2015).

Nevertheless, to apply systems thinking and horizontal working must one have an organizational maturity allowing the resources to be spread out (Wheelwright & Clark, 1992). The smaller the organization, the more focused does the resource spending tends to be due to the shortage of available resources (Wheelwright & Clark, 1992). A too narrow scope when trying to solve a problem might result in a suboptimal solution being applied (Moss Kanter, 2006), which is referred to as working on the verticals. On the other hand, might a too sprawled focus result in the development failing due to a lacking focus, enabling other actors to have enough focus to outcompete the developed solution (Moss Kanter, 2006).

2.3.7 New business models

A more digitalized value offering often requires a different business model compared to a non-digital value offering (Sandström & Karlson, 2016). However, the change to a new business model can be difficult for established actors compared to new actors due to the established actor's lock-in effects from existing relationships and ways of working (Sandström & Karlson, 2016). In order to realize the full potential of the smart city and smart mobility is new business models needed for the actors within the ecosystem (Bélissent, 2010). The development of smart

mobility will result in actors with few contact points to mobility establishing themselves in mobility, possibly disrupting the establishes actors, leading to a need for new business models for the new and old actors (Van Audenhove, et al., 2018). A too old way of addressing the value offering related to smart mobility will not take into consideration how the technology has developed nor how the solutions are being used, resulting in a suboptimal value transfer between the actors (Bélissent, 2010). The dispersion of solutions will require a variety of new business models adapted to their specific solution to maximize the value transfer (Van Audenhove, et al., 2018).

3. Methodology

The methodology is following the research process of qualitative research proposed by Bryman & Bell (2015). The collection of data was collected in a triangulation manner by utilizing the triple helix. Consequently, interviews were done with actors from the university, industry and local government in order to compare and explain the current situation, which is in line with Etzkowitz and Leydesdorff (2000). The chapter will start by introducing the triple helix and continue by describing the research design of the thesis.

3.1 Triple helix

The triple helix is a model presented by Etzkowitz and Leydesdorff (2000) and consists of three relations which is used to compare and explain current research systems in a social context. By combining the views of all actors from the triple helix it is possible to create a system's view representing the whole society (Etzkowitz & Leydesdorff, 2000), and thus we use interviews with representatives of the triple helix as the main source of novel data for this study. The three actors are the university, government, and industry (Etzkowitz & Leydesdorff, 2000).

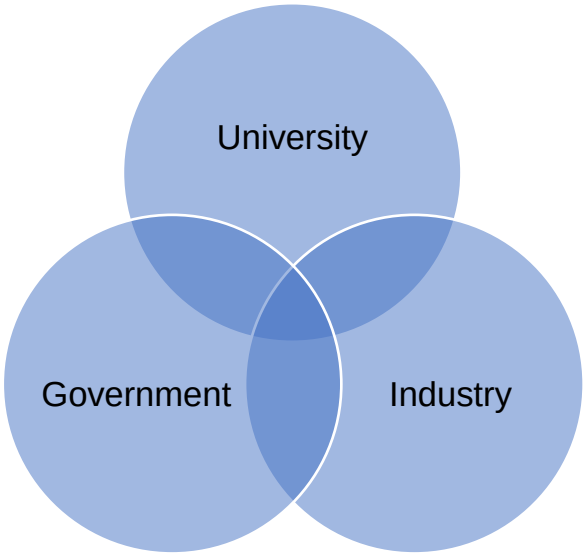

Figure 4 – An illustration of the different contact points between the triple helix (Etzkowitz & Ranga, 2013). Modified by the authors.

The relationship between the actors is based on them coexisting and collaborating in order to influence the development of the society (Etzkowitz & Leydesdorff, 2000). Different actors can have various degree of influence over the development and innovation during different times (Etzkowitz & Leydesdorff, 2000). In order for one actor to survive in the ecosystem and prosper collaboration is in some degree needed, otherwise there is a risk that the different actors are working against each other (Etzkowitz & Leydesdorff, 2000). Each actor has their area of responsibility with the industry's main focus being the generation of wealth, the university's focus being the generation of knowledge, and the government's focus being the governance of

the public space and operations (Leydesdorff & Meyer, 2006). Different actors can take the role of being the leader in the constellation depending on the nature of the ecosystem in which the actors find themselves (Etzkowitz & Ranga, 2013). The primary constellations are either the government leading the collaboration, the industry being the main driving force, or a balance between all three actors (Etzkowitz & Ranga, 2013).

The collaboration can result in knowledge exchange between the actors, possibly benefiting the society as a whole (Etzkowitz H., 2003). The knowledge exchange can be beneficial during the whole life cycle of a solution, from development to decommissioning, due to the possible new insights that might be brought forward by either or all actors of the triple helix (Etzkowitz H., 2003). Shinn (2002) argues that the society has gone towards being in an endless transition always trying to find and utilize new knowledge in order to drive the development of society forward.

Technology transfer in one of the important factors in triple helix due to the universities creating and transferring more technology than before (Etzkowitz & Ranga, 2013). Today are many of the new technologies from the universities transferred to startups or research laboratories outside of the universities (Etzkowitz & Ranga, 2013). The transfer is necessary for the knowledge to be capitalized and transferred to the society and eventually benefit economic growth (Etzkowitz & Ranga, 2013).

Another crucial factor in the triple helix is collaboration. It is essential with the integration between the different actors (Etzkowitz & Ranga, 2013). By using the conflicts between the actors, there is a possibility to transform the conflicts into collaboration (Etzkowitz & Ranga, 2013). One of the things to deal with the collaboration and conflicts is to create a collaborative leadership which can be the bridge between the different actors (Etzkowitz & Ranga, 2013). This role can have a crucial role by connection the right people from the different sectors in order to find new knowledge and communication (Etzkowitz & Ranga, 2013).

Triple helix can be divided into three functions, according to Etzkowitz & Ragna (2013). These are innovation, knowledge, and consensus spaces. The innovation space is often activities that take place in a hybrid organization, which consists of actors from both the public and private sector and aims at creating an environment in which innovation can be stimulated. The knowledge space can be found in university and firms and governments that mainly focus on research (Etzkowitz & Ranga, 2013). The consensus space is about that the different actors should be interdependent and not isolated and is reached through collaboration and interaction (Etzkowitz & Ranga, 2013).

3.2 Research design

The methodology is following the research process of qualitative research proposed by Bryman & Bell (2015). It is preferred to have a combination of both qualitative analysis quantitative (Eriksson & Wiedersheim-Paul, 2014). However, quantitative analysis is not applicable due to

the scope and nature of the project. The process consists of the formalization of a general research question, the selection of relevant sites and subjects, the collection of relevant data, the interpretation of data, the conceptual and theoretical work, and lastly the writing up of the findings and conclusions. See figure 5 for an illustration of the methodology.

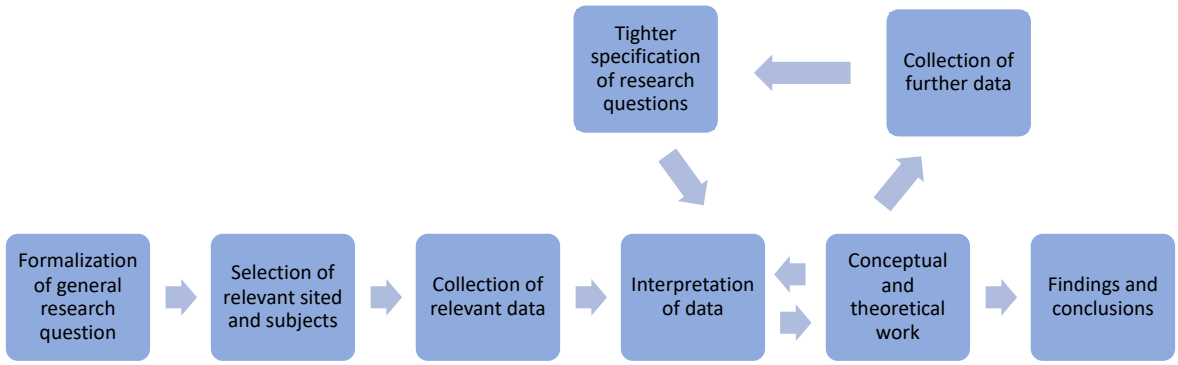

Figure 5 – An illustration of the methodology (Bryman & Bell, 2015). Modified by the authors.

3.2.1 Formalization of general research questions

By creating general research questions for the report, it is possible to set the direction of the project and thereby simplify the future work process. The research questions may be refined if needed (Bryman & Bell, 2015).

The research questions were developed through a process initiated by a discussion with the supervisor and a brief literature review to grant the authors adequate knowledge to create preliminary research questions. The preliminary research questions were reduced and presented to the academic supervisor, who provided the necessary input to refine and choose the final research questions. The research question was reformulated several times due to new findings, scope and delimitation during the work of the thesis, all this together with discussion with the supervisor in order to come up with the final research question.

3.2.2 Selecting relevant sites and subjects

To be able to drive the research forward in an efficient manner should a relevant research object or subject be selected (Bryman & Bell, 2015). The research subject helps to focus the research on a particular area of interest.

The area of interest for the thesis is the nature of the smart mobility, as described by the actors of the triple helix, with the needs of the different actors within a smart city in mind, as well as what is needed to be developed in order for the development processes to deliver relevant solutions. Also, it was decided to define the scope to only contain Europe due to the complexity and differences between different cities in different continents. The data collection and

literature review were done in order to contribute to an understanding of the chosen area of interest.

In order to select individuals to interview within the academic, industrial, and local government sector were people involved in a high-level collaboration project related to smart mobility that could have relevant insights to the research question from their respective point of view chosen. Why these people were chosen was the belief that it is necessary to know the subject in order to come with trustworthy input on a general level and not too much deep focus on small subject areas. The selected projects were characterized by high-intensity collaboration development projects between the industry, academia, and local government. This because of the natural scope of the project which one of the focus areas was the way or working. It could be early seen in the research that there are collaboration projects in the cities between the different actors and the researcher wanted to explore more on these and saw that the people involved in these had knowledge about the subject that this thesis focused on.

The selection and identification of data references were done by the authors primarily but had the support of the academic advisor when needed. The published material was found on the Chalmers Library website, Google scholar, websites related to the European Parliament and the European Commission, and various project websites related to smart mobility development efforts.

Examples of search words are; *smart mobility, ICT, smart city, intelligent transport systems, digital single market, a development project in a shared space, public-private partnership, mobility as a service,* and *transport as a service.*

3.2.3 Collection of relevant data

To improve validity can the collection of data be conducted in a triangulating manner by providing data from multiple locations at once. By having multiple sources of data, is it possible to achieve a higher data quality than with a single source (Bryman & Bell, 2015). In this master thesis, the collection of data was done triangularly by utilizing the different point of views from the actors of the triple helix.

The data collection was based on both primary and secondary sources coming from prominent actors in the development of smart cities, actors affected by the development, and researchers in the field. The data collection was based on the comparison of the university, governmental, and industrial point of view. In addition to the literature review were interviews used.

Semi-structured interviews

The interviews had a semi-structured form to provide the possibility to adapt to ongoing interviews. The semi-structured format was chosen to allow the respondents to divert from the structure in order to allow new ideas to be brought up by the respondent and the discussion.

Both notes and recordings were taken during the interviews. In order to have a representative sample among the interviewees, a balance between the number of interviews representing industry, academia, and the political side was strived for. The actors are displayed in Table 1.

The interviewees of the triple helix were chosen after identifying actors active in the smart mobility field, and that could have relevant insights into the research questions from their respective point of view. The actors are seen in Table 1, and a total of 18 interviews were conducted. The actors were identified primarily through web searches to identify projects and actors active in the field, but also through the use of referrals by the actors themselves. The referrals from the actors themselves aided in the identification of relevant actors as well as getting in touch with the newly identified actors, speeding up the data collection. The use of referrals presented a risk of getting a one-sided picture of the situation. However, that risk was reduced due to the low number of actors that were identified through referrals.

The interviews started with a question to define smart mobility in order to see if they had a shared view with the literature that has been found. The approach was chosen in order to see if the right knowledge was in place and if their view was similar to the literature and the researcher, which all of the interview objects had. Furthermore, the interview continued with questions regarding the current situation about smart mobility, coordination and collaborations project within smart mobility and finally, questions about the future of smart mobility. Depending on whether the interview object was from the industry, university or government, the questions were asked to see what the other actors and themselves could do to stimulate the future of smart mobility. At the end of the interview was a verbal summary done of the interview, if anything was wrong or missing this was corrected.

Table 1 shows the respondents' position and which part of the triple helix they represent.

Table 1 – Description of the interviewees' position and belonging to the triple helix

Triple Helix	Position		
Local Government	Middle Manager, Infrastructure and Mobility Issues #1		
Local Government	Middle Manager, Infrastructure and Mobility Issues #2		
Local Government	Politician, Infrastructure and Mobility Issues #1		
Local Government	Politician, Infrastructure and Mobility Issues #2		
Local Government	Senior Advisor, Business Development		
Industry	CEO, Consultancy within Infrastructure and Mobility Issues		
Industry	Key Account Manager, Communications Industry		
Industry	Project Manager, Automotive Industry		
Industry	Product Manager, Communications Technology		
Industry	Senior Project Manager, Collaboratory Research Project within Mobility		
Industry	Senior Manager Innovation, Communications Technology		
Industry	Senior Manager Product & Marketing, Communications Technology		
University	Professor, Research Institute Climate and Energy Transformation		
University	Researcher, Research Institute Traffic analysis and logistics		
University	Researcher and Manager, Research Institute Sustainable Mobility		
University	Researcher, Research Institute Electromobility		
University	Senior Lecturer, Research Institute Technology Management and Economics		
University	Senior Project Manager, Research Institute Sustainable Mobility		
Triple Helix Total	**Industry**	**University**	**Local**
18	**7**	**6**	**5**

Trustworthiness of data

The problem related to the trustworthiness of the collection of data is solved by gathering data from multiple sources and thus performing a triangulation. The triangulation will lead to the minimization of the risk of presenting the wrong conclusion and resulting in higher data quality, although the risk might still be present (Bryman & Bell, 2015). The trustworthiness was ensured by combining a relatively large number of interviewees from a variety of functions across the triple helix.

After the conclusions were finalized were the interviewees presented with the option to review the data, analysis, and conclusions to comment upon whether their views had been misunderstood as well as if whether they had been misquoted. The review of the thesis was done to establish a feedback loop between the authors and the interviewees in order to minimize the probability of coming up with the wrong conclusions and thereby validate the findings and conclusions.

3.2.4 Interpretation of data

The collected data should be codified to be able to be processed and analyzed later on. The data itself has little value unless it is processed and compiled (Bryman & Bell, 2015).

The collected data was compiled and codified before it was analyzed in order to highlight trends and vital information before the analysis. The authors conducted the analysis with the support of the academic supervisor.

After the interviews were carried out, they were analyzed by listening to the recording again, reading notes taken during the interviews and making a summary in order to create a sense of what themes that could be found. The interpretation of the data was done through compiling and codifying the notes, recordings, and summaries from the interviews to find general themes among the respondents which were relevant to the research question and common enough to justify further analysis. The compilation and codification of the findings were made multiple times sequentially by compiling and codifying the results of the previous compilation and codification effort to reach a higher-level understanding of the situation.

In order for the empirical findings to be brought up in the report, a subject had to be mentioned either by at least half of the respondents from two of three from the triple helix actors or by almost all of the respondents of one or more actors. When a category was decided to be brought in the report different examples and statements from the respondents within this category was analyzed as well, even if it was mentioned by fewer respondents than necessary for it to be classified as an own category.

From the summary and analysis from the interviews where the different themes found. In the initial state, there were several different themes among the codified data that had been mentioned during the interviews by the interviewees, and this was all the themes that were found during the collection of data. All of these themes were written down on post-its, together with how many times they were mentioned. The post-its were grouped on a whiteboard based on the common themes on the post-its. The grouping was done by the researchers themselves. The themes were categorized under three different parts, trends, preference, and way of working. Themes that had not been mentioned enough amount of times were removed or integrated into a similar category. In the end were 19 themes grouped under preferences, way of working, and trends.

3.2.5 Conceptual and theoretical work

A theoretical framework is constructed in order to provide guidance in the continued research and the analysis of the collected data (Eriksson & Wiedersheim-Paul, 2014). The analysis should connect the empirical data with the theoretical framework and relate the data to the research questions.

It might be needed to adapt the research question depending on the outcome of the theoretical framework because of new relevant information which might make it necessary to conduct further data collections. Consequently, it might be needed to interpret the data and conduct the conceptual and theoretical work again. The loop can be undertaken multiple times (Bryman & Bell, 2015).

The actual construction of the theoretical work was conducted with the support of the academic supervisor. The theoretical framework included topics that either were identified during the interviews or needed to describe the smart mobility concept. It was needed to construct the theoretical framework during the whole research effort depending on the findings from the interviews.

3.2.6 Writing up findings and conclusions

In order to present the results in a structured manner, it is needed to compile the results of the previous steps in a convincing way (Bryman & Bell, 2015).

All conclusions were finalized by discussing and reviewing the data collection at the end of the project after all data points were present. In order to not look pass any information from the data did the authors try to not be colored by the previously collected data, literature, or their own experiences, and instead try to analyze the data set as a whole. By doing so was it possible to reveal new conclusions instead of using the data to confirm previous conclusions only. The findings, analysis, and conclusions are all presented according to the same identified themes. The writing of and conducting of the findings, analysis, and conclusions were done in chronological order to avoid being influenced by confirmation bias.

3.3 Ethical considerations

Consideration regarding the ethical aspects are crucial when conducting research (Bryman & Bell, 2015), and must be taken into account to reduce the harm done by the research. According to Diener & Crandall (1978), four primary fields of ethics must be taken into consideration, namely:

The participants of a study, either as research objects or as sources of other information, must be protected against harm on themselves, for example, the information collected from an interview must never result in blowback on the interviewee (Bryman & Bell, 2015). To avoid this was the integrity of the interviewees protected by not disclosing information critical for identifying the individuals.

Before the interviews, all respondents agreed to participate in the study and to be anonymous in order not to harm their position. This was done to ensure that the participants were able to talk freely about the subject and not be limited by any potential consequences due to their position.

The participants of the research study should be informed and asked whether they wish to participate, with the option to opt-out (Bryman & Bell, 2015). To avoid taking advantage of the participants was the participants informed of the purpose of the research and the possible actions that might be expected of them.

Before the interviews was a small introduction to the thesis email to the participants in order to get knowledge about the scope of the thesis and what the researchers wanted to get out of the interview.

3.4 Method critique

As we only have interviewed 18 persons from different parts of the triple helix, there could be criticism towards the reliability, the general themes that permeate this report is brought up by the respondents, however, we believe that same themes would have been brought up as they are general and represent every city in Europe. However, as it has been hard to find respondents outside of Scandinavia, we believe that Scandinavia is relatively similar to the rest of Europe, especially as all parts of triple helix have contact with actors spread across different countries in Europe.

In addition to the relatively low number of interviewees can their connection to the mobility lead to a problem in creating a higher-level understanding of the situation. In order to understand the situation thoroughly would respondents in fields more or less related to mobility be necessary.

Furthermore, to make the result even more reliable could quantitate data have been used. By using a survey, would it be possible to get a more significant number of respondents with greater width and thereby more accurate findings. Perhaps could a survey have reached several respondents within Europe with more geographical spread than the current data collection. However, as the interviews have been semi-structured, could it be hard to create a similar survey with reliable answers without affecting the respondents' impartiality.

To validate the results could a case study have been conducted. Such a case study would be beneficial for the research to study what the local government actually prefers together with how a cross-organizational collaboration project is conducted in detail.

Another criticism is how the grouping of the themes was done, as the researcher themselves grouped it. The grouping was done by discussing and seeing patterns. The grouping could have been done in another way and perhaps see other themes. However, according to us, the themes that were seen was clear and could not have been missed. However, if more data was collected could perhaps new themes arise.

4. Empirical findings

In the following chapter are the empirical findings from the interviews presented. The findings are categorized as the preferences on smart mobility, the problems in the current way of working, and the trends within smart mobility. The respondents' answers are summarized in table 2.

***Table 2** – A summary of the major findings from the interviews and how many of the actors who brought up each category*

Findings	No. Respondents Industry	No. Respondents University	No. Respondents Local Government
Preferences on smart mobility			
Efficient mobility system			
Area efficient transports	1	3	5
Infrastructure investment	2	1	4
Optimization of logistics	3	4	4
Robustness	1	1	5
Affordability	2	1	4
Sustainability	6	6	5
Simplicity for the end user	2	2	5
Trends			
Electrification	3	1	4
Autonomation	2	2	3
Servitization	4	2	3
Digitalization	4	4	4
Problems in the current way of working			
Need for a vision	2	3	4
Coordination & collaboration	4	6	5
Requirement setting	3	3	5
Compatible rules and regulations	5	6	4
Technology utilization	1	3	3
Working on the verticals	4	2	3
New business models	3	3	3

4.1 Preferences on smart mobility

The preferences of the society will be presented in the following subchapter, divided into different categories, as described by the respondents from the triple helix.

4.1.1 Efficient mobility system

The efficient mobility system was brought forward by all actors as essential for smart mobility. The efficient mobility system is divided into the following categories: area efficient transports, infrastructural investments, and the optimization of the logistics. These categories are derived from the respondent's answers regarding what an efficient mobility system includes and are presented below.

Area efficient transports

All respondents from the local government communicated about the importance of creating a mobility system that is area efficient, as opposed to the mobility system of today. The local governmental respondents mentioned that there is an ongoing effort in creating a situation benefiting the development of area efficient transports and the usage of the cities in a more area efficient way. The local governmental respondents' views of the area efficient transports were shared among three of the respondents from the university and remained unmentioned by the others. The topic was brought up by only one of the industrial representatives who shared the view of its importance. It is clear that the view of the importance of area efficient transports is not spread evenly across the triple helix.

Infrastructure investments

The respondents agreed upon the need for creating an infrastructure compatible with the development in the field of mobility in addition to developing new mobility solutions. They argued for the need to shift the configurations of the infrastructure from fulfilling the needs of the current bulk transportation mode of the mobility system, the car, to a more varied mobility system consisting of a large number of different transport modes. The different actors had different views on the infrastructure investments. The industry discussed the difficulty in updating and the need for updating the infrastructure but did not mention the cost as an important factor to be considered. The local government, on the other hand, discussed both the difficulty in updating and cost related to updating the infrastructure. Only one respondent from the university discussed the topic and had a view similar to the local government.

Optimization of logistics

A majority of the respondents communicated the importance of and need for the optimization of logistics. Without an optimized logistic system, will it be challenging to create a smart city. The respondents point out that it is required to coordinate the systems so it can become more

efficient. Many of the respondents discussed whether the implementation of the technology itself serves a purpose or if the optimization of the logistical system is the most important factor. The respondents concluded that the optimization of the system is the highest priority, which can be achieved through the use of certain technologies. The exemplified technologies were mainly related to the communication between the vehicles and the infrastructure, while autonomous vehicles were not brought up necessarily as a solution due to the low percentage of the time spent driving at professional drivers and the difficulties in integrating autonomous driving solutions with older non-autonomous solutions.

Two of the respondents from the university talked about last mile delivery in city centers. If last mile deliveries are merged into one delivery, could it minimize the amount of traffic in the city center. However, this requires the optimization of logistics, and the respondent talked about that it would require a logistic center where the goods can be divided into the same delivery. Conversely, it would require regulations forcing companies to switch to this solution. Otherwise, there is no reason for the industry to switch, even if it would be better for the citizens and the environment as they are pleased to fulfill the customers' requirements for fast delivery services.

4.1.2 Robustness

All respondents from the local government mentioned robustness. The mobility system needs to be robust, meaning it is capable of handling different situations and insensitive to disturbances while having the same capacity.

Moreover, the respondents from the local government talked about the robustness in the aspect of maintenance. They said that it is important to have a sustainable maintenance procedure, as well as being able to integrate new technologies and solutions with the older functions of the city and have them working together. Without proper integration will the adoption of new solutions lead to the creation of isolated parts without adequate communication. A way of achieving the robustness needed by the system was brought forward by the respondents from the local governments as creating a large number of more or less detached systems that can deliver the necessary functionality to a smaller part of the system alone, to avoid having the whole system being taken out of operation in the case of a disturbance.

One of the respondents from the university and one from the industry each mentioned the robustness, but their focus was not on the robustness of the system but rather the robustness of the individual solutions instead. Their views were that individual solutions also need to be able to withstand disturbances and coping with various scenarios.

4.1.3 Affordability

According to some of the respondents, primarily from the industry and the local government, must the solution itself be affordable in order for the solutions to be adopted by the local

government and its inhabitants, and to be developed by the industry. The procurement of solutions, including mobility solutions, is heavily influenced by the costs, both in procuring and operating the solution, according to the governmental respondents. The operational and procurement-related costs are important due to the problematic situation of deciding which areas of the public sector to prioritize when using public funds.

" It needs to be affordable for the society, the individuals, and the industry" – Middle Manager, Infrastructure and Mobility Issues #1, Local Government

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As mentioned by the interviewees from the local government does the term affordable for the local government translate into how much the acquisition and operational cost is in relation to the value the solution adds. A solution that is either too expensive to acquire or to operate and maintain will not be adopted by the local government and thereby will most likely not be made available to the end users. As defined by the industrial respondents does affordability for the industry mean how affordable the development, production, and operation of the solution is for the providing company

Something that several respondents talked about is that the new technical solutions need to be affordable for the customers in order for the end user to adopt them. If it is not cheaper than their current solution, they will not shift their behavior. Many of the components of the self-driving vehicles are not off-the-shelf products and must often be explicitly developed in each case, resulting in a more expensive end product.

4.1.4 Sustainability

All respondents argued for the importance of sustainability in the mobility solutions in the city. The discussions on sustainability included social, economic, and environmental with a heavy emphasis on the two latter. When the respondents discussed environmental sustainability, it included actions on reducing energy consumption, emissions, and the use of resources. The social sustainability was described to focus on the inclusion of previously excluded parts of the society by enabling them to move themselves more freely as well as creating a more attractive environment to live in compared to the situation today.

To be able to cope with the need for increased environmental sustainability was the consensus of actors representing all parts of the triple helix that there is a need for creating more energy efficient solutions. However, there was no clear consensus on how to reach the energy efficient solutions in detail. Some of the respondents argued for the need for having solutions consuming less energy when producing, using, and decommissioning the solutions. Others argued for the reduction in the usage of the mobility solutions altogether as the most efficient way of reducing energy consumption. The respondents were all arguing for a need to combine the two

approaches by both developing better technology as well as creating less sprawled urban areas and thereby reduce the need for using energy consuming solutions.

"An overall more sustainable city will lead a higher quality of life and economic growth for the city and its inhabitants" – Senior Lecturer, Research Institute Technology Management and Economics, University

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Respondents representing all parts of the triple helix mentioned the importance of economic growth for the society and the industry. The economic sustainability was described by the respondents as the actions leading to a financially stable and beneficial situation for the cities, the inhabitants, and the companies. In the long term can the solutions be adopted on a larger scale and thereby enable the continued development of better solutions and can provide a more beneficial situation for performing in accordance with the environmental sustainability. The views of the respondents were that the economic growth of the actors within a city is dependent of the stability of the city's economy, as it creates a beneficial situation for the businesses and citizens in the city.

4.1.5 Simplicity for the end user

In order for the solutions to be adopted, it is needed, according to the respondents from all parts of the triple helix, that the solutions will contribute to a simpler usage and way of living than the previous solutions. Their arguments revolved around that the simplicity would contribute to the lowering of the barriers to change as well as increasing the value of the solution. The respondents' views are that the adequate level of simplicity has not been achieved by the current solutions and that a multimodal, integrated solution would increase the simplicity drastically.

4.2 Trends

A number of trends affecting the development of smart mobility were described by the respondents and will be presented in the following sub-chapters. The respondents argued that the trends have the possibility to create a shift in the market dynamics for the actors in the ecosystem.

4.2.1 Electrification

All of the respondents agreed that one of the biggest trends is electrification as it can change how the mobility sector is constructed. However, some argued that it could be good, but it is essential to see the whole life cycle and not only look at the usage, as the production of the batteries and electricity can include emissions. All of the respondents from the local government agreed that the electrification is good, as it can lower the noise and emission in the city center, which makes the city more livable for the citizens, and the view was shared by the respondents

from the industry and university. Furthermore, many of the respondents mentioned the target set up by EU, and that these could be solved by electrification.

4.2.2 Autonomation

The term autonomous is something that the respondents mentioned, but they also discussed how necessary it actually is. Many of the respondents did not believe that autonomous vehicles will solve any actual problems in the mobility system.

> *"Autonomous vehicles look cool in the eyes of consumers and the city, but it might still be the same number of cars on the road, which does not solve anything" – Researcher, Research Institute Electromobility, University*

One researcher discussed whether the autonomation of vehicles actually is solving anything in the long term. An example was given that a truck driver's time is only allocated to driving 30% of the time, the rest of the time is allocated to delivering the cargo, maintaining the vehicles and other similar activities. A similar argumentation applies to the private car, which is parked 95% of the time. An autonomous private car will not lower the number of vehicles on the road nor improve the traffic flow on a system level, but only free up time for the individual in the car by providing them with the possibility to do other things than actually driving while in the car. The respondents were also critical to whether the autonomous vehicles would result in any optimization or increased utilization of the system as a whole if other actors and modes of transportation would be allowed to coexist with the autonomous vehicles.

One respondent from the industry said that autonomous vehicles are coming and that it has many benefits and can improve the flow efficiency on the roads as well as freeing up the drivers' time. However, without the regulatory prerequisites supporting the autonomous vehicles is there a risk that the autonomous vehicles would result in a low technology utilization in the mobility system meaning that even if the technology would be available would it not be adopted or used widely. The majority of the respondents supported the view that other technologies will have a more significant impact on the mobility system than the autonomously, although the autonomously is still a factor to consider when constructing the new mobility system. Some of the industrial respondents brought forward the view that the goals of the local government were not necessarily the same as the goals of the industry, resulting in a lack of coordination regarding the application of the technologies.

4.2.3 Servitization

The respondents mentioned the shift in the consumers' behavior going from wanting to buy a product to want to buy a service. Their views are that the shift results in the consumers wanting a complete package easing their everyday life with as little responsibility for the service as

possible instead of buying an object giving them mobility but with the responsibility for maintaining and operating the object.

Several respondents argued for that the concept of shared economy will continue to grow as several shared services already exist, with carpools as the most referred to example, and the development of new solutions has a focus on shared resources as opposed to individual ownership.

The respondents' views are that it is hard to compete with some mobility solutions available on the market as they are heavily subsidized. An example of a subsidized solution brought up was the phenomena of company cars, which include several benefits as paid fuel and discounted parking as well as a beneficial tax situation for both the company and the individual. In order for other mobility services to be able to enter the benefits arena did the respondents argue for that it can be necessary to either subside the new mobility solutions as much or to stop subsiding the current solutions.

4.2.4 Digitalization

All respondents agreed that digitalization is one of the key factors in smart mobility and believe that the digitalization is the future and can help with solving many problems and make the city more efficient.

"Data is the new gold "– CEO, Consultancy within Infrastructure and Mobility Issues, Industry

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One respondent from the industry meant that the city itself would be reshaped due to the availability of data and traceability of actions that will influence the decision-making processes of the governments and industry as well as changing the behavior of the end-users.

However, one respondent from the public sector talked about how necessary the digitalization is and why it is necessary. The respondent was arguing for that the societies have been functioning quite well before the digitalization, and that increasing connectivity comes with a need for data security that the industry and society might not be equipped for to handle. What is known is that there is a need for digitalization and making the city more efficient. However, there is no consensus on the drivers of the need for digitalization.

The topic of data security was brought up by respondents of all fields and was considered a key factor to the digitalization. The consensus was that the development of the legislative view of the importance of data security as well as the consumers' awareness of data security had increased the last couple of years. The respondents agreed that the consumers and actors in the triple helix could have a changed opinion on the importance of data security and how to reach

adequate data security. The view from the respondents was that the data security had to be incorporated with the new solutions to be able to be allowed on the market and to be adopted by the consumers.

4.3 Problems in the way of working

The problems in the current way of working when developing smart mobility solutions among the local government and the industry, as described by the respondents, will be presented in the following chapter.

4.3.1 Need for a vision

During the interviews did many respondents talk about that a common vision is missing. As a wide range of new technical solutions is on the rise, it became clear that it is not understood fully what the actual problem is and how to solve it from the different views of the triple helix.

Accordingly, the interviews entail that the common ambition to reach the environmental goals of the EU. Although, due to the consensus that there is no clear common vision related to smart mobility, it becomes unclear which direction the development is going and what the best solutions are for the cities. However, the governmental actors argue that there is a high-level vision for the city's development in terms of mobility, but not enough to provide a clear direction for the industry to gather themselves around.

However, this is a conflict of interest in having a common vision. Some of the respondents believe that it can be impossible to have a common vision because the government, industry, and university are working in different ways. It was brought forward that the industry is often working on a global, national, and local level simultaneously, while the local government works on a local level and the university has a focus ranging between the global and local level depending on the research. The respondents argued that the different focuses lead to difficulty in creating a common vision in line with all the actors. The different points of interest for the different actors lead to them being colored by how the vision affects their own sphere, according to the respondents.

During the interviews was the need for a long-term perspective mentioned by all the respondents from the government. One big problem in is the length of the mandate periods resulting in politicians wanting to focus on getting reelected possibly and harming the long-term thinking. However, all respondents were cleared that long-term thinking is necessary for the development of smart mobility and the society to prosper. An example brought up by a governmental respondent was that the lengthy implementation time span for infrastructural solutions could lead to different efforts counteracting each other due to them being started at different times. The need for analyzing the long-term impacts of the actions in the mobility system was brought up as an important factor, although it was defined as a difficult action due to the complexity of the system.

"It is all about the long-term perspective, and the politicians often thinks in a mandate period, which is a problem as the changes cannot be finished in four years, and many of the societal investment cost a lot and takes longer time to implement." – Professor, Research Institute Climate and Energy Transformation, University

4.3.2 Coordination and collaboration

Several respondents from the university brought forward that one major issue is the lacking coordination and collaboration between the industry, government, and university. One example is that the local government does not know what the most beneficial solution for the city is due to a large number of solutions existing on the market. However, it is stated that the government needs to decrease the fragmentation on the market to reach the goal of an efficient and focused transport system. The complexity of the mobility system is brought forward by the respondents as the reason for the need to have multiple solutions coexisting and the reason for the importance of coordination.

Four of the respondents from the industry talked about what they want to have more coordination and collaboration with the local government and university, and that there are several collaborations ongoing, but as smart mobility requires a high degree of collaboration it is stated that the industry desires a higher degree of collaboration and coordination than today. However, some respondents from the industry said that they see the collaborations project more as a delivering project and capital investment as they get investment from the local government. The local government is putting money into development and research project that will benefit the society and many industries see it only as a cash flow.

The respondents from the local government mentioned that the establishments of mobility actors within the city of Gothenburg have followed a number of different approaches. One example was the establishment of the Volvo-based carpool Sunfleet that was developed through close cooperation between the industry and the local government to develop a more sustainable way of transporting their employees. A more up-to-date example is the establishment of the electric scooters. The actors providing the electric scooters had a different approach as instead of close cooperation with the local government did the electric scooter providers only communicate whether to see if their current operations were violating any regulations rather than how the actors could cooperate to deliver more value. The more established the electric scooters have become, the more of dialogue has taken place to avoid creating an unsustainable situation capable of creating new regulations that could hinder their operations.

4.3.3 Requirement setting

Many of the respondent coming from the industry and university talked about that the city itself needs to set requirements for what they want to achieve with the smart mobility. The argument for doing so is that such a statement will provide a goal for the ecosystem to orient itself around, thereby providing a more focused development effort. However, the respondents coming both from the local government and some of the industry did not share the belief that the city should set the requirements. The governmental and industrial respondents argued for that the governmental actors lack knowledge of the field, and that it was outside of their responsibility, while the respondents from the university presented a mixed view whether the governmental actors had the knowledge and responsibility or not. The respondents from the local government instead proposed that their role is to provide the conditions for the development of future mobility and not influence the free market.

There is a consensus among the respondents from the industry and university that the city and its governmental actors are not as far developed as the rest of the actors within the mobility ecosystem, while the respondents from the governments present conflicting views on how developed the city is.

> *" It is not the cities that should say which solutions they want or how the future of mobility will look like. Rotterdam, Amsterdam, Brussel, Lyon and Madrid say the same thing. However, the city needs to supervise that it is area efficient, energy efficient, low noise, safe for the citizens, and fossil fuel free. It needs to be accessible for the society, the individual and businesses as it means that the citizens can live in the city." – Middle Manager, Infrastructure and Mobility Issues #1, Local Government*

4.3.4 New and compatible rules and regulations

Many of the respondents brought forward the view that new regulations have to be developed in order to cope with the new era of mobility that is on the rise, both on a local and national level. The regulations on a local level were exemplified through how the flows of vehicles can be steered through not allowing certain types of vehicles through some points of the cities. The regulations on a national level were exemplified through imposing, or removing, taxes on certain types of vehicles. Some pointed out that the local government needs to update its regulations in order for the industry to release their products. However, the respondents representing the local government said that they would change the laws only if necessary. They argued that the difficulty lies in how much the regulatory apparatus should adapt to itself to the technology, and how much the technology should adapt itself to the regulatory apparatus.

Something that all of the respondents agreed on is that the government has a slow process when it comes to changes in laws and regulations. However, the respondents from the local government also said that it is important not to benefit only one company and not create regulations benefiting one solution. Lastly, the local government does not want to build themselves around one solution and get stuck with that solution with no possibilities to improve their situation cheaply, but it still happens sometimes due to inadequate knowledge according to one of the respondents from the industry. An example of these issues is a request to make separate lanes for autonomous cars, and other regulations that actually only benefits that solution and lock in the city in one type of solution.

4.3.5 Technology utilization

From the interviews was it mentioned that most cities know that there is a need for digitalization and becoming smarter. However, the question of whether all applications in the city require the latest and most advanced technology was raised. Interviewees across the triple helix emphasized on the importance of applying the right technology to the right situation. It is not optimal to use the 5G network for all applications in a smart city to the risk of overloading the network when there are other technologies requiring less resources. With that being said, was the consensus that although not all applications need real-time updates will most applications benefit from increased connectivity some extent.

"The digitalization is coming, but how necessary is it?" – Senior Advisor, Business Development, Local Government

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4.3.6 Working on the verticals

From the interviews, it became clear that the industry is working on the verticals both due to themselves mentioning it and a view coming both from the university and the government. Today there is a technology push situation without a clear overall goal of the development. The only actors working horizontally across different domains of mobility are the governments and the universities, apart from the collaboration project consisting of all actors of the triple helix. However, some interviewees state that it is necessary for the industry to continue to work on the verticals in order for them to obtain domain-specific knowledge, although it is necessary to have some actors working horizontally tying together different solutions into a functioning ecosystem. However, as one of the respondents from the industry said that it is important with the horizontal view, even if your company is working vertical.

4.3.7 New business models

Many of the respondents talked about that it is necessary with new business models that are adjusted to smart mobility. One example brought up by one of the respondents from the

university was about last mile deliveries. The transportation of the goods could be bike-based and be oriented by centralized drop-off points to minimize the number of goods in transit in the city center. However, this requires a whole new business model and regulations, according to the respondents. An additional example brought up by a respondent from the university was that a change in the regulation on the size of the parking lots to the houses in the urban areas could result in the freeing of space which could be used for creating delivery boxes, but it would require new business models for the real estate-owners and delivery companies. Another example was brought up by a respondent from the university as to how the automotive industry will cope with a possible transition towards mobility as a service, MaaS, as it could potentially decrease the number of sold vehicles and that the respondent was unsure whether the industrial actors are prepared for the transition.

5. Analysis of the empirical findings

In the following chapter are the empirical findings are analyzed. The analysis aims to identify relationships between the different findings and what they implicate for the system.

5.1 Preferences on smart mobility

The previously identified preferences are analyzed in the following subchapter.

5.1.1 Efficient mobility systems

The efficient mobility system is divided into three parts, which is in line with the empirical findings and the theoretical framework. However, the achievement of an efficient mobility system can be done in several ways, but one of the essential parts is also that the system as a whole need to be connected, which is not achieved today according to Skjutare, Dahlén, & Van Rens (2018) that argues the same as the respondents from the interviews from all parts of triple helix mentioned. The argumentation adds to the previous literature that having a connected smart mobility system, can it be easier to see where there are potential for efficiency improvements. However, area efficient transports, infrastructure investment, and optimization of logistics are hands-on solutions that benefit the efficiency of the mobility systems if where factors are taking into account. Furthermore, the preference here is to have an efficient mobility system and take these three parts into consideration.

Area efficient transports

One of the preferences mentioned in the empirical findings is area efficient transport. This preference is important as the cities are becoming more urban, an area efficient use of the land becomes crucial as presented in chapter 4.1.1. A large portion of the land today is mainly used by cars and by having area efficient transport it could free up space in the city as mentioned by respondents from the local government which is in line with previous literature. If space is freed by using more area efficient transport could this space instead be used for buildings, playgrounds, outdoor cafés, parks and other meeting places, which can benefit the social sustainability.

Both Firth (2014) and Wulfhorst, Kenworthy, Kesselring, and Lanzendorf (2013) argues that the area efficient modes of transport should be prioritized when developing the urban environment. However, our results suggest that there might be a difference in prioritization regarding area efficient transport between the industry and the local government. The views of the local government are in line with the previous literature and want to have area efficient transport, but it was only mentioned by one of the respondents in the industry, which can be seen that it is not a priority among the industrial actors. However, this conclusion can be hard to draw as this study have only interviews a relatively small amount on people. The reason for

the industry not focusing on area efficient transportation can be due to them not always having the same knowledge within infrastructure as the local government has. The lack of focus from the industry on the infrastructure could be explained by the fact that they are not incentivized to take the infrastructure into account. The industry does not have any responsibility for the infrastructure at all, and definitely does not pay for the consequences of a suboptimal infrastructure and thereby does not have any incentives like to local government has.

Finally, the local government argues for that the industry should develop future mobility solutions that are in line with the local government's preferences and the literature and take area efficiency into account, and not continue to develop solutions that are, for example, not shared contrasting area efficiency. Consequently, the area efficiency of mobility is a preference that should be taken into account by all actors of the triple helix, and that it is only acknowledged by the local government today.

Infrastructure investments

The view that the current infrastructure might not be optimal for the future mobility was brought forward by all the respondents as well as the Department for Business Innovation & Skills (2013). The respondents claimed that the current infrastructure would need to be changed in order to both stimulate the development of smart mobility even further as well as reducing the waste of resources in the current infrastructure, which is also supported by the views of Bélissent (2010). However, the change of the infrastructure can be both costly and highly complex, as mentioned by Tzortzopoulos and Formoso (1999). The industry did not mention the cost factor for updating the infrastructure, which can be seen as a knowledge gap as they do not have the same infrastructural knowledge as the government. However, the local government talked about the cost and complexity, which is in line with the literature from Tzortzopoulos and Formoso (1999). Only one of the respondents from the university mention the issues with difficulties and cost in updating the infrastructure, this can be with similar argumentations for the industry's knowledge gap. However, one of our primary arguments for this knowledge gap for the industry and the university can be because of the local governments lacks in spreading their knowledge, preference, and communication.

When taking the preferences of smart mobility into account is the view coming from both the literature and respondents that the current infrastructure must be changed to create compatibility with the new mobility solutions. The current focus of the infrastructure was brought forward to favorizing the car and might not allow adequate integration of newer mobility solutions. To create a more efficient mobility system was it brought forward by the respondents and the literature that the integration of old and new solutions is essential. However, that would require that the local government are aware of which solutions and modes of transport that are most beneficial for the mobility system and not. A compatible infrastructure can benefit the mobility system and the smart city as a whole. Something that should be kept in mind is that there are multiple modes of transportation that need to be integrated into the same infrastructure, which

is mentioned by Raghunathan, Bergman, Hooker, Serra, and Kobori (2018) together with the respondents.

Furthermore, in order to achieve the different layers in smart cities, it is necessary with the infrastructural investment so that everything can be connected to the digital layer. We found that from the interviews that there is no such discussion that is ongoing today to connect the society to a digital layer. Finally, we found that infrastructure investment is seen as a preference by the respondents in the empirical findings. However, it is not a preference, it is more a solution that should be taking into account, which is in line with the literature. Without infrastructure investment is it hard to build a smart mobility system, so it needs to be done. The preference is more a to have a compatible and up to date infrastructure that is social sustainable and area efficient, and in order to have this it is first necessary with infrastructure investments.

Optimization of logistics

In order to achieve a smart city and smart mobility infrastructure, investment and area efficiency is required, as mentioned in previous subchapters, but it also requires an optimization of the logistics, as stated by Büscher, Coulton, Efstratiou, Gellersen, and Hemment (2012).

Alonso-Mora, Samaranayake, Wallar, Frazzoli and Rus (2017) points out in their study that optimization of logistics could be done without any involvement of high-tech solutions, and still meet the demands of the mobility system in a large urban area as they utilized the resources by better optimization of logistics. The same arguments were proposed by Holguín-Veras et al. (2011), who exemplified the same phenomena with off-hour deliveries in New York City. A conclusion of this is that non-high technology solution can optimize the system, which is the contrast of the industrial respondents' views concluding that the optimization of the system is achieved through the use of specific technologies. The industrial respondents' example was having intravehicular communication and communicate the state of the vehicle, so there can be a communication and use this data to optimize the traffic and prevent, for example, clog in the traffic. However, another industrial respondent talked about optimization of logistics can be done by last mile delivery and merging deliveries into one delivery instead of several deliveries per day, which is in line with Alonso-Mora, Samaranayake, Wallar, Frazzoli and Rus (2017). The industrial respondents were the only actors to describe the optimization of logistics in detail, which can be explained by the fact that the industry is the one actor providing the solutions to the society, whereas the university and local government are actors simply acting as stakeholders and describing the system on a macro level. Therefore, we found that the optimization of logistics as described by the industrial respondents are split into both high-tech solutions and non-tech solutions, with both being possible. To achieve an efficient mobility system could the optimization of logistic be used both high-tech and non-tech solutions.

When the area efficiency and infrastructure investment is done, it can free up space as mentioned in the above chapter, and this goes it goes hand in hand with optimization of logistics as it can also free up space in the city. An interesting conclusion is that the optimization of

logistics can be achieved by both non-tech and high-tech solutions, and it should consist of a mix of both that benefit the smart mobility system. However, with the same argument as for infrastructure investment is an optimization of logistics not a preference, more as a solution that needs to be done in order to achieve a functioning mobility system that can always be optimized.

5.1.2 Robustness

Robustness for the mobility system is a crucial factor for the local government as all the respondents mentioned it from the local government as well as Mees (2005). If the city's mobility system is not robust, will it not be sustainable for the citizen, university, or the industry to locate themselves in the city. If there are continuous mobility will it not be sustainable in the long-term to live in the city. The robustness of the mobility system was exemplified by the respondents as how much the traffic is clogged, how much maintenance problems there are with the infrastructure, and how hard it is to transport oneself and goods in the city. A similar argumentation was supported by Cats and Jenelius (2015b), who also drew the connection between the value of the mobility system for the actors in the ecosystem and the robustness (Cats & Jenelius, 2015a). If the robustness is not achieved it is likely that no one will place one's operations in the city, increasing the importance of the robustness for all actors in the triple helix. Intermetra business & Market research group AB (2018) argued in similarly meaning that the robustness and reliability are crucial for creating an attractive living environment for the end users, as they sought after simplicity and a system that is always functioning.

The robustness can be achieved in several different ways, which intra- and intervehicle communication can be seen one solution that benefits the robustness. Intravehicular communication can be used to increase the awareness of the state of the well-being of the vehicles and prevent possible breakdown, and we found that this can increase the robustness in the city. The intra- and intervehicle communication is one of the solutions that benefit the robustness in the system, without communication in the mobility system will not be robust with the new era and highly advanced technology that is rising.

Robustness is a preference that was mention by all the respondents from the local government. The industry and university did not share the importance of the robustness for the mobility system. This can be explained to their lack of focus on how the mobility system as a whole function in a city, which the local government has.

5.1.3 Affordability

Affordability for the industry means how affordable the development, production, and operation of the solution is for the providing company, as brought forward by the interviewees. The affordability for the industry has the following implication, if there is no economic rationale for a company to put its effort into one solution, will they cease to do so, resulting in a solution not made available to the end users. Also, affordability for the industry means that it should be

affordable to have their industry in the city, there should be citizens that can work for the companies, it should be possible to sell product and operate their business. The governmental respondents described the affordability for the government as the costs related to acquiring and operating solutions if the costs related to the solution is too high will the government not adopt the solution, which results in the industry either possibly being less motivated in developing related solutions. The argumentation of the interviewees is in line with Hine (2012), who describes the affordability for achieving adequate adoption of the solution. However, as Li, Namaki Raghi, and Kapl (2017) describe, is the current way of evaluating the solutions not always capable of weighing in the difference in composition and might thereby give an unfair comparison influencing the adoption rate. For the end users, which in this case is the citizens, does the affordability mean the individual's ability to make the solution available to the individual based on monetary, time, or energy factors. If the solution is not affordable for the end user, either through subsidies or by the offer itself, will the adoption of the solution not happen, meaning that the efforts made in the previous steps have been in vain. Furthermore, should it be affordable for the citizens to transport themselves in the city, affordable in that term that they can get a job in the city, provide them economically by having a job and finally transport themselves in an affordable way. The argumentation is in line with what Stålander and Willander (2013) say, as they point out that new technical solution will never succeed if it does not have any financial benefits for the end user, as time, price, or energy factors.

5.1.4 Sustainability

Future mobility has an emphasis on environmental sustainability due to the currently unsustainable way of conducting transport today, as described by the respondents. The respondents' views are supported by the arguments of Hine (2012), who describes the close relationship between the mobility system and the sustainability of the society. The view if Hine (2012) and the respondents are supported by Lyons (2004) who argued that the mobility system affects the overall sustainability of the society and must be taken into consideration. Therefore, is this a highly vital preference to consider in all its forms, which was supported by the views of the respondents.

Both the respondents and European Commission (2011) argued for that environmentally sustainable mobility system can be achieved by developing more energy efficient solutions, more environmentally friendly propulsion technologies, and reducing the need for the vehicular mobility altogether.

By creating and adopting more environmentally friendly propulsion alternatives, it is possible to improve environmental sustainability by reducing the emissions by changing from combustion-based propulsion technologies to electric. Most of the respondents from the interviews claims that electrification is the future to achieve environmental sustainability. However, if the produced energy needed by the electric propulsion technologies is not produced sustainable will the propulsion have little effect on the overall sustainability, which is in line with the views of Korhonen, Honkasalo, and Seppälä (2017). Therefore, true sustainability will

not be achieved if the whole life cycle is not looked at, as stated by Korhonen, Honkasalo, and Seppälä (2017) and Niero and Irving Olsen (2016), nor will an adequate solution be achieved if the whole picture is not analyzed, as stated by Anderson and Johnson (1997). None of the respondents talked about the whole life cycle analyze.

If it is possible to create a living environment minimizing the need for mobility driven by produced energy, is there a potential for creating more sustainable mobility than today. By doing so will the overall energy consumption of the mobility system drop, leading to a reduced environmental effect with possible positive health effects adding to the effects, which is similar to what the European Commission (2010) describes. The argumentation is also similar to the points of Litman (2003), who proposes that the most significant effect on sustainability is achieved by planning the mobility system to reduce the need for mobility altogether. The health effects are related to the social sustainability meaning that having environmentally friendly models of transports can benefit social sustainability in the city. The effects of a more social sustainable mobility can cascade to the other parts of the sustainability concept, which according to Arbib and Seba (2017) is done by creating a mobility that is adaptable for everyone in the society.

To have economic sustainability and growth is a goal from the city as it creates an attractive city, and helps the development of the city, businesses, and university, which according to Falconer and Mitchell (2012) is achievable through the application of smart cities. On the contrary, an overloaded infrastructure hindering the mobility can present a significant obstacle to the economic growth by standing in the way of utilizing the full potential of the area, as stated by Arbib and Seba (2017).

5.1.5 Simplicity for the end user

The most basic need to be fulfilled is that the newly developed solution should simplify the life of the consumer enough to justify the use of the solution. The view is supported by both Intermetra Business and Market Research Group (2018), Van Audenhove, et al., 2018, and the respondents. As Intermetra Business and Market Research Group (2019) argues that one of the biggest problems with the future of mobility is the trust the end users have towards the technological development, it is possible to lower the barriers to change and increase the trust by creating a simple solution for the end users. A solution, or system, without an adequate level of simplicity for the end user might not trigger the adoption of the solution leading to an unimproved mobility system. Although the simplicity is beneficial for the individual user does the simplicity imply that a larger group of people can use the mobility solution, which in turn can lead to the creation of a more efficient mobility system which leads to that the population of a city can increase and use the mobility system.

The local government can be seen as the one actor responsible for looking out for the needs of the population in terms of mobility due to their overall responsibility for the development of the society. If the population can increase without being restricted to the current bottlenecks of

the mobility system, it is possible to create a more beneficial climate for the population and the business, leading to increased economic growth. When it comes to solutions related to smart mobility, it is essential for all the companies to concern the end customer and the simplicity for the end user when developing the solutions. Moreover, simplicity for the end user also contributes to social sustainability in the city as they can feel trust for the system and can move around with ease which makes the life more manageable, which is in line with the views of Arbib and Seba (2017). By always consider the simplicity for the end user agrees with the argument by (Van Audenhove, et al., 2018) as well.

The preference for achieving simplicity for the end user was brought up more by the respondents from the local government than by the respondents from the industry and university and can be explained by the different focuses on the applications of the technologies.

5.2 Trends affecting smart mobility

The identified trends from the interviews of future mobility are electrification, autonomously, servitization, digitalization and data security. As the development of these trends will most likely follow a rapid pace due to the high speed in increasing the computational capabilities, removing the technological bottlenecks, as described by Schaller (1997), are the companies are very keen to implement all the trends, as many of the respondents believe that this is the future when it comes to new solutions and technology. Therefore, everything will most likely contain elements of these trends.

Without an application of the future trends in the future mobility solutions is there a risk that the consumers and governmental actors will shy away from the solutions, thereby putting the company at risk. As mentioned by Fulton, Mason, and Meroux (2017), Arbib and Seba (2017), and Johnson and Walker (2016) will the use of the new technologies possibly change the nature of the ecosystem entirely. The increased technological capabilities of the smart mobility sector will probably lead to an additional stimulation of the innovation ecosystem, as mentioned by Bates (2001), which is why it is important to continue to stay up to date with the latest technological trends.

Many of the actors in the center of the mobility revolution have their views distorted by the fact that many actors within the mobility and smart city ecosystems are focusing too much on pinpoint, vertical applications of their technologies rather than the big picture of what the ecosystem need, falling into the potholes as described by Arnold and Wade (2015) and Moss Kanter (2006). To be able to create a solution that will be adopted by a group large enough is there a need to be closely connected to the market, as described by Ogden Armour and David (1980), to be able to understand the needs of the market fully.

5.2.1 Electrification

The electrification of the mobility system will lead to a reduction of the environmental footprint coming from the operation of the solutions, as described by IRENA (2017) and Automotive News Europe (2016) which is similar to the argumentation from all the respondents. However, as described by Korhonen, Honkasalo, and Seppälä (2017) must the whole power generation supply chain be sustainable in order for the emissions and pollutions to be reduced. As stated in chapter 5.1.4, if the whole life cycle of a solution is not looked at will true sustainability not be reached. As one of the goals with smart mobility is to reduce the pollution in city centers which is also one of the targets that EU has set up (European Commission, 2014), therefore, is electrification one of the technical solutions to this problem. All of this is similar to what the respondents said during the interviews, this can be because of the electrification is ongoing and therefore are the respondents kept up to date and enlightened about the trend. The connection between electrification and sustainability is brought forward by the respondents even more. The respondents argued that electric vehicles contribute to less pollution and less noise, which contributes to both environmental and social sustainability, which in turn is in line with the previous literature.

5.2.2 Autonomation

Autonomous technologies are an ongoing trend which can both provide benefits and disadvantages to the mobility system. The benefits are that it can provide improved traffic safety, fewer traffic jams, reduce labor costs, and allow inexpensive travel with more productive use of time, as mentioned in previous literature. Conversely, one respondent mentioned that if the cost for the travel is decreased and the time on the transport could be used more efficiently would it probably increase the amount of travel together with a reduced in job opportunities in the transportation sector as everything is autonomous which will result in more energy consumption. The increased energy consumption is a disadvantage that was seen by one of the respondents from the industry, which is very much likely to be true. The reason for only one respondent to discuss the topic can partially be explained to the respondent's connection to the automotive industry.

Even if autonomous vehicles can increase the capacity on the road network, safety, and less emission, as stated by Trafikanalys (2015), can it also cause negative effects. We found that one of the negative effects can be that autonomous vehicles do not solve anything regarding the area efficiency only if the service is shared. Our analysis is, therefore that the autonomous vehicles still takes up a lot of space and does not necessarily free up space in the city if there only one person in each car and this is the opposite of area efficiency. Therefore, autonomous vehicles do not necessarily free up space. However, if autonomous vehicles are combined with electrification, can it be beneficial, or at least less harmful, for the environment.

5.2.3 Servitization

The servitization was brought forward by the interviewees as the future of mobility and in mobility terms it often revolves around the concept of MaaS rather than private ownership of the ingoing parts of the mobility system for the end user, which is in line with the views of Wendle, Ljungberg, Fredricsson, and Lund (2018). The servitization trend together with the product orientation of many companies implies there is a need to shift to servitization in order to be sustainable and have a more circular economy instead of the classic linear economy. By having more servitization, it is possible to decrease the number of products on the market and increase the circularization of the economy. An example of this is to have servitization applied to cars and thereby create a MaaS solution, contributing to the area efficiency, and overall efficiency in the mobility system, as described by Alonso-Mora, Samaranyake, Wallar, Frazzoli, and Rus (2017). Servitization is one of the strategic trends that will affect the future business models, as the society is leaning towards being more service oriented. This was mentioned by the respondents, which is in line with the literature.

One of the respondents from the industry mentioned the shift in the consumers' behavior going from wanting to buy a product to want to buy a service. This is in line with the literature. However, our analysis is that it can be hard to satisfy the customers when delivering services instead of product, due to the complexity of service solutions compare to a product solution.

The respondents argued that the subsidization of today's mobility solutions might affect the transition towards servitized mobility solutions. It can be hard for new mobility solutions to compete with the established mobility solutions for that reason. In order for the adoption of the new servitized mobility solutions to happen must either the established solutions stop being subsidized or that the new solutions are being equally subsidized, according to the respondents.

5.2.4 Digitalization

The digitalization applied to the mobility system can result in a higher connectivity among the applications, which solves the problem proposed by Skjutare, Dahlén, and van Rens (2018) with a lacking connectivity across the whole system, eliminating the existence of isolated applications, and reaches the state proposed by the European Parliament (2010) and Corazza, Guida, Musso, and Tozzi (2016). The increased connectivity can also provide higher availability of relevant data points to utilize in the decision-making and can thereby benefit economic growth, as brought forward by Edquist and Henrekson (2017) as well as the respondents from the interviews. The view is supported by the Swedish Agency for Growth Policy Analysis (2014), who states the digitalization contributed highly to economic growth. The respondents also shared the opinion of the digitalization's connection to economic growth. However, an increased digital society will have consequences to the individual user, as mention by Müncher Kreis e.V. (2017), and must be taken into consideration due to the possibility of a changed public opinion and regulatory view of the situation. The view of Müncher Kreis e.V. (2017) was shared by the respondents who argued for that the possibility of new regulatory

view of the situation is critical for the establishment of new, connected mobility solutions, which adds up to the criticality of understanding how the regulatory apparatus affects the development.

As digitalization is becoming more common in all solutions, the solutions also need to have adequate data security in order to achieve robustness, this was mentioned mostly by the local government during the interview as they are very keen about data security and security for the citizens. The security of the systems is to avoid having the mobility system being hacked, ensuring the functionality and safety of the mobility system and the solutions, as Jansen and Neschke (2018) argued for being critical for a digital system to function. A mobility system without adequate robustness will most likely do more harm than good by having varying performance, which is in line with the views of Panagiotopoulos and Dimitrakopoulos (2018). The data need to be safely stored, so no personal information can be leaked without approval or anonymous, which Gahi, Guennoun, and Mouftah (2016) argue. Data security was mentioned by all parts in triple helix. However, the industry talked more about open data, and how this could benefit the businesses, however, the local government was not sure, as the data security was an issue, and not leak personal information.

5.3 Problems the way of working

The way of working refers to the development processes and the related activities when developing smart mobility solutions in an urban area. These are problems that have been defined both from literature and from interviews, that hinder the way of working optimally. The ingoing parts of the way of working are analyzed in the following subchapter.

5.3.1 Need for a Vision

The lacking vision and spreading of the vision for smart mobility, as claimed by the interviewees, affect the ecosystem's possibility to create solutions that are compatible as there is no vision for the whole ecosystem. The argumentation is supported by the literature that describes it is necessary to have a common vision in order to achieve smart mobility in the cities. Therefore, a shared vision would lower the complexity of developing smart mobility solutions. As smart mobility solutions operate in the public realm, it is rational to assume that the common vision should be developed and spread by the government, as described in chapter 2.3.1 and by the interviewees from the industry and university. However, the findings from the interviews conclude that it is not clear whether the problem of the vision lies in the creation of the vision or if it lies in the spreading of the vision within the local government, and even furthermore, who should set the vision.

The problem with a lacking vision can be divided into problems related to the existence of a vision and problems related to the spreading of a vision. Bergman and Klefsjö (2010) describe that it is crucial with a vision. An analysis of the importance of a vision is that without a well-developed and well-spread vision from the government cannot the industry break down the

city's vision and construct their own that meets the cities preferences and vision of smart mobility in the society. The analysis supports the claims stated in chapter 2.3.2 and chapter 2.2.4, where it is stated that a lack of a vision increases the complexity of the development, which might result in the failure of the project altogether. The unclarities among all of the respondents whether a vision actually exists propose that the problem might lie in the spreading of the vision. If a vision exists, it is not clear, applicable, nor communicated as the employees of the local government and the industry has not adopted the vision entirely. We can see that there is a need for a vision, however everything regarding having a vision, communicating, or if there is an existing vision is unclear. We can also see that it is beneficial to have a vision to which the actors can gather themselves around and coordinate and thereby develop solutions that are compatible system wide.

An inadequately spread vision might lead to the same problems described in chapter 2.3.1. Therefore, it is possible to draw the conclusions that the communication of the vision is as important as the actual creation of it. The respondents argued for that a missing vision makes it problematic to know in which direction to work, and what the cities want from smart mobility, which is supported by the views of Bergman and Klefsjö (2010) and Van Audenhove et al. (2018). There are existing preferences from the actors in the local government, but the preferences have not been communicated well to the ecosystem, leading to the industry not knowing what the preferences are, which can be seen for several of the preferences presented in table 2. The lack of a cohesion view of the situation, mainly comparing the industry's view with the view of the local government supports the arguments.

Long-Term thinking was an issue brought up by all of the respondents during the interviews. The vision should contain long-term goals of the organization as well as strategies for how to achieve the goals, as stated in chapter 2.3.1. Similarly, if the vision is long-term, it makes the industries relevant on the market in the future as well as mention by Van Audenhove, et al. (2018). Nevertheless, from the empirical findings, is there a need for more long term thinking today. However, several respondents from the academia mentioned that there is a problem related to the length of the mandate period of political offices. The mandate period is often only a four-year period, which was brought forward as the main reason for incentivizing the politicians in the local government to have a short-term sight in order to get reelected. An analysis of this is that it is sometimes problematic to think in long-term within the local government as they are very keen about getting reelected, leading to the conclusion that the local government does not have enough long-term thinking integrated into their way of working. The lack of long-term thinking within the local government can be problematic as it was brought forward by respondents from the local government as being one of their main responsibilities. If the one actor with the responsibility to have long-term thinking does not priorities, the long-term thinking implies that no actor will have the long-term actions in mind when developing and implementing smart mobility solutions, which might result in suboptimal mobility systems and solutions.

The local government's focus on the development and implementation of large-scale mobility projects in an urban area which can explain why the importance of a long-term perspective was brought up more by the respondents from the local government than by the respondents from the university and industry.

5.3.2 Coordination and collaboration

Respondents from all parts of the triple helix mentioned collaboration as an essential factor for developing smart mobility and that it affects the way of working, which is in line with the views presented by the literature. According to Etzkowitz & Ranga (2013), it is crucial to have collaboration in order to find new knowledge and solutions, which according to Angelidou (2014) is due to the need for balancing between the factors of the smart city.

In order to increase the knowledge and build coordination and collaboration is it necessary to build a bridge between the different actors due to the highly complex environment of an urban development project, as stated in chapter 2.3.1. Both Tzortzopoulos and Formoso (1999) and Vanolo (2014) argues that the gaps in understanding the situation can be addressed by collaboration between public and private actors. One solution is to increase the knowledge transfer and can create a collaborative leadership leading to better utilization of the joint resources and leveraging the different fields of expertise, which is in line with the views of McQuaid (2000). We have seen that there are several knowledge gaps as the local government and the industry often see different things but not each other's view. Conclusively, it is necessary with coordination and collaboration, otherwise is there a risk of missing out on knowledge, which is stated as often being the case in urban development projects in chapter 2.3.2.

The lack of coordination can be exemplified even further by how the establishment of new mobility actors takes place, as mentioned in the interviews. The exemplified increased interaction and collaborative approach would most likely benefit the ecosystem as a whole and is supported by the arguments stated in chapter 2.3.2. The government need to coordinate themselves with the new actors in the mobility field to avoid creating an unsustainable situation for the mobility system. Without proper interaction between the governmental actors and the new actors is there a risk of working against each other and thereby wasting resources or taking actions that need to be counteracted in a later stage. However, the collaboration between the actors might increase the complexity of the development effort even further. The increased complexity might lead to the failure of the whole development effort, as stated by Soomro and Zhang (2015) as it might be challenging to define the optimum level of collaboration in a complex ecosystem.

Collaboration and coordination can contribute to the creation of consensus on the responsibility issue, which increases the importance for the inter-organizational collaborations even further, as stated in chapter 3.1. A continuously developing situation without a clear target can lead to an even less coordinated situation, which has similarities to the reasoning of McQuaid (2000).

What we found that is primarily needed to be decided and developed by one or more actors are what the city as an ecosystem need from a mobility solution. A conclusion is that by communicating what the society needs, it is easier for the rest of the ecosystem to focus their development effort. However, due to the nature of the development of the smart mobility ecosystem, as described by both Tzortzopoulos and Formoso (1999) and Horstman and Witteveen (2013), will one single actor probably not rise to take on the managing role and decide which direction to work towards. Due to the nature of the collaboration of smart mobility solutions will the decision making most likely follow a consensus-oriented process requiring a high degree of cooperation, as described in chapter 2.3.2

Therefore, it is most likely impossible for one actor to take a leading role without intense cooperation with the other actors. A joint actor consisting of representatives from all actors of the triple helix is more likely to take on a more managing role than an individual actor. A joint actor, however, will make it difficult to entirely create a separation of the commercial side and the governance of the solutions, as brought forward by Amos (2004). However, the governance of the joint actor has different implications depending on how it is constructed. Due to the width of the application and loose connection between the actors will the management of a collaborative actor probably benefit from having the network-society management, achieving coordination by letting the different actors interact themselves, which is supported by Klinj and Teisman (2000b). The project- and process management forms are more applicable in an organization consisting of one or more actors that are well-integrated, which the smart mobility development efforts are not.

The respondents claimed that there are many collaboration projects between the government, industry, and the university not fulfilling their potential. The industrial respondents stated that they often see the collaboration projects as delivery project and not something that they could make use of while they also believe that the local government does not have enough competence to contribute to the technical solution except for investments. The industrial respondents' view of the lacking competence of the local government was supported by Kitchin, Coletta, Evans, and Heaphy (2018). However, the industry's view of the collaboration projects as delivery projects was not described by the literature and can only be speculated about, even if the results from the interviews imply that all actors seem to be aware of the importance of coordination and collaboration. Which, together with the view coming from the literature, it is hard to understand why the actors do not put into more resources into creating adequate coordination and collaboration efforts. One can argue for that the reason for the actors not allocating enough resources into coordinating and collaborating has not been found, but it is possible to speculate on whether the shared responsibility and difficulty in working cross-organizational results in the failure when trying to create the coordination and collaboration needed by the ecosystem.

The constant development of the society, as Shinn (2002) brought forward, will create an increased need for coordination among the actors in order to keep up with the pace and create relevant solutions. The view of Shinn (2002) was partially supported by the respondents who argued that the occurrence of the identified trends has created a rapidly changing situation for

the actors in the ecosystem. An increased collaboration by involving the universities can result in a higher knowledge transfer, as Etzkowitz and Ranga (2013) argue for can result in the higher utilization of the knowledge and creation of new enterprises. A constantly changing and complex situation implies that the coordination between actors is essential for being able to develop solutions that are relevant and compatible. It is highly unlikely for one actor to be able to have adequate knowledge of all parts of the whole mobility system at a reasonable cost, especially since the situation is continuously changing.

Due to the different scopes of the actors, with the companies often having a multinational or global point of view and the local government focusing mainly on the local environment, are multinational strategies among the governmental actors essential for achieving a connected society. The compatibility across markets are needed to create attractive conditions for the industry to want to invest in the technologies related to mobility, as described in chapter 2.3.2. The views described in chapter 2.3.2 supports the thesis that having multinational cooperation between the governmental actors makes it possible to create needed conditions for the industry, partly by creating standards for developed solutions or putting their resources into multiple possible solutions at once. However, the differences in the scope of the actors can lead to difficulties when coordinating and collaborating among themselves.

5.3.3 Requirement setting

There is a conflict of interest in setting the requirements, as mentioned in chapter 4.3.3. The industry wants the local government to set requirements, as stated by the industrial respondents. However, the local government does not want to set requirements, due to them believing that they do not have enough knowledge to set requirements together with the right to free enterprises making them unwilling to influence the industry unless it is necessary according to the governmental respondents. The university is also ambivalent in who should set the demand. Our finding here is that there is a conflict of interest.

Furthermore, we also found from the interviews that the government has knowledge of urban development that the industry does not have it in the same way according to respondents from across the triple helix. Besides, the industry has more knowledge about the technology than the government, which contributes to the possible conflict of interest in setting requirements, as knowledge is missing in both actors, as stated by respondents from across the triple helix. The lack of consensus on who is responsible for setting the requirements can also contribute to the lack of coordination and collaboration as well, which is discussed in the subchapter above and supported by Klijn and Teisman (2000a). The respondents, together with Ross and Schoman (1977) agreed with the arguments of Klijn and Teisman (2000a) and argued that it is difficult to create relevant solutions unless having an adequate requirement-setting process. The respondents agreed with Bäckstrand (2006) and Klijn and Teisman (2000a) on the matter that the governance of multi-actor partnerships increases the difficulty in setting the requirements, although they also agreed with Brouwer, Woodhill, Hemmati, Verhoosel, and van Vugt (2016) that multi-actor partnerships and consensus were essential for setting relevant requirements.

One solution to who should set requirements is that the local government can develop a cross-functional organization who define, develop, and set the requirements on the system. Such an organization enables the local government to maintain control, simultaneously as the industry can work freely towards fulfilling the requirements set by the cross-functional organization. By working in such a manner, can it be to connect the preferences and requirements with the industry's competence more efficient than today. However, it is crucial that the local government has the right knowledge within the requirement-setting organization, which is not the case today according to the argumentation of chapter 5.3.2. Another solution is that the local government can outsource the requirement setting to a suitable industrial actor. In order to outsource the requirement-setting to the industry, it is important for the local government to have a clear requirement-setting organization that has a holistic approach to avoid locking themselves in a vertical application. The aim of the requirement-setting organization should be to have a horizontal perspective for each layer of the city and to check that all actors comply with set requirements and standards to enable a connected city. Either way, how this conflict of interest is solved is it necessary with the set of requirements in some way, but firstly there is a need to set the first requirement, and that is; who should set the requirements?

5.3.4 New and compatible rules and regulations

The local government needs to create regulations in order to create an arena in which the companies, and other actors, are able to develop and operate their solutions, which is agreed upon by Ojo, Curry, Janowski, and Dzhusupova (2015) and Van Audenhove, et al. (2018). The new technology and solutions will create a need for new rules and regulations governing and protecting the actors on the market. The view brought forward by the respondents that the lacking coverage of today's regulations on smart mobility and smart cities stands in line with the points of Riva Sanseverino and Orlando (2014) who argued for that there are no relevant regulations for the area. Therefore, do the results imply that it is necessary to create new regulations to avoid having grey areas in the legislation.

The new rules and regulations will lead to new conditions on the market, possibly influencing the development even further, which, according to Van Audenhove, et al. (2018) might drive the innovation, as stated in chapter 2.3.4. Trafikanalys (2016) and the interviews share this view as without compatibility between the regulatory processes, and the industry is there a risk that the development is influenced in a negative manner resulting in a suboptimal solution, or a solution in breach of the regulatory standards of the society. As regulations, for example, fewer combustion engines on the market drives innovation as alternative solutions need to be developed, which is stated by Van Audenhove et al. (2018) and also stated by the local government during the interviews. As mentioned in chapter 2.3.2 might the differences in legislative actions applicable to the private and public sector result in a higher difficulty in cooperating, leading to a need to create a common understanding on how the actual work should be conducted. An unclear understanding of responsibility and what is allowed to do and not, will put the cooperative project at risk, as described in chapter 2.3.3.

As stated from the interviews is there lack of consensus on who should be for setting the requirements on how the development should go can we draw the conclusion that the cities always keep in mind that the situation is dynamic and can change rapidly, translating into that the rules and regulations might hinder the development or become obsolete quickly. It is vital that the cities keep themselves up to date, partly by interacting with the joint projects, to know how to construct the regulations to avoid having them act as a hinder for the development. By constructing a regulatory framework that is up to date will the cities, as mentioned by the interviewees from the local government and Ojo, Curry, Janowski, and Dzhusupova (2015), give the industry the conditions to work more freely and thereby come up with more relevant solutions for the mobility system. Furthermore, the governments' processes can be seen as slow, and this can also hinder the development as the technology often can move faster than the government rules and regulation process.

The change in how the digital market is regulated in the EU has led to the need for a more synchronized regulatory framework across the EU to avoid the fragmentation of the different national markets, as stated in chapter 2.3.4. According to the interviews and the literature has pressure from the EU on how to address the sustainability issues led to an increased need to cooperate and create synchronized legislation in addition to the cities' own legislation on the local level. However, such a coordination can be challenging to put in place due to the number of actors with different conditions that need to be taken in consideration, as mentioned by both McQuaid (2000) and the European Commission (2016d), especially the legal differences between the public and private actors, as mentioned by Drewry (2000). The potential change in the regulatory framework can present a dynamic situation that is hard to predict and to cope with due to the uncertainties in the situation. Without the compatibility in the regulatory framework will the compatibility between solutions be hard to reach, as mentioned in chapter 2.3.2.

5.3.5 Technology utilization

By having the right technology on the right application, it is possible to reduce the amount of maintenance, create a more robust system, as well as increase resource utilization. Even if the digitalization is on the rise, and there is a need for digitalized applications does it not necessarily mean that every application has to be digitalized as much as possible, arguments similar to Adner and Kapoor (2016) who proposes that new and old solutions should coexist in order to maximize the value for the ecosystem. The view was partially shared by the respondents who argued that applying 5G solutions to all applications result in an unnecessary complex system that does not utilize the full potential of the technology if it does not require such an advanced solution, and thereby overshooting the needs with the performance of the technology, which is also supported by Oliver (2002).

The different layers of the smart city, as described in chapter 1.1, are equally important and the view was shared by the respondents as a city cannot function without the ingoing parts of it. The digital layer, however, implies a built-in weakness as the connection between all

applications can result in a decreased robustness of the system as the applications are dependent on the same infrastructure, as described by the respondents. Therefore, might it be wise to avoid connecting all applications to the same grid, or even to avoid connecting all solutions at all.

5.3.6 Working on the verticals

The results point towards it is clear that many actors in the industry are working on the verticals. Some of the respondents from the industry mentioned it themselves, but the university and local government also mentioned it. This way of working can affect the coordination, making it more challenging to grasp the whole picture, resulting in the failure of the smart mobility implementation, although it is important to have some degree of verticality to achieve an adequate knowledge depth. However, Arnold and Wade (2015) argue for that a focus on the subcomponents might result in failing to analyze the situation correctly, although Anderson and Johnson (1997) brought forward the importance of having some degree of verticality combined with the horizontal view.

The different actors were claimed by the respondents to have different fields of responsibility for the development, which is supported by the views of Hoon Kwak, Chih, and Ibbs (2009). The respondents said that the separation of the actors might be necessary to be able to cope with the complexity of the development as well as the conflict of interests among the actors, which is in line with Shoji (2001). To have the local government to work on the vertical might not fruitful due to their lacking technical knowledge and the difficulty in finding a solution benefiting both the whole city and the individual citizens. It might be difficult to reach an adequate level of innovativeness if the actors are working too much on the verticals, which is in line with chapter 2.3.6. An analysis of this is that if adequate innovativeness is not reached can the development be affected in such a way that the solutions actually benefiting the society are not being developed, or at least that the development is stuck in an incremental innovation cycle instead of the possibly necessary disruptive innovations. Therefore, can it be needed to achieve coordination by having one or multiple actors working horizontally while others are working vertically, achieving the long- and short-term perspective on different levels of the system, which adds to previous literature. However, as stated in chapter 2.3.6, it is crucial not to have a too narrow scope to avoid the difficulties in connecting the components of the situation to construct an understanding on a higher level. However, still, we can see that the companies' primary concern does not lie in this area but rather on the application of their own technologies.

5.3.7 Business models

As mentioned by Vandermerwe and Rada (1988) might the new way of delivering value to the end user create a need to change the business models of the mobility actors. The view was shared by the respondents who added that they were skeptical about whether the industry is prepared for the needed shift. If one actor of the industry fails to evolve is there a risk that another more capable actor will outcompete them with a better-developed business model. The respondents claimed that it is essential for the actors within smart mobility to continuously

develop their business models to utilize the potential of the new technologies and ways of delivering value, which is in line with the views of Sandström and Karlson (2016), Bélissent (2018), and Van Audenhove et al. (2018).

Circular economy was claimed by the respondents to have a strong connection to mobility and should be taken into consideration when creating new business models for the mobility actors. From the literature is can smart mobility be seen as an expression of the circular economy as it enables a closed system not necessarily releasing emissions and enables a high utilization rate and thereby reduce the resource consumption, as described in chapter 2.2.3. Consequently, the interviews response on circular economy is in line with the literature.

One of the more significant trends that is ahead is the electrification. Electric propulsion is in line with the circular economy principles if the origin of the electric energy is sustainable, which is not the case for the majority of the energy production today, as described in chapter 2.2.1 and chapter 2.2.3. The arguments of Korhonen, Honkasalo, and Seppälä (2017) that the use of sustainable technologies is enabling an additional shift towards a sustainable society is in line with the views of Seba (2014), that the more that has adopted a certain technology, the bigger the demand and the faster will the shift towards that technology be. The views of Korhonen, Honkasalo, and Seppälä (2017) and Seba (2014) is in line with the views of the respondents who argued for that the electrification might reshape the entire mobility sector. Therefore, it is important to keep the business models up to date as the technologies evolve.

Our results point towards that it is also needed to develop new business models describing how the value is being transferred in the ecosystem, how the value is captured, and how the solutions' operations are being sustained. Without a long-term perspective, vision, and business model, it is not possible to create a sustainable city and industry, which is supported by the work of Anderson and Johnson (1997) as well as the respondents. If a short-term perspective only is used without a long-term perspective, it is possible that the company will not survive on the market or create suboptimal solutions. Lastly, the servitization was mentioned by the respondents as a new business model and that the society should shift towards more servitization.

5.4. Triple helix

The following subchapter is an analysis of triple helix and how consensus, knowledge and innovation space could be used in order to come to a shared understanding, as the results from the empirical findings differ between the different actors in the triple helix.

The conflict of interest between the actors of the triple helix leads to further difficulty in coordinating around how to achieve smart mobility. A consensus of how the different areas of responsibility should look like would enable the development and possibly increase the speed of the development, as described in chapter 2.3.2. The conflict mainly revolved around who should set requirements. However, the government does not necessarily have the technical

knowledge, as described by Kitchin, Coletta, Evans, and Heaphy (2018), which has been seen from the interviews and therefore might be hard to convince if not presented in an efficient way promoting the public and governmental benefit.

However, there are many points that all three parts of triple helix agree on, for example, that a vision for the ecosystem must be in place. The importance of a vision is something that was mentioned during the interviews, that the vision of smart mobility and smart city is missing, and that it, therefore, can be hard to coordinate. One of the problems, in this case, is that the overall vision has never been created. The companies have instead created only a mission than a vision when it comes to mobility.

As mentioned in chapter 5.3.2, we can see that there is a need for more coordination and collaboration. An important factor that Etzkowitz & Ranga (2013) suggest that increases collaboration and coordination is knowledge transfer. We can see that all parts of triple helix need to transfer their knowledge to the other actors. By transferring their knowledge, it is possible to benefit the mobility, and not only leave solutions unused, wasting their potential and the resources that were put into the development. The transfer is necessary for the knowledge to be capitalized and transferred to the society and eventually benefit economic growth. Furthermore, an innovation space, as described in chapter 3.1, can also be beneficial for the knowledge transfer as the solutions can be handed over to the industry, approved by the local government, or create new ideas together. A shared space where the different actors can work together lower the barriers to coordinating and collaborating across organizational boundaries.

We believe that these two factors can help coordination and collaboration. Finally, it has been seen that there is a conflict of interest in setting requirements, as no one wants to take responsibility for setting the requirements. A suggestion to solve this is a consensus space, as stated in chapter 3.1. This can lower the barriers even further to the coordination and collaboration between the actors. The consensus space could thereby address the conflict of interest on the matter which should set the requirements by having the actors discussing and coming up with a joint conclusion.

6. Conclusions

The chapter consists of the concluding remarks of the study and evaluates whether the research question has been answered by the research effort and to what extent. The conclusion is presented in three categories, which is the same structure during the whole report, preference, trends and way of working.

6.1 Preferences

According to the previous literature as well as our interviews, the general goals of the smart mobility are to reduce the environmental and noise pollution, easing the congestions on the roads, increase in efficiency, increasing the safety, and improving the system's speed and capacity, while reducing the overall costs related to the mobility.

We found that society's preferences on smart mobility are an efficient mobility system that is robust, affordable, sustainable, and that also simplifies life for the end user. These preferences should be taken into account by all parts of the triple helix when developing, implementing, and evaluating solutions, according to the interviews and literature.

Our findings suggest that the efficiency of the mobility system revolves around having an overall efficient mobility system where area efficiency is taken into account. By having area efficient mobility in the city, it is possible to free up space that could be used for buildings or meeting places that benefits the social sustainability. However, we found that there is a clash when prioritizing area efficiency between the industry and the local government, as the views of the local government are more in line with previous literature than the views of the industry that still focuses on selling products at a high quantity than services.

Furthermore, the optimization of the logistics and infrastructural investments was seen as sub-preferences within efficiency by the interviewees, but these are more solutions to fulfill the preference. However, it is necessary with infrastructural investments to create an infrastructure that is compatible with both new and old mobility solutions to achieve area efficiency. Finally, the optimization of logistic also contributes to an efficient mobility system, and this can be done with both high-tech solutions, as utilizing vehicular communication technologies to optimize the mobility system, and non-tech solutions, as scheduling the usage of the mobility system more efficiently.

The robustness is a preference that we found highly important to the local government, and this can be achieved with intra- and inter-vehicle communication in order to achieve a robust smart mobility system. The view of the robustness' importance was not shared among the industry and university as only one respondent of each category mentioned it compared to almost all respondents from the local government. However, most important is to have a robust society in a social sustainable matter so that the citizens can move freely in the city.

The conclusion we found regarding the affordability is that the mobility solution should be affordable for all actors in the city. It should be affordable for the citizen to move around, live and get a job in the city. Similarly, should it be affordable for the industry to have their operations in the city. Lastly should it be affordable for the local government to purchase and operate the smart mobility solutions.

From the literature and the interviews was sustainability found to be a preference that all parts of the society should take into account. Sustainability revolved around, economic, environmental and social sustainability. Sustainability in all its forms can be seen as the core of a smart city and must be integrated into all activities and processes when developing smart mobility.

One of the preferences that the society has was found to be simplicity for the end user. From the interviews, it became clear that all activities should be aimed at fulfilling the needs of the customer, which is to be simple, as it was found in the literature that the citizens do not want to change their way of living.

The different actors of the triple helix have several preferences that need to be fulfilled as well as a number of factors influencing the development. There are similarities between what needs to be done by each actor, but there are also differences. The different actors have different ways of working, and different responsibilities, which leads to a lack of "one size fits all" solution. Thereby must the different actors' situation be analyzed individually and merged with the general preferences of the ecosystem.

6.2 Trends

Four trends were found in the interviews and literature. These trends are electrification, autonomous, digitalization, and servitization. These trends will permeate future mobility and affect the smart mobility field profoundly in the future and must be included in various extent in the development of smart mobility solutions. Some of the trends are already ongoing, and others are in the near future, as servitization.

6.3 Way of working

It has become clear from the interviews that the different actors in the triple helix present the same arguments from a different point of views in the general case. However, there are areas where the different actors have not reached consensus on what the problem is and who is to blame.

We can see from interviews that a common vision to work towards is missing, which affects the coordination efforts. It is difficult to achieve adequate coordination, or even develop successful solutions if the industry and local government do not have a clear nor joint vision that is well spread of what to achieve. The common vision should contain the previously

mentioned preferences. However, it is necessary with an actor that sets requirements in order to know which direction to develop towards. Our interviews revealed that who should set the requirements is a conflict of interest between the industry and the local government. Not having one actor to set requirements makes it hard to achieve an adequate way of working. It is problematic that no one steps forward and sets the requirements for smart mobility as it would decrease the difficulty in the development substantially by enabling the actors to focus their efforts. The industry argues that the local government should decide what is needed, and the local government argues that they lack the domain-specific knowledge needed and that it is not their responsibility to affect the free market. There is a need for consensus between this, so the different parts are working towards the same goal.

The interviews showed that the different focuses of the actors of the triple helix could result in difficulties when collaborating and creating a common vision as the local government's focus is only locally. The industrial actors can have focuses varying from being local to global at the same time, and with the needs of the society varies depending on the location and technological maturity. Therefore, the importance of long-term thinking has been identified from the interviews, due to the complexity of the urban mobility systems as well as the life length of the solutions and infrastructure of the system. Without an adequate planning horizon, is there a risk that efforts separated chronologically will counteract each other.

From the interviews, we found that the current regulatory framework might hinder the development of smart mobility or result in non-applicable regulations to the solutions, which in turn might affect the society negatively. It is needed to construct regulations that are up to date and relevant to the new solutions to avoid suboptimal situations and help stimulating the development. However, the nature of the process creating regulations might not be able to cope with the pace of technological development.

In order to avoid wasting resources when creating and using the mobility system is the technology utilization of highest importance. Not all applications require the most advanced technologies, as that would result in not utilizing the full potential of the technology and would result in an unnecessarily high cost. However, the technology utilization implies that the performance of the technology should be high enough to fulfill the needs of the solutions to avoid creating a suboptimal solution.

Another conclusion is that the vast majority of the companies active in smart mobility domain are working on the verticals, which was mostly stated by the industry from the interviews. Working on the verticals means that they are developing solutions that are very specific to one problem and have little regards to the possibility to apply the knowledge of the solution to problems in adjacent areas or the ecosystem in general and create synergy effects. This finding implies that the industry, university, nor the local government truly knows what they want or need. The problem with working on the verticals is that lock-in effects occur, and it can be more challenging to update or integrate the new solutions to both current and future solutions.

We also found from the literature, that in order to achieve the optimal adoption rate and value delivery will the new solutions most likely need new business models. New business trends could increase the sustainability of the solutions. Without new business models that are compatible with the trends and new solutions, it is possible that the society will refrain from the new solutions and that the smart mobility effort will stagnate. Servitization is one of the strategic trends found from the literature and interviews that will affect the future business models, as the society is leaning more to services oriented.

One of the gaps within triple helix is there is a knowledge gap which was seen when comparing views from the interviews between the industry and local government. The industry has a lacking understanding of the city's requirements and city planning, as the local government wants to achieve better area efficiency while none of the respondents from the industry mentioned that. This can be because absent communication of the requirements from the cites or that the industry is still very product oriented in sales and still wants to sell products. Furthermore, to archive higher coordination and collaboration in triple helix could innovation space, knowledge transfer and consensus space be adopted.

7. Further research

Several areas have been identified in need of further research to sort out any lack of clarities on how the situation looks like and are presented below.

A more thorough research effort capturing the preferences and requirements coming from the individual actors within a city in higher detail would help the creation of relevant solutions.

It would be beneficial to evaluate the performance of the current collaboration efforts in order to see which efforts that are value-adding, and how the general collaboration across the actors are doing and why.

An evaluation on which actor should be the one setting the requirements for the ecosystem would benefit the creation of consensus among the actors and also see how a horizontal actor could look like and operate.

Pilot tests evaluating smart mobility solutions in real life would benefit the creation of relevant solutions as well as the implementation of them.

8. References

Acemoglu, D., Aghion, P., & Zilibotti, F. (2003). Vertical Integration and Distance to Frontier. *Journal of the European Economic Association, 1*(2-3), 630-638.

Adner, R., & Kapoor, R. (2016). Right tech, wrong time. *Harvard Business Review, 94*(November), 60-67.

Alm, E., Colliander, N., Deforche, F., Lind, F., Stohne, V., & Sundström, S. (2016). *Digitizing Europe: Why Northern European frontrunners must drive digitization of the EU economy.* The Boston Consulting Group. Retrieved 02 15, 2019, from http://imagesrc. bcg. com/BCG_COM/Digitizing-Europe-May-2016_tcm9-37

Alonso-Mora, J., Samaranayake, S., Wallar, A., Frazzoli, E., & Rus, D. (2017). On-demand high-capacity ride-sharing via dynamic trip-vehicle assignment. *Proceedings of the National Academy of Sciences, 114(3)*, pp. 462-467.

Amos, P. (2004). *Public and Private Sector Roles in the Supply of Transport Infrastructure and Services - Operational Guidance for World Bank Staff.* Washington: World Bank.

Anderson, V., & Johnson, L. (1997). *System Thinking Basics: From Concepts to Casual Loops.* Cambridge: Pegasus Communications, Inc.

Angelidou, M. (2014). Smart city policies: A spatial approach. *Cities, 41*(July), 3-11.

Arbib, J., & Seba, T. (2017). *Rethinking Transportation 2020-2030.* San Francisco: RethinkX.

Arnold, R. D., & Wade, J. P. (2015). A Definition of Systems Thinking: A Systems Approach. *Procedia Computer Science, 44*(2015), 669-678.

Assadourian, E. (2010). Transforming Cultures: From Consumerism to Sustainability. *Journal of Macromarketing, 30*(2), 186-191.

Automotive News Europe. (2016, April 08). *Germany to tackle older diesels by empowering city bans.* Retrieved 03 12, 2019, from Automotive News Europe: http://europe.autonews.com/article/20160408/ANE/160409801/germany- to-tackle-older-diesels-by-empowering-city-bans.

Avila-Torres, P., Caballero, R., Litvinchev, I., Lopez-Irarragorri, F., & Vasant, P. (2018). The urban transport planning with uncertainty in demand and travel time: a comparison of two defuzzication methods. *Journal of Ambient Intelligence and Humanized Computing, 9*(3), 843-856.

Baines, T., Lightfoot, H., & Smart, P. (2011). Servitization within manufacturing: Exploring the provision of advanced services and their impact on vertical integration. *Journal of Manufacturing Technology Management, 22(7)*, 947-954.

Bakici, T., Almirall, E., & Wareham, J. (2013). A smart city initiative: The case of Barcelona. *Journal of the Knowledge Economy, 4(2),*, 135–148.

Bates, T. (2001). The Continuing Evolution of ICT Capacity: The Implications for Education. In G. M. Farrell, *The Changing Faces of Virtual Education* (pp. 29-46). Vancouver: The Commonwealth of Learning.

Bélissent, J. (2010). *Getting Clever About Smart Cities: New Opportunities Require New Business Models.* Cambridge: Forrester Research.

Benevolo, C., Dameri, R., & D'Auria, B. (2014). Smart Mobility in Smart City: ICT intensity, impact and public benefits. *itAIS 2014 XI Conference of the Italian Chapter of AIS Digital Innovation and Inclusive Knowledge in Times of Change,*. Genoa.

Bergman, B., & Klefsjö, B. (2010). *Quality : from customer needs to customer satisfaction.* Lund: Studentlitteratur.

Brouwer, H., Woodhill, J., Hemmati, M., Verhoosel, K., & van Vugt, S. (2016). *The MSP Guide - How to Design and Facilitate Multi-Stakeholder Partnerships.* Warwickshire: Practical Action Publishing Ltd.

Bryman, A., & Bell, E. (2015). *Business Research Methods.* Oxford: Oxford University Press.

Büscher, M., Coulton, P., Efstratiou, C., Gellersen, H., & Hemment, D. (2012). Connected, Computed, Collective: Smart Mobilities. In J. Urry, & M. Grieco, *Mobilities: New Perspective on Transport and Society* (pp. 135-158). Farnham: Ashgate Publishing Limited.

Bäckstrand, K. (2006). Multi-Stakeholder Partnerships for Sustainable Development: Rethinking Legitimacy, Accountability and Effectiveness. *European Environment, 16*(2006), 290-306.

Caragliu, A., Del Bo, A., & Nijkamp, P. (2011). Smart Cities in Europe. *Journal of Urban Technology, 18*(2), 65-82.

Cats, O., & Jenelius, E. (2015a). The value of new public transport links for network robustness and redundancy. *Transportmetrica A: Transport Science, 11*(9), 819-835.

Cats, O., & Jenelius, E. (2015b). Planning for the unexpected: The value of reserve capacity for public transport network robustness. *Transportation Research Part A, 81*(2015), 47-61.

Chourabi, H., Nam, T., Walker, S., Ramon Gil-Garcia, J., Mellouli, S., Nahon, K., . . . Jochen Scholl, H. (2012). Understanding Smart Cities: An Integrative Framework. *45th Hawaii International Conference on System Sciences* (pp. 2289-2297). Wailea: IEEE Computer Society.

Corazza, M. V., Guida, U., Musso, A., & Tozzi, M. (2016). A New Generation of Buses to Support More Sustainable Urban Transport Policies: A Path Towards "Greener" Awareness Among Bus Stakeholders in Europe. *Research in Transportation Economics, 55*(2016), 20-29.

Corazza, M. V., Magnalardo, S., Musso, A., Petracci, E., Tozzi, M., Vasari, D., & de Verdalle, E. (2018). Testing an Innovative Predictive Management System for Bus Fleets: Outcomes from the Ravenna Case Study. *IET Intelligent Transport Systems, 12*(4), 286-293.

Costa, P. B., Morais Neto, G. C., & Bertolde, A. I. (2017). Urban Mobility Indexes: A Brief Review of the Literature. *Transportation Research Procedia, 25*(2017), 3645-3655.

Department for Business Innovation & Skills. (2013). *Smart Cities: Background Paper.* London: Department for Business Innovation & Skills.

Diener, E., & Crandall, R. (1978). *Ethics in Social and Behavioral Science.* Chicago: University of Chicago Press.

Drewry, G. (2000). Public-Private Partnerships - Rethinking the Boundary Between Public and Private Law. In S. Osborne, *Public-Private Partnerships: Theory and Practice in International Perspecive* (pp. 57-69). London: Routledge.

Dutch Government. (2016). *Declaration of Amsterdam "Cooperation in the Field of Connected and Automated Driving".* Amstedram: Dutch Government.

Edquist, H., & Henrekson, M. (2017). Swedish lessons: How Important are ICT and R&D to Economic Growth? *Structural Change and Economic Dynamics, 42*(2017), 1-12.

Elloumi, O. (2015). *Horizontal platforms offer fast track to vertical applications – applicability of one M2M to smart city and smart living.* oneM2M: Alcatel-Lucent.

Eriksson, L., & Wiedersheim-Paul, F. (2014). *Att utreda, forska och rapportera* (10 ed.). Stockholm: LIber AB.

Etzkowitz, H. (2003). Innovation in Innovation: The Triple Helix of University-Industry-Government Relations. *Studies of Science, 42*(3), 297-337.

Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: from National Systems and ‘‘Mode 2’’ to a Triple Helix of university–industry–government relations. *Research policy*, *29*(2), 109.

Etzkowitz, H., & Ranga, M. (2013). Triple Helix systems: an analytical framework for innovation policy and practice in the Knowledge Society. *Industry and Higher Education, 27(4)*, 237–262.

European Commission. (2010). *Communication from the Commission Europe 2020 - A strategy for smart, sustainable and inclusive growth.* Brussels.

European Commission. (2011). *White Paper on transport.* Belgium: Publications Office of the European Union.

European Commission. (2014). *Communication from the Commision to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - A Policy Framework for Climate and Energy in the Period from 2020 to 2030.* Brussels: European Commission.

European Commission. (2016a, Nov 30). *Fact Sheet An EU strategy on cooperative, connected and automated mobility.* Retrieved 02 03, 2019, from European Commission: http://europa.eu/rapid/press-release_MEMO-16-3933_en.htm

European Commission. (2016b). *Strategic Plan 2016-2020: Directorate-General for Communications Networks, Content and Technology.* Brussels: European Commission.

European Commission. (2016c). *Proposal for a Directive of the European Parliament and of the Council on Copyright in the DIgital Single Market (2016/0280 (COD)).* Brussels: European Commission.

European Commission. (2016d). *C-ITS Platform - Final Report.* Brussels: European Commission.

European Commission. (2017). *Security Policy & Governance Framework for Deployment and Operation of Euorpean Coopearative Intelligent Transport Systems (C-ITS).* Brussels: Euopean Commission.

European Commission. (2018). *Communication from the Commission: On the Road to Automated Mobility: An EU strategy for Mobility of the Future.* Brussels: European Commission.

European Commission. (n.d.). *Smart Cities*. Retrieved 02 03, 2019, from European Comission: https://ec.europa.eu/info/eu-regional-and-urban-development/topics/cities-and-urban-development/city-initiatives/smart-cities_en#what-are-smart-cities

European Environment Agency. (2016). *Towards clean and smart mobility- Transport and environment in Europe.* Luxembourg: Publications Office of the European Union.

European Environmental Agency. (2015). *Urban sustainability issues - what is a resource-efficient city?* Copenhagen: European Environmental Agency.

European Parliament. (2010). *Directive 2010/40/EU of the European Parliament and of the Council of 7 July 2010 on the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport.* Brussels: European Parliament.

Falconer, G., & Mitchell, S. (2012). *Smart city framework: a systematic process for enabling smart + connected communities.* San Jose, CA: Cisco IBSG.

Firth, D. (2014). *Urban Mobility Strategy.* Stockholm: The City of Stockholm Traffic Administration Tekniska Nämndhuset.

Fromhold-Eisebith, M. (2017). Cyber-Physical Systems in Smart Cities - Mastering Technological, Economic, and Social Challenges. In H. Song, R. Srinivasan, & T. J. Sookoor, *Smart Cities: Foundations, Principles, and Applications* (pp. 1-22). Hoboken: Wiley.

Fulton, L., Mason, J., & Meroux, D. (2017). *Three Revolutions in Urban Transportation - How to achieve the full potential of vehicle electrification, automation and shared mobility in urban trans- portation systems around the world by 2050.* UC Davids & Institute for transportation and development policy.

Gahi, Y., Guennoun, M., & Mouftah, H. T. (2016). Big Data Analytics: Security and Privacy Challenges. *2016 IEEE Symposium on Computers and Communication (ISCC)* (pp. 952-957). Messina: IEEE.

Götz, K., & Ohnmacht, T. (2012). Research on Mobility and Lifestyle - What are the results? In J. Urry, & M. Grieco, *Mobilities: New Perspectives on Transport and Society* (pp. 91-108). Farnham: Ashgate Publishing Limited.

Hine, J. (2012). Mobility and Transport Disadvantage. In J. Urry, & M. Grieco, *Mobilities: New Perspectives on Transport and Society* (pp. 21-39). Farnham: Ashgate Publishing Limited.

Holguín-Veras, J., Ozbay, K., Kornhauser, A., Brom, M. A., Iyer, S., Yushimito, W. F., . . . Silas, M. A. (2011). Overall Impacts of Off-Hour Delivery Programs in New York City Metropolitan Area. *Transportation Research Record, 2238*(1), 68-76.

Hoon Kwak, Y., Chih, Y., & Ibbs, W. C. (2009). Toward a Comprehensive Understanding of Public Private Partnerships for Infrastructure Development. *California Management Review, 51*(2), 50-78.

Horstman, A., & Witteveen, W. (2013). Performance Indicators in the Best Value Approach. *Journal for the Advancement of Performance Information and Value, 5*(2), 59-78.

Intermetra Business & Market Research Group. (2019). *Framtidens mobilister - självkörande bilar, hållbara drivmedel, delningsvilja.* Gothenburg: Intermetra Business & Market Research Group.

Intermetra business & Market research group AB. (2018). *Kombinerad Mobilitet Kundperspektiv.* Gothenburg: Intermetra business & Market research group AB.

IRENA. (2017). *Electric Vehicles - Technology brief.* Abu Dhabi: International Renewable Energy Agency.

Jansen, C., & Jeschke, S. (2018). Mitigating risks of digitalization through manged industrial security services. *AI & Society, 33*(2), 163-173.

Johnson, C., & Walker, J. (2016). *Peak car ownership - the market opportunity of electric automated mobility services.* Boulder, CO: Rocky Mountain Institute.

Karim, D. M. (2017). Creating an Innovative Mobility Ecosystem for Urban Planning Areas. In G. Meyer, & S. Shaheen, *Disrupting Mobility - Impacts of Sharing Economy and Innovative Transportation on Cities* (pp. 21-47). Cham: Springer International Publishing AG.

Kato, S., Tsugawa, S., Tokuda, K., Matsui, T., & Fujii, H. (2002). Vehicle Control Algorithms for Cooperative Driving With Automated Vehicles and Intervehicle Communications. *IEEE Transactions on Intelligent Transportation Systems, 3*(3), 155-161.

Kitchin, R., Coletta, C., Evans, L., & Heaphy, L. (2018). Creating Smart Cities. In R. Kitchin, C. Coletta, L. Evans, & L. Heaphy, *Creating Smart Cities* (pp. 1-18). London: Routledge.

Klijn, E.-H., & Teisman, G. (2000a). Public-Private Partnershis in the European Union - Officially Suspect, Embraced in Daily Practice. In S. Osborne, *Public-Private*

Partnerships: Theory and Practice in International Perspective (pp. 166-186). London: Routledge.

Klijn, E.-H., & Teisman, G. R. (2000b). Governing Public-Private Partnerships: Analysing and Managing the Process and Institutional Characteristics of Public-Private Partnerships. In S. Osborne, *Public-Private Partnerships: Theory and Practice in International Perspective* (pp. 84-102). London: Routledge.

Komninos, N., Pallot, M., & Schaffers, H. (2013). Special Issue on Smart Cities and the Future Internet in Europe. *Journal of Knowledge Economy, 4*(2), 119-134.

Korhonen, J., Honkasalo, A., & Seppälä, J. (2017). Circular Economy: The Concept and its Limitations. *Ecological Economics, 143*(2018), 37-46.

Leiserowitz, A. A., Kates, R. W., & Parris, T. M. (2006). Sustainability Values, Attitudes, and Behaviors: A Review of Multinational and Global Trends. *Annual Review Environmental Resources, 31*(2006), 413-444.

Letaifa, S. B. (2015). How to strategize smart cities: Revealing the SMART model. *Journal of Business Research, 68(7)*, 1414–1419.

Leydesdorff, L., & Meyer, M. (2006). Triple Helix Indicators of Knowledge-Based Innovation Systems - Introduction to the Special Issue. *Research Policy, 35*(2006), 1441-1449.

Li, Y., Namaki Raghi, B., & Kapl, B. (2017). Using Public Procurement as an Instrument for Implementation of ITS. *12th ITS European Congress.* Strasbourg.

Lieder, M., & Rashid, A. (2016). Towards circular economy implementation: a comprehensive review in context of manufacturing industry. *Journal of cleaner production 115*, 36-51.

Litman, T. (2003). Measuring transportation: Traffic, mobility and accessibility. *ITE Journal, October*(73), 28-32.

Litman, T. (2003). *Reinventing Transportation - Exploring the Paradigm Shift Needed to Reconcile Transportation and Sustainability Objectives.* Victoria: Victoria Transport Policy Institute.

Lyons, G. (2004). Transport and society. *Transport reviews, 24*(4), 485-509.

Magnusson, J., & Nilsson, A. (2014). *Enterprise System Platforms - Transforming the Agenda.* Lund: Studentlitteratur AB.

Manville, C., Cochrane, G., Cave, J., Millard, J., Pederson, J., Thaarup, R., . . . Kottering, B. (2014). *Mapping Smart Cities in the EU.* Brussels: European Parliament - Directorate-general for Internal Politics.

Mattas, K., Makridis, M., Hallac, P., Alonso Raposo, M., Thiel, C., Toledo, T., & Ciuffo, B. (2018). Simulating deployment of connectivity and automation on the Antwerp ring road. *IET Intelligent Transport Systems, 12*(9), 1036-1044.

McQuaid, R. W. (2000). The Theory of Partnerships. In S. Osborne, *Public-Private Partnerships: Theory and Practice in International Perspective* (pp. 9-35). London: Routledge.

Mees, P. (2005). Responding to the Complex Transport Needs of Dispersed Wealthy Cities: a Comparison of Melbourne. Australia and Toronto, Canada. In G. Jörnson, & E. Tengström, *Urban Transport Development* (pp. 32-44). Berlin: Springer.

Mihyeon Jeon, C., Amekudzi, A. A., & Guensler, R. L. (2013). Sustainability assessment at the transportation planning level: Performance measurers and indexes. *Transport Policy, 25*(2013), 10-21.

Monzon, A. (2015). Smart cities concept and challenges: Bases for the assessment of smart city projects. *2015 International Conference on Smart Cities and Green ICT Systems (SMARTGREENS).* Lisbon: SMARTGREENS.

Moss Kanter, R. (2006). Innovation: The Classic Traps. *Harvard Business Review, 84*(11), 73-83.

Murray, A., Skene, K., & Haynes, K. (2017, Murray, Alan, Keith Skene, and Kathryn Haynes. "The circular economy: An interdisciplinary exploration of the concept and application in a global context." Journal of Business Ethics 140.3 (2017): 369-380.). The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context. *Journal of Business Ethics 140.3*, 369-380.

Münchner Kreis e.V. (2017). *Mobility.Fulfilment.System. - On the Future of Mobility 2025+*. Munich: Müncher Kreis e.V.

Nicolas, J. P., Pochet, P., & Poimboeuf, H. (2003). Towards sustainable mobility indicators. application to the Lyons conurbation. *Transport policy, 10*(2003), 197-208.

Niero, M., & Irving Olsen, S. (2016). Circular Economy: To Be or Not to Be in a Closed Product Loop? A Life Cycle Assessment of Aluminium Cans with Inclusions of Alloying Elements. *Resources, Conservation and Recycling, 114*(2016), 18-31.

Ogden Armour, H., & David, T. J. (1980). Vertical Integration and Technological Innovation. *The Review of Economics and Statistics, 62*(3), 470-474.

Ojo, A., Curry, E., Janowski, T., & Dzhusupova, Z. (2015). Designing Next Generation Smart City Initiatives: The SCID Framework. In M. Rodríguez-Bolívar, *Transforming City Governments for Successful Smart Cities* (pp. 43-68). Cham: Springer.

Oliver, R. W. (2002). Real-time strategy: the strategic sweet spot. *Journal of Business Strategy, 23*(2), 6-9.

Panagiotopoulos, I., & Dimitrakopoulos, G. (2018). Diffie-Hellman process and its use in secure and authenticated VC networks. *IET Intelligent Transport Systems, 12*(9), 1082-1087.

Perätola, S., & Ahokangas, P. (2018). Toward Smart City Business Models. *Journal of Business Models, 6*(2), 65-70.

Pettersson, F. (2014). *Swedish Infrastructure Policy and Planning Conditions for Sustainability.* (Doctoral Thesis): Lund University.

Puentes, R. (2015, January 20). *Opinions*. Retrieved June 03, 2019, from Brookings: https://www.brookings.edu/opinions/why-infrastructure-matters-rotten-roads-bum-economy/

Raghunathan, A. U., Bergman, D., Hooker, J., Serra, T., & Kobori, S. (2018). *Seamless Multimodal Transportation Scheduling.* Ithaca: Cornell University.

Riva Sanseverino, R., & Orlando, S. (2014). The Integration and Sharing of Resources for a New Quality of Living. In E. Riva Sanseverino, R. Riva Sanseverino, V. Vaccaro, & G. Zizzo, *Smart Rules for Smart Cities - Managing Efficient Cities in Euro-Mediterranean Countries* (pp. 29-44). Cham: Springer.

Ross, D. T., & Schoman, JR., K. E. (1977). Structured Analysis for Requirment Definition. *IEEE Transactions on Software Engineering, 3*(1), 6-15.

Sandström, C., & Karlson, N. (2016). *Digital Disruption: Konsekvenser för företagande, individer och samhälle.* Stockholm: Ratio.

Schaller, R. R. (1997). Moore's Law: Past, Present, and Future. *IEEE Spectrum, 34*(6), 53-59.

Seba, T. (2014). *Clean Disruption of Energy and Transportation.* Silicon Valley: Clean Planet Ventures.

Shamming, R., Herendeen, R. A., Hanson, M. J., & Wilson, E. J. (2010). A Multivariate Analysis of the Energy Intensity of Sprawl Versus Compact Living in the U.S. for 2003. *Ecological Economics, 69*(12), 2363-2373.

Shinn, T. (2002). The Triple Helix and New Production of Knowledge: Prepackaged Thinking on Science and Technology. *Social Studies of Science, 32*(4), 599-614.

Shoji, K. (2001). Lessons from Japanese Experiences of Role of Public and Private Sectors in Urban Transport. *Japan Railway & Transport Review, 29*(December), 12-18.

Sidewalk Labs. (2017). *Vision Sections of RFP Submission.* Tortonto: Sidewalk Labs.

Skjutare, K., Dahlén, A., & Van Rens, H. (2018). *Multimodal Information Sharing.* Gothenburg: Closer.

Smith, L., Maull, R. S., & Ng, I. C. (2012). Servitization and Operations Management: A Service-Dominant Logic Approach. *International Journal of Operations and Production Management, 34*(2), 242-269.

Soomro, M., & Zhang, X. (2015). Roles of Private-Sector Partners in Transportation Public-Private Partnership Failures. *Journal of Management in Engineering, 31*(4), 1-12.

Strasser, M., & Albayrak, S. (2016). The Current Situation and Future Trends of Marketplaces for Mobility Services: Findings From Qualitative Expert Interviews. *5th Internation Conference on Smart Cities and Green ICT Systems,*, (pp. 1-11). Rome.

Stålstad, C., & Williander, M. (2013). *Nya affärsmodeller för elbilar*. Gothenburg: RISE Viktoria.

Swedish Government. (2018). *Conclusions from the Third High-Level Meeting on Connected and Automated Driving.* Gothenburg: Swedish Government.

The Swedish Agency for Growth Policy Analysis. (2014). *Hur driver IKT produktivitet och tillväxt? Analyser av kvantitativa data.* The Swedish Agency for Growth Policy Analysis.

Trafikanalys. (2015). *Självkörande bilar Rapport – utveckling och möjliga effekter 2015:6.* Stockholm: Brita Saxton.

Trafikanalys. (2016). *Nya tjänster för delad mobilitet - Rapport 2016:15.* Stockholm: Trafikanalys.

Tzortzopoulos, P., & Formoso, C. (1999). Considerations on application of lean construction principles to design management. *Proceedings IGCL-7* (pp. 335-344). Berkeley: University of California.

United Nations. (2018). *World Urbanization Prospects.* Population Division, Department of Economic and Social Affairs. Online Edition: The 2018 Revision.

Van Audenhove, F.-J., Korn, A., Steylemans, N., Smith, A., Rominger, G., Bettati, A., . . . Haon, S. (2018). *The Future of Mobility 3.0 - Reinventing mobility in the era of disruption and creativity.* Arthur D. Little.

Vandermerwe, S., & Rada, J. (1988). Servitization of Business: adding Value by Adding Services. *European Management Journal, 6*(4), 314-324.

Vanolo, A. (2014). Smartmentality: The Smart City as Disciplinary Strategy. *Urban Studies, 51*(5), 883-898.

Wendle, B., Ljungberg, C., Fredricsson, C., & Lund, E. (2018). *Framtidanalys för morgondagens resor transporter i svenska städer - Kunskapsunderlag till utredningen ”Samordning för bostadsbyggande” (N 2017:08).* Lund: Trivector Traffic.

Wheelwright, S. C., & Clark, K. B. (1992). *Revolutionizign Product Development - Quantum Leaps in Speed, Efficiency, and Quality.* New York: The Free Press.

Williams, B. (2008). *Intelligent Transport Systems Standards.* Norwood, MA: Artech House.

World Commission on Environment and Development. (1987). *Our Common Future: Report of the 1987 World Commission on Environment and Development.* Oxford: Oxford University Press.

Wulfhorst, G., Kenworthy, J., Kesselring, S., & Lanzendorf, M. (2013). Perspectives on Mobility Cultures in Megacities. In I. f. Research, *Megacity Mobility Culture* (pp. 243-258). Munich: Springer.

Appendix A – Interview Questions

Demographics

- Job title
- Education
- How long have you worked within the field?
- Have you worked in another field before?

Background Smart Mobility

- How would you define smart mobility?
- How do you work with mobility today?
- How would you define the core values for why one should work with smart mobility?
- Which preferences do the society have on mobility?
    - Today?
    - In the future?
- What requirements are there on smart mobility from:
    - The city
    - The citizens
    - Technology
        - The “actual” solution
        - Supporting solutions
    - Economic factors
    - Sustainability

Collaboration and Coordination

- Does the industry have to interact with the local government?
    - Why?
    - How?
- Does the local government have to interact with the industry?
    - Why?
    - How?
- How does the interaction between the industry and the local government look like when establishing new mobility solutions?
    - How did the establishment of the following solutions look like?
        - Sunfleet
        - Uber
        - MaaS solutions, eg. UbiGo
            - Why was the project discontinued?
        - Voi/Tier/Lyme

    - What separated the establishments?
    - Why?
    - What was the learnings?
- What went well in the collaboration
    - Why?
- What went less well in the collaboration?
    - Why?
- How would the optimal collaboration look like?

Future

- How does the optimal system for smart mobility look like?
    - Which problems are there;
        - Today?
        - In the future?
        - In implementing smart mobility solutions?
    - Why?
- How does the prioritization look like between established solutions and future solutions?
- Which mobility solutions are sought after by the society?
- How is the desirability of the solution decided?
- What happens if a solution is not desirable?
- Which mobility solutions are sought after by the industry?
- How will the general trend within smart mobility look like in the future?
- How will the marked and the needs look like in the future?
    - Will they change?
- What is needed to be improved?
- What will happen with the industry in the future?
- Which success factors are important for achieving smart mobility in a society?

University

- What do the universities have to do in order to stimulate the development?

Industry

- What does the industry have to do in order to stimulate the development?

Local government

- How does your possibilities to influence the (rest of) local government look like?
- How has it developed?

- How does the maturity look like, with regards to the understanding of smart mobility, among the local government?
- Do they/you have adequate knowledge of the field?
- Do you have adequate knowledge of their field?
    - How?
    - Why?
- What does the local government have to do in order to stimulate the development?