CHALMERS
UNIVERSITY OF TECHNOLOGY

Multi-modal Transport Solution Using E-scooters & Public Transportation

To support the transition to a car free society

Master's thesis in Product Development

ADITYA GANESH

Department of Space, Earth and Environment
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2020

Master's thesis 2020

Multi-modal Transport Solution Using E-scooters & Public Transportation

To support the transition to a car free society

ADITYA GANESH

CHALMERS
UNIVERSITY OF TECHNOLOGY

Challenge Lab
Department of Space, Earth and Environment
Chalmers University of Technology
Gothenburg, Sweden 2020

Multi-modal Transport Solution Using E-scooters & Public Transportation:
To support the transition to a car free society

Aditya Ganesh

Supervisor: Jaan-Henrik Kain
Department of Architecture and Civil Engineering

Examiner: John Holmberg
Department of Space, Earth and Environment

Master's Thesis 2020
Department of Space, Earth and Environment
Chalmers University of Technology
SE-412 96 Gothenburg
Sweden

Cover: E-scooter parked in front of central station. Photograph from Pikist

Typeset in LaTeX
Gothenburg, Sweden 2020

Multi-modal Transport Solution Using E-scooters & Public Transportation:
To support the transition to a car free society

ADITYA GANESH
Department of Space, Earth and Environment
Chalmers University of Technology

Abstract

The growth of cities have led to increase in cars on the roads. Thus cars put a great demand not just on the infrastructure but also the environment. Thus it is crucial to encourage the use of public transport systems. The public transport systems come with there fair share of problems related to access and convenience to the users. At the same time the e-scooter services have been a new phenomenon in micromobility and are touted by the pundits to solve the gaps in the way the transport systems function in the cites and are also considered to be a sustainable alternative to the cars and help in achieving a car free society. Though these e-scooters are constantly in conflict with the societies functioning and considered to be a problem by some sections of the society. The study looks into the aspects of if and how the e-scooters can influence the car users to give up car and use more public transportation in Västra Götaland region. This is done by focusing the study on understanding the car user needs through interviews and surveys. The study carries out Force Field Analysis to determine the forces acting towards and against a car free society. Additionally through systems mapping the study also captures the complexity of the system which includes car users, e-scooter services and public transportation.

Keywords: Personal Mobility, Car User Needs, E-scooters, Public Transportation

Acknowledgement

I would like to thank Challenge Lab for allowing me to be part of a thesis contributing to sustainability in the society. I would also like to thank John Holmberg, Johan Holmén and Gavin McCrory for their patience and motivation throughout the thesis. A special thanks to Linnea Johansson for inspiring me to take up a thesis at Challenge Lab. Also, a special token of gratitude to all the stakeholders and interviewees from the city of Gothenburg and Västra Götaland region, without whom this study would not have been possible. Finally, I would like to express gratitude to my supervisor Jaan-Henrik Kain for providing continuous support and guidance throughout this long journey.

Contents

List of Figures

List of Tables

1

Introduction

1.1 Background

Since the invention of automobiles, cars have influenced largely how the cities and towns of the modern world are designed. Cars have lead to a large portion of the land in cities and towns being dedicated for roads, parking lots, driveways and traffic signal systems. Cars are an essential travel mode for people and influence the mobility habits of people. Furthermore, the cities are growing rapidly, and by 2030 it is estimated that 70% of the world's population would reside in urban spaces (Council, 2017). This rapid growth of cities has increased the congestion in cities due to the increase in the number of cars. Cars are a prevalent mode of transport amongst people but they do come with sustainability issues such as carbon emission, inaccessible to all, congestion on the roads. The public transport system has been found capable of overcoming the problems with cars if planned properly (Pojani & Stead, 2015). But the exponential growth of cities creates a burden of the urban transportation systems, as they find it harder to reach the ends of the ever-growing cities.

Due to the existing gaps in the transportation requirements micromobility options are cropping up across cities in the globe and they promise to address the transport problems of cities. Additionally, they plan to fill the existing gap in the public transportation system (Alphabet, 2019). Micromobility is, especially expected to address the issue of first & last-mile commute. The most dominating new technology of micromobility, which is currently occupying the city space are the e-scooters (NACTO, 2019). The e-scooter services are easy to use and quick to travel. They are promoted as an alternative to the use of the car and most of the e-scooter service providers claim they are the ideal platform to support the public transportation system (EY, 2020)(Fong & Mcdermott, 2019). On the contrary, the e-scooters do have their fair share of problems and often seen to be in conflict with the human population and the exciting infrastructure (CNN, 2019). It is, therefore, the interest of this study to determine the potential role, which the e-scooter services can play in the transition from cars to the use of public transportation.

1.2 Local Context

By 2035 it is estimated that Gothenburg city will have a population of 17.5 million people and Gothenburg would transform form a small city to a big city. According to transport administration (2014) of Gothenburg, there is a strategic plan to limit the number of vehicles in the transport system to ensure accessibility and transportation to all residents. Further, the strategy is to allow commuters to, travel to and from the city without increasing the number of cars from current levels. The reduction of cars

is also part of Västra Götaland region's future plan "Målbild Koll 2035", where the goal is to reduce the number of cars and increase access to more sustainable modes of transport such as cycling and walking (Götalandsregionen, 2018). Västtrafik, the transport agency of Västra Götaland region as a part of their goal for 2035, conducted a user survey "Hållplats 2019" and determined that 67% of the residents wanted more space for cycling and 68% wanted the current car traffic levels to decrease. Furthermore, the Swedish transport administration calculates that the number of cars should be reduced by 20% from the 2010 levels to achieve the climate objectives of Sweden. Few of the targets for 2035 by the urban transport committee of Gothenburg city are listed bellow (transport administration, 2014):

1. At least 35% of journeys in Gothenburg should be taken on foot or by bicycle.
2. At least 55% of motorised journeys in Gothenburg should be by public transport.
3. The maximum time to travel between two random cores or key destination should not be more than 30 minutes.

There is a strong push from the region to not just limit the number of cars but also to reduce the number of cars on the roads. This is to target the congestion on the roads and cater to the environmental impact due to cars.

1.3 E-scooter Services

E-scooter services have been a new phenomenon in cities across Europe and the United States. They try to address the issues of portable personal mobility through micro-mobility to help people move within the cities (Ajao, 2019). Starting 2018 there has been an explosion in app-based dockless e-scooter service providers across different cities (Dimitrova, 2019). This new technology though popular amongst people has had its fair share of negative publicity due to them being parked randomly in the middle of a sidewalk and causing inconvenience to people walking and more importantly to blind people. Furthermore, it has been a common occurrence to find them in canals or rivers (CNN, 2019). Also, the safety aspect has been frequently questioned with the number of accidents increasing and leading to fatalities (Brustein, Lanxon, & Foy, 2019). In Sweden itself, 241 cases of accidents were reported in 2019 which included the death of a person in Helsingborg, compared to 21 accidents the previous year (Local, 2019). These issues have resulted in Swedish authorities starting to look into regulating the use of e-scooters (Dimitrova, 2019).

E-scooters have been found to replace the usage of cars. A study in Portland, USA found that 34% of the respondents stopped using personal cars or car sharing. On the contrary, they have an influence on lower emission transport methods such as walking and cycling. 48% of the respondents said they choose to use e-scooters over walking or cycling (PBOT, 2019). Furthermore, they are found to be not environmental friendly. A study at North Carolina State University in the United States found that the carbon emission of e-scooter is more significant compared to that of walking, biking, public

transportation and even car in few cases while considering the entire life span of the e-scooters (Hollingsworth, Copeland, & Johnson, 2019). The e-scooters have their fair share of advantages and disadvantages, which is discussed in section 4.1.

1.4 Aim and Research Question

The research aims to determine the possibility of using e-scooter services to facilitate the transition of car users to use public transport system in Västra Götaland region, VGR. As explained in the section 1.2, e-scooters services are a new phenomenon in micromobility. Therefore the research aims to determine the e-scooter's potential to fulfill the needs of the car user. Thus, e-scooters creates a great interest to determine the possibility of providing a multi-modal transport solution along with public transportation. This leads to the research question:

"Can the e-scooter services play a role in car users adapting public transport systems?"

To answer the research question it is important to evaluate the interplay between the complex dynamics of the technology of e-scooters, the current regulations, the current infrastructure, public transportation and the car user's needs. This leads to the sub questions of:

i What are the needs of car users for transition to other modes of transport?

ii What are the advantages and disadvantages offered by e-scooters to facilitate the transition?

iii What are the barriers and drivers to provide a multi-modal transport solution?

1.5 Limitations

The scope of the study was limited to using e-scooter services to address the needs of car users to transition to the public transportation system in Västra Götaland region,VGR. Also, the study does not consider the effect of individual e-scooter ownership. Furthermore, the study does not focus on other modes of transportation, such as shared bikes or taxis due to limitation in time. However, the impact of shared car services has been included in the study, as it was observed that it played a role in fulfilling a few of the needs of e-scooter users. The working and implications for shared car services are not studied in detail.

The empirical study of car users and e-scooter users using interview focuses only on the aspect of using the e-scooters to fulfill the needs of car users to adopt the use of public transport system, Västtrafik. Furthermore, the subjects for empirical study using interviews were identified using the snowball process. This method runs the risk of not interviewing the right person. The study was affected by the onset of the pandemic of COVID 19, making it a challenge to access people for workshops. The

casual loop diagram (systems mapping) of the car users, public transportation and e-scooter services was thus carried out by the author instead of having a workshop with stakeholders. This runs the risk of not capturing the complete perspective. Finally, the outcome of the study is limited to recommendations for e-scooter service providers in VGR, though the findings can be applied to other regions in Sweden.

1.6 Help for Reading the Report

This section provides a brief information on "*what to expect?*", from the forthcoming chapters in the report. The purpose is to help the reader understand the methodology followed in the study.

Chapter 2: Phase I at Challenge Lab
This chapter focuses on the work done in the Phase I at Challenge lab to determine the leverage point and research question related to sustainability issues in transportation for Västra Götaland region.

Chapter 3: Methods
This chapter provides information on the methods followed in the Phase II of Challenge Lab to answer the research question.

Chapter 4: Literature Review
The literature review was carried out to determine the pros and cons due to the e-scooter services across the globe. Additionally, it also gathers information on the needs of car users from around the world. The information in this chapter was instrumental in developing questions for the qualitative and quantitative studies regarding the needs of the user in VGR concerning the mobility of people.

Chapter 5: Surveys
This chapter presents the data gathered and the analysis of the surveys on car user's and e-scooter user's needs. The surveys were used to determine the applicability of the user needs identified in the literature review. Additionally, it also captures the factors which the users felt the necessity to be improved in e-scooter services and public transportation. This information was instrumental in helping developing questions for personal interviews.

Chapter 6: Interviews
The interviews were used to confirm the findings from the literature review and surveys. This chapter presents the analysis of the data gathered in the interviews with the help of KJ method. Additionally, it also uses force field analysis to analyse the data from interviews to determine the drivers and barriers for the transition of car users to public transportation. The analysis tools of KJ method and the force field analysis are explained in detail in Chapter 3, methods.

Chapter 7: Systems Mapping
This chapter puts together the information from the analysis of surveys and interviews to develop a causal loop diagram of the current landscape of VGR to include the effects of car users, e-scooter services and public transportation. This is instrumental in visualising the interplay between the factors affecting the use of e-scooter services and public transportation system from a car user perspective.

Chapter 8 & 9: Discussion and Conclusion
These two chapters put together all the information gathered in the study and provides the author's inference on the current set up and possible recommendation to help in the transition of private car users to use more public transportation.

2

Phase I at Challenge Lab

2.1 Introduction to Challenge Lab

In the current scenario in the world, it is crucial to address the environmental impact of human's behaviour and actions. Furthermore, while addressing the environmental impact it is important to consider the challenges it poses to sustainability to mankind. To address this, the United Nations came up with seventeen sustainable development goals, SDG to transform the world. Furthermore, these goals were adopted by all the UN member nations in 2015 (United Nations, 2020).

The critical issues being faced now is the challenge with countries, agencies or even organizations trying to address the SDG identified individually. The individualistic goal approach causes the lack of synergy to achieve the SDG and does not factor in the issues it causes on the other sustainable development goals.

The "Challenge Lab" at Chalmers started in 2014, focuses on addressing the sustainability challenges related to Västra Götaland region. The Challenge Lab is a unique initiative which identifies the importance of transformation supported by integration of all the sustainability challenges. Additionally it tries to bring in a systematic change by providing a platform for stakeholders in academia, industry, the public sector and the civil society to collaborate to solve sustainability challenges related to Västra Götaland region.(Challenge Lab, 2020)

2.2 Work and results of Phase I at Challenge Lab

Phase 1 of the the Challenge Lab focused on identifying the sustainability challenges related to Västra Götaland region and further identify and develope a related research question for the thesis study. The thematic area to be addressed for the year 2020 was choosen by Challenge Lab as "Mobility" in Västra Götaland region by the Challenge Lab. Further, the thematic area was categorized into the below mentioned four themes.

1. Mobility due to tourism.
2. Mobility of goods.
3. Collective mobility.
4. Personal (Individual) mobility.

2.2.1 Backcasting Process

It is very natural to be influenced by the ongoings in the present societal systems, be it the current technological influence or the societal norms. Thus planning a future based on the current trends, would limit the vison and the possibility of an ideal future. Backcasting as a planning method overcomes this flaw. Backcasting helps to visualize the complex societal systems coupled with ecological challenges. Furthermore it provides an opportunity to visualize a future towards sustainability by considering socio-ecological principles as a base (Azar, Holmberg, & Lindgren, 1996). These socio-ecological principles envisioned, would enable handling the complex societal systems in a systematic and coordinated way (Holmberg & Robert, 2000). This section highlights the backcasting process (figure 1) followed at Challenge Lab to identify the leverage point related to issues with mobility in Västra Götaland region.

Backcasting process follows four steps mentioned below:

1. Frame condition for a sustainable future.
2. Analyse the present situations in relation to the envisioned conditions.
3. Identify leverage points for bridging the gaps.
4. Identify strategies for the the identified leverage.

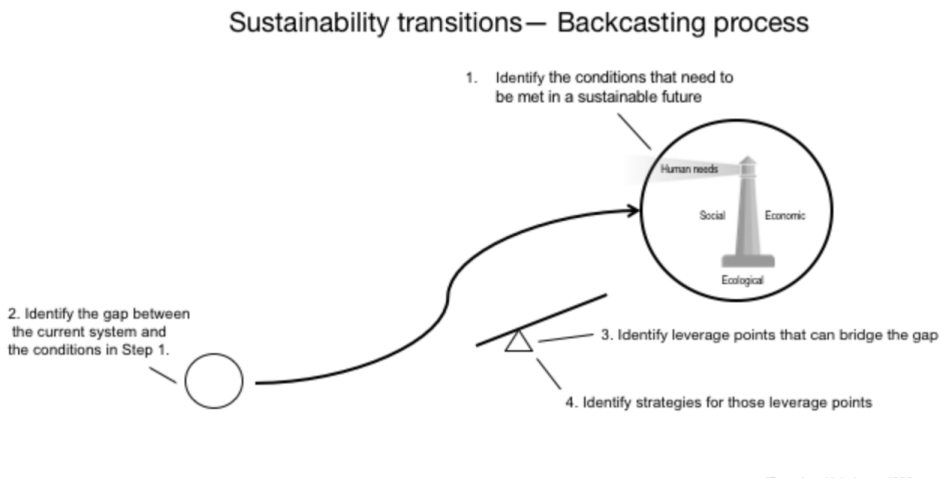


Figure 1: Backcasting process

The following steps explains the process set up by Challenge Lab to define the desired future and develop the research question.

2.2.2 Step 1 - Frame condition for a sustainable future

Self-leadership Workshop
The self-leadership is the first activity carried out as a part of the Challenge Lab process to help students identify their core values and strengths. The self awareness about the values and the strengths is crucial for students while going forward with the research project.

The workshop started with each student identifying upto five core values which they feel is important to them. Then the the group is divided into groups of three. In each group the students are allowed to express the importance of "storytelling" and its purpose is to build trust and openness. Each person in the group are assigned separate roles, focus person, listener and observer. Starting with focus person, who shares personal experience related to the chooses values. The listener's role is to listen to the focus person without commenting or asking questions. The listener is only allowed to affirm the communication through body language, such as nodding the head or a smile. This allows the focus person to express what he/she is thinking without being influenced by the other person. Simultaneously the observer, is supposed to observe the interaction between the focus person and the listener. Furthermore the observer is also responsible to monitor the time. This exercise is repeated until all the members in the group have expressed about their values. Later, each person is allowed to express what they perceive are the three main strength of the other two students. Thus, this exercise helps in building trust and bond between students due the sharing of experience.

The "storytelling" exercise is then followed by personal strength exercise. In this exercise the students are tasked with identifying three of their strengths and then discussing them with another students. The strength identification is crucial to be aware of the strengths of the group, as it is improves coordination during the process of identifying leverage points during phase I. Furthermore it also helps students identify the negative aspects of the strengths when overdone and how could it be balanced.

The sustainability light house
The visualizing the desirable future was the next activity in the process at Challenge Lab. This visualization was achieved by using the sustainability light house (Holmberg & Larsson, 2018). The sustainability light house (figure 2) provides a framework to facilitate the transformative change to achieve sustainability. It allows to visualize and encompass the desirable future uninfluenced by the current dynamics of the society. The sustainability light house identifies four dimensions based on socio-ecological principles which are interdependent on each other and are crucial to visualize the the desired future. The dimensions are namely, human needs and well-being, social sustainability, economic sustainability and environmental sustainability (Holmberg & Larsson, 2018).

Figure 2: Sustainability light house

To formulate the principles for a desired future, the sustainability light house was used in backcasting process during the workshop. The whole group was divided into four groups based on the identified thematic areas of mobility. These groups were then involved in formulating the principles for the four dimensions of the sustainability light house. The groups used brainstorming technique to come up with keywords/principles to identify the respective sustainability principles. The identified keywords/principles were then grouped depending on their relevance to each other, followed by identifying a common keyword to represent the grouped keywords/principles. This result was then presented to the other groups followed by a discussion to combine, refine and understand the underlying reason for the keywords. The identified principles related to mobility can be seen in figure 3.

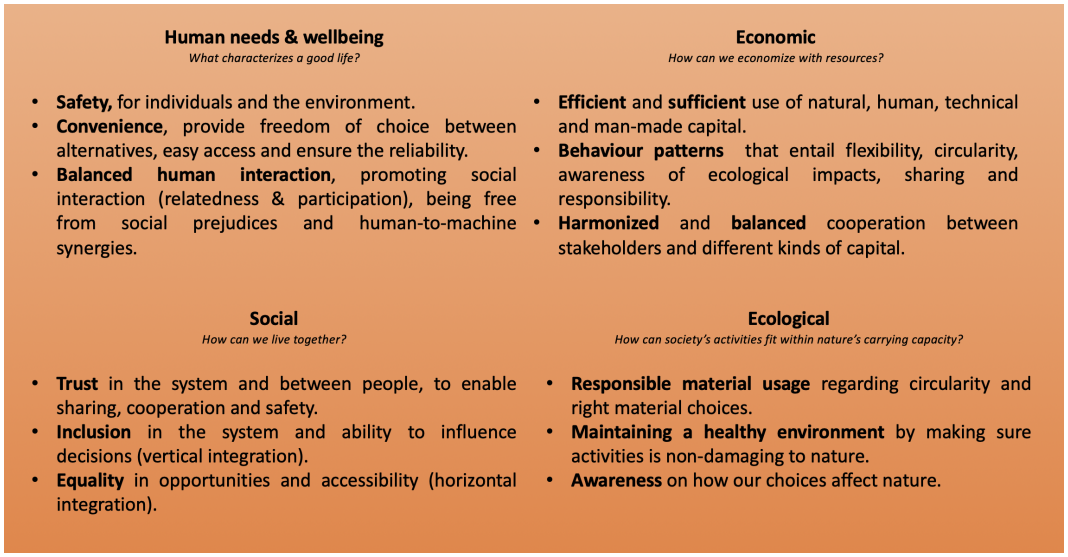


Figure 3: Sustainability principles

2.2.3 Step 2 - Analyse the present situations in relation to the envisioned conditions

System mapping

System mapping uses the multi layer perspective, MLP, to capture the current happenings in the society. As Geels (2005) describes the MLP has three levels, namely, meso-level, micro-level and macro-level. The meso-level captures the current regimes (system) and primarily captures "how things are working currently". The micro-level on the other hand looks at the new niches (technology, regulations etc) which are cropping up and they provide a greater learning opportunity to challenge the current regime. Finally the macro-level captures the socio-technical landscape, which includes the wider exogenous environment and affects the socio-technical development (globalization, environmental problems etc)(Geels, 2005).

Socio-technical system

It is critical to understand that the aspect of the current regimes are affected by the socio-technical actors such as regulators, politicians and society (A. Smith, Stirling, & Berkhout, 2005). The society and technology are interconnected to each other and influence each other at different levels with six factors of knowledge, societal norms, regulations, market dynamics, existing technology and infrastructure influencing each other (figure 4)(Geels, 2002).

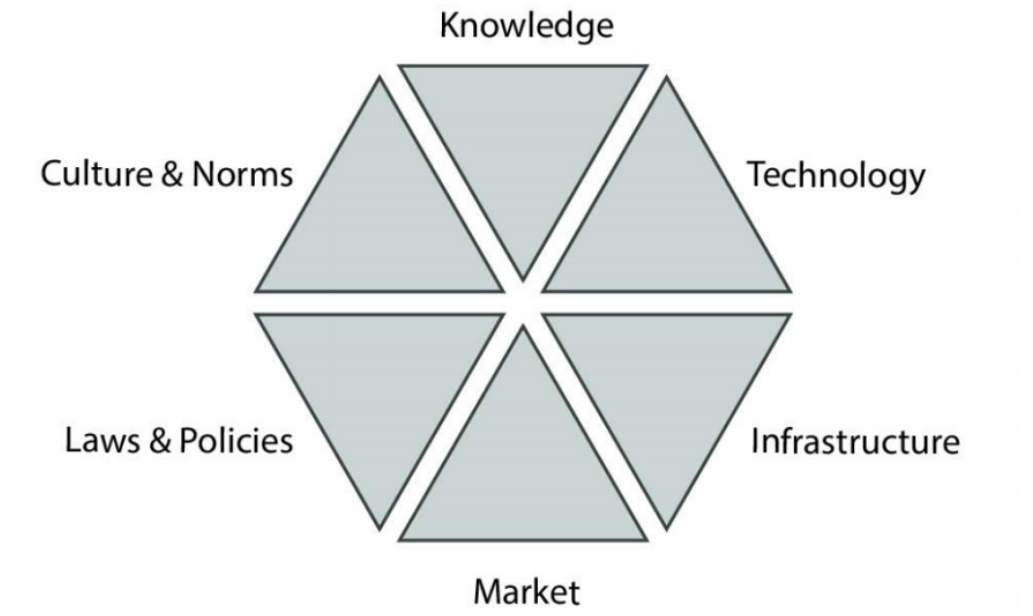


Figure 4: Factors of the socio-technical system

Challenge Lab works to bring changes at the macro-level to have a sustainable society. The current meso-level (regimes) and micro-level (niches) were captured using system mapping in the four thematic areas identified. This was achieved by splitting the challenge lab students in four groups to work on one thematic each. The groups then captured the regimes and niches in Västra Götaland region through brainstorming. The captured information were further categorised based on the six factors of socio-technical systems. Once the regime and niches were captured the groups also worked on the other three themes to discuss and add any missed out information. Furthermore the system mapping and grouping of the tasks acted as enablers to form questions in the four thematic areas to be taken into the stakeholder discussions.

Stake holder dialogue
The stakeholder dialogue was carried out after the system mapping of the regimes and niches of Västra Götaland region. The purpose of the dialogue was to verify the system mapping and to fill possible gaps in the captured system mapping. Furthermore, dialogue with the stakeholders would help in identifying challenges which they are facing in the current system to attain the future determined in step 1. Also, it would help to identify the drivers and barriers to bring change in the system.

The stakeholder dialogue was carried out in a fishbowl setting. Fishbowl setting provides an opportunity to encourage dynamic group interactions and active participation in a large group setting. This is achieved by having a small group which includes the experts in the field to carry out the discussion in the inner circle and the rest of the group in the outer circle observing the discussion. Sometimes it is allowed to interact with the outer circle to keep the energy and flow of the discussion progres-

sive (Arivananthan, 2015). The challenge lab students facilitated the dialogues with stakeholders by sharing the roles of facilitators, active dialoguers and metalisteners. Each dialogue had inner circle with the experts, facilitators and the active dialoguers to engage the conversation with the experts. The outer circle consisted of metalisteners to observe the dialogue and the notetakes.

Totally three dialogues were carried out. One for the theme for mobility of goods, followed by mobility due to tourism. The final dialogue included both personal mobility and collective mobility. The experts invited to the dialogues represented a broad spectrum of expertise. It included, researchers, experts from the public sector and private sectors.

The dialogues resulted in the updating of the system mapping. Furthermore provide an insight into niche areas in the current setup in the region and developing technologies where further research needed to be carried out to understand and arrive at the envisioned future. Also, after the dialogue the themes of personal mobility and collective mobility was decided to be combined into mobility of people, as it was identified during the dialogue that they are dependent on each other.

2.2.4 Step 3 - Identify leverage points for bridging the gaps.

The outcome of the dialogue was the identification in existing challenges and barriers for sustainable mobility. The Challenge Lab students were split into groups based on the three thematic ares of, mobility due to tourism, mobility of goods and mobility of people based on the interest of the students. A second system mapping was carried out to identify the leverage points. The leverage point is an "area of potential" in a system where a smaller intervention can lead to larger changes in the system. The students identified one or two leverage points in each thematic area. During the identification of the leverage points the following questions were factored in.

1. Sustainability challenge: What is the biggest challenge to address?
2. Static/Dynamic system: Which "lock-in" to address? and which factors are important related to the regional problem?
3. Stakeholders/processes: Which individuals and/or organizations are interested? and which are the connected ongoing processes?

The "leverage point" identified for the thematic area of mobility of people was "*Actual vs perceived needs of cars*". This identified leverage point was then linked to the top five key factors which affected it: perceived convenience of users, existing infrastructure of the region, business model of car manufacturers, alternate modes of transportation and public transport. These five factors were identified based on system mapping done initially and the stakeholder dialogues. Furthermore, it was mapped how these factors are connected to each other and the leverage point. This led to the identification of the objective "Reduce the number of cars on the roads".

2.2.5 Step 4 - Identify strategies for the the identified leverage

Based on the objective identified "Reduce the number of cars on the roads" and the information gathered during the phase I of the research, it was observed during preliminary literature search that, there has been a lot of work carried out to determine solutions to reduce cars. The findings have been to increase public transportation (Pojani & Stead, 2015), to provide multi-modal transport solutions (Kabashkin, 2015) and even to plan/design car free societies (Khreis, Nieuwenhuijsen, & Bastiaanssen, 2017). Also, during the backcasting process at Challenge Lab, e-scooters were identified as a niche new technology which could influence how people travel. The motivation to reduce the number of cars with the help of e-scooters and the research question has been explained in the sections 1.2 & 1.4 respectively.

3

Methods

This section describes the methodology, which was followed to answer the research questions. The figure 5 shows the different methods which will be used to gather information and analyze it. The research's primary focus is to determine the car user needs, which needs to be fulfilled by e-scooters to help in the transition to using public transportation. The empirical evidence was collected through surveys and interviews. To analyze the collected information KJ method and force field analysis was carried out to determine the barriers and drivers. Furthermore, systems mapping was carried out to visualize the current system along with the user needs to determine the existing interplay and disconnect.

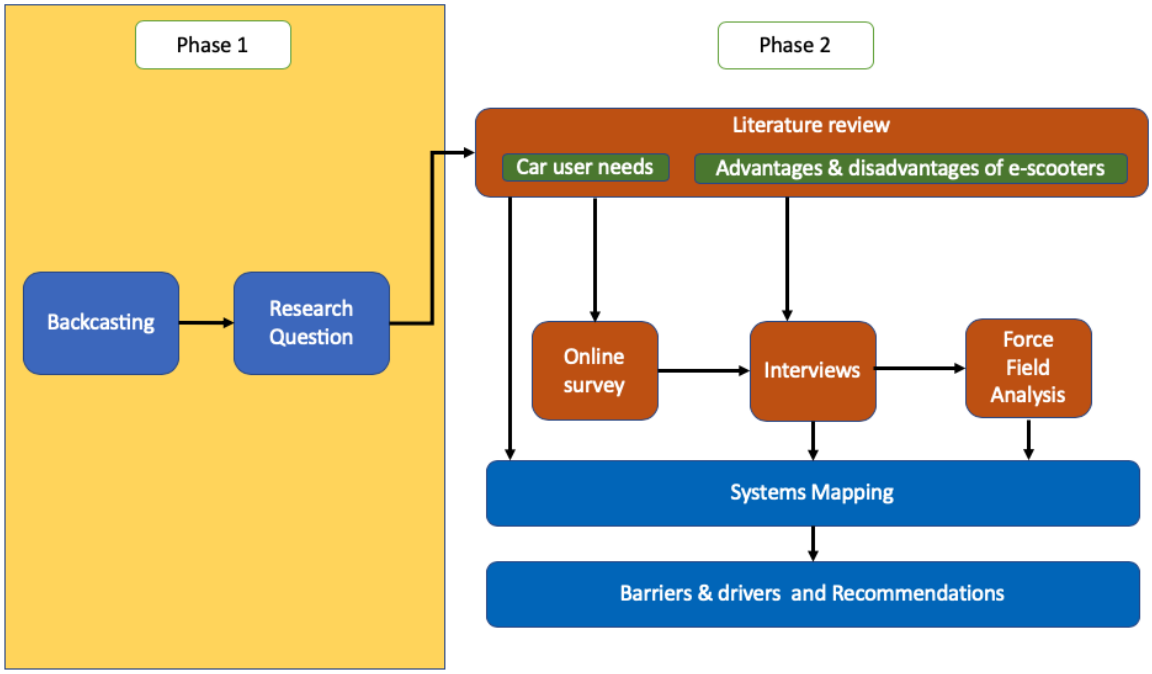


Figure 5: Methods

3.1 Literature review

A literature review provided the opportunity to gather background information on the existing research and also capture the findings from those researches. The traditional literature review is used to analyse and summarise researches and to identify gaps in the study. Further, it helps in defining objectives to carry out a study(O'Gorman & MacIntosh, 2015).

Literature review was carried out through internet search, Google scholar and Chalmers library to find relevant research and articles regarding the topic. The literature search and review focused on two aspects.

1. Identify the needs of the car users for transition to other modes of transport.
2. Identification of advantages and disadvantages of e-scooter services.

The most important aspect of the literature search was to identify the needs of car users, as this determines the goals for e-scooter services to fulfil. The literature search thus provided key insights into the e-scooter technology and user needs. Additionally, the literature search helped in identifying key factors which are important to provide a multi-modal transport solution using e-scooters and public transport system. Additionally helping in forming questions for online surveys and personal interviews.

To determine the car user needs the following keywords and phrases were used for literature search to identify the car users needs "car user needs", "needs of car users", "public transportation & cars", "car use and public transportatio", "reduce car usage", "car users Gothenburg", "public transportation and cars in Gothenburg" and "car usage in Västra Götaland region".

The literature review was also used to identify the advantage and disadvantages of e-scooter services. Additionally the literature review was instrumental in identifying how different cites across the globe are adopting to this new mode of transportation and the challenges they are facing. This was determined by searching for key words and phrases of "e-scooters advantages", "benefits of e-scooter services", "e-scooters policies", "e-scooters in Sweden", "e-scooters safety", "e-scooters accidents", "e-scooters in Europe", "e-scooter policies", "e-scooters and regulations", "e-scooter life-cycle", "e-scooters and environment" and "issues with e-scooters".

3.2 Quantitative Research - Online Survey

A quantitative research allows to investigate facts and confirm results from other experiments. Thus, it provides an opportunity to build further knowledge in a systematic way and support in carrying out new studies (Apuke, 2017).

The quantitative research was carried out through customer surveys. Two customer surveys were carried out online. The questions of the customer survey were developed based on the results from the literature review. Furthermore, the customer survey focused on confirming the applicability of the car user needs in the local context related to Västra Götaland region. The second survey focused on determining the user needs which were being fulfilled by e-scooters. The purpose of the online survey was to generate information on needs and identify patterns through quantitative data. Also, the surveys had some non-quantitative open ended questions to understand the reasons for the choices made. The results from the survey were used in developing questions for the interviews to carry out a detailed qualitative analysis.

3.3 Qualitative Research - Personal Interviews

Qualitative research supports creating high-quality information by contacting the customers directly. Interviews provide an opportunity to come in direct contact with the customers and concerned stakeholders also allowing to capture non-verbal information (Ulrich & Eppinger, 2012).

The personal interviews were based on the factors identified from the literature search and the results from online surveys. They were in-depth interviews. Interviews were carried out online using video sharing platforms of Skype & Zoom. Additionally, the interviews were of semi-structured type. The semi-structured interviews are found to contribute towards a qualitative discussion with open-ended question without sticking to a definitive question pattern (Adams, 2015). The interviews were recorded to ensure all the minute and valuable details can be captured and later converted to transcripts (Rutakumwa et al., 2019). Additionally, the identity of the interviewees has been made anonymous by changing the names, as few interviewees requested for anonymity.

The interview focused on three groups of people, the first two groups being the car users and e-scooter users who are introduced in table 1 and table 2. The questions for the car user group was directed to understand there needs of car usage and also to determine their perception of public transport and e-scooter services.The information from the car users interview played a primary role in identifying the drivers and barriers for modal shift to public transportation, further these identified drivers and barriers were used to carry out the force field analysis (figure 44). The questions to the e-scooter users were directed to understand how they use the e-scooters and what user needs they are fulfilling. The guiding questions for the interviews can be found in appendix C.

Table 1: Introduction of interviewees - Car users

	Daniel	Lars	Jessica	Joakim
Residence	Ale municipality	Gothenburg	Boras	Gothenburg
Gender	Male	Male	Female	Male
People in household	2	3	3	>3
Age group	26-35	51-65	36-50	26-35

Table 2: Introduction of interviewees - E-scooter users

	Fredrik	Alex	Gustav	Amanda
Residence	Gothenburg	Gothenburg	Gothenburg	Gothenburg
Gender	Male	Male	Male	Female
People in household	2	1	1	1
Age group	26-35	26-35	18-25	18-25

The third group of the interviews focused on the other stakeholders. The group of other stakeholders included individuals form academic research, e-scooter service industry and transport strategist, who are introduced in table 3. The member of this group was identified using snowballing sampling during the interviewees. Snowballing sampling helps in identifying relevant stakeholders related to the research when it is difficult to identify the relevant stakeholders related to the research topic (Naderifar, Goli, & Ghaljaie, 2017). This group were questioned about how the current landscape look related to the e-scooter business and the public transportation. Also the interviews tried to determine the future plans and trends for the public authorities and e-scooters service providers.

Table 3: Introduction of interviewees - Stakeholders

Interviewees	Business/Organization	Title
Lucas	E-scooter service industry	Operations Manager
Alice	Chalmers university of technology	Researcher
Clara	RISE	Researcher
Isabelle	Trafikkontoret, Göteborgs stad	Strategic traffic planner

3.3.1 KJ method & Force Field Analysis

To analyse the transcripts of the interviews and the comments from the surveys were done using the KJ method. KJ Method is used to organize different ideas and fragmented information into cohesive groups (project management.com, 2017). KJ method allows to group the information from different interviews into categories and prioritize them(Spool, 2004). Additionally the categorized information from the interviews was analysed further using force field analysis, FFA, to identify the driving and restrictive forces. FFA is a technique used to implement changes in structure, technology and people. It provides opportunity to evaluate forces affecting the desired change. FFA as a tool is capable of capturing both internal and external forces resisting the change. Furthermore, it is a capable tool to bring in strategic changes to achieve a change (J. Thomas, 1985). The information gathered from the surveys and interview were then used to identify the driving forces and restrictive forces leading to a transition towards public transport usage for car users with the help of FFA.

3.4 System Mapping

System mapping was carried out based on the information form FFA, user surveys and personal interviews. This was be achieved by using casual loop diagram to capture the dynamics of the complete system. The casual loop diagrams helps in visualizing the current system and additionally helps to map out relations between seemingly isolated things (Bala, Arshad, & Noh, 2017).

The end result of the system mapping therefore enabled to identify the effects of car user needs for transition to using public transportation. Also, it helped to determine the effect the e-scooters are having on the current system to support this change.

4

Literature Review

4.1 Advantages and Disadvantages of E-scooter services

This section looks into the media reports on e-scooters to identify the advantages and disadvantages created after the introduction of the e-scooter services. Further, this section also includes information from the scholarly articles and literature available on these advantages and disadvantages.

4.1.1 Advantages

Travel time & cost of travel
Studies have determined that e-scooters have a capability to travel quickly and at a lower costs compared to car. A study carried out by C. S. Smith and Schwieterman (2018) in Chicago, USA found that, for shorter trips between 0.8 to 4.2 kilometers the e-scooters were a good alternatives costing less than the cars and public transportation. additionally they even out performed the bike sharing service available and saved upto four minutes of travel time. The study further determined that the e-scooters were successful in providing a quick access to jobs compared to public transportation or walking within the city limits of Chicago.

Convenience of use
E-scooters have been found to be convenient for people to use it. E-scooters are smaller compared to bicycles and thus can be made to be available at more spaces. Further the e-scooter services work on the dockless parking platform, thus they are free standing and provides a greater flexibility for users for parking (C. S. Smith & Schwieterman, 2018). Robinson (2018) expresses the usage of e-scooter services are perceived by users to be easy, with mobile applications being used to find the location of the e-scooter and using the same application to lock,unlock and make payments.

Replacing car usage
Some studies have found that, e-scooters have a potential to reduce the car usage. In a pilot program carried out in Portland, USA by PBOT (2019) it was found that 38% of residents and 48% of visitors to the city used e-scooters instead of using car. Further 6% of the respondents in the study claimed that they had gotten rid of the car and another 16% were considering selling their cars. In a Survey by e-scooter service provider Voi, 12% of the e-scooter users responded that it had replaced car usage (EY, 2020).

Lower carbon emissions on use
It has been found that, while using a e-scooter its carbon footprint is much lower than a petrol or diesel powered car. Further the efficiency related to power is also considerably high. 1 kWh (Kilowatt Hour) of energy allows an e-scooter to travel around 128 kilometres, where as the same 1kWh allows a petrol-powered car to travel less than 1.6 kilometers (The Royal Society for the Prevention of Accidents, 2019). This energy efficiency of the e-scooters is due to the fact that they have less weight per person compared to cars. Additionally for the same reason of lower weight per person, they are more energy efficient to manufacture compared to cars. In Portland during the pilot, it was determined that e-scooters prevented automobiles for emitting 122 metric tons of carbon emissions (PBOT, 2019). Further they are estimated to produce 25% of the CO2 emissions of the car (France 24, 2019).

Potential to solve last mile problem
E-scooters provide advantage in parking constrained environments, they fill a void where their is limited access to public transport. Accessing a e-scooter is easier compared to public transport or shared bike service. The use of e-scooters do not face last-mile problems. In Portland, USA, the results of the e-scooter pilot program determine that they provided travel opportunities when the public transportation is lacking. In East Portland where the public transportation is underrepresented compared to rest of the city, when e-scooters were introduced it was found to help people in movement. The result found that the average travel distance using e-scooters was 2.6 kilometers compared to the city average of 1.6 kilometers (PBOT, 2019). The survey by e-scooter service provider, Voi, determined that 63% of its respondents use e-scooters in combination with public transportation (EY, 2020).

4.1.2 Disadvantages

Safety Concern
E-scooters have created a major safety concern, with the number of accidents and deaths increasing as the number of users increase. In the United States 8 deaths were reported in 2017 while using e-scooter services (The Royal Society for the Prevention of Accidents, 2019) and has seen more than 300% increase in deaths with 29 being reported in 2019 (Quartz, 2019). The injuries reported due to e-scooters has also seen an exponential increases, with injuries increasing 83% from 8,016 in 2017 to 14,651 in 2018 in the United States (Pesce, 2020). These accidents and injuries with use of e-scooters can be attributed to lack of awareness of regulations or disregard to the regulations. This has lead to illegal and risky riding habits, such as riding in areas where they are not allowed, double riding (i.e passenger doubling), or not using helmets. In Portland, USA it was found that 90% of the users did not use helmet while riding, even though its an offence. Further it was also found that e-scooter users used sidewalks in the absence of bike lanes and this caused people walking to feel unsafe (PBOT, 2019). Additionally a study by Haworth and Schramm (2019) in Brisbane, Australia determined that more than half the population rode the e-scooters illegally by riding on roads and not using helmets. The study further identified that even the

service providers didn't follow the rules, thus encouraging risky riding. The study found that, when Lime a e-scooter service provider introduced their services in Brisbane the helmet were easily available but with time the helmets were not found with the scooters.

Weather factor

Weather has so far played a role in determine the availability of e-scooters services. Bad weather causes a safety concern for the usage of e-scooters and it is not advised to ride in icy or snowy conditions as it leads to the e-scooters slipping and resulting in accidents. It is a common sight that the e-scooters services are withdrawn during winter, thus affecting the services depending on the season. Voi the Swedish e-scooter service provider had suspended the service over a week in Stockholm in 2018 (Griswold, 2019). In Milwaukee, USA the e-scooter service providers monitor the weather and decide if the services are available or not (Carson, 2020).

Non-Profitable Business

Although the dock-less sharing services provide advantages, none of the e-scooter service providers has been profitable yet. The main reasons for this have been immense competition, which forces the e-scooter services to lower the price for usage to have a user base. The e-scooters are expected to have a life span of 5 months, but in reality, it is found to be much lower, which is around 28 days (Faxér, 2019). Furthermore, the business model works by using trucks to pick up scooters to charge and redistribute the e-scooters and adds additional logistical cost to the businesses. The low lifespan and the high operating price has increased operational cost compared to returns on the service provided. Some basic calculation carried out by Griswold (2019) in Louisville, USA found that Bird the e-scooter service provided looses 293$ per e-scooter over its lifespan. The main reason for low lifespan has been attributed to be vandalism. The e-scooters have been found in canals, rivers and bushes. Also, in many cases, the reckless riding on the user's part results in damaging the e-scooters, thus lowering the life of the scooters (CNN, 2019). All these factors together have resulted in the e-scooter services to be nonprofitable.

Pollution

E-scooters have also come into conflict with the society, primarily due to the way the dock-less bike-sharing services work. Since they can be parked anywhere, they can often be found to be parked on roads and sidewalks and causes inconvenience to other modes of transport. Further, the business models focus on increasing the supply of e-scooters in areas of high usage, resulting encroachment of public places for parking and results in blockage of parts and visual pollution. Additionally, then tend to fall in heavy winds and thus end up blocking the sidewalks. Also, due to the issue with vandalism, they have often ended up in rivers and canals, thus polluting them since they are equipped with batteries this further causes a significant threat to the organisms in the water (CNN, 2019).

The e-scooter service business model uses redistribution using cargo trucks. The carbon emissions are found to be high when the manufacturing, charging, redistribution and the lower lifespan of e-scooters are considered. Therefore no advantage over cars is seen. The life cycle assessment carried out by (Hollingsworth et al., 2019) found that e-scooter emits 202 grams of CO2 per passenger-mile, which is similar to that of combustion engine cars. The CO2 emission by e-scooters is 3.5 times than that of electric cars (Fournier, 2019). Additionally, even while just considering the journey, the emission by e-scooters is 40 times of public transportation (France 24, 2019).

Availability
The way the e-scooter services are set up to maximize the profitability, they provide a more significant number of scooters based on the density of the population. Thus, increasing the usage and generating revenue for the companies. This results in the city centers having greater availability of e-scooters and reduction in supply as one move towards the suburbs. In the pilot program at Portland, USA, it was found that despite regulations requiring the deployment of e-scooters in East Portland, only one company complied (PBOT, 2019). Further, due to this dependency, there is a lack of services in rural areas or towns as profitability is a challenge (Zipper, 2020). Additionally, due to the dockless nature of the parking of e-scooters, it cannot be considered to be always available at the same location.

Replacing lower emission travel modes
Th e-scooter have been found to replace waking or cycling as a mode of transport. Walking and cycling are considered to be beneficial for the individuals' health and to have a low carbon footprint. In Portland, USA it was found that 42% of the e-scooter users said, they would have walked or cycled in case of the absence of e-scooters (PBOT, 2019). In Paris, France it was found that e-scooters replace half of the trips which were walk able and 30% of the users said they would of used public transportation if e-scooters were not available (Wired, 2019).

Size Restrictions
E-scooters are designed to carry one person and the form factor also does not allow users to carry big bags. This limits the usage of this new travel mode for various purposes, such as to go for groceries shopping, moving furniture and also for multiple people to travel. In a focus group conducted by PBOT (2019) Portland, USA, the users expressed that transporting kids was not possible with e-scooters.

Regulatory challenges
One primary concern with the e-scooters is the ambiguity over the regulations needed for e-scooters. E-scooters are relatively a new mode of transport which shares the infrastructure of the existing transport modes. E-scooters being a novel technology and also with the cities looking for alternatives to decongest the roads, has resulted in the regulations being updated as more data is received on the usage and functioning of the e-scooter services. When the e-scooters arrived in the American cities, they did not have any permit, which later lead to the introduction of orders and fines to

regulate the services (smart city, 2020). In European countries such as Austria and Sweden have categorized them in the same categories as bicycles, even though they run on electric motor and can travel much faster than a bicycle (The Local, 2019) (smart city, 2020).

The regulatory concerns for e-scooters includes issues such as categorisation of transport mode, safety aspects and use of infrastructure. To understand the issues due to unclear or lack of regulations, a literature study was carried out to determine how regulators and different cities across the world are adapting to this new phenomenon of e-scooters, which is explained in detail in the section 6.

4.1.3 Inference on advantages & disadvantages

The literature search on e-scooters services have found it to be cost effective and quicker for shorter distances than public transportation. Furthermore they have a great potential to solve the last mile problem, whenever the public transportation has been lacking. This factors are helped by the dockless nature of the services with the support of small size of e-scooters making it easier to ride and park. But the small size and dockless nature brings in challenges such as allowing only one person to travel and limitation carrying big bags and constant availability of the service being a concern. Also, the weather has been found to have an effect on choice of e-scooter as a mode of transport.

Additionally, it has had an positive effect in reducing car usage especially in USA. But the e-scooters have also resulted in reduction in people using more sustainable transport modes such as walking or biking. Also a conflict is seen with regard to environmental benefits with studies showing benefits on usage, but having a serious carbon implications over its life cycle, which is found to be short due to a serious issue of vandalism. Additionally the short life cycle of the e-scooters has had a profound effect on the balance sheets of the e-scooter service providers.

Furthermore, the e-scooters conflict with the other modes of transport. There has been an increase in injuries and accidents. The accidents are commonly observed and are mostly attributed to bad riding habits and confusion created due to lack of dedicated riding space, as they mostly tend to use bike paths.

4.2 Policy comparison

This section looks at the regulations related to four areas of “safety”, “parking”, “number and distribution” and “law enforcement”. For the comparison purpose six cities namely Portland, Dallas, Paris, Stockholm, Berlin and Brisbane spread over three continents of North America, Europe and Australia were picked with no specific reasoning going into their selection other than for the geographic spread. They were picked based on their mentions in literature and newsletter during the preliminary

literature research on e-scooter services. The comparison is also summarized in the figure 6.

4.2.1 Safety

Safety has been a concern after the launch of e-scooter services in cities. To avoid conflict with the other travel modes especially pedestrians, the e-scooters have been banned to be ridden on sidewalks which is seen in four of the six cities. With exceptions of Dallas where barring one restricted zone in the center of the city it could be used on sidewalks and Brisbane making it mandatory to use on sidewalks instead of bikepaths (Riga, 2019). Additionally all the cities have some form of speed limit ranging from 20 to 25 kms/hour with an exception of Dallas which has a relatively higher speed limit of 56 kms/hour(City of Dallas, 2019). It is observed that in the cities of Paris, Berlin, Portland and Stockholm they share the rules and infrastructure of bicycles and are supposed to use bike paths available and in case of absence of them to be ridden on roads (PBOT, 2019) (Gössling, 2020) (Tidey, 2019) (Queensland Government, 2019)(Kreuzer, 2019).

All the cities also have age limits set to use the e-scooters, the age restrictions ranging from 12 to 18 years. Where Paris has the lowest age limit with 12 years of users and on the other end in Stockholm and Dallas the users should be an adult, i.e at least 18 years old (Tier, 2020). Along with the age limit the cities of Portland, Dallas and Brisbane have made it mandatory to wear an helmet while riding an e-scooter. Whereas in Paris, it is mandatory to have an helmet on using on faster roads, otherwise it is just an recommendation (BBC, 2019)(Crellin, 2019).

4.2.2 Parking

E-scooters have had a lot of issues related to bad parking (CNN, 2019). Also due to the dockless business model there is no dedicated parking space (C. S. Smith & Schwieterman, 2018). Though the e-scooter companies and authorities in the cites have placed restriction on parking in few areas with the help of geofencing technologies and information provided through e-scooter applications (Brandt & Toll, 2019). None of the cities were found to have any regulations on how to park other than for guidelines (City of Dallas, 2019). The same guidelines are communicated by e-scooter service providers, such as, parking in a way that it does not block the movement of pedestrian or other vehicles or cause public safety risk (VOI Technologies, 2020). Also Bird, a e-scooter service provider in Paris has started to provide incentives for riders for parking in dedicated spaces (Bird, 2019). Thus the parking behaviour have mainly been dependent on the user of the e-scooter making it a challenge to regulate the parking. Further enforcement of good parking habits is difficult as they are dependent on the interpretation of the law enforcing officers.

4.2.3 Number of e-scooters and their distribution

It was found that the cities of Portland, Berlin, Paris and Brisbane have some form of limiting factor on the number of e-scooters which could operate in the cities to avoid the clutter on the streets (Wired, 2019). Further authorities in Portland have made it mandatory for e-scooter services providers to evenly provide services in all parts of the city while emphasising a greater supply of e-scooters where the access to public transport is lower (PBOT, 2019). On the contrary on such restrictions were found to be existing in the cities of Stockholm and Dallas.

4.2.4 Law Enforcement

In Brisbane the users are fined for not wearing a helmet, riding on bikepaths and over speeding by the police (Riga, 2019). It was also found that the cities of Berlin and Paris has been enforcing laws on the usage of e-scooters by issuing fines for bad parking and riding on sidewalks (Marcus, 2020) (Crellin, 2019). Though the challenge has been, when the e-scooters are already parked it is not possible to determine the user, The city of Dallas has addressed this by picking up e-scooters which are not parked properly around and fines the e-scooter operator. Furthermore in Dallas the e-scooters are subjected to the same laws as cars and the police has started to fine on sidewalk riding and riding without a helmet (Lawrence, 2019). In Portland though there were no fines during the first pilot program in 2018, during the second pilot program in 2019 fines were introduced for riding on sidewalks or bad parking habits, along with companies being asked to use geofencing technology to limit parking in areas such as public parks (K. Thomas, 2019). In Stockholm no visible law enforcement was found as the e-scooters are treated in the same categories as bikes.

4.2.5 Inference on regulatory challenges

Literature search determines that most of the cites have been reacting to the e-scooter services baring Portland who have been proactive in promoting safer use of e-scooters and training residents to use them. It is common finding that there are regulations related to both speed and age. Additionally it has been a common practice to regulate the use of e-scooters on bike paths. The use of helmets was found to be mandatory or recommended.

The literature search also found that regulating the parking of e-scooters has been a challenge, with only guidelines in place to promote safer parking habits. Additionally the cities have been issuing fines for badly parked e-scooters. But it is important to note that Sweden has not been enforcing regulations on e-scooters as they are categorized in the same category of bikes.

Cities	Safey				Parking restricitions	Limit on e-scooter numbers	Law enforcement (fines)			
	Speed (kms/ hour)	Age	Infrastructure	Helmet			Over Speeding****	Bad parking	Helmet	Riding on wrong infrastructure
Berlin	20	14	Bike paths*	Recommended	Guidelines	Yes	No	Yes	N/A	Yes
Brisbane	25	16	Sidewalks**	Mandatory	Guidelines	Yes	Yes	Yes	Yes	Yes
Dallas	56	18	Bike paths*	Mandatory	Guidelines	No	No	Yes***	Yes	Yes
Paris	25	12	Bike paths*	Recommended	Guidelines+ Dedicated parkign places	Yes	No	Yes	N/A	Yes
Portland	24	16	Bike paths*	Mandatory	Guidelines	Yes	No	Yes	Yes	Yes
Stockholm	20	18	Bike paths*	Recommended	Guidelines	No	No	No	N/A	No

*	Use roads in the absence of bike paths
**	Use roads in the absence of side walks
***	Dallas fines operator in case of badly parked e-scooters
****	It is to be noted that the speed limit on the e-scooter services are being enforced usign geofencing technology

Figure 6: Policy Comparison

4.3 User Needs

The focus of the study is to determine the possibility of e-scooters to fill needs of car users to use public transportation. To make this possible the study focuses on capturing and understanding the needs of the car users. To initiate the capturing of the needs of car users a literature search was carried out to identify these needs.

4.3.1 Studies on user needs around the world

This section includes the information on the studies carried out in the different countries such as Australia, Scotland, Netherlands and England to determine the reasons for the modal chose for transportation and the user needs which needs to be fulfilled.

Australia
Corpuz (2007) carried out a study in New South Wales, Australia to determine the reasons affecting the choice of the travel mode. Corpuz (2007) determined that socio-demographic characteristics played a significant role. Having a job, having a higher household income, having kids at home resulted in using the car over public transportation. On the other hand, students, 11 to 20 year old and the ones with no cars used public transportation more. The study determined that the factors of the purpose of travel and time of the day played a significant role.

Furthermore, it was determined that the most crucial factors affecting the choice of the mode were access & frequency of public transportation, travel time, availability of parking, cost of travel, comfort and convenience. The study found that a third of the private vehicle uses would use more of public transportation if it were more accessible and frequent. It also determined that half the people who use public transport did it to avoid issues with parking.

Scotland
Stradling and Anderson (2012) as the part of Sottish Social Attitudes Survey in 2002 conducted surveys and interviews in Scotland to determine the attitude to modal shift from car to other modes. The study determined that 80% of the population depended on using car neither structurally or consciously. Further, the study determined 29% were able to substitute short car journeys with bus and 23% were willing to use more of public transportation if they were improved. The study also found no statistical difference in variation over different age groups. The study determined the underling needs and factors of car users which needs to be fulfilled to enable the transition for modal shift. The factors identified were: Convenience, journey time, the cost of travel, the weather condition, comfort and safety. It also found of all the men three quarters drove compared to half of female respondents. It also determined factors such as health and environment affected the mode used to travel.

The study also looks at using push or pull methods to bring in a modal shift from car to public transport. These methods could be increase in petrol cost, levying peak fee

in the city center, making public transport reliable and cheaper. Almost half of the respondents said any of these factors would result in shifting to public transportation.

Netherlands
Steg (2003) in her study in Netherlands identified that, car use was evaluated more positively over public transportation. The main reasons for this were found to be convenience, independence, flexibility, comfort, speed, pleasurable and reliability. But, she also found that people who don't use cars and use public transport for travelling, perceived it to be safer. But, the car users said it was safer over public transport. It also found that people who don't use cars also perceived the use of cars to be more attractive. The study determined women, young people and low-income used car less compared to men. The use of car was evaluated positively in densely populated Netherlands, where public transport was widely available. But the study also found that their is a possibility to persuade people to use public transport. The study also identified the negative aspects from frequent car drivers to be travel cost, traffic safety and status. Steg concludes saying people who relate the use of car to freedom will be the hardest to persuade and it is better to not try doing that.

England
Webb (2011) carried out a study on the attitude of people towards public transport in Plymouth, England. The study determined that women perceived public transport positively as cheaper and frequent. On the other hand, men preferred cars, saying they were quicker and reliable. The central negative aspect associated with cars was identified to be the issues with expensive parking cost. Still, at the same time, the availability of parking was found to be positive in Plymouth. The other main advantages were determined to be flexibility, convenience, shorter travel time, cleanliness and comfort. Webb concludes saying the use of public transport can be encouraged by using push/pull policies as seen in the German city of Freiburg.

4.3.2 Studies on user needs in Västra Götaland Region

This section looks into the user needs related to Västra Götaland Region which has been identified by the survey of "Hallplats 2019", carried out by Västtrafik (2019) on the usage of different modes of transport. Also "Resvaneundersökning 2017" conducted by Göteborgs Stad (2018), which looked into travel patterns in VGR.

User needs defining car usage
The surveys determined that the need to be spontaneous and the feeling of independence offer by car led to the ownership of cars. Further the car users felt that the cost of using is much cheaper than public transport. 50% of the car users believe that, using car is more affordable than using public transport. The survey found that the car users believed, cars provided an opportunity to be spontaneous (79%). Furthermore, 59% of the car users said, they use car because they enjoyed driving. The survey looked into how important the cars are perceived by the population. Compared to the urban residents the rural residents living in rural areas believed car was a neces-

sity. 27% in Gothenburg municipality said they could travel without a car compared to 92% in rural areas who said they could not (Västtrafik, 2019).

Modal shift needs

A willingness to pick more sustainable modes of transport over car was found to exisit amongst the population. It found 28% were willing to travel more collectively and 27% wanted to cycle more often (Västtrafik, 2019).

Three main factors that would influence the modal shift from cars (figure 7) were identified during the survey by Västtrafik (2019). First factor was, the change in life situations such as job location, relocation and finances would influence it (39%). The second factor was personal values such as environmental impact and health benefits (22%). The third factor was external factors such as fuel price and public transport cost would impact their choice (4%). The survey also found that majority of people agreed that, the important factors affecting there choice of mode were duration of travel (82%) and cost of travel (65%). Also 48% of the respondents said environmental factor played a role (figure 8).

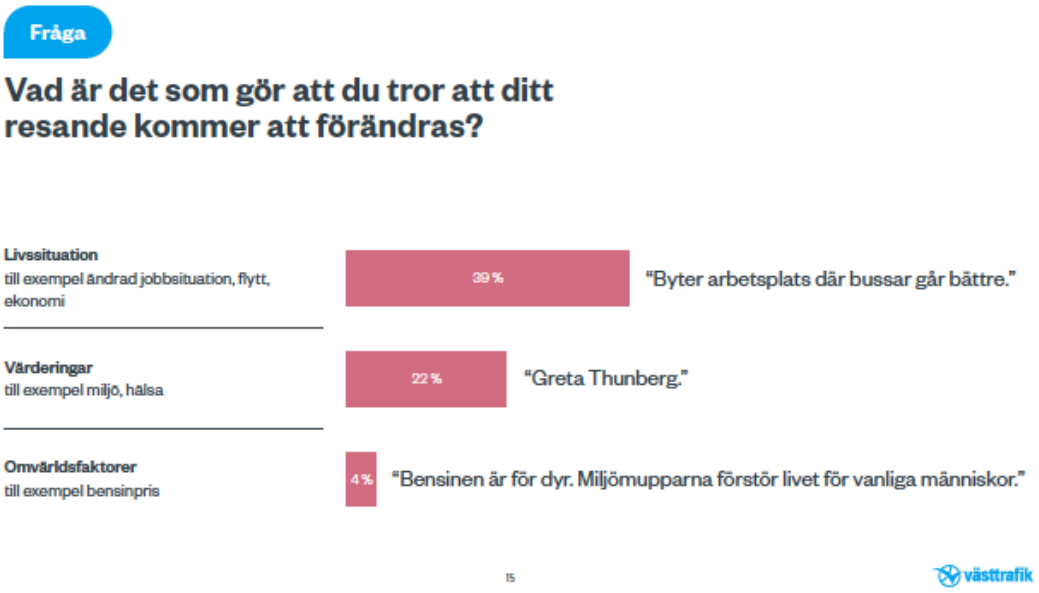


Figure 7: Factors for modal shift
(Västtrafik, 2019)

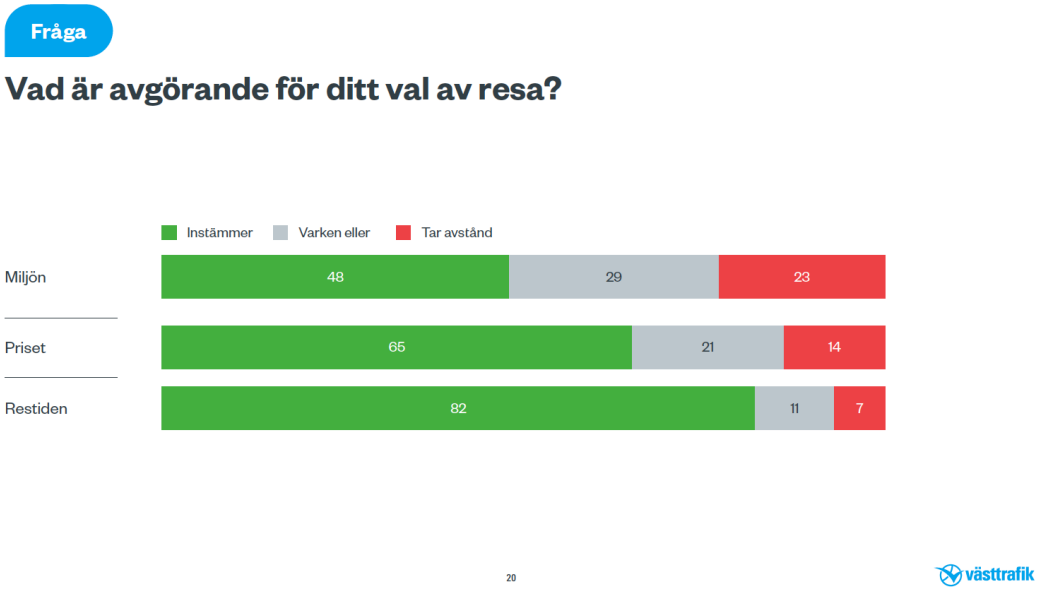


Figure 8: Factors which affect the choice of the mode of transport (Västtrafik, 2019)

4.3.3 Travel patterns and preferences in Västra Götaland Region

This section looks into the travel preferences in Västra Götaland Region in the surveys of "Hallplats 2019" and "Resvaneundersökning 2017".

Effect of Duration and Distance of travel

The travel distance on weekdays were determined to be relatively short. 20% of the trips are shorter than 2 kilometers, followed by 23% of the trips in the range of 2 to 5 kilometers, 18% of the trips in the rage of 5 to 10 kilometers,17% of the trips in the range of 10-20 kilometers and 22% of the trips greater than 20 kilometers. The study further determined for trips shorter than 2 kms, 58% walked followed by 24% using car, cycling is 12% and collective journey using bus and tram is 5%. (figure 9)(Göteborgs Stad, 2018).

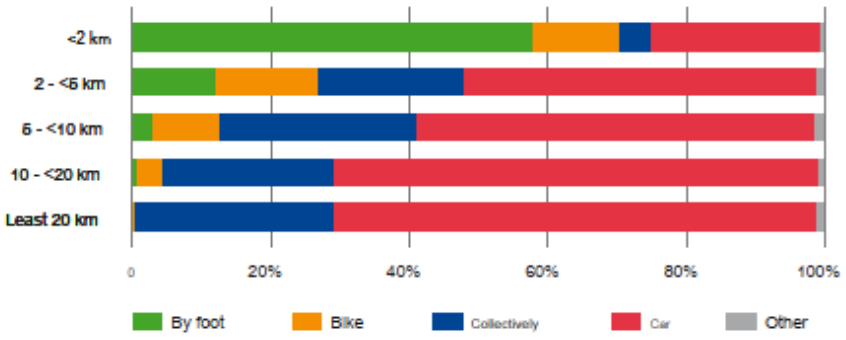


Figure 9: Length of journey using different modes of transport (Göteborgs Stad, 2018)

Additionally the average travel time to school was found to be 40 minutes. The time to pick/drop children to school was 39 minutes and the work commute time was 30 minutes (figure 10). The average travel distance was found to be highest for commuting for business purposes with 28 Kilometers followed by 17 kilometers for both school and work (figure 11)(Göteborgs Stad, 2018).

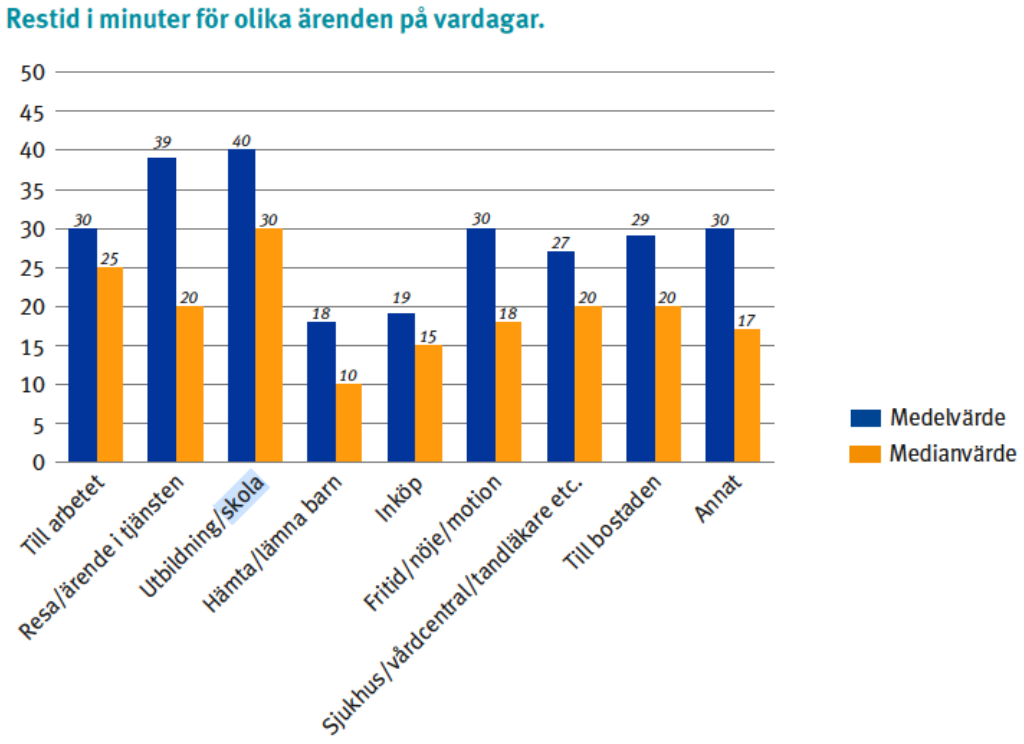


Figure 10: Average travel time for different purposes (Göteborgs Stad, 2018)

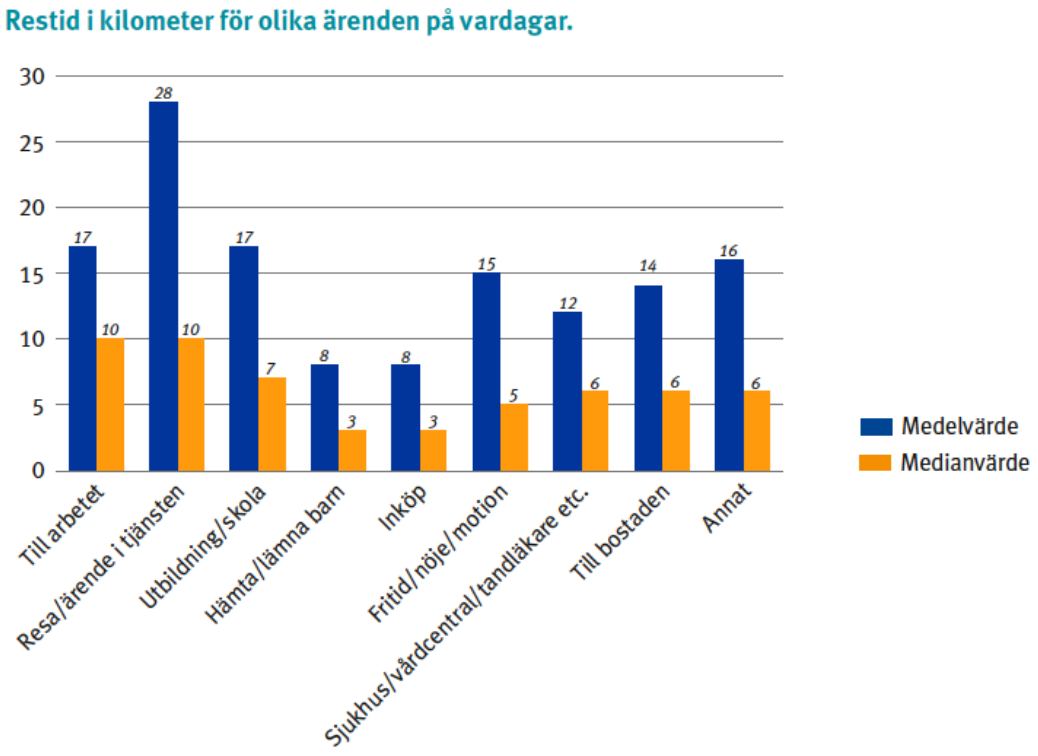


Figure 11: Average travel distance for different purposes (Göteborgs Stad, 2018)

Furthermore, it found that work travel distance of 11% of the population in VGR was less than 2 kilometers. 17% in Gothenburg municipality and 20% in other municipalities travelled between 2 and 5 kilometers. The break up of distances can be found in the figure 12 below. It was also found that 71% of the population in Gothenburg municipality and 63% in the other municipalities of the region travelled less than 20 kilometers for work(Göteborgs Stad, 2018).

fördelning per reslängd	< 2 km	2 – < 5 km	5 – < 10 km	10 – < 20 km	20 km och mer
Totalt	9 %	26 %	21 %	34 %	10 %
Kvinna	14 %	20 %	21 %	18 %	27 %
Man	9 %	16 %	19 %	22 %	34 %
Göteborgsregionen	11 %	17 %	21 %	22 %	29 %
Kommuner i omnejd	11 %	20 %	15 %	17 %	37 %

Figure 12: Work travel distance in Gothenburg and other municipalities (Göteborgs Stad, 2018)

Purpose of travel

The survey also identified different reasons for travel and the modes of travel on weekdays and determined the use of car was high for all purposes other than picking and dropping kids to school (figure 13). It was found that the 33% of the travel on weekdays is for work, followed by leisure/pleasure/exercise activities with 20% and travel for shopping was 17%. Furthermore, majority of the travel to work is done by car by 51% followed by 27% using public transportation. Travel by bicycling and on foot is 10% each.When travelling to school/training the public transport use is high with 66%. Travel to pick and drop kids to school was 66% by public transportation. The share of car use was less with 8% (Göteborgs Stad, 2018).

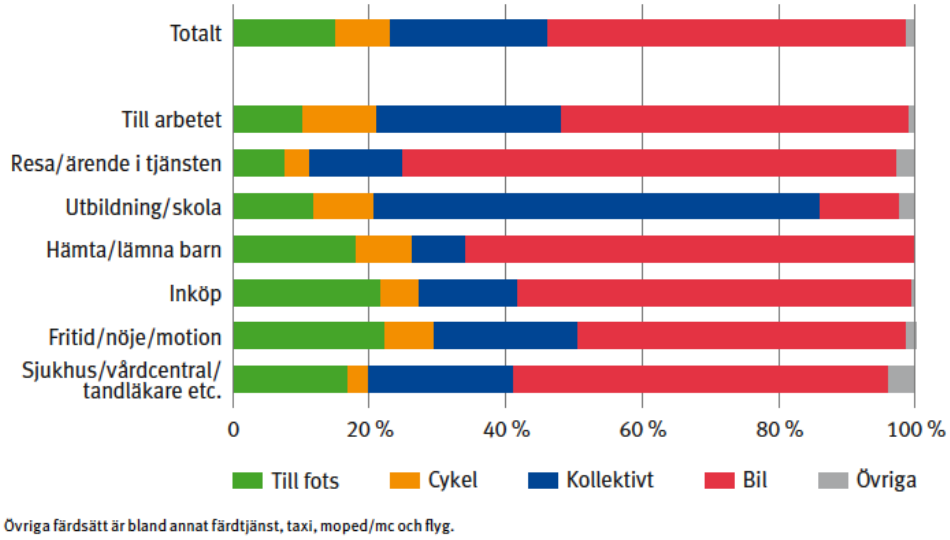


Figure 13: Different purpose and modes of travel on weekdays (Göteborgs Stad, 2018)

Choice of travel mode

Household and kids at home plays a role in the choice of mode for travel. People living in households with two adults and households with two adults & kids carried out 70% of the car travel. At the same time it was found that households with one adult living, mostly walked or used public transportation (figure 14)(Göteborgs Stad, 2018).

Fördelning av resor med olika färdsätt på personer i olika hushållstyper, vardagar.

	EN VUXEN UTAN BARN	EN VUXEN MED BARN	TVÅ VUXNA UTAN BARN	TVÅ VUXNA MED BARN	ÖVRIGA
Totalt	17 %	3 %	34 %	31 %	15 %
Till fots	23 %	3 %	32 %	31 %	11 %
Cykel	19 %	2 %	35 %	31 %	13 %
Kollektivt	23 %	3 %	31 %	24 %	18 %
Bil	12 %	3 %	35 %	34 %	15 %
Befolkningen	20 %	7 %	27 %	33 %	12 %

Figure 14: Effect of household and age on travel mode (Göteborgs Stad, 2018)

Preferred mode of transport

The survey found that 65% of the respondents preferred car as their first choice amongst different transport modes. The survey on car usage determined that 40% car users, used the car more than five times a week. It was followed by 25% of the people using it two to four days a week.

Additionally the survey determined that, the public transportation was the second most widely used transport mode. 19% of the respondents used public transport more than 5 days per week and 16% of the respondents using it 2 to 4 days a week. Further on the usage of the other modes of transport such as rental bikes, e-scooters, carpooling etc, approximately 85% of the respondents said they never used them (figure 15)(Västtrafik, 2019).

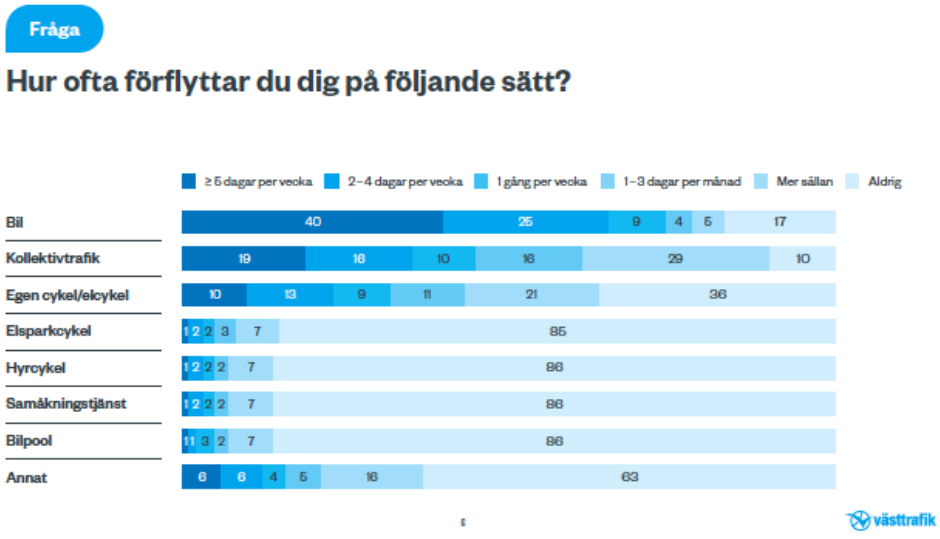


Figure 15: Usage of different modes of transport (Västtrafik, 2019)

In a survey conducted by Göteborgs Stad (2018) in Västra Götaland Region in 2017, determined that 80% of the inhabitants carried out 1 trip in a day and 2.5 trips on a weekend. It also determined that the majority of the travel happened within the Gothenburg municipality, with 90% of the total travel. The study also found out that 53% of the travel was done by cars.

Furthermore the car journey was identified to be higher amongst men (57%) than women (49%). Also the age group of 45 to 54 was identified to be using cars more than the other age groups. Gothenburg municipality has significantly low car use with 49%, when compared to other municipalities which have 65% (Göteborgs Stad, 2018).

41% of the population in Västra Götaland Region is concentrated in Gothenburg city, and the city accounts for 75% of the trips. On weekdays 62% of the Gothenburg city's population uses public transportation followed by 28% using car. The other regions in proportion has less percentage of both car and public transportation as seen in figure 16 (Göteborgs Stad, 2018).

Andel av befolkningen (16–84 år) i respektive kommun samt deras andel av resor som genomförs vardagar med kollektivtrafiken respektive med bil.

	ANDEL AV BEFOLKNING	ANDEL AV KOLLEKTIVTRAFIKRESOR	ANDEL AV BILRESOR
Ale	2 %	2 %	2 %
Alingsås	3 %	2 %	3 %
Bollebygd	1 %	0 %	1 %
Borås	8 %	5 %	8 %
Göteborg	41 %	62 %	28 %
Härryda	3 %	2 %	4 %
Kungsbacka	6 %	4 %	7 %
Kungälv	3 %	2 %	5 %
Lerum	3 %	2 %	5 %
Lilla Edet	1 %	1 %	1 %
Mark	2 %	1 %	3 %
Mölndal	5 %	4 %	5 %
Orust	1 %	0 %	2 %
Partille	3 %	2 %	3 %
Stenungsund	2 %	1 %	3 %
Tjörn	1 %	0 %	2 %
Trollhättan	4 %	2 %	5 %
Uddevalla	4 %	2 %	5 %
Varberg	4 %	2 %	5 %
Vänersborg	3 %	1 %	3 %
Öckerö	1 %	1 %	1 %

Figure 16: Trip share in the region
(Göteborgs Stad, 2018)

Age factor was found to play a role in the the choice of the mode of transport (figure 17). People in the age group of 25 to 44 years accounts for almost half of the trips made on foot or by bicycle. Further it determined that the people in the age group 25 and 64 accounted for the 77% of the car trips (Göteborgs Stad, 2018).

Fördelning av resor med olika färdsätt på olika åldersgrupper, vardagar.

	16–24 år	25–44 år*	45–64 år*	65–84 år*
Totalt	11 %	40 %	33 %	16 %
Till fots	11 %	47 %	25 %	17 %
Cykel	11 %	47 %	32 %	10 %
Kollektivt	23 %	43 %	23 %	11 %
Bil	5 %	37 %	40 %	19 %
Befolkningen	14 %	35 %	31 %	20 %

Figure 17: Travel share based on age
(Göteborgs Stad, 2018)

4.3.4 Inference from the literature search on car user needs

The literature search found that having kids at home resulted in people preferring to use more cars. The use of car was found to be higher amongst men. As men perceive cars to be more reliable and convenient compared to women. Also, cars are expected to provide advantage over public transportation in terms of travel time, accessibility and flexibility. It was also found that cost of travel also plays a important role in choosing the mode of transport. The literature search also identifies that reliability of public transportation is questioned by users across countries. Furthermore, it was identified that the weather and parking availability are influencing factors in the choice of the mode of travel. Bad weather and parking availability would have a positive effect on the use of car. On the other hand, good weather lack of parking would have the opposite effect.

The surveys in Sweden also agrees with the findings in other countries, with people perceiving cars to be more cost efficient, reliable, convenient. But it was also found that place where people live influence the mode of transport, with urban population using more public transportation compared to rural population. In Sweden too people find duration and cost of travel plays a crucial role.

The literature research helped in identifying various needs of the car users which the current public transportation system is not able to fulfil. The identified needs have been listed down and then grouped into two categories as seen in table 4, instrumental needs which are easily quantifiable and perceived needs which needs to be looked into depth by interacting with people to understand what it means to the individual.

These needs acted as a foundation for forming the questions for survey and interviews.

Table 4: Car user needs

Perceived Needs	1. **Convenience** (Stradling & Anderson, 2012)(Webb, 2011) 2. **Comfort** (Steg, 2003)(Webb, 2011) 3. **Flexiblity** (Steg, 2003)(Webb, 2011)(Västtrafik, 2019) 4. **Saftey** (Steg, 2003)(Västtrafik, 2019) 5. **Accessibility** (Corpuz, 2007) (Västtrafik, 2019) 6. **Status** (Steg, 2003) 7. **Independence/Freedom** (Steg, 2003)(Västtrafik, 2019) 8. **Reliability** (Stradling & Anderson, 2012)(Steg, 2003)(Webb, 2011) 9. **Pleasurable** (Steg, 2003) (Västtrafik, 2019) 10. **Control** (Stradling & Anderson, 2012) 11. **Sustainability**(Västtrafik, 2019)
Instrumental Needs	1. **No waiting** (Steg, 2003) 2. **Speed of travel** (Corpuz, 2007)(Webb, 2011) 3. **Travel Time** (Webb, 2011)(Västtrafik, 2019) 4. **Arriving closer to destination**(Corpuz, 2007) 5. **Cost of travel** (Stradling & Anderson, 2012)(Västtrafik, 2019)

5

Survey

Two surveys with the titles "Survey on car user needs" and "Survey on E-scooters" were conducted to obtain primarily quantitative data. The first survey focused on the needs of the car users and the second one focused on gathering information on E-scooters users and their needs being fulfilled. Furthermore, the surveys were conducted on social media targeting the residents of Västra Götaland region. The purpose of the survey was to determine the opinions of residents of Västra Götaland region regarding the needs for car usage,user needs of the e-scooters and the factors needing improvement in the current public transport system.

5.1 Survey on car user needs

In this survey a total 117 responses were received from across the world of which 103 were from Västra Götaland region. Furthermore, out of 103 respondents 82 used car. For the analysis of the survey only the respondents in Västra Götaland region who use car has been considered. To analyse the survey the respondents have been categorized into two groups residents of Gothenburg city (38%)and the rest of the residents of Västra Götaland region (62%). It can be noted that some of the graphs and statistic total up more than 100%. This is due to the fact that some respondents used multiple options for questions.

5.1.1 Purpose of use

Gothenburg City
In total 31 respondents from Gothenburg city said they used car. The car was used for multiple purposes (figure 18). Most of the respondents used the car for daily commuting purposes, with 61% using it to travel to work and 42% using it to travel to school or for training purposes. Furthermore 94% of the respondents said they used the car for leisure & travelling purpose. 19% of the respondents used it to pick & drop children, this was followed by 13% for shopping and 13% for visiting friends & relatives.

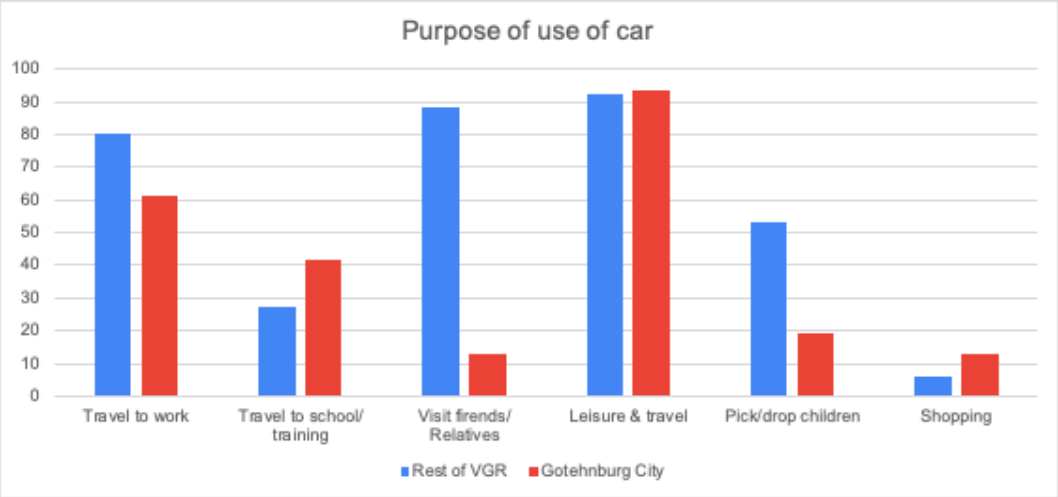


Figure 18: Purpose of use of car

Rest of VGR

Total of 51 respondents from rest of VGR responded that they used car, see figure 18. Majority of the residents used the car for daily commuting, with 80% using it to travel to work and 27% using it to travel to school or for training purposes. Furthermore 92% of the respondents said they used the car for leisure & travelling purpose. 88% of the respondents used it for for visiting friends & relatives, followed 57% to pick & drop children and finally 6% for shopping.

5.1.2 Important user needs of car users

Gothenburg city

The survey asked the respondents to rate the importance of the user needs identified in literature review for car use (figure 19). The most important needs were determined to be convenience and flexibility with 87% and 81% of the respondents agreeing to it. The other needs of independence/freedom (68%), comfort (61%), accessibility (52%), safety (39%) and reliability (35%) were also considered to be of importance. Whereas, cost (3%) and status (19%) was not considered to be of an greater need by the respondents.

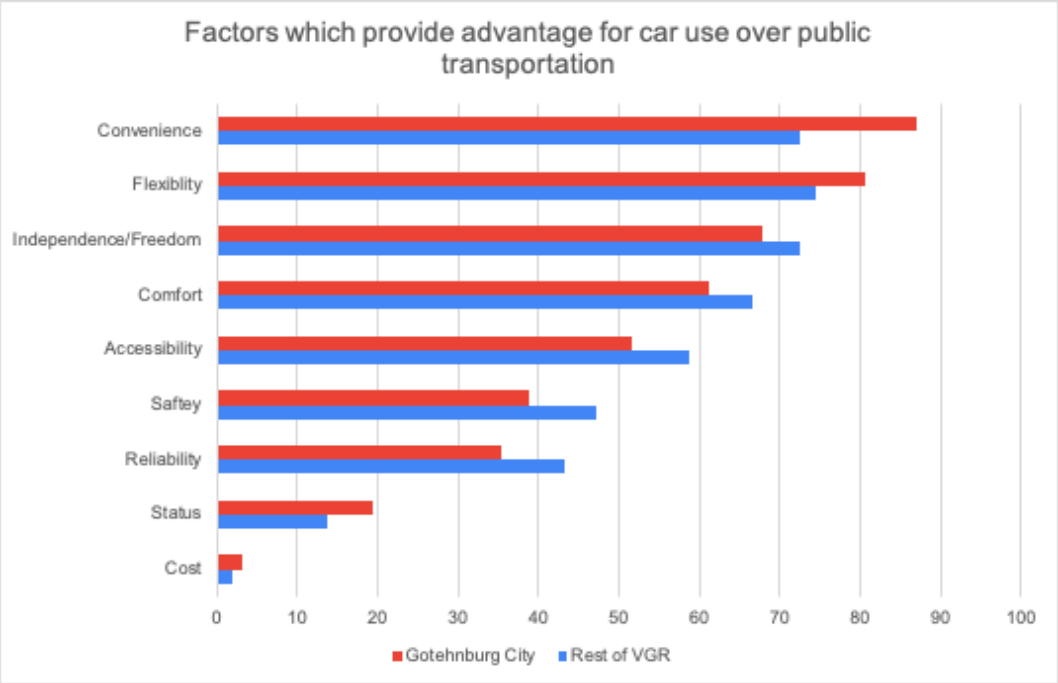


Figure 19: The most important user needs of car users

Rest of VGR

The VGR residents (figure 19), responded flexibility was the most important need, with 75% respondents. This was followed by convenience and independence/freedom with both having 73% respondents. Comfort (67%), accessibility (59%), safety (47%) and reliability (43%) were also considered to be important needs. Whereas, cost (2%) and status (14%) was not considered to be of an greater need by the respondents similar to Gothenburg city.

5.1.3 Ratings of user needs

The eight needs of car users of convenience, comfort, flexibility, safety, accessibility, status, independence/freedom and reliability were asked to be rated on a scale of 1 to 5. Furthermore this question was to determine the importance of these car user needs. In the rating scale, 1 corresponded to not important and 5 corresponded to very important (figure 20). The average ratings of car user needs can be seen in figure 21.

Very Important	Important	Neutral	Low importance	Not Important
5	4	3	2	1

Figure 20: Survey rating scale

Gothenburg city

1. **Convenience** had a average rating of 4.35 and 90% of the respondents considered convince to be either very important (48%) or important (42%).
2. **Reliability** had the highest average rating of all the user needs with 4.39 and 84% considered it to be either very important (58%) or important (26%).
3. **Flexibility** had the same average rating as convenience, i.e 4.35. 84% of the respondents considered it to be either very important (55%) or important (29%).
4. **Independence/Freedom** with an average rating of 4.16 came next. 74% of the respondents considered it to be either very important (48%) or important (26%). Furthermore 19% of the respondents had a neutral opinion about the feeling of independence & freedom.
5. **Accessibility** had an average rating of 4.13. 74% of the respondents considered it to be either very important (39%) or important (35%). Furthermore 26% of the respondents said they had a neutral opinion about accessibility to car.
6. **Safety** had an average rating of 3.9 with the opinion of very important and important getting 32% of responses. This was followed by neutral getting 29% of the response.
7. **Comfort** had an average rating of 3.71. 45% of the respondents had a neutral opinion associated with the comfort of the car. Whereas, 29% said it was important followed by 23% responded it was very important.
8. **Status** had the lowest average rating with 1.97. 45% of the respondents said it was not important, followed by 29% saying it was of low importance and 13% had a neutral opinion about it. Only 13% considered it to be either very important (3%) or important (10%).

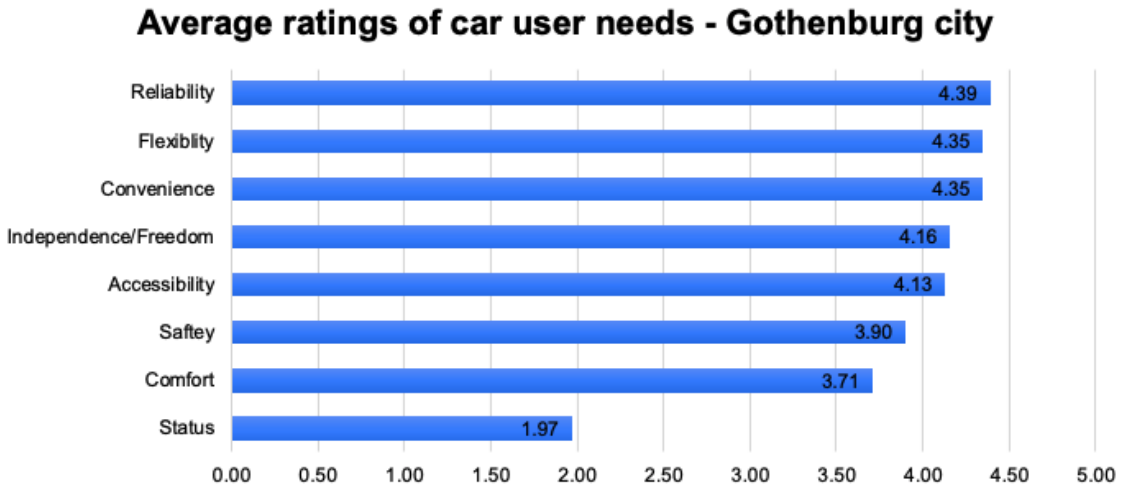


Figure 21: Average ratings of car user needs - Gothenburg city

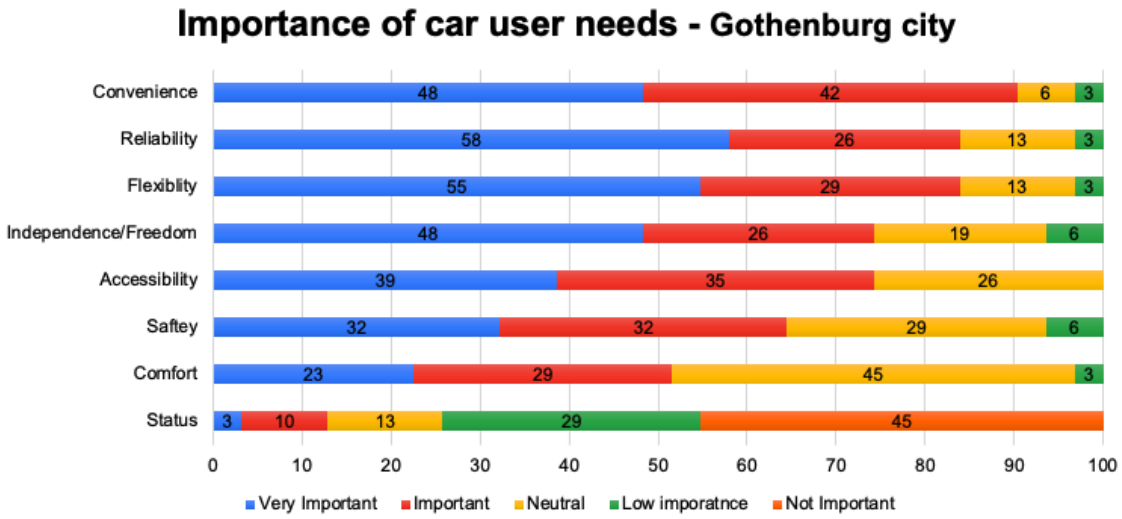


Figure 22: Importance of car user needs - Gothenburg city

Rest of VGR

1. **Convenience** had a average rating of 4.14 and 82% of the respondents considered convince to be either very important (35%) or important (47%).

2. **Reliability** had a average rating of 4.35 and 88% considered it to be either very important (53%) or important (35%).

3. **Flexibility** had the highest average rating of 4.37. 83% of the respondents considered it to be either very important (59%) or important (24%). Further, 14% have a neutral opinion about it.

4. **Independence/Freedom** with an average rating of 3.98. 70% of the respondents considered it to be either very important (43%) or important (27%).Furthermore 18% of the respondents had a neutral opinion about the feeling of independence & freedom.

5. **Accessibility** had an average rating of 4.00. 70% of the respondents considered it to be either very important (39%) or important (31%).Furthermore 22% of the respondents said they had a neutral opinion about accessibility to car.

6. **Safety** had an average rating of 4.2. 82% of the respondents considered it to be either very important (45%) or important (37%).Furthermore 14% of the respondents said they had a neutral opinion.

7. **Comfort** had an average rating of 3.65. 65% of the respondents considered it to be either very important (20%) or important (45%). Further, 20% have a neutral opinion about it.

8. **Status** had the lowest average rating with 2.10. 39% of the respondents said it was not important, followed by 25% saying it was of low importance and

25% had a neutral opinion about it. Only 10% considered it to be either very important (4%) or important (6%).

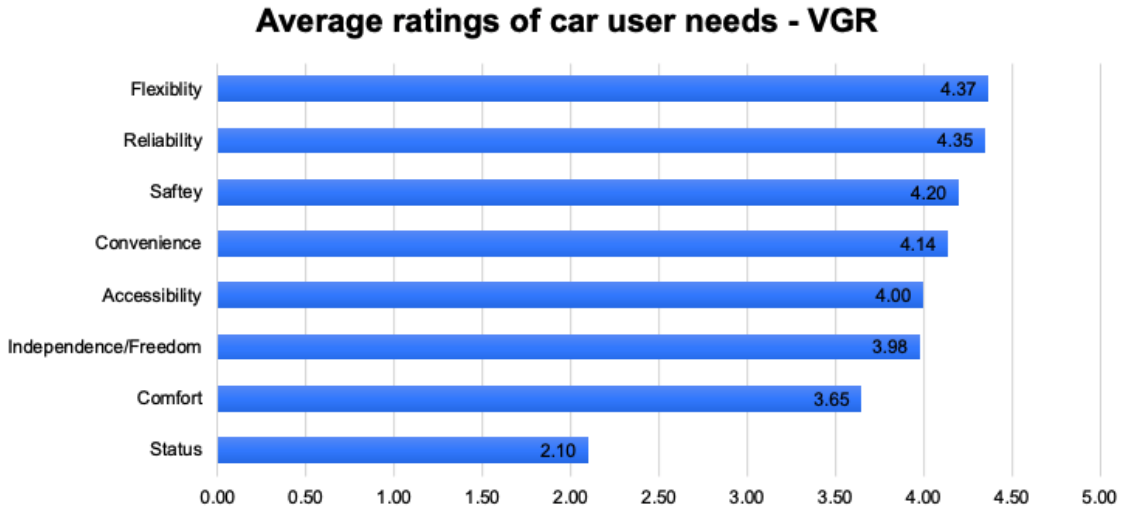


Figure 23: Average ratings of car user needs - VGR

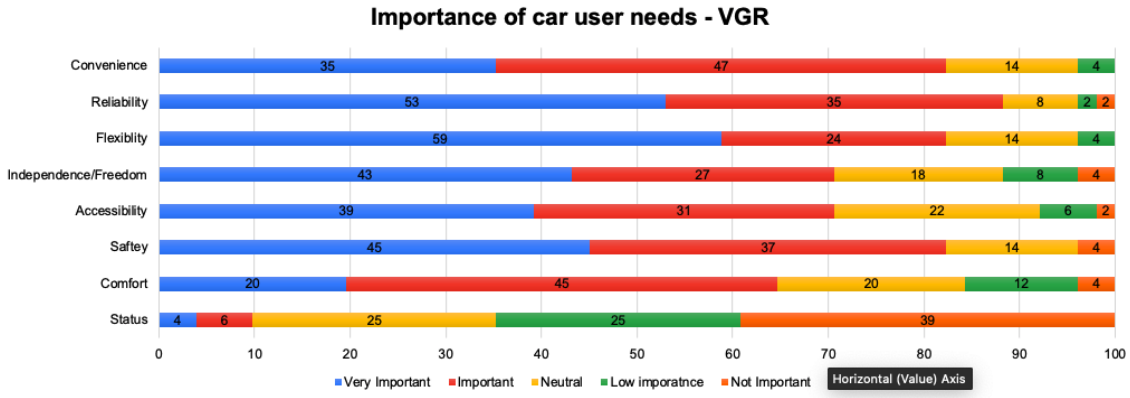


Figure 24: Importance of car user needs - VGR

5.1.4 Use of public transport by car users

Gothenburg City

Of the 31 respondents 32% of the car users did not use public transportation. It was found that 45% used it 2 to 5 times per week. Further 19% of the population used it more than 10 times a week. 6% using once a week and another 6% using 2 to 3 times a month.

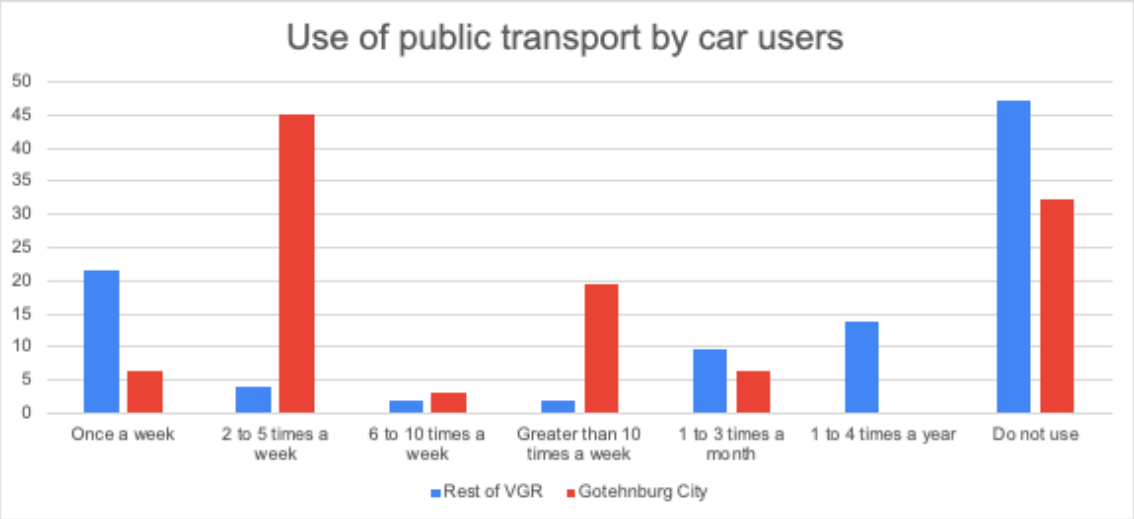


Figure 25: Use of public transport by car users

Rest of VGR
Of the 51 respondents 47% of the car users do not use public transport. 22% use it once per week. Further 14% of the respondents used it, at the most 4 times a year, 10% used it upto 3 times a month and another 4% use it 2 to 5 times a month.

5.1.5 Purpose of use of public transport by car users

Gothenburg city
All the respondents use the public transport in some capacity for daily commuting for work (62%) or travel to school (32%). 42% of the respondents use it for visiting friends & family, 32% for leisure & travel purpose and 3% for shopping purposes.

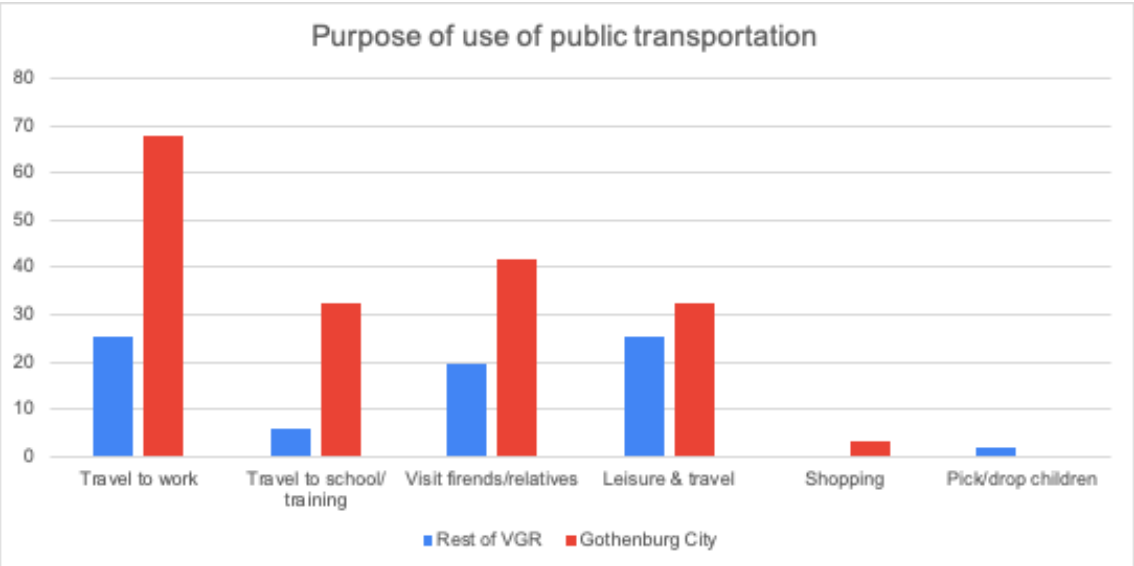


Figure 26: Purpose of use of public transport by car users

Rest of VGR
68% of the 27 respondents who used public transport, used it for commuting to work, followed by 42% using it for leisure & travel, 32% of the respondents used it for visiting friends & family and another 32% for travel to school.

5.1.6 Needs to be improved in public transportation

Gothenburg city
Frequency, accessibility, speed and reliability of the public transportation were the main factors (figure 27), which the car users felt, had to improved in the current public transport system. 45% of the respondents said frequency has to be improved, followed by 42% for improved accessibility, 35% for improved speed of travel and 32% for improved reliability. A small portion of the respondents said, improved safety (10%), reduced crowding (6%), reduced cost (6%) and improved comfort (3%) as other user needs which needed to be bettered.

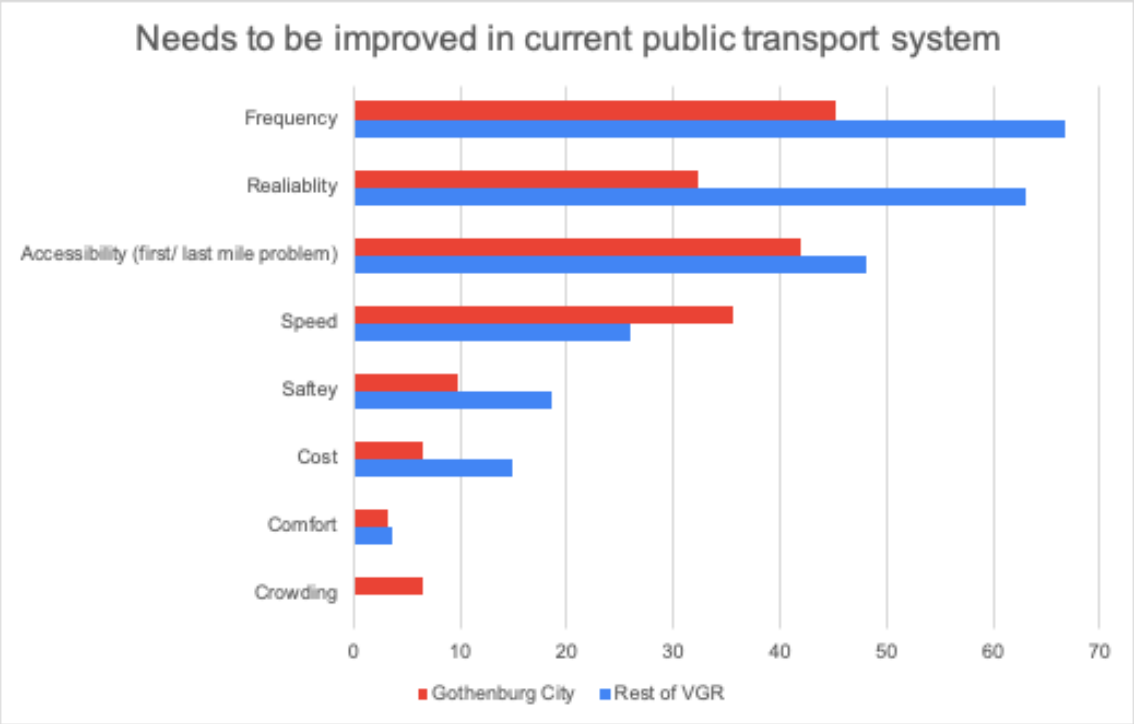


Figure 27: Needs to be improved in public transportation

Rest of VGR
Similar to Gothenburg city, frequency, accessibility, speed and reliability of the the public transportation were the main factors 27) which the car users of rest of VGR felt which need to improved in the current public transport system. 67% of the respondents said frequency has to be improved, followed by 63% for improved reliability and 48% for improved accessibility. Furthermore 26% felt the need to improve the speed followed by improved safety (19%), reduced cost (15%), and improved comfort (4%).

5.1.7 Preferred mode of transport

Gothenburg city
Of the 31 responses received from car users in Gothenburg city, 52% said they preferred mode of transport is car, followed by 19% opting for public transport system, 16% preferring bicycles, 10% preferring walking and 3% preferring using E-bicycle.

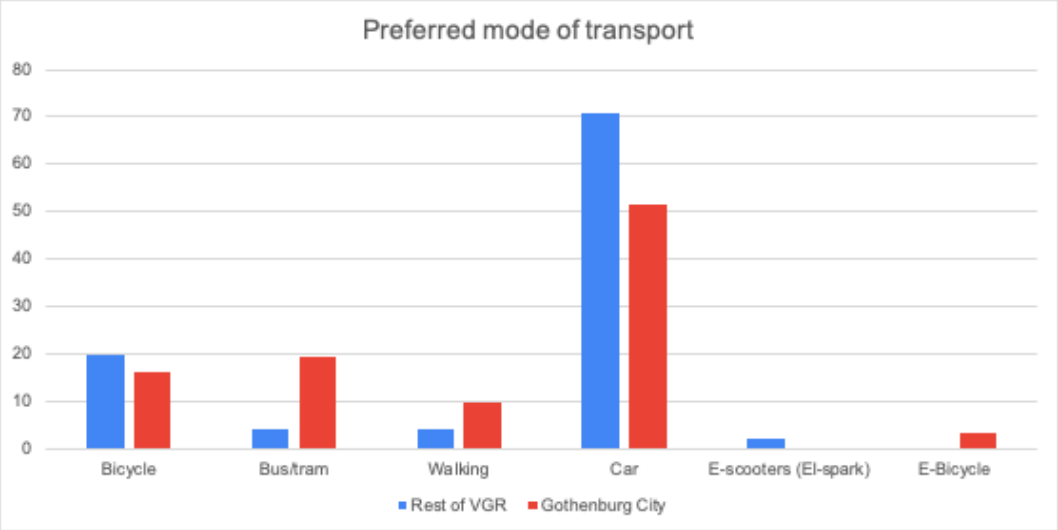


Figure 28: Preferred mode of transport

Rest of VGR
71% of the 51 respondents said their preferred mode of transport is car, followed by 20% preferring bicycle, 4% each for public transportation and walking and only 2% preferred e-scooters.

5.1.8 Effect of age on preferred transport mode

It was determined from the survey that people preferred car as their primary mode of transportation (figure 29). 52% of respondents amongst across all age groups responded that they prefer car. The preference for the car peaks in the age group of 36-50 years with 65% voting for it as there most preferred mode. This is followed by bicycle which is preferred by 20% of the car users. Another 12% of the car users prefer pubic transportation followed by 10% preferring to walk.

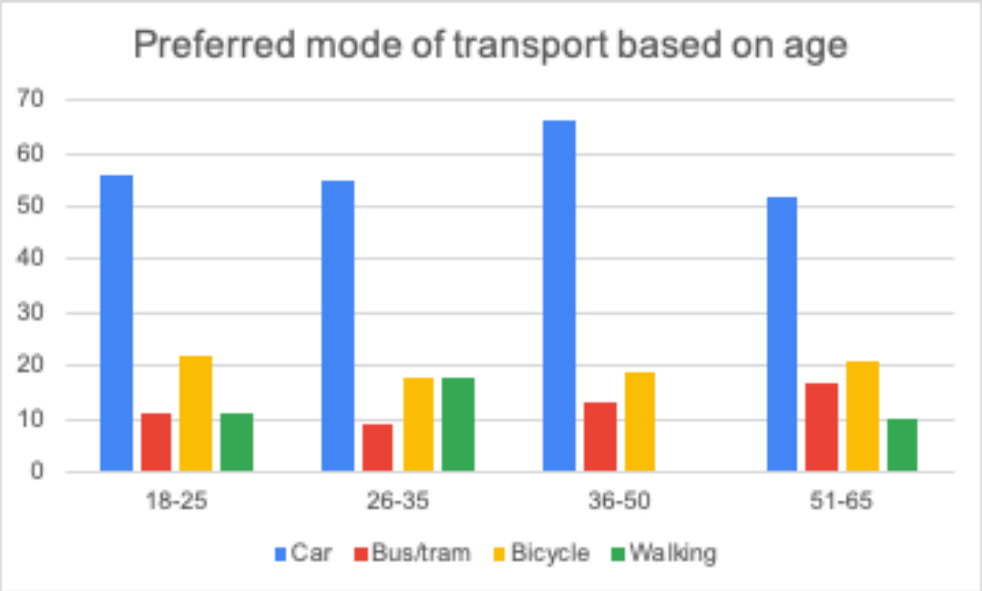


Figure 29: Preferred mode of transport based on age

5.1.9 Effect of gender on preferred transport mode

It was determined that men in general preferred cars more compared to women (figure 30). With 63% of the men preferring car compared to 40% of the women. The preference for bicycles and public transportation is approximately same for both men and women with 20% and 13% respectively. Though it was found that women prefer to walk more (20%) compared to men (7%).

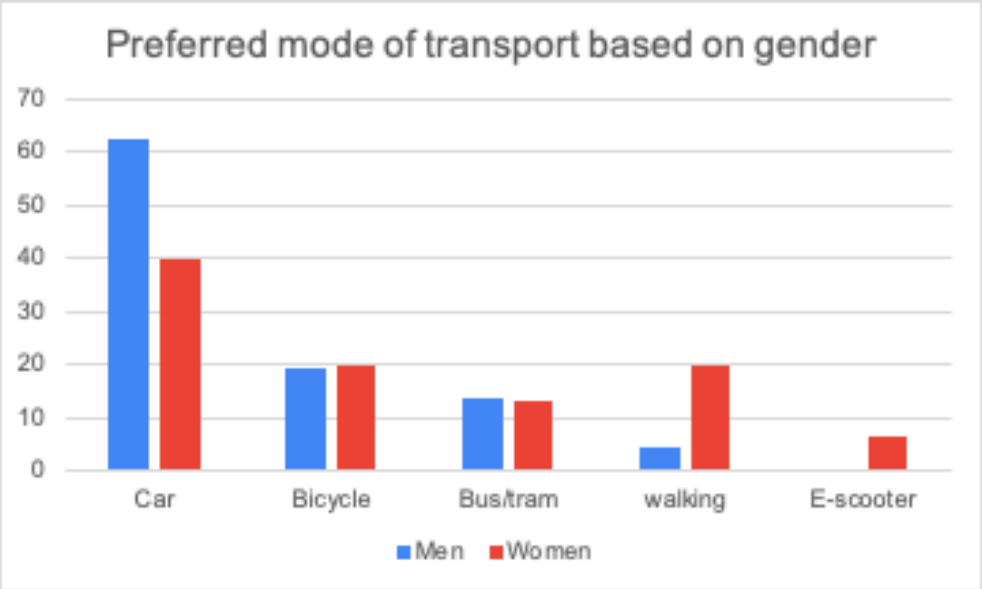


Figure 30: Preferred mode of transport based on gender

5.1.10 Effect of gender on needs to be improved in public transportation

The needs of reliability, frequency and accessibility were rated as the most import factors which needed to be improved in the current public transport system by both men and women (figure 31). Further speed was also identified as a important need to be fulfilled by the respondents. Though men tended to rate these four needs higher than women. But the factors of comfort, safety and crowing of public transport was rated higher by women compared to men, though they were low in number, less than 13%.

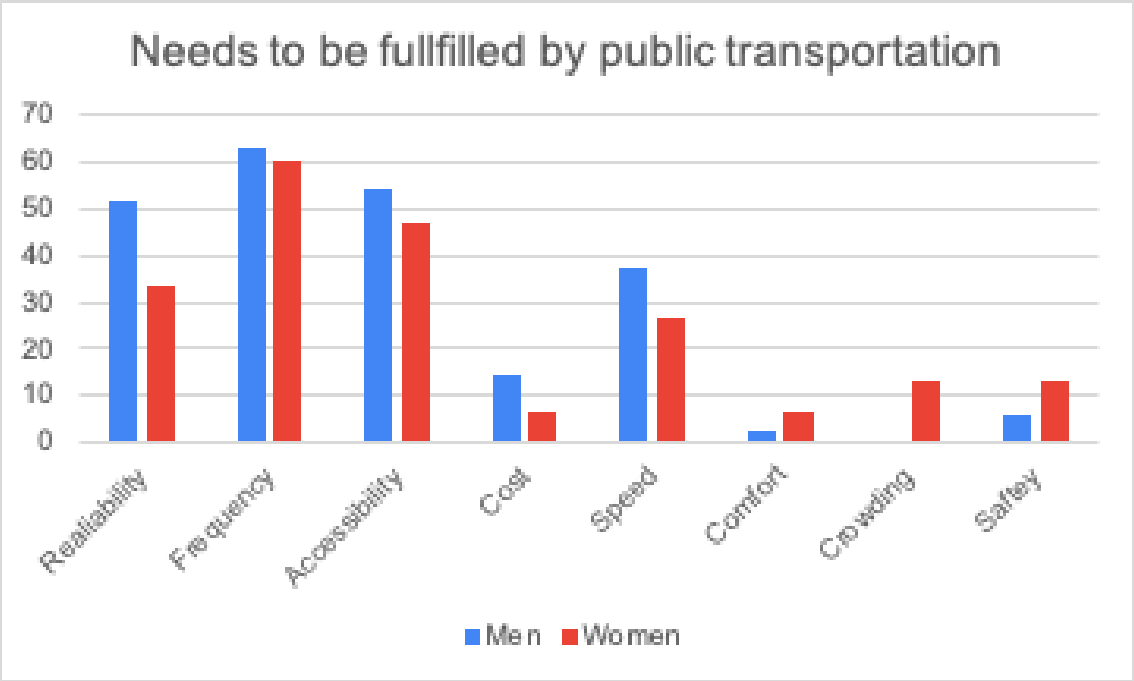


Figure 31: Effect of gender on needs to be improved in public transport system

5.2 Survey on e-scooters

In this survey a total of 55 responses were received from Västra Götaland region. Further of the 55 respondents, 36 claimed to use e-scooters. All the e-scooter users were residents of the city of Gothenburg. It can be noted that some of the graphs and statistic total up more than 100%. This is due to the fact that some respondents used multiple options for questions.

5.2.1 Purpose of use of e-scooters

The e-scooters similar to cars was found to be used for multiple purpose (figure 32), with it being used highest for daily commuting 67%, which included travelling for work (56%) and travelling to school (11%). This was followed by it being used for leisure/holiday/travel (56%) purposes. Further 39% used it to visit friends or relatives.

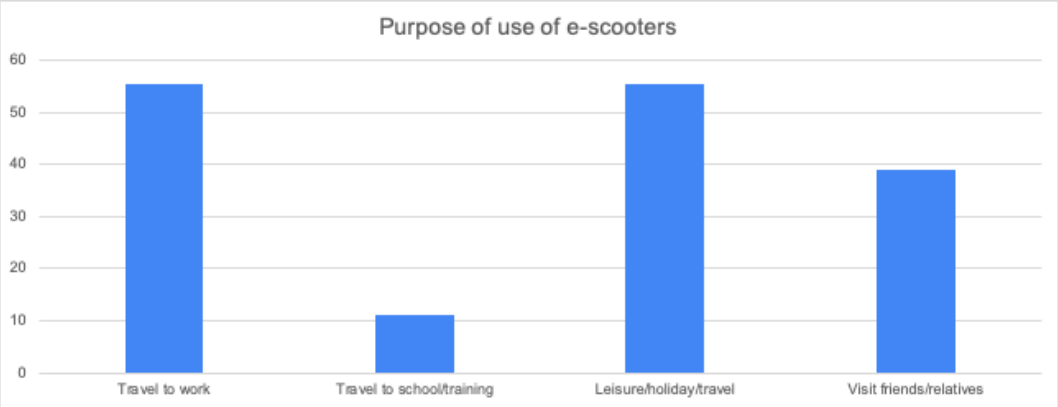


Figure 32: Purpose of use of e-scooters

5.2.2 Usage of e-scooters

The survey showed that the usage of e-scooters was relatively low (figure 33), with 44% using it twice a week, 22% using it once a week and 17% using it 2-5 times a week. Only 6% of the respondents claimed to use it more than 10 times a week.

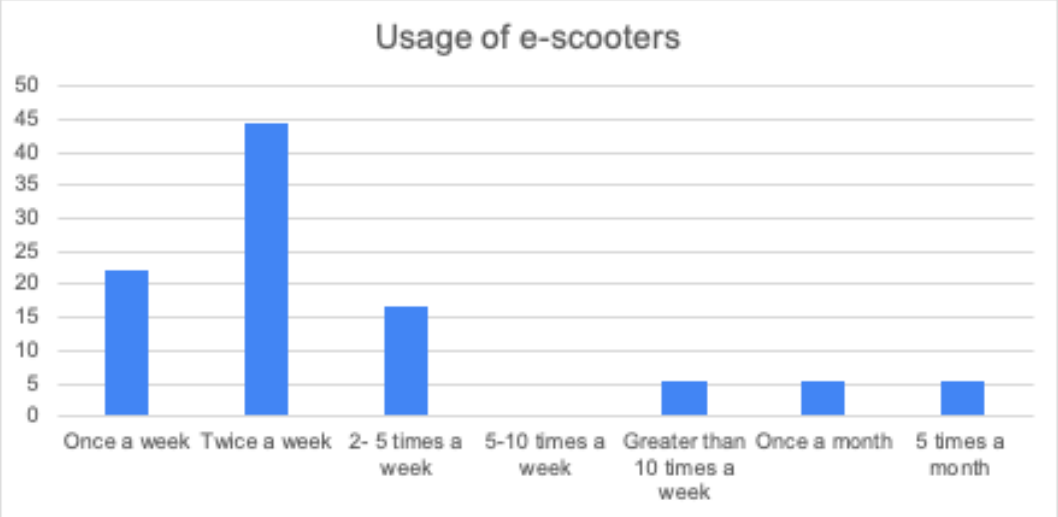


Figure 33: Usage of e-scooters

5.2.3 How e-scooters are used

The survey also tried to identify how e-scooters are used (figure 34), i.e. only the e-scooters, walking to reach a e-scooter before using it or combining e-scooter with public transportation. 50% of the respondents used the e-scooters in combination with walking. This was followed by 28% using it in combination with public transportation. The remaining 22% of the respondents claimed to have direct access to e-scooters.

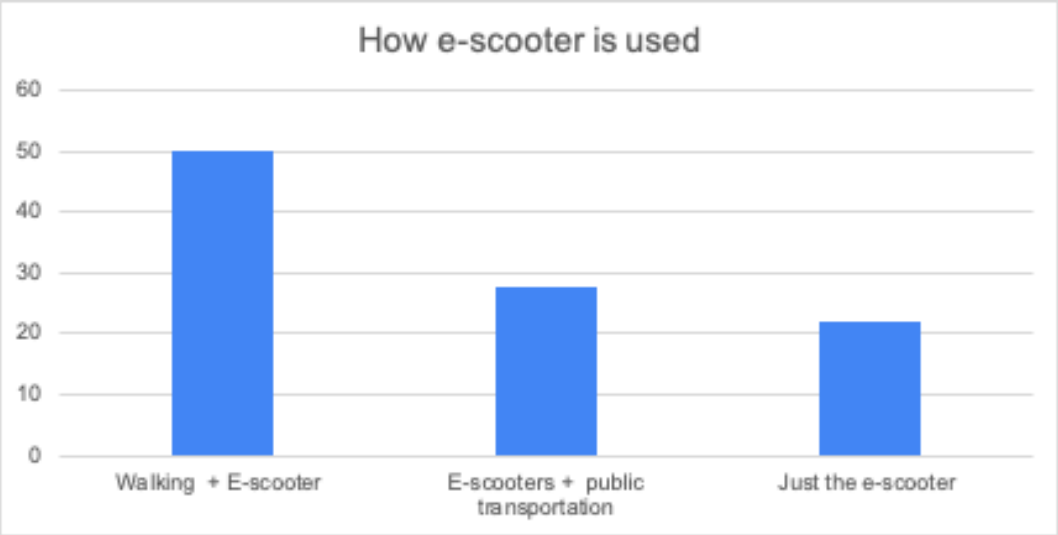


Figure 34: How e-scooters are used

5.2.4 E-scooter users needs in association with car user needs

The survey tried to determine to what extent the e-scooter users associated the car user needs identified (figure 35). 78% found the e-scooters to be convenient followed by flexibility (61%), accessibility (50%), comfort (44%) and independence/ freedom (39%). Though only a small number of respondents agreed on the e-scooter services to be reliable (17%) and cost efficient (28%).

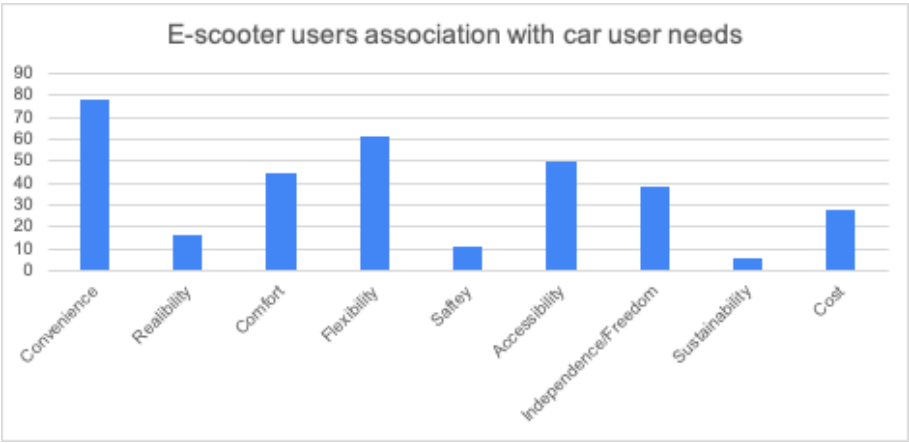


Figure 35: E-scooter users association with car user needs

5.2.5 Improvements expected in e-scooter services

The survey tried to determine what needs to be improved in e-scooter services to increase the user experience (figure 36). 50% of the respondents wanted the e-scooters usage cost to be reduced. Further 44% wanted the safety aspect of the usage to be improved, 33% wanted the availability to be increased and 28% wanted the speed to be increased. Further the reliability aspect only 6% wanted it to be improved.

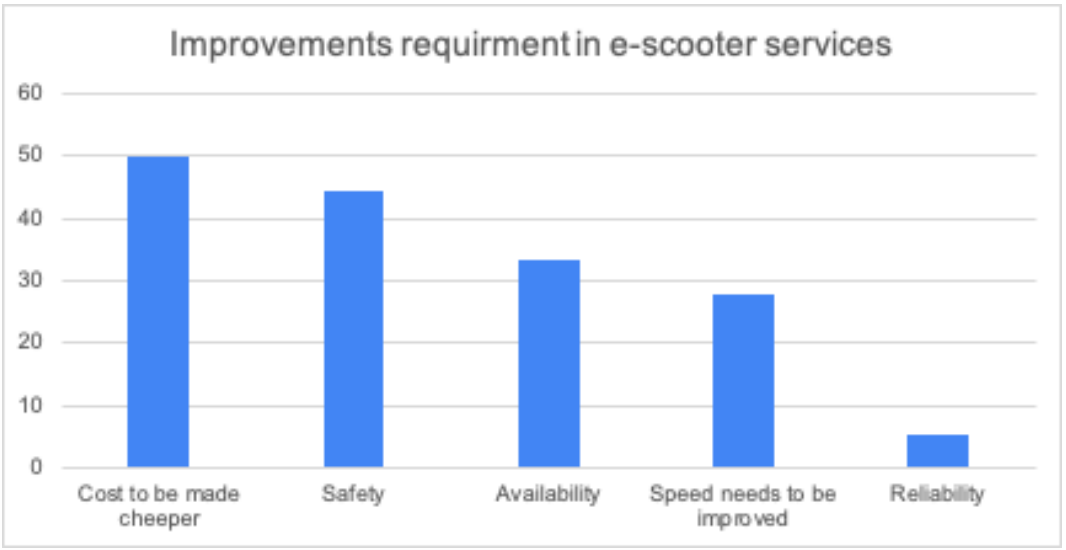


Figure 36: Improvements expected in e-scooter services

5.2.6 Car usage and effect of e-scooters on car usage

It was found that 50% of the e-scooter users used car. Further 56% believed e-scooters had resulted in reduction in car usage. On the other hand 44% responded it had no effect on the car usage.

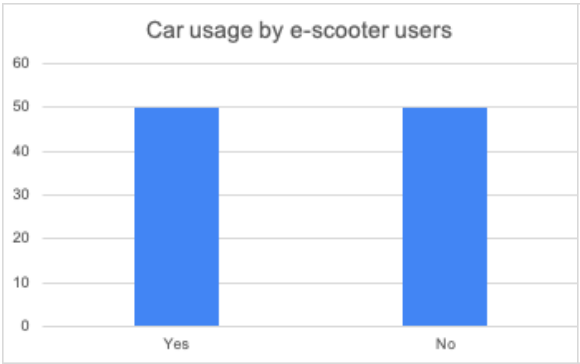


Figure 37: Car usage by e-scooter users

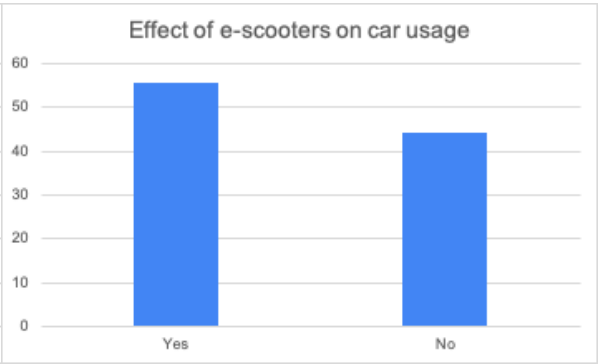


Figure 38: effect of e-scooters on car usage

5.2.7 Age and kids factor

The age of the e-scooter users who responded was found to be relatively low with 72% falling in the age group of 26-35 years and another 17% in the group 18-25 years. Also it was found that the majority of the e-scooter users (72%) did not have kids.

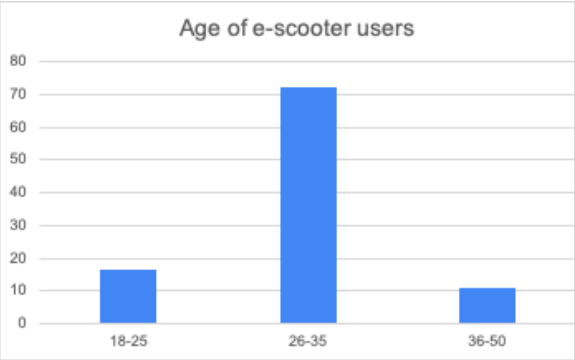


Figure 39: Age of e-scooter users

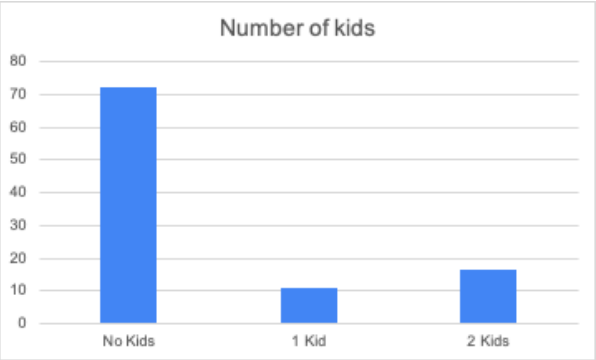


Figure 40: Number of kids

5.3 Non e-scooter users

The survey on e-scooter users also captured information from non users. The motivation was to capture the reasons for not using the e-scooter service. In total there were 19 responses.

5.3.1 Reason for not using e-scooters

The main two reason stated by respondents for not using e-scooter services were the cost (53%) of it and the the belief that they caused more problem than solving it (42%). Further 16% claimed their accessibility was not consistent and they did not provide the opportunity to carry bags.

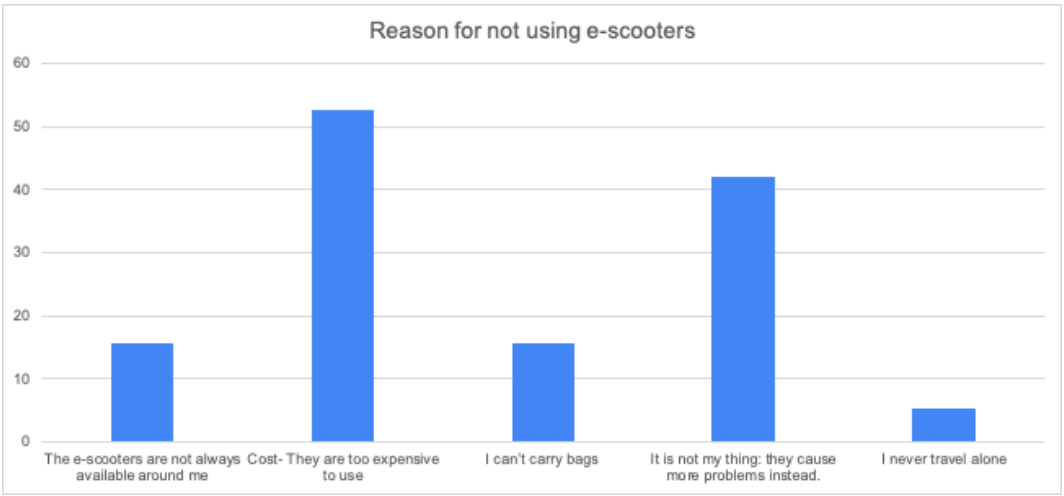


Figure 41: Reason for not using e-scooters

5.3.2 Possibility of using e-scooters with public transportation and improvement in e-scooter services

53% of the non e-scooter users believed the e-scooter could be combined with public transport to improve the travel experience. Further the respondents expressed cost of the e-scooter services (79%) should be reduced for them to use it. The other sizable contributing reasons were availability of parking near bus/tram stops (37%) and availability of e-scooters (32%).

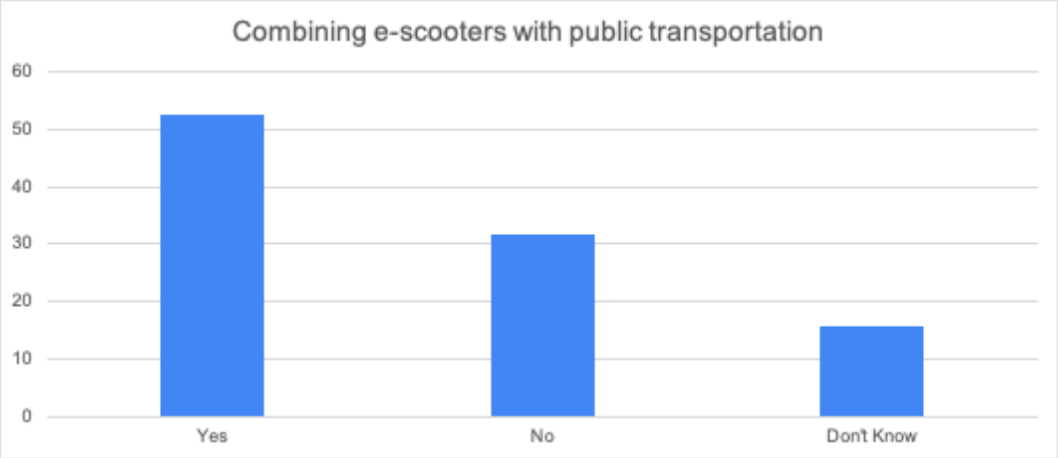


Figure 42: Combining e-scooters with public transportation

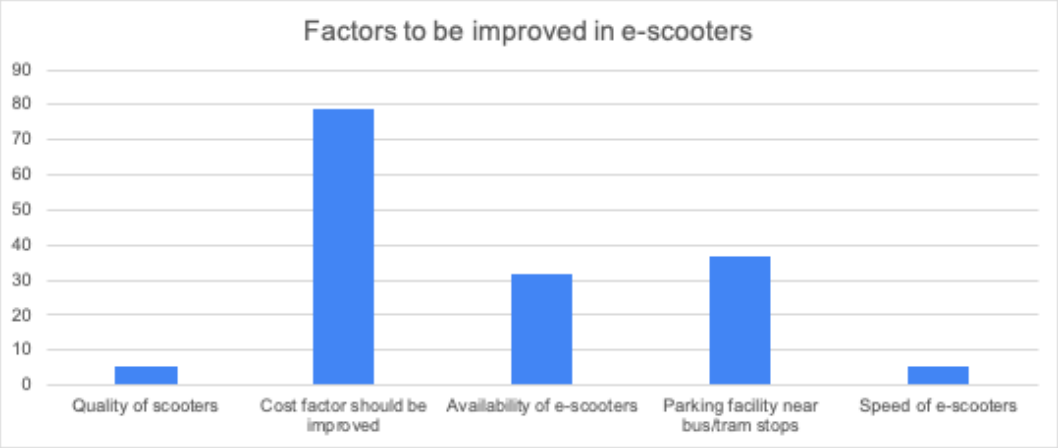


Figure 43: Factors to be improves in e-scooters to influence the usage

5.4 Analysis of survey

Car users
Survey results suggest the all people who use car, usually use it for daily commuting. It is also suggests in Gothenburg city, the use of car is mostly done for travel & leisure, where as, a sizable population of people living in other municipalities of Västra Götaland region, use it for other purposes such as visiting friends & relatives and pick &drop children. The survey also determined that the car is used by almost everyone in rest of VGR compared to Gothenburg city.

The car user needs of convenience, flexibility, Independence & freedom, comfort and availability was rated highly by all respondents. But the user needs of status and cost was considered to be not important irrespective of the municipality they live in.Rest of VGR rated the need to improve frequency, reliability, accessibility, speed and safety in public transportation higher compared to Gothenburg city. But a few respondents considered that the cost and comfort factors should be improved.

Gothenburg city residents have a higher tendency to use public transport compared to residents of rest of VGR. The residents of the city use the public transport mainly for daily commuting purposes. The use of public transport was also found to be low amongst residents of rest of VGR, but they did use it more often for leisure & travel purposes. Though it was foudn that the car usage was very prevalent amongst the population. A high number of car users rated the car as the preferred mode of transport. With 52% in Gothenburg city and 71% in rest of VGR. Public transport and bicycle were the second most preferred modes of transport in Gothenburg city and rest of VGR respectively. Further the effect of age and gender seem to follow the same trend as the general population.

E-scooter users
The survey results determine that the use of e-scooters is low, even amongst the e-scooters users with 94% using it less than 5 times a week. Furthermore the main purpose of use was found to be daily commuting or using it for leisure& travel purposes.Furthermore age and having kids at home can be related to the use of e-scooters. It was found that the population of the e-scooter users was relatively young with 89% of the respondents being younger than 35 years. Further it was also found that majority of the users did not have kids (72%).

The effect of e-scooters on car usage was found to be limited. Half of the e-scooter users still used car. Further, 50% of the respondents believed that, the availability of e-scooter services has resulted in less usage of the car. But it was found that the e-scooter users associate with some of the user needs of car users while using the e-scooters. The e-scooter users associate to the car user needs of convenience, flexibility, accessibility and independence/freedom while using the e-scooters in a positive way. Thought the respondents expect the cost, safety and availability factors of e-scooter services to be improved.

Non-e-scooter users
The main reason for respondents not using e-scooter was determined to be their belief that the e-scooters caused more problems. This was in addition to the belief that the cost of e-scooter usage was high. Though the majority respondents believed in the possibility of combining e-scooters with public transport system. They further believed, improved availability, parking option closer to bus/tram stops and reduced cost of usage would influence them in using the e-scooters.

5.4.1 Comments from surveys

In the quantitative surveys, there were section in the surveys where the respondents could comment on the preferred mode of transport. Further in the survey on e-scooters the respondents could comment on what needs to be improved in e-scooters and its effect on their lives. A total 57 comments were collected during the surveys and the results can be found in appendix B. In order to analyze the received comments, they were separated into five different categories.

Better parking: It was expressed that the parking of e-scooters needs to be improved. The respondents believed there was chaos created due to bad parking habits. They have found them parked badly blocking paths and fallen over. This is believed to have a negative impact on the opinion on the mode of transport according to the respondents.

Reduce cost: The cost of the usage for e-scooters was expressed to be high by both the e-scooter users and non users. The respondents expressed the reduced cost would lead them to use it more often.

Effect on other modes: The e-scooter users expressed that the usage has reduced the use of public transportation and also resulted in people walking to destinations which are at closer distances. But few of the respondents did express that they were a good alternative for shorter trips in the absence or delay of public transportation.

Perception about car: The car users had a positive perception about the car as a transport mode. The common belief was that, the cars were easily available as they owned it. Also, it made it flexible to travel. The cars were also believed to be the quickest way to travel between two places compared to other transport modes. Additionally the residents in rural areas had limited or no access to public transportation or e-scooters, thus making car the obvious choice as the preferred mode of transport.

Awareness on sustainability: The awareness related to sustainability of using public transportation was evident amongst the respondents. The respondents expressed their willingness to use public transportation more, if it were more accessible. Further the respondents also expressed to walk or use bicycle if they had to travel shorter distances.

6

Interviews

The interviews were analysed using KJ method and categorised into six categories which is explained below in section 6.1. In total 12 interviews were carried out. The interviews were split into three groups,which are listed below.

1. Private car users
2. E-scooter users
3. Other stakeholders

6.1 Transition to public transportation

The interview analysis highlighted both similarities and differences on how the car users perceived their needs for transportation. The information from the interviews were grouped into six categories after analyzing the interview transcripts. The six categories are namely, dependency, activities & leisure, mindset, landscape, economics and shopping. These categories are further explained below along with few example of the statements from the interviews. Additionally the effect of e-scooters are added where ever applicable from the e-scooter user perspective.

Dependency:
This category includes the reasons which create a dependency of the choice of car as travel mode. During the interviews it was identified that, factors such as having kids or pets, the weather condition and the need to have the opportunity to travel quickly created dependency and are a great barrier, thus affecting the choice of public transportation. It was determined that the same factors of bad weather or the need for multiple people to travel together limited the choice of e-scooter as a travel mode.

"We have a dog, so if we have to go on a picnic to the ocean then its much easier to take the car instead of a tram" - Daniel, car user

"If in need to pick up my kids when they are sick or something, there are no buses from my workplace from 11 A.M to 2 P.M or very limited, so I cant use public transportation." - Joakim, car user

"E-scooters don't go fast so its safe, but if its icy or raining then it would be slippery and I would not use it" - Amanda, e-scooter user

Activity & leisure:
This category include the factors which influence the effect on the choice of travel mode for visiting friends and family or to travel for recreational purposes. The interviewees expressed the lack of public transportation when they have to visit their families who live in the rural areas. Further they found it to be inconvenient to carry bags while using public transport to reach their families living in rural areas. On the other hand the interviewees expressed positive opinion of using public transport to travel to meet friends & family living within the city. Furthermore the interviewees were positive about the possibility of using car sharing services for long distance travels.

"I use the car extensively in summer, when I go to visit my parents who live in the north of Sweden, I cant get there using bus. Also, when we go the car is always packed and its harder to take it on a train or a bus" - Joakim, car user

"When I travel to the city to meet my friends, I always take public transport, the access in the city center is very good."- Daniel, car user

"We have been living in a big apartment and we have car sharing service here, in the future we can join one of those and will have no difference at all" - Lars, car user

"I don't own a car, I don't have a need for it. I only use it if it's a road trip or if I have to move to a new apartment. Then I use the shared car service." - Fredrik, e-scooter user

"In Sweden when I lived Lund I had a car for 8 months. But it did not make sense with the parking fee and less availability of parking space. I do rent cars over the weekend to do trips otherwise I don't need to own them." - Alex, e-scooter user

Mindset:
This category includes factor which are influenced by the awareness and attributes of the car user with regard to the choice of the transport mode. It was determined that, there was a broad awareness of environmental benefits of not using the car. Further the interviewees believed that the technology available with mobile applications made it easier to use both the public transportation and e-scooters. On the other hand it was found that there was a lack of willingness to wait for public transportation. The interviewees believed "being used to car" made it difficult to try other modes of transport. Furthermore both the e-scooter users and car users believed the e-scooters were unsafe to use.

"When I take a flight and take an airport bus, the bus stops 2 kilometers away from my home then I take a e-scooter." - Amanda, e-scooter user

"I am all for public transportation. I have kids without a car licence and I want them to use public transportation as much as possible." - Jessica, car user

"Now the apps are good and tell if the bus is coming and I know the right direction to stand in. Now I know the timings and it avoids me getting anxiety." - Lars, car user

"I save lot of time when I take the car. Because I spend a lot of time waiting for the connection, since I don't have a direct bus to my workplace." - Joakim, car user

"I would say I have been lazy to use other modes of transport." - Lars, car user

"E-scooters are a safety concern. I am responsible and know the rules to follow and I am following them. But you could still can have a crash. While not wearing an helmet you can crash at 20 Km/h and injure yourself" - Fredrik, e-scooter user

Landscape:
The category of landscape include the current system set up of how the public transportation or the e-scooters are perceived. Furthermore it also includes how the current infrastructure in VGR functions along with implications of the current undertakings by the public agencies and the e-scooter service providers.

There a quite a few drivers towards the use of public transport system in the Gothenburg city limits. The interviewees find driving car around the center of the city to be inconvenient. On the other hand it is found that there is a satisfaction with the public transport or the e-scooter within the city, especially around the center of the city. Furthermore the e-scooters providers are looking into the possibility of providing services in other cities of VRG along with the use of fencing technology to improve the usage patterns.

"Cars are tough to use in big cities such as Gothenburg, but in smaller cities it is convenient to use car than public transportation." - Amanda, e-scooter user

"If using car, most of the trips would take longer and cost a bit more. They are expensive to own here with parking fee." - Alex, e-scooter user

"Borås is a good example for small cities. We plan to provide our e-scooter service there in the coming months." Lucas, operations manager, e-scooter service company

"I can quickly travel from A to B without waiting for the bus, that's the advantage the e-scooters are bringing. They are available within 200 meters. And boom you are at your destination." - Fredrik, e-scooter user

"In the future the geofencing will be better, so parking will be better as we will also mark e-scooter parking spaces, so that e-scooter users will use this parking spaces" - Isabelle, Trafikkontoret, strategic traffic planner

The public transportation also had barriers. The interviewees expressed dissatisfaction with the public transport system, specifically in the suburbs and the rural areas. Furthermore the trams are considered to be unreliable and uncomfortable to travel. For e-scooter services the major concern is the non profitably and the lack of urban space. E-scooter services are also found to be unreliable. Further the interview with the e-scooters providers and the city strategist reveled that there is a lack of coherence between them.

"The trams are very uncomfortable, they shake a lot." - Amanda, e-scooter user

"I have 20 kilometers to Hestra and 10 kilometers to the closest bus stop, so there is really no other option than car." - Jessica, car user

"One sense where we lack urban space is parking space, we can pick up and drop wherever we want to. If city can provide dedicated parking space that would be really helpfull." - Lucas, operations manager, e-scooter service company

"The policy makers take their own time to come back to update the policies, they have to go through their bureaucracy and it takes time, it's a bit frustrating , but that's how it works." - Lucas, operations manager, E-scooter service company

"E-scooter companies are not economically sustainable on there own currently, so we are not sure if they will be around after a few years." - Isabelle, Trafikkontoret, strategic traffic planner

"We cant actually force e-scooter companies to do anything, we have volunteer agreement and its voluntary for them, but they are positive about it." - Isabelle, Trafikkontoret, strategic traffic planner

Economic benefits:
This category looks at the economic aspects of the transport mode. It was found during the interviews that, there is an understating of the cost benefits of using public transportation over car. Also, it was also found that the usage of e-scooter is economical for short distances.

"I am not satisfied with public transportation, but at the same time they are not expensive, so really can't complain." - Joakim, car user

"For a longer distance, like 5 kilometers bus is better compared to e-scooters. But e-scooters are good for short distances of 1 to 2 kilometers." - Amanda, e-scooter user

"The way the e-scooters are set up, it works really well at least around Gothenburg. They can add a subscription model, so incentivize the usage. I find them to be a bit expensive compared to public transportation." - Fredrik, e-scooter user

"Sometimes e-scooters have helped to compliment public transportation. But the public transportation is cheaper. Although the e-scooters are very flexible so the premium cost is justifiable." - Gustav, e-scooter user

Shopping:
The possibility of shopping was discussed during the interviews, it was determined that the usage of car is carried out for shopping bulky purpose such as furniture. But at the same time the interviewees agreed on the possibility of e-commerce in case of absence of the car.

"At least for bigger stuff like IKEA or to buy a Christmas tree I need a car but it can be done by paying someone to deliver it or by ordering online." - Lars, car user

"I don't own a car, I don't have a need for it. I only use it if it's a road trip or if I have to move to a new apartment. Then I use the shared car service." - Fredrik, e-scooter user

6.2 Drivers & barriers for transition to public transportation

The force field analysis was carried out to quantify both the driving forces and the restrictive forces. This quantification for the forces was done by scoring the number of mentions in the interviews, i.e. the multiple mentions of the factors were accounted. This can be explained with an example. Considering two questions answered by the car user Jessica, in the interview regarding the restrictive force of "supply of public transportation (suburbs and other VGR regions)". As we see below, it can be noticed from the answers that the lack of public transportation has been mentioned in both the answers, thus the force would be scored as two.

"Question 1: To what extent do you use car?"
"I live very remotely in the forest and use the car every time I have to go somewhere."

"Question 2: What are the benefits of using the car?" "I can get somewhere basically, I have 20 kilometers to Hestra and 10 kilometers to the closest bus stop, so there is really no other option than car."

Though it is important to consider the fact that the interpretation of the transcripts is subjective. To improve the accuracy of the scoring, three copies of the interview transcripts were scored one at a time, i.e. individually and then compared against each other to ensure the scores were repeatable.

As explained in the section 6.1, the driving forces and restrictive forces were identified by analyzing the interviews. This helped to determine the forces in play which would facilitate or restrict the transition of car users to use public transportation. The forces were categorized into six groups. The six categories being, “dependency”, “activities & leisure”, “mindset”, “landscape”, “economics” and “shopping”. The FFA can be seen in the figure 44.

In total 80 driving forces and 99 restrictive forces were identified across all categories. The tables 5 & 6 provides information on the number of forces determined from interviewing the three groups, i.e. car users, e-scooter users and the stakeholders.

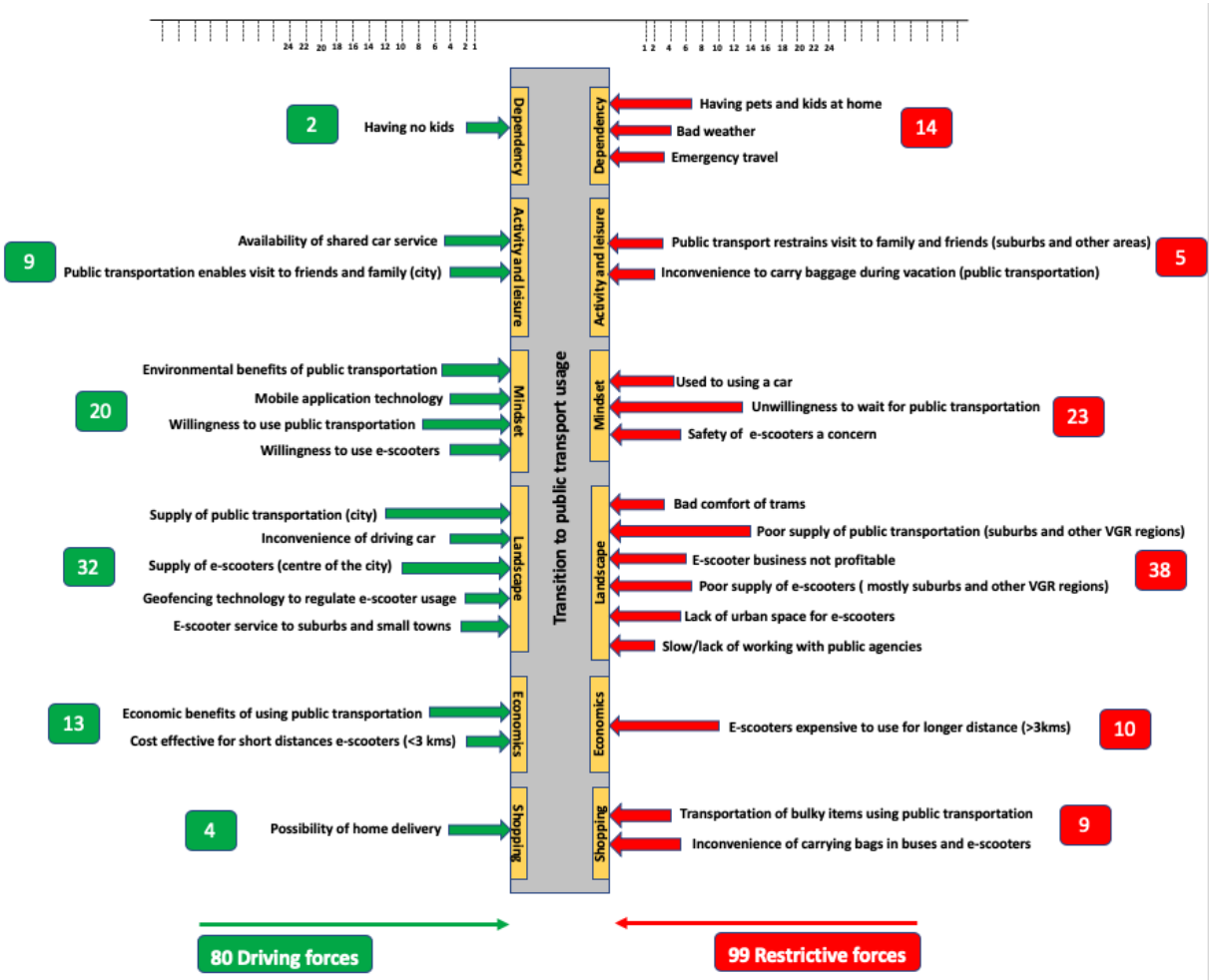


Figure 44: Force field analysis

6.2.1 Driving forces

The top three categories which contributed to the driving forces were landscape (32), Mindset (20) and Economics (13). Further the top three driving forces were the good supply of public transportation within Goteborg city which had 13 mentions followed by higher supply of e-scooters in Gothenburg city and low cost of public transportation both getting 10 mentions each.

6.2.2 Restrictive forces

The top three categories which contributed to the restrictive forces were, landscape (38), mindset(23) and dependency (14). Further the top three restrictive forces were identified to be poor supply of public transportation in the suburbs of Gothenburg and the rest of VGR (14), followed by unwillingness to wait for public transportation (13) and e-scooters being expensive to travel over longer distances (10).

Categories	Driving forces	Car users	E-scooter users	Stakeholders	Total
Dependency	Having no kids	2	0	0	2
Activity and leisure	Availability of shared car services	3	2	0	5
	Enable visit to friends and family (city)	3	1	0	4
Mindset	Environmental benefits of public transportation	5	0	0	5
	Mobile application technology	3	1	0	4
	Willingness to use public transportation	3	4	0	7
	Willingness to use e-scooters	4	0	0	4
Landscape	Supply of public transportation(city)	6	6	1	13
	Inconvenience of driving car (city)	2	2	0	4
	supply of e-scooters(center of the city)	3	4	3	10
	Geofencing technology to regulate e-scooter usage	0	0	2	2
	E-scooters service to suburbs and small towns	0	0	3	3
Economics	Economic benefit of using public transportation	3	7	0	10
	Cost of e-scooters (short distances <3 km)	0	2	1	3
Shopping	Possibility of home delivery	2	2	0	4
Total driving forces					80

Table 5: Driving forces

Categories	Restraining forces	Car users	E-scooter users	Stakeholders	Total
Dependency	Having pets and kids at home	7	0	0	7
	Bad weather	1	3	0	4
	Emergency travel	3	0	0	3
Activity and leisure	Restrains visit to friends and family in rural areas	3	0	0	3
	Inconvenience to carry baggage during vacation	2	0	0	2
Mindset	Used to using car	5	0	0	5
	Unwillingness to wait for public transportation	10	3	0	13
	Safety concerns e-scooters	1	3	1	5
Landscape	Bad comfort of trams	0	2	1	3
	Supply of public transportation (suburbs and VGR)	9	3	2	14
	E-scooter business not profitable	0	0	6	6
	Poor supply of e-scooters (suburbs and other regions)	3	1	3	7
	Lack of urban space for e-scooters	0	0	5	5
	Slow/lack of working with public agencies	0	0	3	3
Economics	E-scooters expensive to use for long distances	2	7	1	10
Shopping	Transportation of bulky items using bus/tram	2	2	0	4
	Inconvenience of carrying bags in buses and e-scooters	3	2	0	5
Total driving forces					99

Table 6: Restrictive forces

7

Systems Mapping

The information on the needs of the car users obtained from the surveys, the interviews and the driving & restrictive forces from FFA acted as inputs to develop the system mapping.

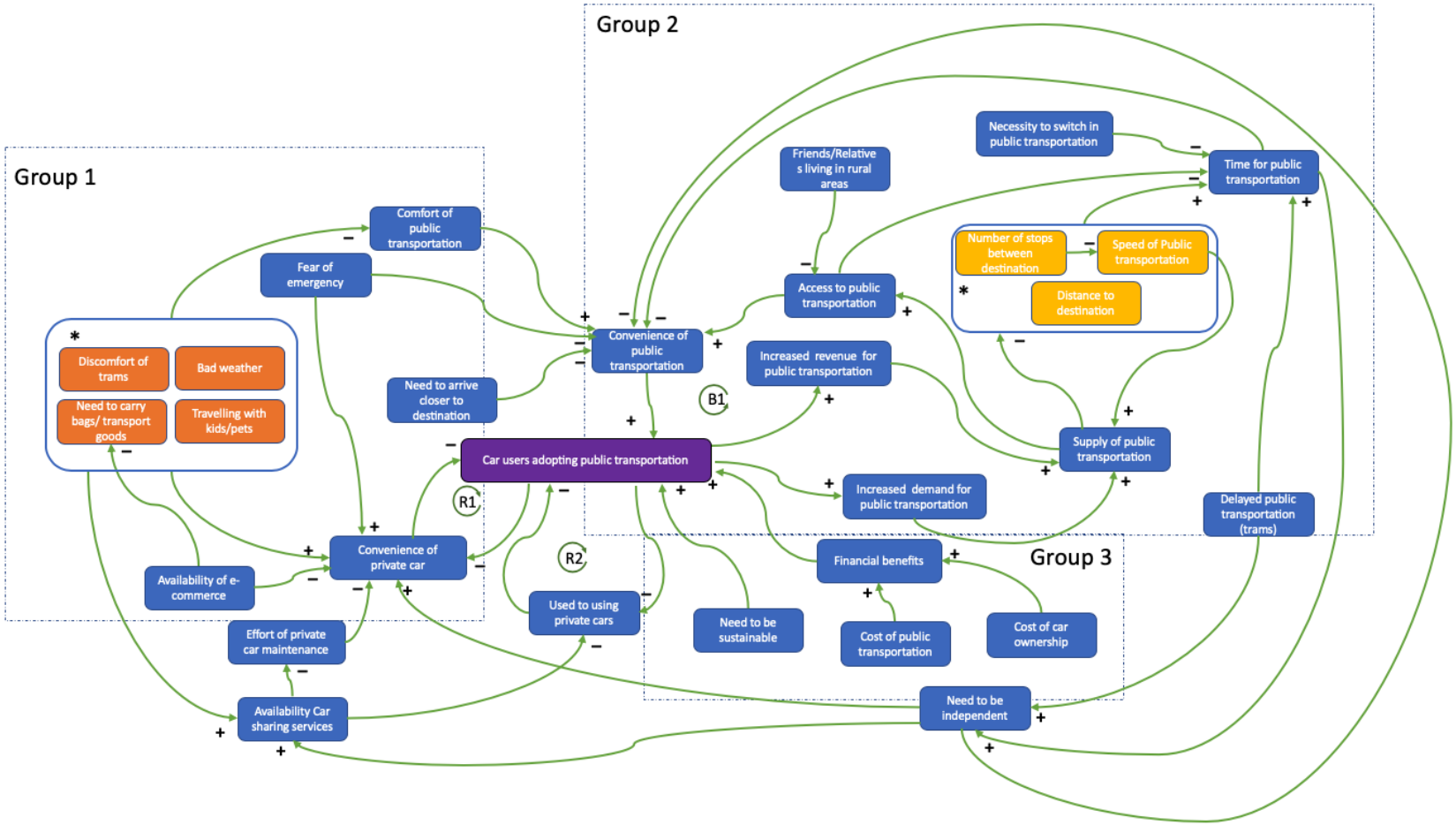
The systems mapping was carried out in two steps, In the first step the current public transportation system was captured along with the effect it has on the possibility of car users adopting the public transport system. The second step introduces the e-scooter service to determine the effect it is having on the car users and the usage of public transport system.

1. Step 1: Effect of public transportation on car users.
2. Step 2: Effect of e-scooters on the system (Step 1).

7.1 Step 1: Effect of public transportation on car users

System mapping was developed with the primary purpose of car users adopting public transportation (figure 45). The system was developed including the car users and their needs and the public transportation system. Additionally the developed systems was then grouped into three categories based on commonalities to analyse the map.

Group 1: Convenience of private car due to discomfort of public transportation
The discomfort of the public transportation is a major concern for the car users. It was found during the interviews that, bad weather resulted in the car users wanting not to use the public transportation. Additionally the need to carry bags, or move furniture made it inconvenient to use the public transportation. Also, having kids or pets at home meant, it is easier to use the car especially for recreational purposes such as picnics or outings. Also having young kids at home created a fear of emergency, in case parents need to get to the children quickly form the workplaces. The users believed having a car is convenient and it would take away the dependency on public transportation.



* The system elements are grouped together to avoid the clutter to visualize easily. The loop connected to the box implies all the elements have the same effect on the element it is connected to. Also, if the loop is connected to an individual element in the box, it means it is just applicable for that element.

Figure 45: Systems mapping - Effect of public transportation on car users

Group 2: Time factor and access to public transportation
It was also determined that, there is a strong unwillingness to wait for the public transportation. This time factor is greatly influenced the supply and access of the public transportation. Further in cases where the user missed a bus or a tram, they lacked a willingness want to wait for the next bus/tram. In addition the time of travel was considered to be slow, as the bus or tram don't follow the shortest travel paths to the destination, in addition to having many stops in between. In general the perception of supply and access to the public transposition in the center of the city was considered to be very good. The opinion changed to being unsatisfied when they stay in the suburbs or other areas of VGR. The location of residence created a greater effect on the waiting time for public transportation. As it meant the users had to plan and wait for the bus/tram to arrive. Also in many case the access to the public transposition was low due to less supply or being at a far distance especially in rural areas where the friends or relatives lived. This factor reinforced the need to own a personal car to reach the final destination without being dependent on the pubic transportation.

Group 3: Financial & environmental benefits of using public transportation
In was determined that the users were aware of the financial benefits of the public transportation and admitted that, the cost of maintaining a car was high compared to using public transportation. Also, due to the initial investment on the cars, they wanted to maximize the car usage. At the same time it was also found that they did consider not buying a new car once the current one reaches its end of life. This thought was influenced by availability of shared car services. The car users believed they could use public transportation for daily commuting and rent or share a car if they need to travel outstation for vacation. Further they believed they could use the shared car services in the future as it would lead to no effort in maintenance of the car.

In general, the awareness of the environmental benefits of not using a car was found to be high. With many user either switching to electric cars or wanting to switch. Also the understanding of ecological benefits of using shared service, such as public transportation and shared car services was high.

7.1.1 Reinforcing and balancing loops

In the system two reinforcing loops, R1 and R2 and a balancing loop B1 was determined (figure 45). In the reinforcing loop R1, the convenience of the private car has a negative impact towards private car users adopting public transportation, which in turn has a negative impact on the convenience of the car. The reinforcing loop R2, used to using private cars has a similar impact as the loop R1.

The balancing loop B1 start by private car users adopting public transportation having a positive effect on revenue for public transportation agency, then the increased revenue being used to increase the supply of the public transportation. Further the

increase in supply would in turn lead to increase in access to public transportation, which would then have a positive affect on car users to use more public transportation.

7.2 Step 2: Effect of e-scooters on the system

In step 2 the elements of the e-scooter service system was added to the system mapping, as seen in figure 46. Further the influence it has been bearing on the public transportation and car usage was mapped.

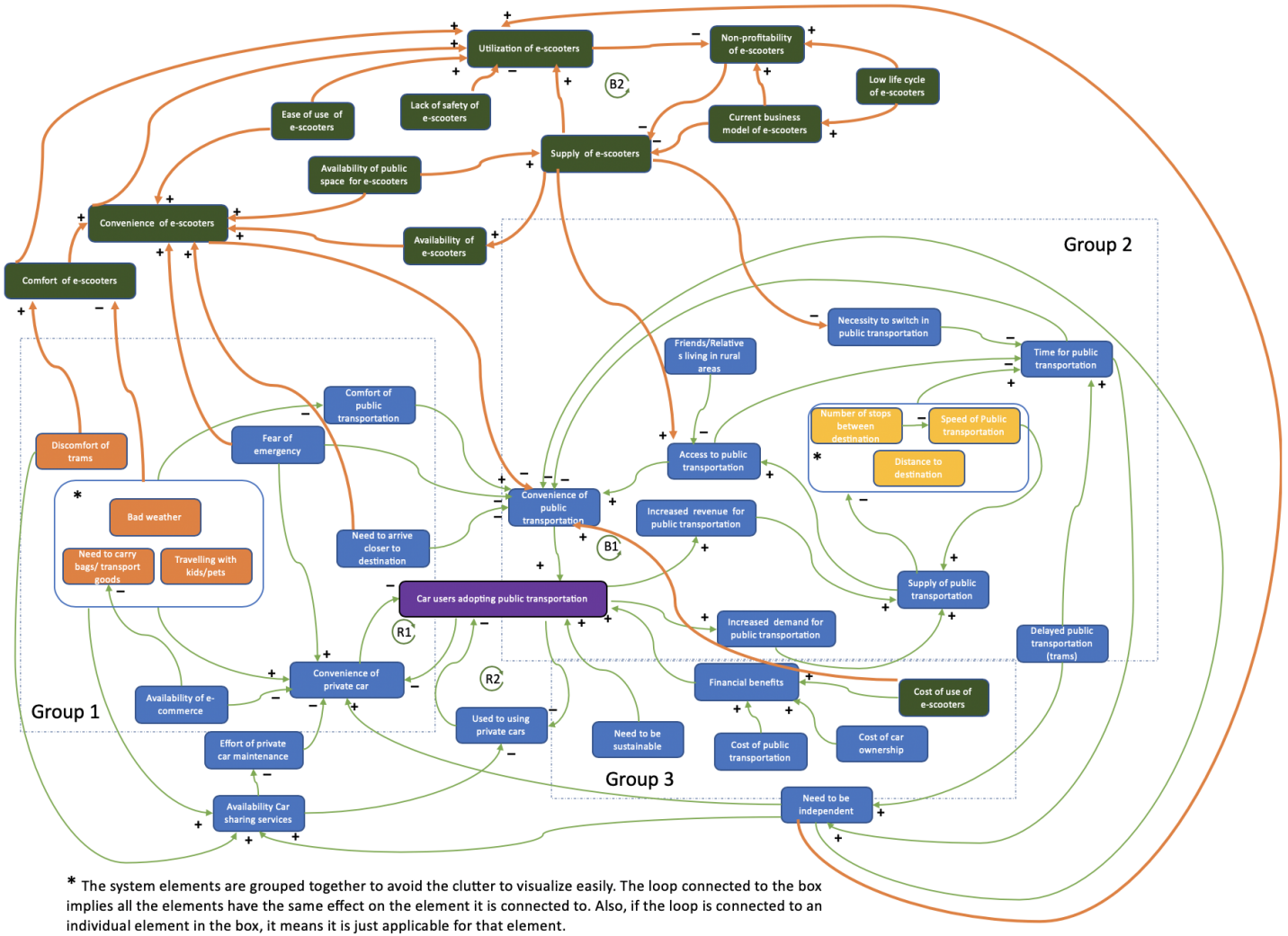
Effect on Group 1
Here the e-scooters were found to encounter the same issues such as the public transportation, such as bad weather, traveling with kids or pets and the need to carry bags. On the positive side, the e-scooters were found capable of addressing the car user needs of fear of emergency and need to arrive closer to destination.

Effect on Group 2
E-scooters were found have the highest effect in this category, where they were used by e-scooter users as an alternative to pubic transport in case of delayed transport. Though it must be noted that the e-scooter service do come with a risk of being not available always due to there dockless nature. The e-scooter users even mentioned that they used it connect to public transport to travel one part of the journey to avoid waiting for the pubic transport. It was identified that the e-scooters were either used during emergencies, such as late nights where public transport is not available, or the users did not have time to wait for public transportation. Though few of the users did admit to using it on a daily basic for commuting.

Effect on Group 3
E-scooter were perceived to be quite expensive to use it for longer distances compared to public transportation. Though the user believe they are priced ok for short distance travel of two to three kilometers. On the environmental benefits it as seen in the literature review, the interviewees were skeptical about the benefits of it.

7.2.1 Balancing loop

One balancing loop, B2 was found in the e-scooter system. Non profitability of e-scooter was found to have a negative effect on the supply of e-scooters. And further a increased supply of e-scooters will have a positive effect on utilization of e-scooters, which would then have a negative effect on the non profitability of it.



* The system elements are grouped together to avoid the clutter to visualize easily. The loop connected to the box implies all the elements have the same effect on the element it is connected to. Also, if the loop is connected to an individual element in the box, it means it is just applicable for that element.

Figure 46: Systems mapping - Effect of public transportation and e-scooter services on car users

7.3 Analysis of the systems mapping

It can be determined form the systems map and the interviews analysis that the e-scooter services are having little effect on the private car users. Also it can be found the e-scooters cannot address few of the needs of the car users, especially with regard to having kids, carrying bags or address the effect of bad weather. Further it is observed in that the e-scooters along with public transportation, need to influence the reinforcing loops R1 and R2 related to private car use to support the transition to public transportation. The interference on the reinforcing loops would then have an positive impact on the balancing loop B1, and help in improvement of the utilization and funds to public transport system to make it better and result in making it a more attractive proposition as a transport mode. Currently the availability of shared car services and e-commerce are the factors which is seen to have an opposite effect on the reinforcing loops R1 and R2.

Furthermore the balancing loop of B1 is greatly affected by the need of the users to be independent. E-scooter services have been able to address and support the issues in public transportation related to access and delays. As e-scooter services are relatively new and private car owners not willing to try different modes, the private car users are oblivious to the possibility and potential of e-scooter services to support the public transportation. Thus, even though the e-scooter services are disconnected with the private car users, it is found to be helping out people who do not own a car. The e-scooters are helping bridge the gap in the public transportation by improving the access to the end destination or providing an alternative transport mode in case of delays of buses or trams, thus taking away the need to own a car. Further it can be determined that having shared car services have been instrumental in making up for the limitations in public transportation and e-scooter services by helping people who do not own a car by fulfilling few of the needs, especially related to leisure travel or moving bulky items. It is evident for the casual loop diagram, that the e-scooters and the shared car services together are a cost effective alternative to fill the gap in public transportation and have taken away the need to own a car for residents who have never owned a car before.

8

Discussion

This section presents the arguments related to the research questions, specifically focusing on the three research sub questions in relation to car usage and transition to public transportation with the help of e-scooter services. Also the section provides few additional interesting findings from the interviews and surveys.

8.1 Needs of private car users

The first research sub-question was "*What are the needs of car users for the transition to other modes of transport?*". The research was able to identify the needs of car users of VGR. The user studies confirmed most of the user needs identified in the literature search. The user needs such as the need to be independent, reliability and convenience were rated highly. But the user studies also determined that the local population in VGR did not associate with the "status" aspect as a need. Additionally it did not recognize the cost of ownership of a car as a significant factor, contrary to findings from other researches. The residents of VGR though they acknowledge that the cost of car ownership is higher. The higher cost is considered to be tangible enough as it overcomes the gaps in the public transportation concerning reliability, accessibility and flexibility. From the interviews, two needs were found to contribute heavily towards private car users not using public transport.

Having kids or pets at home was found to be a significant stumbling block for the transition to the public transport system. Having kids at home, especially young kids who are dependant on parents to travel played a vital role in users preferring car over other modes of transport. Also, the literature study confirms this as Göteborgs Stad (2018) found that car use was higher amongst people with kids. Moreover, the surveys conducted in VGR determined that the highest use of the car was for travel and leisure purpose. This need can directly be associated with the need to be independent/freedom as the users mitigate the dependency on others in their personal lives during this time and allow them to be spontaneous. Thus having a car at home made it convenient to travel or go on vacations. The same reasons were found to apply to people having pets at home. This purpose and need to be independent for vacation travel is currently being fulfilled only by cars. However, the need to own a car can be mitigated with the help of shared car services in this scenario. Further having kids at home was found to arouse a need to travel quickly in case of emergency, such as going to school to pick them up.

Furthermore, the literature search determined that the ownership of cars were influenced by the income and the location of jobs or residence. This factor was found to be valid with the local population. The residents who live in the suburbs of Gothenburg

and other areas of VGR tend to have higher ownership of cars. They tend to use the car for daily purposes of commuting. This factor was also found to be true in cases of having friends and relatives in the rural area, as they believe having a car at home made it convenient to travel.

Also, a critical reason of unwillingness to wait was evident in the research, with the car users expressing the need to improve the reliability and frequency of public transportation. This unwillingness to wait for public transit was determined to be instrumental in creating other users needs of the feeling of Independence& freedom of using car, reliability and frequency issues related to the use of public transportation. As owning a car made it always accessible. Further corroborated by the fact of, the spare or non-existent supply of public transit in the suburbs of Gothenburg and other parts of VGR. This further reinforces towards the need of unwillingness to wait. Thought it identifed that, the car users had a broad understating of implications of the financial aspect of having increased public transportation in rural areas on the transport agency. The car users understood that it might not be financially feasible for Västtrafik to increase the supply of public transportation.

Additionally a need to be sustainable was identified in the user studies and the literature on the local population of VGR. Many of the car users were found to be transitioning towards electric cars to reduce the carbon footprint. In general, people were willing to travel more collectively if the issues with public transportation improved concerning reliability, frequency and accessibility.

8.2 Advantages and disadvantages offered by e-scooters

The second research sub-question was "*What are the advantages and disadvantages offered by e-scooters to facilitate the transition?*". The study of the e-scooters determined that the e-scooters have been successful in filling the limitations in pubic transportation identified by the car users related to reliability, frequency and accessibility. However, the e-scooters are mostly used by residents of Gothenburg who do not own a car. The unwillingness to wait for public transportation was also evident among the e-scooter users. But primarily it was found that the e-scooter uses used the services only in case of emergencies where they did not have time to wait for public transportation. The reason for this being, the cost of e-scooter services are considered to come at a premium. The premium cost of the e-scooters thus has ensured in public transportation being the preferred mode of transport amongst the e-scooter users. Though it must be noted that the car users felt that the cost of the e-scooter services was high.

Additionally, the feeling of independence & freedom was found to be associated with e-scooters too similar to cars, the contributing factor being the ability to control the e-scooter and not being dependent on the public transport system. The residents of Gothenburg agreed the opinion of e-scooters being quick and easy to use, similar to users in the other cites such as Portland. Additionally, the supply of e-scooters

was found to be high and accessible in the center of the city of Gothenburg. The users were happy with the availability of them, though the e-scooters services are not available always in other parts of Gothenburg. Still, it was determined during the interviews that the e-scooter service providers plan to service other areas along with extending the services to smaller cities in the future. Currently, the e-scooters services are not available elsewhere in VGR, and the expansion to other cities would thus play a vital role in solving the last mile problem for commuters who travel between cities, encouraging them to use commuter trains more.

This reason of e-scooters being used during an emergency can be attributed to unsafe riding leading to accidents as people are in a hurry to get to the destination and may overlook the safety requirements such as riding on sidewalks. Furthermore, the study confirms the impact on sustainable modes of transport concerning e-scooter users admitting to walk or bike less. But due to the premium cost factor, the e-scooters were not found to have affected the use of buses or trams in the city of Gothenburg as it was found in the other cities across the globe.

It is imperative to consider that the e-scooters do not solve the issues for car users in case they have kids at home. The e-scooters, due to the limitation of the size factor, cannot support multiple people to travel together and also does not provide the required safety to have kids on them. Additionally, they do not offer the opportunity to carry bulky items. The e-scooters users though admitted that the e-scooters helped in travelling between destinations, solely for commuting purposes. Thus e-scooters provided a great potential in supporting the public transport system concerning commuting in the city of Gothenburg, where it was determined that the 90% of the travel of VGR takes place. The e-scooter users also confirmed with the literature that the bad weather affected the use of them, but that led to the usage of public transportation more.

Though the literature determined the environmental concerns of the e-scooters with e-scooters producing higher Co2 compared to public transportation. It was determined that the residents of VGR were not aware of the sustainability challenges of the e-scooter services. Thus the negative implications of the e-scooter towards the environment did not affect the usage. Additionally as mentioned earlier the premium cost of e-scooters has resulted in residents picking up sustainable mode of transport, i.e. the pubic transportation as a primary choice without being aware of it.

8.3 Barriers and drivers to provide a multi-modal transport solution

The third research sub-question to be answered was "*What are the barriers and drivers to provide a multi-modal transport solution?*". The main driving force supporting the use of public transportation was determined to be availability of car sharing services. The car sharing services were determined to play a major role in fulfilling few of the

user needs of e-scooter users. The e-scooter have a limitation in size, which meant that the e-scooter users relied on car sharing services to go on vacations and to move and using online delivery service more for shopping purposes. The non private car users are using these services to fulfill the gaps created by the public transportation. It is important to consider the age factor with regard to non ownership of the cars, they users of e-scooters and shared car services they tend to be younger and have no kids at home. Usually students or new graduates, the age of the these users are approximately below 35 years. These users are observed to be using a multi-modal combination of shared cars, e-scooter services and public transportation to fulfill their travel needs. Being younger and with a need to invest a substantial amount in car ownership has led then to try different modes of transportation, thus being able to reap the benefits of e-scooters and shared car service, both of which can be consider a new way of traveling. Though it is crucial to consider that the study could not determine the effect of the having kids on the e-scooter users. It is a possibility in the future that the non private car users once they have kids at home, might consider buying cars. The way the shared car services evolves and the extended availability of the shared car services can be instrumental in deterring in the need for car ownership. The car sharing services are becoming popular as they provide advantage of taking away the burden of maintenance of a private car. This was corroborated by the car users admitting to the possibility of using this car sharing service to fulfill few of there needs such as visiting friends and relatives in rural areas. Thus it is very important to have car sharing services to compliment the e-scooter services and public transportation in fulfilling few needs of people.

Additionally the need to be sustainable was identified as an instrumental driving force. The residents of VGR were aware of the environmental implications of gasoline cars. This aspect leading few of the interviewees to buy electric cars to reduce the carbon impact on the environment. Many of the users wanted to use public transportation whenever possible as it is believed to be sustainable and pocket friendly. Though it was found that having car at home created a self-reliance on car, i.e it stopped the car users from trying out other modes of transport. The car users from the city of Gothenburg admitted that the public transport was good in the city especially around the center, but still they used car as they had one at home. This mindset of being used to using a car, due to owning a car was evident during the interviews.

Disconnect between e-scooter services and private car users

As observed in the second step of system mapping (figure 46), there is a clear disconnect between private car users and the e-scooter services. This disconnect can be considered the biggest contributing factor for non existence of a multi modal transport solution of e-scooters and public transportation. The research determined that the use of e-scooters was majorly amongst younger population, i.e younger than 35 years. As it is well know that e-scooters is a new mode of transport which started a couple of years ago the younger population was quick to adopt. Additionally, this quick adaptation can be attributed to the high investment requirement to own a private car. This investment for owning a car is quite hard for students or young professionals.

Thus they are forced to try out different modes and methods of transportation which try to fulfill the gap created due to the absence of a private car. On the contrary the older population, which owns a private car thus have no push to use e-scooters.

Negative perception of e-scooters
E-scooters have been found to be in bad news due to bad riding habits, not being sustainable and the conflict with the other modes due to sharing infrastructure. Most importantly as identified in the literature, bad parking habits have been a significant concern for the residents of Gothenburg. The bad habits have resulted in e-scooters blocking sidewalks. Additionally, with Sweden categorizing the e-scooters in the same category of bikes, makes it challenging to regulate them. Therefore, making it dependent on the recommendations of the e-scooter service providers and good Samaritan habits. There is a strong need to address these issues as it has been affecting the perspectives of the residents who don't use them.

Lack of infrastructure
The lack of infrastructure was identified as a concern which could limit the growth to the e-scooter services. The increase in e-scooters would burden the bikepaths and create conflict with the bike users. Additionally the city of Gothenburg was never planned to include e-scooters as a travel mode. This means there is a lack of dedicated riding and parking place. Thus leading to the e-scooters taking up space in public areas dedicated for walking,or parking bikes. This factor will play a limiting role in increasing the availability of the e-scooters as they get popular in the future.

8.4 Interesting observations

Cost dilemma of e-scooter services
As discussed earlier, the e-scooter service providers found the e-scooter services to be expensive. Additionally from the surveys the car users expressed that reducing the prices of e-scooter services would make them use the e-scooters. As it has been found that the high prices of e-scooter services is resulting in e-scooter users using public transportation as primary mode. Thus making e-scooters services cheaper though might encourage private car users to use e-scooters, it might lead to e-scooter users using less of public transportation.

E-scooter services providers committed
The research also determines a strong commitment from e-scooter service provides to be sustainable. Over the last few months it has been found that the e-scooter service provides have been introducing new e-scooter models which have a greater life expectancy of up to two years. If the e-scooter if span is going to last the life span of two years, they would help in improving the revenues for e-scooter service providers and help them to be profitable along with making e-scooters more environmentally friendly.

During the interviews it was also determined that the e-scooter services providers are working towards being environmentally sustainable. They have been introducing new e-scooter models with swappable batteries and these swappable batteries are being replaced using electric cargo bikes for transportation. This in turn reduces the carbon footprint of the e-scooters, as they don't need to use trucks replace the e-scooters. Also with the introduction of swappable batteries the service providers avoiding moving the e-scooters form its location, ensuring the e-scooter is available to the previous user, thus addressing the last mile problem. It was also determined that the e-scooter service providers are trying to work closely with the public agencies and transportation authorities to address the concerns related to regulations. Furthermore as discussed earlier the e-scooter service provided were found to be committed towards servicing smaller cities in Västra Götaland region.

Opposite effects of bad weather
It was also found from the interviews that, e-scooter users preferred to use public transportation more during bad weather when it is raining or roads are icy. On the contrary the car users considered bad weather to be a detrimental factor for using public transportation, which made cars a better option.

8.5 Recommendations

The most important factor identified in the study was the gap between the e-scooter service and the private car users. Though the e-scooters have been able fulfil few of the limitations of public transportation especially with regard to residents who don't own a car in Gothenburg city. It is crucial for private car users to try using e-scooter services to understand the possibility it offers to overcome the gaps in public transportation. i.e similar to how the current e-scooter users are using them. To encourage private car users to use e-scooters services three are three recommendations.

Recommendation 1: Introduction of designated and widespread parking
Having dedicated parking spaces not only solves the current problem of bad parking. It also has an effect of the visual appeal of the e-scooters. This would help in overcoming the barrier related to negative perception about e-scooters with regard to causing inconvenience to other modes of transport. Additionally the continuous availability and appeal of e-scooters would encourage people to use e-scooters more. As seen in the figure 47, it would not only solve the issues of parking it would have a positive influence on convenience aspect of using e-scooters. Furthermore it is important to have the dedicated parking facility widespread closer to, residences, bus/tram stops, workplaces and commercial places. This would ensure in developing the sense of continuous availability of the e-scooters. Though it is important to still have the option of the ability to park closer to final destinations as it will not be possible to provide dedicated parking spaces everywhere, so as to not loose the advantage of dockless parking. The option to have dockless parking has been the selling point for the e-scooter services and the this was confirmed in the interviews and the surveys, with respondents claiming the dockless nature making it very convenient to use. The

use of dedicated parking spaces can be promoted through parking recommendation and financial incentives for using them.

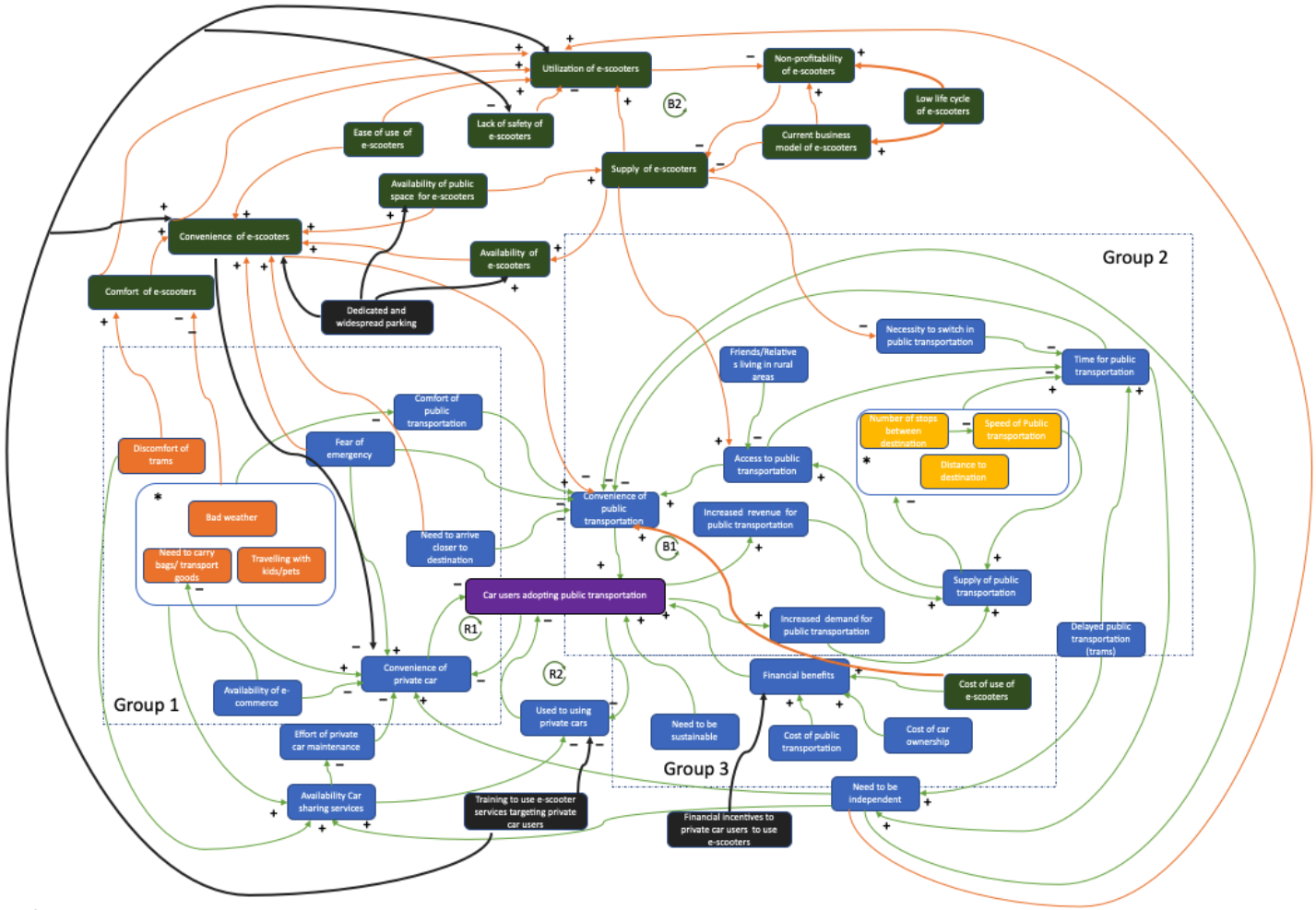
Recommendation 2: Training to use e-scooters targeting private car users
The e-scooter service providers should run training programs. This training would help in imbibing safe riding habits, such as being considerate to other people who share the infrastructure, such as bike paths and parking on side walks. The training programs are very important to change way people use e-scooters and also change the perception about the lack of safety in e-scooters. Additionally the training should target private car users and older people. This would let the user interact with the service providers and get familiar to using e-scooters in safe controlled environment. Thus providing an opportunity to try the e-scooters. The training could also be use to promote the advantages of e-scooter and also train in safe riding and good parking habits. This focused training then would affect the perception of being used to using cars (figure 47) and help the private car users to visualize the possible benefits of using the e-scooters along with public transportation.

Recommendation 3: Financial incentives for older users
The e-scooter services should provide financial incentives for older e-scooter users, i.e approximately 35 years and older. As this group is found to own cars and not try other modes of transport. The financial incentives would encourage the private car users to try e-scooter services. But it is to be noted that this is more a complementary recommendation to the other two recommendations, to tilt the balance of the finical benefits towards using e-scooters and public transportation.

8.6 Inference on the method

The study started with backcasting process in Phase I of Challenge Lab. The methods in the phase I was exercised through with a lot of dialogues and interaction with stakeholders. The other methods followed in phase II of the study has used the KJ Method, force field analysis and systems mapping to analyze the information gathered through the interviews and surveys. It is essential to consider the fact that, the data collected through the surveys and especially interviews are a small sample and runs the risk of being biased and not being representative of the whole population of VGR.

Also, the methods used to analyze the data, KJ method, FFA and systems mapping have been carried out by one individual, i.e. the author. At the same time, these methods are recommended to be carried out by a group of stakeholders. However, effort and precaution have been taken to have an unbiased analysis by continuous evaluation of the results. The e-scooter service providers need to gather more information from users and involve other stakeholders to determine the needs of private car users to address them in the local context.



* The system elements are grouped together to avoid the clutter to visualize easily. The loop connected to the box implies all the elements have the same effect on the element it is connected to. Also, if the loop is connected to an individual element in the box, it means it is just applicable for that element.
* Elements in Black are the recommendations.

Figure 47: Systems mapping - Effect of recommendation on the system

9

Conclusion

To address the challenge created by cars towards a sustainable society related to Västra Götaland region. The first part of the thesis aimed to assess the possibility of e-scooter services to help fulfill the needs of car users, along with public transportation in VGR. The region has a plan to reduce the number of journeys carried out by cars and increase the use of public transport.

From the study, it was found to be evident that the push and pull forces exists in the system concerning buying new cars, with higher taxes and parking costs being the push force towards the use of public transportation. The low cost of public transport and availability of e-scooter services and shared car services acting as a pull force. But it was found that cars were necessary to fulfill a few of the needs of the users. Thus the need for a car is created. But the need to have a personal vehicle can be overcome with the help of shared car services. Though this shared service is available at a premium cost, they provide an advantage in terms with taking away the necessity to invest in buying and maintaining a car. The e-scooter users, younger in age were found to be successfully using the e-scooter services, shared car services and public transportation as a multi-modal transport solution to mitigate the need to own a car and use more sustainable methods of travel. Additionally, the study determines that the e-scooter are capable of supporting the gaps in the public transport concerning frequency, reliability and accessibility. These aware the same needs identified by car users as a crucial to be addressed in public transportation. E-scooters thus can be instrumental in helping in travelling between two destinations, such as for daily commuting between two places.

The study also identifies that the e-scooter services are limited to the city. Thus the e-scooters can only be effective complementing public transport system in Gothenburg and municipalities around it. Though e-scooters companies are planning to extend the services to smaller cities, they might start to have a similar effect in other parts of VGR. It is imperative that e-scooters alone cannot fulfill all the needs of the users. Thus shared car services are needed to satisfy some of the needs of the residents. Therefore, shared car services need to grow in other parts of VGR.

The crucial finding of the study was the disconnect between private car users and e-scooter services. Impact of the push forces is absent on residents who already own a car. Thus the transition to other modes of transport has is solely depended on the pull forces. Additionally, the findings of the research are that the e-scooters would have limited effect on private car users. Following the three recommendations of the study, there is a possibility to make private car users use e-scooters. The use of e-scooters would begin with leisure trips, which could potentially grow into commuting

trips and replacing few journeys which would otherwise be carried out using cars, especially alone. The use of the e-scooters thus would help in car users understanding the benefits they offer in filling the gaps in public transportation.

Though it can be concluded that cars cannot be completely be rid off, and as Steg (2003) says not all car users can be convinced to use public transportation. The e-scooter services if they manage to be sustainable both environmentally and financially, they along with shared car services will be instrumental in fulfilling the limitations of public transportation to the extent of influencing the residents not to buy cars. Additionally with cars and public transport system moving towards being powered by electric motors along with the e-scooter services can shape into a potent multi-modal transport alternative in the near future as it takes away need for car ownership in the city of Gothenburg. Thus the e-scooters along with shared car services are showing a trend in having detrimental effect on the increase in the number of car ownership in Västra Götaland region, especially in the city of Gothenburg.

Appendices

A

Surveys

A.1 Survey on car user needs

1.Do you own a car?
•Yes •No

2.Do you plan on buying a car?
•Yes •No

3.Do you use a car?
•Yes •No

4.For what purpose do you use the car?
•work/school •Shopping •Visit friends/relatives •Leisure/holidays/travel •Others

5. What factors mentioned below influence the use of the car?
•Convenience •Comfort •Flexibility •Safety •Accessibility •Status
•Independence/Freedom •Reliability •Pleasurable •Control •Other

6.How important is "convenience" when you use the car? (On the scale 1 to 5)

7.How important is "comfort" when you use the car? (On the scale 1 to 5)

8.How important is "flexibility" when you use the car? (On the scale 1 to 5)

9.How important is "safety" when you use the car? (On the scale 1 to 5)

10.How important is "accessibility" when you use the car? (On the scale 1 to 5)

11. How important is "status" when you use the car? (On the scale 1 to 5)

12. How important is "independence/freedom" when you use the car? (On the scale 1 to 5)

13. How important is "reliability" when you use the car? (On the scale 1 to 5)

14.Do you use public transport?
•Yes •No

15.For what purpose do you use public transportation?
•work/school •Shopping •Visit friends/relatives •Leisure/holidays/travel •Other

16.How often do you use public transportation?
•Once a week •Twice a week •2-5 times a week •6-10 times a week •>10 times a week

17.What needs to be improved to make you use make you use more of public transportation?
•Frequency •Reliability •Speed •Safety •others
•Accessibility (last-mile/first-mile problem)
Elaborate on your choice (optional)

18.Which are the modes of transport you use for commuting?
•Car •bus/tram •Walking •bike/bicycle •E-scooter •other

19.Which is your preferred mode of transport?
(select the top three in the order of preference)
•Car •bus/tram •Walking •bike/bicycle •E-scooter •other

20.Describe why did you choose any particular mode of transport.

21.How old are you?
•<18 •18-25 •26-35 •36-50 •51-65 •>65

22.What is your gender?
•Male •Female •Other

23.How many people live in your household?
•1 •2 •3 •>3

24.How many kids do you have?
•None •1 •2 •3 •>3

25.Where do you live?
•Gothenburg city •Västra Götaland region •Stockholm •Others

A.2 Survey on e-scooters

1.Do you use e-scooters?
•Yes •No

2.How do you use e-scooters?
•Just the e-scooter (it is always available to where I am)
•Walking + E-scooter (I have a walk a bit to access the e-scooters)
•E-scooters + public transportation (last mile/first mile)

•E-scooter + shared car services •Others

3.For what purpose do you use e-scooter?
•Travel to work •Visit friends/relatives •Travel to school/training
•leisure/holiday/travel •To pick children •Others

4.How often do you use e-scooters?
•Once a week •Twice a week •2- 5 times a week •> 10 times a week

5. What factors mentioned below influences the use of e-scooters?
• Convenience • Comfort • Flexibility • Safety • Accessibility
• Independence/freedom • Reliability • Cost • Other

6. What needs to be improved by the e-scooter services?
•Availability •Cost to be made cheaper •Speed to be improved •Safety •Other

7. Do you use a car?
•Yes •No

8. Describe how e-scooter usage affected your choice of travel mode (optional)

9. Has e-scooters resulted in you using cars less?
•Yes •No

10.Describe, how can e-scooter services improve so that you can use more of public transportation (optional)

11.Express your opinion on how e-scooters have helped in reducing the car usage / Express why e-scooters have not helped in reducing car (optional)

12.What is the reason for not using the e-scooter?
•The services are not available in my city/town
•The e-scooters are not always available around me
•They are too expensive to use
•They are slow to travel with
•I never travel alone
•I can't carry bags
•Don't know
•It is not my thing; they cause more problems instead

13.Do you think you could use the e-scooters to connect to public transportation? (to solve the last mile commute)
• Yes • No • Don't know

14.What should the e-scooter service providers improve, so that you will use it to

connect to public transportation?
•Availability of e-scooters
•Speed of e-scooters
•Parking facility near bus/tram stops
•Cost factor should be improved •Others

15.Express your opinion on what the e-scooter services should offer for you to use it

16.How old are you?
•<18 •18-25 •26-35 •36-50 •51-65 •>65

17.What is your gender ?
• Male • Female

18.How many kids do you have?
•0 •1 •2 •3 •>3

19.What is the number of people in your household?
•1 •2 •3 •>3

20.Where do you live?
•Gothenburg city •Västra Götaland region •Stockholm •Others

B

Survey comments

B.1 Car users preferred mode of transport

Car users Gothenburg city	
Peferede mode of transport	**Comments**
bike/cycle	Convenient, good exercise, saving time and money
Car	Freedom
Car	Speed and save time
Car	Convenience and cost
bike/cycle	Elektrici bicykle is fantastik but the Winter is to cold
bike/cycle	Convinience of the bike in yhe city
Car	To commute to work takes too long time Vs car
Car	Convenience and reliability with the car over bus/tram
bike/cycle	Cycling gives training and transport to work
Car	Time to get to work + too far to walk
walking	Environmental reason. I also have a Tesla.
walking	Self employed
Bus/tram	I have a fast and nice car. Its enogh för me.
Car	I walk when I can, i.e. when there's no load to carry or distance is within 3/4 km. Car to and from work, to save time. If a client is in the town city, I sure go by bus and subway.
Car	It is flexibel, and easy. I do allot of business calls while drivning, that you cannot do using public transportation
Car	Convenience
Car	I love to cycle but I live too far from work and 3 kids need to be driven to school and preschool.
Bus/tram	Bus/Tram when going to places where public transport is fastest, using car when I need flexibility. Always prefer to walk when a shorter distance if I have the time
Bus/tram	Climate and relaxation

Car users - Rest of VGR	
Preferred mode of transport	**Comments**
bike/cycle	Fresh air, light exercise.
Car	Live in Countryside. Nearly impossible to take buses.
bike/cycle	Least travel time
Car	I live in a rural area, there is really no alternative.
Train	Train is comfortable for longer travel. Electric car for daily travels.
Car	Superior flexibility and comfort.
Car	Most convenient where I live
bike/cycle	It depends on the distance. Most destinations – I would at least 95% – a bike is sufficient for me.
Car	Quick, flexible and lowest cost with our electric hybrid
Car	The car takes me were I want when I want it to.
Car	To long time from door to work and back home with public transportation, uses car instead
Car	Easy and fast
Car	Flexibility, reliability, safety, efficiency, speed and much more
Car	Easy
Car	Most suitable
Car	Better for the environment and health
E-scooters	Love the feeling
Car	Most comfortable
Car	Distance
Car	I live in a rural area, public transport is not a viable option most of the time. Also I drive an electric car and thus feel the load on the environment is quite low.
Car	Easy
bike/cycle	Because of the Climate Crisis
Running	Distance
Car	Convenience
Car	EV car, convenience
Car	If I have to travel long I take the car otherwise I try to walk.
bike/cycle	Suite most needs
bike/cycle	Distance and weather
Car	being able to have wheelchair and other necessities with us.
Car	Se tidigare svar
walking	I like to walk when the distance is reasonable, because it requires no tools nor machines, and it gives me exercise.
Car	The flexibility and travel time
Car	I need a car for my work

C

Interview questions

C.1 Car Users

1. To what extent do you use the car, compared to other modes of transport Alt a: Why do you prefer the car over other transport modes? Alt b: Why do you prefer other transport modes?
2. How satisfied are you with your preferred mode of transport?
3. For what purposes do you use the car?
4. What benefits do you see in owning/using a car?
5. What challenges do you see in the current public transport system?
6. How satisfied are you with the current public transport system?
7. How do you think it should improve for you to use it more?
8. Does the location where you stay affect your choice of your mode of transport?
9. How would you feel about living without a car?
10. What do you think of other modes of transport? (walking, electric-bikes, e-scooters)
11. Have you used e-scooters? Or do you consider using them?
12. If you have used e-scooters, for what purpose did you use?
13. Anything more you would like to add?

C.2 E-scooter users

1. What is your preferred mode of transport and why?
2. For what purposes do you use e-scooters? And before e-scooters, which modes did you use for these purposes?
3. Do you see, e-scooters changing the way people travel?
4. How has using e-scooters changed the way you travel?
5. Has e-scooters made you use the car less?
6. Do you think e-scooters has made you use more public transportation?

7. Has e-scooters made you bike or walk less?
8. How satisfied are you with e-scooters?
9. What challenges do you see with e-scooters?
10. What do you think the e-scooter services should improve in the product or the service?

C.3 E-scooter service providers

1. How do you think e-scooters can solve the mobility issue?
2. What challenges do you see with urban spaces?
3. Co2 emissions is greater with redistribution how are you tackling it?
4. The profitability of the business model? When it is expected to get profitable?
5. Plans for implementing the services in rural areas and the challenges faced with it?
6. Do you plan on having them located close to residential areas, so people can use it to connect to public transportation?
7. What are the challenges you are facing with regulations?
8. Have you thought about working with the local public transportation to act as a complementing system?
9. Do you work with municipalities to get favourable regulations for business? Or the challenges you are facing?
10. What role do politicians have to play?
11. How are you planning on taking the issue with vandalism?

C.4 Regulators & researchers

1. Do you see e-scooters as a solution or a problem?
2. What challenges do you think the e-scooters create?
3. E-scooters share the infrastructure but are not designed for the current infrastructure? How do you think they should be addressed?
4. Dock less parking is an issue, how are the regulators planning to address this?
5. Carbon emission with redistribution or replacing batteries is high, localised charging is needed?

6. Do you think the e-scooters can act as a complimentary service to public transportation? Or work together with them?

7. Can it help reduce the number of cars on the roads?

8. They are non-existing in other parts of VGR or outskirts of the city, this is where they can have a bigger impact due to lack of public transportation. How do you think this should be addressed?

References

Adams, W. C. (2015). Conducting Semi-Structured Interviews. *Handbook of Practical Program Evaluation: Fourth Edition*(August 2015), 492–505. doi: 10.1002/9781119171386.ch19

Ajao, A. (2019). *Electric Scooters And Micro-Mobility: Here's Everything You Need To Know.* Retrieved 2020-03-05, from https://www.forbes.com/sites/adeyemiajao/2019/02/01/everything-you-want-to-know-about-scooters-and-micro-mobility/{\#}152bcb255de6

Alphabet. (2019). *Micro-mobility and the last-mile trend — Alphabet.* Retrieved 2020-06-04, from https://www.alphabet.com/en-ww/blog/micro-mobility-and-last-mile-trend

Apuke, O. D. (2017). Quantitative Research Methods : A Synopsis Approach. *Kuwait Chapter of Arabian Journal of Business and Management Review*, *6*(11), 40–47. doi: 10.12816/0040336

Arivananthan, M. (2015). FishBowl - Maximizing participation in direct conversations with experts. *Unicef*, 1–6.

Azar, C., Holmberg, J., & Lindgren, K. (1996). *ECOLOGICAL ECONOMICS Methodological and Ideological Options Socio-ecological indicators for sustainability* (Vol. 18; Tech. Rep.).

Bala, B. K., Arshad, F. M., & Noh, K. M. (2017). Causal Loop Diagrams. (January 2004), 37–51. doi: 10.1007/978-981-10-2045-2_3

BBC. (2019). *Electric scooters: France introduces new rules to 'restore tranquillity' - BBC News.* Retrieved 2020-06-14, from https://www.bbc.com/news/world-europe-50189279

Bird. (2019). *Bird Introduces Designated Parking in Paris - Bird · Enjoy the ride.* Retrieved 2020-06-15, from https://www.bird.co/press/bird-introduces-designated-parking-in-paris/

Brandt, P., & Toll, M. (2019). *Stockholm tar fram nytt regelverk för elscootrar.* Retrieved 2020-06-15, from https://www.stockholmdirekt.se/nyheter/stockholm-tar-fram-nytt-regelverk-for-elscootrar/repscu!o@95lFIFWJQQAi6unSZafQ/

Brustein, J., Lanxon, N., & Foy, S. (2019). *Why E-Scooters Are on the Rise, Along With Injuries: QuickTake - Bloomberg.* Retrieved 2020-03-05, from https://www.bloomberg.com/news/articles/2019-07-20/why-e-scooters-are-on-the-rise-along-with-injuries-quicktake

Carson, S. (2020). *Milwaukee e-scooters in winter: What happens to them, where do they go.* Retrieved 2020-05-25, from https://eu.jsonline.com/story/news/local/2019/11/06/milwaukee-e-scooters-winter-what-happens-them-where-do-they-go/4116010002/

Challenge Lab. (2020). *About Challenge Lab – Challenge Lab.* Retrieved 2020-03-03, from https://www.challengelab.chalmers.se/about/

City of Dallas. (2019). *Dockless vehicles.* Retrieved 2020-06-15, from https://dallascityhall.com/departments/transportation/Pages/

Dockless-Vehicles-.aspxhttps://data.louisvilleky.gov/dataset/dockless-vehicles

CNN. (2019). *Electric scooters face bans and restrictions around the world — CNN Travel.* Retrieved 2020-03-05, from https://edition.cnn.com/travel/article/electric-scooter-bans-world/index.html

Corpuz, G. (2007). Public transport or private vehicle: Factors that impact on mode choice. *30th Australasian Transport Research Forum*, 1–11.

Council, W. W. (2017). 70 % of the World ' s Population Will Live in Cities by 2030 , While 60 % of Urban Settlements Remain to be Built (UN-Habitat , World Cities Report) The World Water Council unites with major city networks • By 2030 there will be a 50 % increase in deman.

Crellin, F. (2019). *Paris clamps down on electric scooters as law of the jungle rules - Reuters.* Retrieved 2020-06-15, from https://www.reuters.com/article/us-france-paris-scooters/paris-clamps-down-on-electric-scooters-as-law-of-the-jungle-rules-idUSKCN1TP1ZV

Dimitrova, M. (2019). *Swedish authorities are looking into possible new rules for e-scooters — TheMayor.EU.* Retrieved 2020-03-05, from https://www.themayor.eu/en/swedish-authorities-are-looking-into-possible-new-rules-for-e-scooters

EY. (2020). *Micromobility: Moving cities into a sustainable future* (Tech. Rep.).

Faxér, A. (2019). *A Tough Game for Electric Scooters — Drive Sweden.* Retrieved 2020-06-01, from https://www.drivesweden.net/en/tough-game-electric-scooters

Fong, J., & Mcdermott, P. (2019). Micro-Mobility , E-Scooters and Implications for Higher Education. (May), 1–21.

Fournier, C. (2019). *Sustainable Mobility: Are Electric Scooters Eco-Friendly? - Youmatter.* Retrieved 2020-06-01, from https://youmatter.world/en/sustainable-mobility-electric-scooters-28897/

France 24. (2019). *Activists sabotage 'ecologically catastrophic' e-scooters in France - France 24.* Retrieved 2020-06-01, from https://www.france24.com/en/20191205-activists-sabotage-ecologically-catastrophic-e-scooters-in-france

Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: A multi-level perspective and a case-study. *Research Policy*, *31*(8-9), 1257–1274. doi: 10.1016/S0048-7333(02)00062-8

Geels, F. W. (2005). Processes and patterns in transitions and system innovations: Refining the co-evolutionary multi-level perspective. *Technological Forecasting and Social Change*, *72*(6 SPEC. ISS.), 681–696. doi: 10.1016/j.techfore.2004.08.014

Gössling, S. (2020). Integrating e-scooters in urban transportation: Problems, policies, and the prospect of system change. *Transportation Research Part D: Transport and Environment*, *79*(January), 102230. Retrieved from https://doi.org/10.1016/j.trd.2020.102230 doi: 10.1016/j.trd.2020.102230

Götalandsregionen, V. (2018). *Goal image Koll2035 for the urban traffic's core network - Västra Götaland region.* Retrieved 2020-03-05, from https://

www.vgregion.se/kollektivtrafik/trafikforsorjningsprogrammet--sa-utvecklas-kollektivtrafiken/malbild-koll2035-for-stadstrafikens-stomnat/

Göteborgs Stad. (2018). Resvaneundersökning 2017. Retrieved from https://goteborg.se/wps/wcm/connect/6c603463-f0b8-4fc9-9cd4-c1e934b41969/Trafikstrategi{_}eng{_}140821{_}web.pdf?MOD=AJPERES

Griswold, A. (2019). *How European scooter companies plan to beat the winter — Quartz.* Retrieved 2020-05-25, from https://qz.com/1762010/how-european-scooter-companies-plan-to-beat-the-winter/

Haworth, N. L., & Schramm, A. (2019). Illegal and risky riding of electric scooters in Brisbane. *Medical Journal of Australia*, *211*(9), 412–413. doi: 10.5694/mja2.50275

Hollingsworth, J., Copeland, B., & Johnson, J. X. (2019). Are e-scooters polluters? the environmental impacts of shared dockless electric scooters. *Environmental Research Letters*, *14*(8). doi: 10.1088/1748-9326/ab2da8

Holmberg, J., & Larsson, J. (2018). A sustainability lighthouse-supporting transition leadership and conversations on desirable futures. *Sustainability (Switzerland)*, *10*(11). doi: 10.3390/su10113842

Holmberg, J., & Robert, K. H. (2000). Backcasting — a framework for strategic planning. *International Journal of Sustainable Development and World Ecology*, *7*(4), 291–308. doi: 10.1080/13504500009470049

Kabashkin, I. (2015). Modelling of Regional Transit Multimodal Transport Accessibility with Petri Net Simulation. *Procedia Computer Science*, *77*, 151–157. Retrieved from http://dx.doi.org/10.1016/j.procs.2015.12.373 doi: 10.1016/j.procs.2015.12.373

Khreis, H., Nieuwenhuijsen, M., & Bastiaanssen, J. (2017). Creating Car Free Cities: Rational, Requirements, Facilitators and Barriers. *Journal of Transport & Health*, *5*, S65–S66. Retrieved from http://dx.doi.org/10.1016/j.jth.2017.05.210 doi: 10.1016/j.jth.2017.05.210

Kreuzer, A. (2019). *Electric scooters: get to know the new regulations - Bavarian News, U.S. Army Garrison Bavaria.* Retrieved 2020-06-15, from https://www.bavariannews.com/blog/2019/07/19/electric-scooters-get-to-know-the-new-regulations/

Lawrence, M. (2019). *DPD Has Issued About 20 Scooter Citations.* Retrieved 2020-07-24, from https://www.dallasobserver.com/news/dallas-police-have-issued-about-20-citations-to-people-riding-scooters-illegally-11727533

Local, T. (2019). *Sweden to crack down on e-scooter 'mess' with new regulations - The Local.* Retrieved 2020-03-05, from https://www.thelocal.se/20190912/sweden-to-crack-down-on-e-scooter-mess-with-new-regulations

Marcus, I. (2020). *Berlin Police Log High Number of E-Scooter Accidents – The Berlin Spectator.* Retrieved 2020-07-24, from https://berlinspectator.com/2020/06/18/berlin-police-log-high-number-of-e-scooter-accidents/

NACTO. (2019). *Shared Micromobility in the U.S.: 2018 — National Association of City Transportation Officials.* Retrieved 2020-06-04, from https://nacto.org/

shared-micromobility-2018/
Naderifar, M., Goli, H., & Ghaljaie, F. (2017). Snowball Sampling: A Purposeful Method of Sampling in Qualitative Research. *Strides in Development of Medical Education*, *14*(3). doi: 10.5812/sdme.67670
O'Gorman, K., & MacIntosh, R. (2015). Research Methods for Business & Management. In (2nd ed., pp. 31–49). Goodfellow Publishers Ltd. doi: 10.23912/978-1-910158-51-7-2790
PBOT. (2019). *2018 e-scooter findings report* (Tech. Rep.). Retrieved from https://www.portlandoregon.gov/transportation/77294
Pesce, N. L. (2020). *Electric scooter injuries jumped 222% over the past four years - MarketWatch.* Retrieved 2020-05-25, from https://www.marketwatch.com/story/your-first-e-scooter-ride-will-probably-land-you-in-the-hospital-2019-05-03
Pojani, D., & Stead, D. (2015). Sustainable urban transport in the developing world: Beyond megacities. *Sustainability (Switzerland)*, *7*(6), 7784–7805. doi: 10.3390/su7067784
project management.com. (2017). *Affinity Diagram – Kawakita Jiro or KJ Method.* Retrieved 2020-09-08, from https://project-management.com/affinity-diagram-kawakita-jiro-or-kj-method/
Quartz. (2019). *At least 29 people have died in electric scooter crashes — Quartz.* Retrieved 2020-05-25, from https://qz.com/1793164/at-least-29-people-have-died-in-electric-scooter-crashes/
Queensland Government. (2019). *Rules for personal mobility devices — Transport and motoring — Queensland Government.* Retrieved 2020-06-15, from https://www.qld.gov.au/transport/safety/rules/wheeled-devices/personal-mobility-devices
Riga, R. (2019). *Brisbane scooter riders fined for hundreds of safety breaches in Queensland - ABC News.* Retrieved 2020-07-25, from https://www.abc.net.au/news/2019-03-30/electric-scooters-riders-fined-safety-breaches-brisbane-qld/10956110
Robinson, M. (2018). *Should You Ride an Electric Scooter? - The Atlantic.* Retrieved 2020-06-01, from https://www.theatlantic.com/technology/archive/2018/05/electric-scooters-are-the-cargo-shorts-of-transportation/561440/
Rutakumwa, R., Mugisha, J. O., Bernays, S., Kabunga, E., Tumwekwase, G., Mbonye, M., & Seeley, J. (2019). Conducting in-depth interviews with and without voice recorders: a comparative analysis. *Qualitative Research*, 15–17. doi: 10.1177/1468794119884806
smart city, B. (2020). *E-Scooters: A Collision Between Innovation And Controversy.* Retrieved 2020-05-26, from https://hub.beesmart.city/solutions/en/smart-mobility/e-scooters-a-collision-between-innovation-and-controversy
Smith, A., Stirling, A., & Berkhout, F. (2005). The governance of sustainable socio-technical transitions. *Research Policy*, *34*(10), 1491–1510. doi: 10.1016/j.respol.2005.07.005

Smith, C. S., & Schwieterman, J. P. (2018). E-Scooter Senarios: Evaluating the potential mobility benifits of sharde dockless scooters in chicago.

Spool, J. M. (2004). The KJ-Technique: A Group Process for Establishing Priorities. *User Interface Engineering*. Retrieved from https://articles.uie.com/kj{_}technique/http://www.uie.com/articles/kj{_}technique/

Steg, L. (2003). Can Public Transport Compete With the Private Car? *IATSS Research*, *27*(2), 27–35. doi: 10.1016/s0386-1112(14)60141-2

Stradling, S., & Anderson, S. (2012). Unable or unwilling? Attitudes to modal shift in Scotland. , *17*(4), 291–297.

The Local. (2019). *Sweden to crack down on e-scooter 'mess' with new regulations - The Local.* Retrieved 2020-05-26, from https://www.thelocal.se/20190912/sweden-to-crack-down-on-e-scooter-mess-with-new-regulations

The Royal Society for the Prevention of Accidents. (2019). The Royal Society for the Prevention of Accidents Road Safety Factsheet: Electric Scooters (E-Scooters) Electric Scooters (E-Scooters) What are E-Scooters?

Thomas, J. (1985). Force field analysis: A new way to evaluate your strategy. *Long Range Planning*, *18*(6), 54–59. doi: 10.1016/0024-6301(85)90064-0

Thomas, K. (2019). *E-scooter pilot program will return to Portland with new rules, enforcement fines — KATU.* Retrieved 2020-07-24, from https://katu.com/news/local/e-scooter-pilot-program-will-return-to-portland-with-new-rules-and-enforcement

Tidey, A. (2019). *Germany legalises e-scooters but bans them from the pavement — Euronews.* Retrieved 2020-06-15, from https://www.euronews.com/2019/05/17/germany-legalises-e-scooters-but-bans-them-from-the-pavement

Tier. (2020). *Help – TIER.* Retrieved 2020-06-15, from https://www.tier.app/help/

transport administration, U. (2014). Adopted By the Urban Transport Committee February 2014 Transport Strategy for a Close-Knit City. (February).

Ulrich, K. T., & Eppinger, S. D. (2012). Product design and development. In *Mcgraw-hill* (5th ed., pp. 91–117). McGraw-Hill. doi: 10.1016/0956-5663(92)90013-D

United Nations. (2020). *Home - 2019 - United Nations Sustainable Development.* Retrieved 2020-03-03, from https://www.un.org/sustainabledevelopment/

Västtrafik. (2019). *Västtrafik 2035 - framtidens kollektivtrafik — Västtrafik.* Retrieved 2020-03-05, from https://www.vasttrafik.se/info/vasttrafik-2035/

VOI Technologies. (2020). *Voi Scooters - FAQ.* Retrieved 2020-06-15, from https://www.voiscooters.com/faq/

Webb, R. (2011). Public transport versus the private car: a study of attitudes towards transport modes in Plymouth. (1), 325–371.

Wired. (2019). *Paris Ends an E-Scooter Melee With New Rules of the Road — WIRED.* Retrieved 2020-06-01, from https://www.wired.com/story/paris-escooters-regulation/

Zipper, D. (2020). *Local Regulations Can Be an E-Scooter Killer - Bloomberg.* Retrieved 2020-06-19, from https://www.bloomberg.com/news/articles/2020-02-10/local-regulations-can-be-an-e-scooter-killer