Carsharing Potential of Shared E-Scooter Users

Author: Bert Berkers

Title

Carsharing potential of shared e-scooter users

Version

Final version

Date

20 August 2021

Author

Bert (e.w.j.) Berkers

S2161699

Internal supervisor

Prof. dr. ing. K.T. Geurs

External supervisors

N. Knoester MSc

M. Visscher MSc

Study

Bachelor Thesis
Civil Engineering
University of Twente

1 Preface

Initially, I could not find a subject that both fit the requirements of the thesis and my interests since I was not familiar enough with the current state of development. I want to thank my internal supervisor Karst Geurs and Martijn Derksen from Arcadis, who helped me find a suitable subject and company in my field of interest. This lead me to study shared mobility. My external supervisors at Over Morgen imagined that the new generation of shared e-scooter users who grew up in a world surrounded by technology and who did not own a private car yet could prove to have high carsharing potential. Furthermore, the difference between this new generation of potential car sharers and the current users was a point of interest. Perhaps the demands of this new generation require a change in the carsharing offering.

I have learnt a tremendous amount working at Over Morgen and conducting independent research, which is very different from the projects done during my studies. The pandemic and its measures did not help with my productivity. However, I gained much motivation by exploring the world beyond university and participating in, but mostly observing the process of real-world problem-solving. For that, I want to thank those at Over Morgen for having me join in.

A special thanks go out to Nick Knoester and Megan Visscher of Over Morgen for supervising me and accomodating the many meetings & discussions we have had. Setting up the survey was one of the most challenging parts of the study; luckily, several team members of Over Morgen helped during various stages and gave their feedback. Other thanks go out to Shared e-scooter company Felyx who agreed to send out the survey. Finally, I want to thank Karst Geurs again for the various feedback moments we have had.

Bert Berkers

Enschede, August 2021

2 Summary

Shared mobility is a relatively new tool to aid the constant search for mobility that meets today's ever-growing list of constraints. Reducing car ownership is one of the primary methods to improve the built environment. Shared mobility aids in reducing car ownership by filling the same niche a private car takes while doing it much more efficiently; one shared car is shown to replace up to thirteen private cars (Goudappel Coffeng, Greenwheels, 2019). The new and upcoming generation who have not yet bought cars is in a great spot to adapt carsharing to delay and reduce car acquisition. Shared e-scooter users from Rotterdam and Den Haag are familiar with several modes of shared mobility. And are posed to show great carsharing potential.

What is the carsharing potential of shared e-scooter users in Rotterdam and Den Haag?

Forty per cent of the surveyed respondents shows potential for carsharing and expects to use a shared car regularly at some time in the next five years. Furthermore, half of the respondents are confident of their private car use. In contrast, less than ten per cent will not use a car at all.

The shared e-scooter users are much less dependent on a car than current carsharing users. They do not experience as much difficulty not having a private car and most are fine without car ownership.

What carsharing preferences does this group have?

Most respondents prefer Free-floating carsharing; stationbased sharing is chosen only by a handful of (older) respondents. Potential carsharing users are open to all types of service: professional, peer-2-peer and cooperative sharing. However, professional sharing and peer-2-peer are preferred. And even though those who expect to use a private car are not very open to carsharing services, car ownership is correlated with openness to cooperative sharing.

What characteristics does this group have?

The group of shared e-scooter users is younger than the average. In addition, there are many more men than women, though the divide is not as bad as it used to be. Most are highly educated. Moreover, half are still students. The potential carsharing users are more concerned about the environment, whereas the private car users are concerned with maximizing the availability of a car.

3 Contents

3.1 Table of contents

3.2 Table of figures

3.3 Table of tables

4 Introduction

4.1 Societal relevance

Carsharing is an upcoming method of mobility. It has been shown to reduce emissions by reducing the number of vehicle kilometres travelled (Hansjörg Fromm, 2019). It also reduces the number of vehicles needed; one can share the same car with up to thirteen others (Goudappel Coffeng, Greenwheels, 2019). Free-floating shared cars offer the greatest opportunities. Whereas station-based shared cars require dedicated parking spaces in the cityscape, free-floating ones do not and can share the same parking spaces with privately owned cars (Gemeente Rotterdam, 2020). It is thus advantageous to invest extra effort in increasing the share of free-floating shared cars, even more so as this form of carsharing has lagged thus far. The upcoming generation, still without a private car and familiar with shared e-scooters, could be a necessary boost in the transition to (free-floating) carsharing.

In Rotterdam, one of two cities included in the study, the free-floating offering is expected to grow from 1-5% to 10-20% by 2030. One of the city's primary goals is to reduce the number of cars in the public domain to create more public space. Free-floating car-sharing has been found to take up half the space compared to station-based shared cars. The shared e-scooter user may thus be of considerable value in meeting the targeted share of free-floating carsharing.

4.2 Scientific relevance

There is extensive literature about the factors relevant for the uptake of shared cars and other variants of shared mobility. Many facets have been studied, from values (Tobias, 2013) to choice experiments about the optimal distance and cost to a parking spot (Ströhle, Flath, & Gärttner, 2019). Studies have also focused on the young age demographic (18-24 years) and what drives them to adopt shared cars (Burg, 2020). However, nothing has been done to study shared e-scooter users and their likelihood to adopt shared cars. Furthermore, if they do wish so, which variant of shared cars and because of what reasons? This study aims to fill this knowledge gap; the carsharing potential of shared e-scooter users.

5 Theoretical framework

In this chapter, the theoretical underpinning of this study will be outlined. The theories are used to derive explanatory variables for the tendency to use shared cars. In addition, groups of people who share this tendency have been identified.

5.1 Delineation of shared mobility and existing situation

Shared mobility can be defined as an alternative mode of travel that maximises use by sharing the vehicles. This requires the removal of ownership. Access is characteristically short; consecutive access to one vehicle for longer than a day is rare (Machado et al., 2018).
Shared mobility can be split into several parts, as done in figure 3-1. The branches "Carsharing" and "Personal Vehicle Sharing" are relevant for this study.
In this study, business to Consumer (B2C) will be referred to as professional carsharing providers. Companies with this business model have a fleet of vehicles and rent these out to users. Personal vehicle sharing is split up into Peer to Peer (P2P) and fractal ownership. P2P entails sharing privately owned vehicles with other network users who may or may not do the same with their own vehicle. Fractal ownership often takes shape as cooperation, where a set group of users (usually neighbours) share a fleet of cars. They do so after having established a legal cooperation. Several companies in the Netherlands offer services to help facilitate the setup of such a cooperation. These cooperations are also built into new developments, where a pool of shared cars comes with the property.

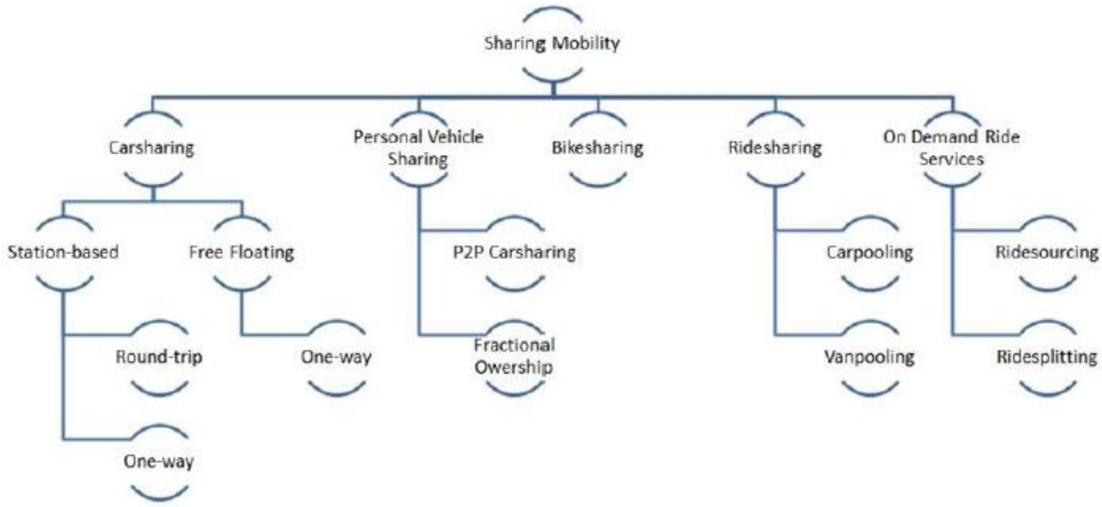

Figure 5-1: Overview of shared mobility (Machado et al., 2018)

A second distinction can be made within carsharing—the system in which the cars are taken in and out of use. The two main types are station-based and free-floating, as Figure 5-2 shows. Station-based entails set locations to park the shared car in and require designated parking spots in the cityscape. Combine this with the two-way system, and this means that users pay for the entire duration they rent the car until they return it to its original spot. These cars are often reserved beforehand.

On the other hand, a one-way station-based carsharing system allows users to leave the car in another parking spot than the one where it was picked up. And as such, users do not have to pay for idle time at their destination. Therefore, many providers of round-trip services claim that one-way sharing is an improvement over round-trip. Though, it brings the same problems as free-floating, the shared cars will eventually be distributed unequally due to a difference in demand, both spatial and temporal (Machado et al., 2018).
Free-floating allows users to park the vehicle in a given area upon finishing their journey. This naturally allows for much more freedom and flexibility. However, it also means that it could be necessary to use a mobile application to find the car, as there is no guarantee to find it in the same spot.

Hybrid systems, a combination stationbased and free-floating allow users to park in both area or station.

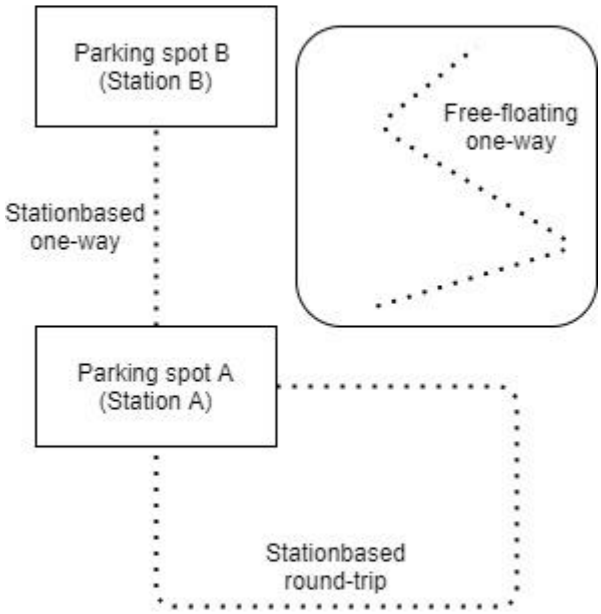

Figure 5-2: Overview station-based & free-floating

5.1.1 Shared cars in the Netherlands

Shared cars have been around in the Netherlands for a few decennia now. In the beginning, this was still very much innovation, and the user group mainly consisted of higher educated, high income and younger people. Eventually, more and more older people also became users (Goudappel Coffeng, Greenwheels, 2019). At its introduction in 2008, the offering mainly was station-based and two-way like the system employed by Greenwheels, a B2C provider. Since 2011 P2P carsharing was introduced and by now has the largest share of vehicles. Free-floating carsharing still plays a minor role, despite being introduced around the same time as P2P sharing (autodelen.info, 2021). Cooperative sharing can be found in various cities, especially in the Randstad.

5.1.2 Shared scooter users

The group of shared scooter users is generally young relative to the rest of the population. In both Vienna and Rotterdam, the users aged between 26-35 were the largest share (Laa & Leth, 2020) (Gemeente Rotterdam, 2020). However, other studies from New Zealand found that the age group just below that, aged 18–25, was larger. More than half of the users were male in both cities as well.

E-scooter trips also replace other modes. In Vienna, the most commonly replaced mode was walking followed by slow public transport modes like tram and bus. In Rotterdam, public transport (27%) was most often replaced by the shared e-scooters, closely followed by the car (23%). Last is a promising development since it means that the scooters are a valid alternative for car use. Walking and cycling took a smaller but nonnegligible chunk of replaced modes as well.

5.1.3 MaaS & KiM study

Mobility as a Service, MaaS is a new service that combines different travel modes, including shared mobility, in one integrated system. Users can access this system via a mobile application. In which they can plan their journey and reserve vehicles. Even though MaaS is not the focus of this study, it is relevant due to the overlap with shared mobility. MaaS includes several shared modes, as well as public transport. One of these shared modes is car sharing. Therefore, the motivations behind the use of MaaS overlap with car sharing. Moreover, given the shared scooter users who will be interviewed, familiarity with the mobile environment is expected. App use is an essential component of both shared e-scooters and MaaS.

The data provided to this study by the “Kennisinstituut voor Mobiliteitsbeleid” (KiM) is a panel study lasting several years. A short description provided by KiM:

“The MPN is a household panel, in which the main objectives are to establish short-run and long-run dynamics in the travel behaviour of individuals and households, and to determine how changes in personal and household characteristics and in other travel-related factors (e.g. economic crisis, reduced taxes on sustainable transport, changes in land-use or increased availability and use of ICT) correlate with changes in travel behaviour (see Hoogendoorn-Lanser et al. (2015) for more details). Starting in July 2013, respondents aged 12 years and older from ±2,500 complete households recorded their travel data using a three-day travel diary. For each respondent, the diary provided information (transport modes, trip purposes, travel companionship, delays, parking costs) about all trips (stages) the respondent had taken. Between 2013 and 2016, this will be repeated at least annually with the same respondents. At the same time, different questionnaires were completed, offering a large amount of background information about respondents and their households.”

In addition to the panel study data, data from a study conducted by KiM about potential user groups for Mobililty as a Service was also provided. This second study contains questions that will be directly used in the survey for this study.

5.2 Explanatory factors for the uptake of car sharing

In this section, factors critical to the uptake of carsharing are outlined. These factors are either grouped by a theory or the type of data they represent. Firstly findings on sociodemographic characteristics in relation to carsharing are presented. Then theory of planned behaviour, which goes into the drivers behind behaviour itself. The theory of innovation diffusion describes the exposure to shared mobility these shared scooter users have had experience. Finally, the theory of life events is used to emphasize the importance of timing in the change of travel behaviour.

5.2.1 Sociodemographic characteristics

Socio-demographic characteristics aim to identify an individual or population. Examples of variables include age, race, ethnicity, gender, marital status, income, education, location, and employment. These characteristics are valuable since they are universally used and can thus be used in comparison to previous findings easily. In addition, some of these characteristics can be an indicator of an experience or typical behaviour shared by members of a homogenous group. Young people, for example, share a set of experiences and behaviour elders do not.

Many studies found that education levels significantly contributed to the likelihood of adopting carsharing (Prieto, Baltas, & Stan, 2017) (Kennisinstituut voor Mobiliteitsbeleid, 2019). The more highly one is educated, the more likely one was found to adopt carsharing.

Age was also found to be of interest. Younger people are generally deemed to be more likely to adopt carsharing schemes (Prieto et al., 2017) (Kennisinstituut voor Mobiliteitsbeleid, 2019) (Burghard & Dütschke, 2018). However, various studies noted this may just be the group early adopters (Burghard & Dütschke, 2018) (Kennisinstituut voor Mobiliteitsbeleid, 2019). A Dutch carsharing company called Greenwheels found that their userbase is equally distributed (Goudappel Coffeng, Greenwheels, 2019). Greenwheels employs a station-based two-way carsharing system, like owning a private car, i.e. park at the same location near one’s house and ride it back home after a day out. The larger share of people older than 30 years using Greenwheels compared to more flexible carsharing schemes could be explained as such.

Location is also relevant since it indicates many spatial factors that are present. Dense, walkable and transit-oriented areas are more likely to sustain a carsharing scheme (Uteng et al., 2019). However, what effect these areas have on carshare uptake is unknown. In addition, areas with more shared cars available are expected to have a higher uptake. Since accessibility and availability will be greater due to the larger and denser offering.

5.2.2 Theory of planned behaviour

The theory of planned behaviour is used to explain the drivers behind people’s behaviour. Attitudes, subjective norms and perceived behavioural control are the three components of this theory. This study aims to determine what drives shared e-scooter users to use a shared car in favour of the private car. The latter can be either bought or leased.
Below is a diagram of the components which make up the theory of planned behaviour. Attitudes, norms, and perceived control influence each other to generate the intention to act out a particular behaviour. Whether behaviour follows from the intention to do so is again influenced by the ability to control. If there are no means to facilitate the intention, then the behaviour cannot be expressed. For example, if there are no shared cars, one may intend to use them, but there are no means. Furthermore, one would not be likely to have an attitude about (the use of) shared cars if you have never seen them, which symbolises the arrow from perceived control to attitude.

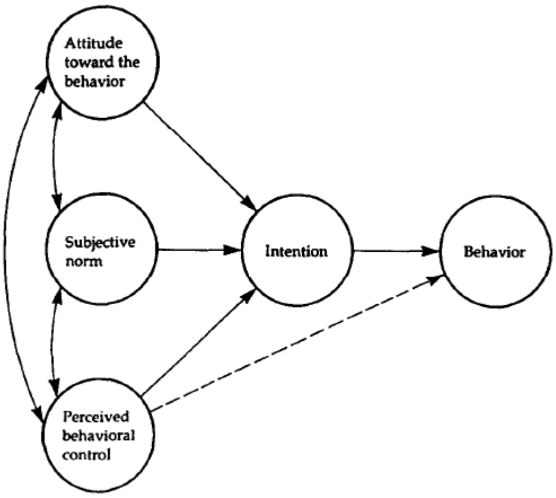

Figure 5-3: Theory of planned behaviour (Ajzen, 1991)

The work of (Jain et al., 2021) was instrumental in defining the factors relevant to shared mobility using the theory of planned behaviour.

Attitudes (Theory of Planned Behaviour)

Attitudes have been shown to strongly predict car share uptake and behaviour in sharing systems (Claasen, 2020). Attitudes are the first part of the theory of planned behaviour. They predispose one to exert particular behaviour given accommodating circumstances. (Jain, Rose, & Johnson, 2021) took an inventory of attitudes. The authors asked current and potential users about their reasons to start and continue using carsharing services. Previous carsharing users, who had quit using these services, were asked to state reasons for quitting. The most prominent attitudes identified are cost savings, convenience, environment friendly, community vs privacy, technology and variety, health, possessions and cleanliness/ personal space.

Cost savings is one of the reasons shared cars are not universally adopted amongst the younger demographic. Primarily since the price of shared cars must compete with public transport prices (Burg, 2020).

The desire to reduce the impact on the environment was found to be a significant influence for car share uptake by many authors (Burg, 2020) (Kennisinstituut voor Mobiliteitsbeleid, 2019) (Jain, Rose, & Johnson, 2021).

Convenience is a broad concept and will be explained more thoroughly under the following heading: Practicalities/ Perceived control. The term will be split into “accessibility”; relates to the ease of use in the spatial dimension, “availability”; relates to the ease of use in the temporal dimension, “effort” ;relates to ownership (or lack thereof), and finally “peace of mind”; which relates to the need (or lack thereof) to plan and book the journey made with a shared car.

The dichotomy between privacy and community is a recurrent theme in literature. Sharing systems promoting privacy are usually anonymous and of a B2C nature. On the other hand, community-oriented services are usually cooperative. Peer 2 Peer systems fall somewhere in the middle of this spectrum. Since they do involve social interaction, i.e. picking up the car, but do not have the community aspect of sharing a car with a large group of familiar neighbours.
Services with these two different characteristics attract different types of customers with different values. For example, the desire for a private space can be explained by some people’s need to keep

their car's interior in mint condition. It can also be attributed to the attitude that cars are part of the household; they are an extension of the private domain (Jain et al., 2021). Trust is another component and is further built upon in the heading below: Practicalities/ Perceived Control.

Health and variety are not considered in this study. Technology, as identified previously, returns as the readiness to use a mobile application.

Practicalities/ Perceived control (Theory of Planned Behaviour)

As mentioned earlier, perceived control is one of the three factors in the theory of planned behaviour. Perceived control will sometimes be referred to as practicalities in this study.

Accessibility is the ease of use in the spatial dimension. Distance to an available car is a large part of accessibility. This distance should be reduced as the marginal increase in expected use is significant; if a shared car is more than 500 meters away, only 20 per cent of carsharing users would decide to make the trip (Herrmann et al., 2014). Similar conclusions were also made by Jain et al., who found that difficulties in access, especially in combination with young children, were major obstacles to (continued) use. It is thus not only distance itself but also factors that apply to the ease of covering this distance.
Sharing systems based on a station-based approach solve this accessibility problem by ensuring consistent locations where users can find the cars. A hierarchical means-end chain analysis was conducted to study the differences between these two approaches. Such a method aims to match attributes of a system to values by asking respondents' associations. Station-based systems were associated with psychological consequences such as "no worries" and "save time". Similarly, free-floating systems were associated with "save time, but not with "no worries". "Freedom", however, was a principal value ascribed to free-floating sharing (Tobias, 2013).

Availability is the ease of use in the temporal dimension. It often recurs in literature as a potential obstacle to shared car use. One study found that many respondents think a car should be available 24/7 (Jain et al., 2021). Moreover, they should also be able to use a shared car during the night. An experiment studying acceptable waiting times showed that ~95 per cent of free-floating sharing system users were not fond of waiting much longer than 30 minutes for a car. More than 50 per cent of users would not even want to wait more than 15 minutes (Ströhle et al., 2019).
Another study asked what mode users would defer to if the availability of free-floating shared cars was lower than desired. Eighty per cent would consider public transport, and thirty per cent would consider their car (Herrmann et al., 2014).

The effort required to plan and reserve a shared car is a common reason to quit using the service (Jain et al., 2021). The need to use an application on their phone to either locate or book a journey only exacerbated planning fatigue for some. Furthermore, the constraint of a pre-planned travel window restricted many user's freedom and became a source of stress since they would now have to plan their entire journey and rush back to return the car in time if something unexpected came up.

Refuelling and cleanliness are more minor problems, but still relevant. Since car-sharing systems are trust-based systems, it is not guaranteed that one will receive a car in perfect condition (clean and fuelled). Furthermore, other users are anonymous when using a B2C provider. This means there is no reciprocity in the system, and thus the frequency of users who return the shared car clean and fuelled drops (Bardhi & Eckhardt, 2021). In comparison, a cooperative sharing system is found to have much stronger trust amongst users relative to a B2C sharing scheme (Uteng et al., 2019).

Car ownership is negatively associated with carshare uptake. Those who already own a car are less likely to want to adopt car sharing. In addition, households in which a car was available also meant that young adults were less likely to use shared cars. Since they could simply borrow one from their parents. Car ownership/ availability was one of the significant factors reducing shared car uptake among Dutch young adults (Burg, 2020).

Social norms (Theory of Planned Behaviour)

Social norms are the third aspect of the theory of planned behaviour. These can be further delineated into norms of close relatives and those of the wider society. Influences from relatives usually play a more prominent role. Status often returns as the need to conform to group norms. For example, if the norm is driving a high-value car, those who drive those cars will have higher status. The desire to have high status among young adults in the Netherlands is not associated with a lower likelihood of using shared cars (Burg, 2020).

5.2.3 Theory of innovation diffusion

The theory of innovation diffusion explains the process of innovation adaptation. The work of (Jain, Rose, & Johnson, 2021) was pivotal for this study because of its application to carsharing. This theory highlights the nonbinary characteristics of this process. Choosing to use the product of innovation is not a simple yes or no question. It is a series of actions and requires several increasingly specific steps of data gathering. The steps are as follows: Knowledge; how does one learn about the existence of this new thing, Persuasion; to find more information about it, Decision; when either carsharing is tried or rejected, Implementation; joins the carsharing service and starts using the service, and finally confirmation; after a period of use the carshare member can choose to continue or discontinue using it.

Exposure & trialability

Exposure is vital as the first step of knowledge gathering. Shared e-scooter users are already familiar with using their mobile phones to unlock a shared vehicle. Furthermore, the whole idea of sharing a vehicle is pretty revolutionary once heard for the first time. To incorporate this entirely new way of moving and living into one’s life is not done at once. The hypothesis is that a shared e-scooter involves enough exposure and trialability of shared mobility to increase shared car uptake.

5.2.4 Life events

Life events play an instrumental role in the change of travel behaviour. These events make someone reevaluate their travel behaviour. The idea is that travel behaviour is relatively stable; there are not too many reasons to change travel methods when going to the same school or job. However, when a new life phase arrives, both spatial and temporal needs change. For example, once one has finished their studies and starts to work full-time, residence and destinations change, travel moments all the same. Therefore, revaluation of mobility needs and car needs is more often done at moments. In this study, a strong focus is upon those about to finish their studies and enter the labour force. When often the first car is bought. Moreover, it is hypothesised that the first car purchase “locks” one into using private cars for the rest of their lives.

Out of all life events, children are the most decisive influence on shared car uptake (Uteng, Julsrud, & George, 2019) (Jain et al., 2021). Whereas young families are more likely to adopt car sharing (Burghard & Dütschke, 2018), families with more than two kids are less likely to be interested. It was also noted that children constitute a significant obstacle to use in some cases (Uteng et al., 2019). To conclude, children are a potential driver towards shared car use, and on the other hand, a strong deterrence depending on personal circumstances.

Relocation is another issue; if one moved from the city centre to the suburbs, where fewer shared cars are available, one would almost certainly stop using the service.

People who have started working full-time are more likely to adopt shared cars (Prieto et al.,2017). In addition, it has been shown that higher incomes lead to a more likely uptake of carsharing.

5.3 Conclusions of the theoretical framework

This chapter outlined shared mobility in general and painted an in-depth characterisation of different shared car offerings. Shared cars are one mode of shared mobility, while MaaS integrates shared mobility and public transport in a digital environment.
Recruitment of new shared car users is done by targeting and tailoring the shared car offering to the needs and attitudes of potential users. These needs (practical issues) and attitudes have been identified. The process of adopting an innovation has been outlined; it explains the greater potential of the e-scooter sharers compared to a regular car-centric person. Several studies have identified various target groups, though none have focussed on the shared e-scooter users. Therefore, the potentially shared car uptake of shared e-scooter users is unknown.

Research objective

To investigate the carsharing potential of shared e-scooter users who have been exposed to shared cars.

6 Research design

In this chapter, the research questions are formulated.

6.1 Main research question

What is the carsharing potential of shared e-scooter users?

6.2 Subquestions

6.2.1 Sub question 1: What is the expectation of future shared/private car use up to five years into the future?

Sub question one explores the expected car use for the next five years. Those who expect to use a car can do so because they have the interest and means to do so. High expectation is thus not only a matter of strong interest. These questions will be combined to formulate three user groups, as will be explained in 2. Firstly, these groups will offer insight into the pure carsharing potential of the shared e-scooter users. Secondly, these three groups will be used to distinguish between potential shared car users and private car users, essential to answering the other three sub-questions. Finally, a time window of five years is chosen since it includes the expected car use of almost all respondents when they start working. In the five year interval, students still in their bachelor are asked to predict their car expectations when starting employment. The transition from student to employment is the focus of car expectations in this study.

6.2.2 Sub question 2: What type of provider and system of carsharing is preferred?

The type of carsharing offered is the provider used. The system of carsharing is either free-floating, station-based or a hybrid of the two. Establishing and implementing these preferences increases the likelihood of fulfilling the carsharing potential as established in sub-question one.

6.2.3 Sub question 3: What influences a person's intention to use a shared car?

Many studies have been conducted to study the influences relevant to the intention to use a shared car. However, none have done so for shared e-scooter users. Therefore, results from this sub-question will be compared to results from studies using different samples to increase understanding of the shared e-scooter user.

6.2.4 Sub question 4: What are the differences between the shared e-scooter users and a representative sample of the Dutch population?

The final subquestion shows differences in car attitude and car ownership between the Dutch population and the survey sample of shared e-scooter users. Comparison with the survey sample will be made twice. Once with the general Dutch population, and once with a subset of the Dutch population interested in- and/or already a user of shared cars.

7 Method

This chapter outlines the steps taken to answer the research questions. Firstly the conceptual model with all variables is presented. Then the choice for and implementation of the survey is explained. Lastly, the steps taken to analyse the data for each sub-question are outlined.

7.1 Conceptual model

The conceptual model in Figure 7-1 is an abstraction of all the variables and their interaction with each other. The block with thick edges in the middle represents the main research question: "carsharing potential of shared e-scooter users". The four arrows pointing towards this middle box are the four sub-questions. The "expected (shared)car user groups", used to answer sub-question one, are defined in chapter 7.2.3. "Carsharing preference" is explained in chapters 7.2.4 and 7.2.5. "intention to use (shared)car" is outlined in chapter 7.2.6. Finally, to answer sub-question four, a comparison is made between the KiM data and the user groups defined in chapter 7.2.3.

The remainder of the method will be explained using the structure of the survey. The conceptual model as presented helps to explain the variables used to answer each sub-question. Furthermore, it shows how these variables are related to each other.

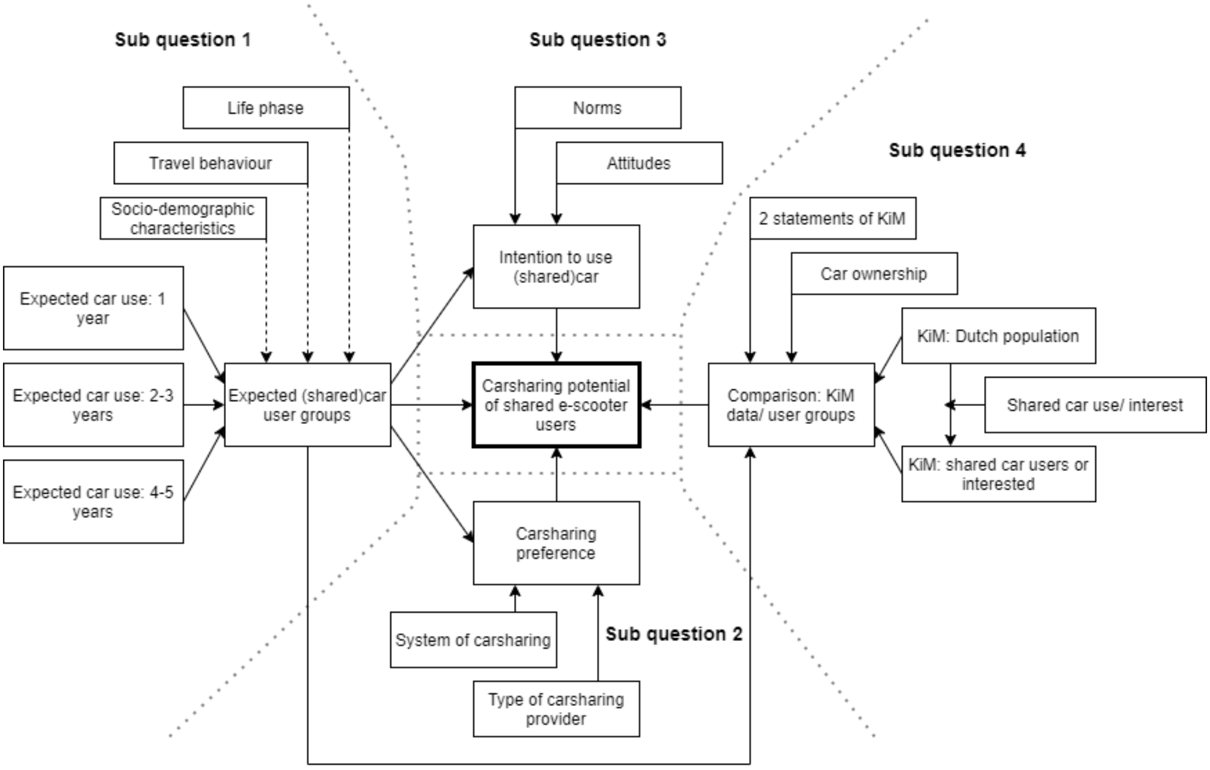

Figure 7-1: conceptual model

The dashed arrows signify segmentation; the user groups are split according to the variables with the dashed arrows.

7.2 Research type: Survey

A survey was conducted to answer the subquestions. It was selected as it offers both quantitative and qualitative means of analysis. An alternative option would have been focus groups. However, these could only help establish a better picture of preferences and intentions behind the adaptation of carsharing. Since the primary aim of this study is the carsharing potential, quantitative means are necessary to extrapolate the results of the survey sample to the shared e-scooter population.

7.2.1 Content of the survey

1. Current travel behaviour 7.2.2
2. Expected car use 7.2.3
3. Preference for type of carsharing 7.2.4
4. Preference for system of carsharing 7.2.5
5. Influences to the intention to use carsharing 7.2.6
6. Comparison with KiM sample 7.2.7
7. Sociodemographic characteristics & life events 7.2.8

7.2.2 Current travel behaviour

Although travel behaviour itself does only returns in the conceptual model to add information to the defined user groups. It is used to verify that potential shared mobility users have a higher travel frequency (Kennisinstituut voor Mobiliteitsbeleid, 2019). The remaining travel questions, such as length of membership, are used to clean the dataset from respondents who have never used a shared e-scooter. Private car ownership and previous use of carsharing services are included to determine if future behaviour follows current circumstances. Finally, change in travel frequency due to corona shows that results are not representative; not everyone's travel behaviour is affected the same. Thus conclusions of frequency may be skewed.

Questions about the current travel behaviour of respondents include:

- Length of shared e-scooter membership thus far.
- Frequency of use for the following modes: shared e-scooter, bicycle, public transport, private car, borrowed private car, and shared car.
- Private car ownership.
- Change in travel frequency because of corona measures.
- Previously used carsharing services.

7.2.3 Expected car use

Six questions are used to gain more insight into the expected car use. They are divided into two groups; expected shared car use and expected private car use. Then each group has three-time intervals; 1 year, 2-3 years, 4-5 years. Finally, the expectation for each of the six questions is expressed as a likelihood using a Likert scale; very unlikely to very likely. Three-time intervals are used instead of expectation per year to simplify the estimation on the respondent's end.

7.2.4 Preference for type of carsharing

These questions ask about the openness towards using services from one of three providers; peer to peer, professional and cooperative. Openness is expressed as a Likert item. A Likert item (one question per variable) is used favouring a full Likert question (multiple questions to answer one variable) to reduce the number of questions required. Furthermore, openness is chosen instead of a ranking with preferences as the types of providers are categorically different from each other.

7.2.5 Preference for system of carsharing

The preference of the system of carsharing is answered using a full Likert question. Various Likert items combined answer one variable. As such, six Likert items are used to ask about the openness to each of the following variables; "start trip in station"/"start trip in area", "end trip in station"/"end trip in area", "two-way"/"one-way". Finally, these six options will be combined to make the systems; station-based, free-floating or hybrid. Such an approach ensures there is no bias towards respondents' previous experiences with another carsharing provider. Nor is there a need to explain the concepts. The questions themselves should be clear enough to stand on their own. Some guiding is included in the questions, which explicitly state "similar to Felyx" when one option aligns with free-floating, the system Felyx employs.

7.2.6 Influences to the intention to use carsharing

A set of questions inquires about the respondent's reasons to chose either private or shared for their travels. The following attitudes and norms, primarily derived from the theory of planned behaviour and (Jain, Rose, & Johnson, 2021), thus apply to the choice of car. There are many other attitudes and norms that could have been asked. These were not included to keep the survey as short as possible. The choice for these variables was ultimately made since they have low cross-correlations in other studies.

Statement	**Influence to carsharing adoption**
Attitude 1: Cheapest option (+)	Shared cars are often cheaper than private cars. But more expensive than public transport.
Attitude 2: Accessibility (+)	Easy access is one of the main advantages of free-floating (can park in front of your door) and private cars. More than 250m walking is a huge turnoff to carshare use.
Attitude 3:Availability (+)	Availability is often cited as the most critical obstacle. Too few available shared cars, and uptake stagnates.
Attitude 4: App use (+)	Uptake of MaaS is associated with frequent use of technology, including apps.
Attitude 5: Maintenance (-)	Private cars require maintenance. Reducing the effort of travel is a driver towards carsharing uptake.
Attitude 6: Reservations (+)	Shared cars often require one to reserve a car beforehand and return it at the end of the reservation window, a barrier to carsharing uptake.
Attitude 7: Environment (+)	Carsharing is beneficial for the environment. It is expected that environmentally conscious people are more likely to belong to the potential car sharers.
Norms 1: Social norms (+)	The extent to which norms of familiy and friends influence one's choice of car choice. This was not found to be relevant in other studies.
Norms 2: Car is part of the household (+)	The cultural norm of a car on the driveway. It is expected that private car users are associated with this norm.

7.2.7 KiM questions

Appropriate variables from the KiM study are selected to answer sub-question 4. Table 1 contains an overview of all used variables from the KiM dataset and formulations thereof to be used in the survey. The KiM questions were initially posed in Dutch; a table with the original Dutch version can be found in appendix C.

Table 1: Overview KiM variables

KiM – id	KiM – label	Survey - id	Survey – label
V20	Is there a car in your household?	3	Me or my partner has a private car.
V109_5	Life without a private car is unimaginable. (five levels Likert item)	6	At this moment life without a private car is; (five levels Likert item)
V109_6	I want the convenience of a car without ownership. (five levels Likert item)	8_1	I want the convenience of a car without ownership. (five levels Likert item)
V119_4	In the last 12 months I have used a shared car like Greenwheels or Snappcar.: Could you state which providers you have used?	5	From which shared car providers have you used services in the last 12 months?

7.2.8 Sociodemographic characteristics & life events

The final questions of the survey are about:

- Sex (male/female/other)
- Age
- Highest attained education
- Current occupation
- Year of graduation
- Household composition
- Postal code (either 4 or 6, tests showed that not everyone wants to share their complete code)

These sociodemographic characteristics should give a clear picture of the respondents. However, income was not asked since it was predicted that many will still be students. Thus they do not have a proper income yet. Year of graduation was instead asked, which gives a clearer image of dispensable income in the sample context; those with a job will earn considerably more than students.

7.2.9 Sample size

Since information about the population of Felyx shared e-scooter users is unknown, a necessary sample size could not be obtained. However, the literature states that around 350 respondents should allow proper component analysis and regressions (Field, 2009).

7.2.10 Survey handout

The survey is distributed using the newsletter sent out by the sharing company Felyx. Furthermore, a Linkedin post was placed to increase the visibility of the survey when it became clear that response rates were insufficient to reach the 350 entries required.

7.3 Testing

The survey has been tested in two different rounds. Firstly, it was evaluated by experts in the field of sustainable mobility. They were also asked to report the time it took to complete the survey. The average time was 7 minutes, with outliers of 5 and 10 minutes. Most commonly given feedback detailed technical aspects. At various questions, different formulations were universally deemed to be better suited. One question about the previous use of shared cars, for example, initially only allowed the choice of one provider. Many highlighted that it should be possible to select multiple.

Furthermore, many questions and their respective explanation were found too long and complicated. Therefore, the new version had drastically shortened explanations. And in some cases, a complete reformulation of the question. Thus, the corresponding variable could still be filled with data but required less effort from the survey taker.

The next version was tested by a larger group of "naïve" people. They knew little about shared mobility, some of whom had never even heard of it. The new version with shorter explanations and strategically enunciated text (bold) was clear. Moreover, even those who had never heard of shared cars were able to answer all questions. Again, the average time was about 7 minutes, with outliers at similar times as in the first test run.

Finally, language and message were improved with help from the HR department of Over Morgen. Moreover, a new introduction and ending were written and revised formulations for many questions and answers.

7.4 Data collection/ Field study

The survey is set out in the Dutch cities of Rotterdam and Den Haag. These cities have been chosen for their advancements in mobility. A broad offering of shared mobility and public transport is present. The choice for these two cities means that respondents have been exposed to shared cars. High exposure is one of the main constraints in choosing the cities, since exposure to innovation is the first step in the theory of innovation adaption. The city of Amsterdam is omitted by choice; shared mobility is much more common and normalized than in the other two cities. Therefore, respondents from Amsterdam are expected to skew the results.
There are thousands of scooter users registered with Felix in these cities. Taking the expected 10% response rate would thus hopefully allow for a large enough sample of 350 respondents.

As of 2021, Felyx has 650 scooters in Rotterdam. Recently regulations have been changed to allow for further growth. In 2021 Felyx can have up to 800 shared e-scooters (Gemeente Rotterdam, 2020). In addition to the slower e-scooters, this year, there will be faster e-scooters capable of reaching speeds up to 45 km/h (Felyx, 2021). Den Haag has 200 scooters owned by Felyx. It is expected that more respondents are from Rotterdam because of the larger number of shared e-scooters.

7.5 Data preparation

Before data from the survey can be analysed, it has to be prepared sufficiently. Firstly it has to be cleaned; then the format has to be changed depending on the type of analysis done. The cleansing of the dataset is done in the following steps:

1. Remove all responses that were done in less than 2-, and more than 20 minutes.
2. Remove all incomplete responses
3. Remove all responses in which users state to never have used a shared e-scooter.

By cleaning the dataset, the number of responses went from 150 to 110. Reformatting of data is needed for any of the regression and correlation analyses. It is done by inverting the positive and negative ends of the Likert items. The survey software coded the very negative pole as five; this should be one; positive Likert item results should have a higher value. Other times, coding positive levels as 1, and neutral and negative Likert item levels as 0 suffices. See appendix A for a complete overview.

7.6 Analysis

In this chapter, the steps taken to quantitatively answer the four research questions are covered.

7.6.1 Kendalls tau-b

Throughout answering the various sub-questions, Kendall's tau will be used to compare the main variables of the sub-question to various sociodemographic and travel behaviours. In addition, the defined user groups are reflected on (private car user/ potential car sharer/ no car user). To be able to use Kendall's tau-b, two assumptions need to be fulfilled (Laerd statistics, 2021):

1. Variables should be measured in ordinal or continuous scale. Likert scales are ordinal. Age for example is continuous. All used variables meet this assumption.
2. Kendall's tau-b measures a monotonic relationship between two variables. This relationship means that as one value increases, the value of another variable will increase/decrease. A monotonic relationship is not necessarily linear but could be. The monotonic relationship has been tested by plotting some variables.

A Kendall's tau-b relationship is simply a correlation, similar to Pearson's p, but instead of using continuous data, it is used for ordinal data.

7.6.2 Method: sub-question 1: What is the expectation of future shared/private car use up to five years into the future?

Subquestion one is answered by defining three user groups. The survey questions about expected car use create six combinations; three-time intervals (1 year, 2-3 year, 4-5 year) times two types of car (shared car, private car). To reflect on each of these six expected car use possibilities does not help in understanding the shared scooter user.

The three target groups were adopted because of three reasons. Firstly, the number of respondents who expect only to use a shared car is too low for statistical analysis (n= 8). Secondly, the distribution of answers for the expected use of shared cars is a normal distribution, as seen in Figure 6-8: Expected car use by the group. This means respondents, on aggregate, are unsure of their future car use.

The private car user (n=53)

The private car users are those respondents who only expect to use private cars in the next five years. They have given a positive answer on the Likert items for the expected use of private cars of all three-time intervals. While simultaneously having a negative or neutral answer for the expected use of shared cars for each corresponding time interval.

Potential shared car users (n=48)

The second group comprises all respondents with a positive answer for the shared car question at least one-time intervals. This definition gives all respondents the potential of shared car use, for they expect to use one sometime in the next five years. Use is regardless of frequency; however, the question did ask for the expected use given structural use of the car.

Car abstinent (n=9)

The third group is car abstinent and does not expect to use any car in the next five years. Although this group only contains nine respondents, it represents such a different car use it justifies its separate grouping.

7.6.3 Method sub question 2: What type of provider and system of carsharing is preferred?

Sub question two is about the type of carsharing preferred by the respondents.

Binary yes/no and combination explanation

Openness to type of provider

Openness to the type of provider is answered by turning the Likert data, scores 1 to 5, into binary data. A respondent can either be open or not. Scores agree and strongly agree (options 1 & 2 from the survey) are coded as one and thus open to this type of provider. The remaining options are coded as zero. Anyone respondent can thus be open to multiple providers. Openness to provider will be shown as a piechart.
The Kendall's tau results in Table 3 shows how the three types of providers correlate with the three user groups, various sociodemographic characteristics and, travel behaviour.

Openness to system of carsharing

Openness to the system of carsharing is answered using the three sets of questions from the survey. These are combined to formulate four system classifications: station-based, free-floating, hybrid and incomplete. Respondents answer the six questions on a Likert scale; a respondent agrees or disagrees with the statement's applicability to them. The five item score is again coded as either 1 or 0. 1 for positive answers and 0 for the remaining ones. Respondents can only prefer one type of sharing, if one prefers both free-floating and station-based it will be classified as hybrid. If no positive preferences are present to classify a respondent to any of the three systems, they will be classified as "incomplete". Following are the formulas to classify respondents:

- Station-based: Only if positive Likert item scores for "pick up at location", "return at location" and "retour/ two-way".
- Free-floating: Only if Likert item positive scores for "pick up at area", "return at area" and "return in different spot/ one-way".
- Hybrid: Positive Likert item scores for any combination of "pick up location/ area", "return location/ area" and "one-way/ two-way".
- Incomplete: When there are not enough positive answers to classify a respondent to any of the above three systems.

The Kendall's tau results in Table 6 show how the four carsharing systems correlate with the type of provider, the three user groups, various sociodemographic characteristics, and travel behaviour.

7.6.4 Method sub-question 3: What influences are relevant to the intention to use a (shared)car?

Sub-question three will be answered using both descriptive and statistical means. Firstly the results are visualized in Figure 8-13. The Likert data is colour coded and plotted by percentage of respondents with a corresponding answer.

Secondly, a binomial logit regression is used to answer sub-question three, influences on the uptake of car(sharing) use. This regression uses a coded binomial value for the independent variable and ordinal or nominal data for the dependent variable. The user groups as defined in paragraph 6.2.1 will be used as the independent variables. Those who belong to the potential carsharing users are coded as 1, those who belong to the private car users are coded as 0. Dependent variables are the attitudes and norms as defined in paragraph 7.2.6. Due to the smallish sample size of 110, only these

nine dependent variables could be included, and no more.
A Kendall's tau table is included to show the correlation between these nine dependent variables and other variables in the study.

7.6.5 Method sub-question 4: Are the shared e-scooter users different from those from a representative sample of the Dutch population?

To answer this sub-question, the dataset provided by the Kennisinstituut voor Mobiliteitsbeleid is first filtered into two groups; one with unfiltered responses (n=1621), a second filtered by previous use of- or interest in a shared car (n=124). The survey sample will then be compared to these two groups. The unfiltered group is a representation of the general Dutch population. Comparing this group to the survey sample is unfair, as a large share of the general population does not even live in cities, thus having no availability for shared mobility. In contrast, the filtered carsharing group is a representation of those already interested in shared cars.

Firstly car ownership is compared using a simple table with percentages.
Then the two groups from the KiM data from earlier are compared to the survey sample using a chi-squared test. This test checks for the independence of two systems (datasets). If the differences are small enough, one can assume a similar group of respondents in both datasets. Finally, results from two Likert scale statements are compared. The chi-squared test will have four degrees of freedom, five items in the scale minus 1. A Mann-Whitney U test was also evaluated but later abandoned as it requires the skewness of the ordinal (Likert) data to be in the same direction.

8 Results

This chapter presents both the survey results and the comparison of these results with the data obtained from KiM. Firstly the representativeness of the survey and KiM data are outlined and compared. Such is done with demographic characteristics and travel frequency.

The survey conducted for this study had ~150 respondents; after cleaning, ~110 entries are used for further analysis. The data obtained from the Kennisinstituut voor Mobiliteit (KiM) contained ~1600 entries and was already cleaned when provided. Finally, the results from the survey will be referred to as "*Survey Sample*", results from the KiM study will be referred to as "*KiM Sample*".

8.1 Representativeness of sample

Representativeness of a sample shows the expected applicability of the taken sample in regards to the whole population. In this study, data is aggregated on a per-year basis for both the survey and KiM data. No data of the average shared scooter users could be obtained.

Age and sex

Both age and sex are evenly distributed in the KiM sample (Figure 8-2). This is expected as it is a representative sample of the Dutch population. The survey sample, Figure 8-1, is skewed towards younger males. However, older age groups are also somewhat represented, especially men.

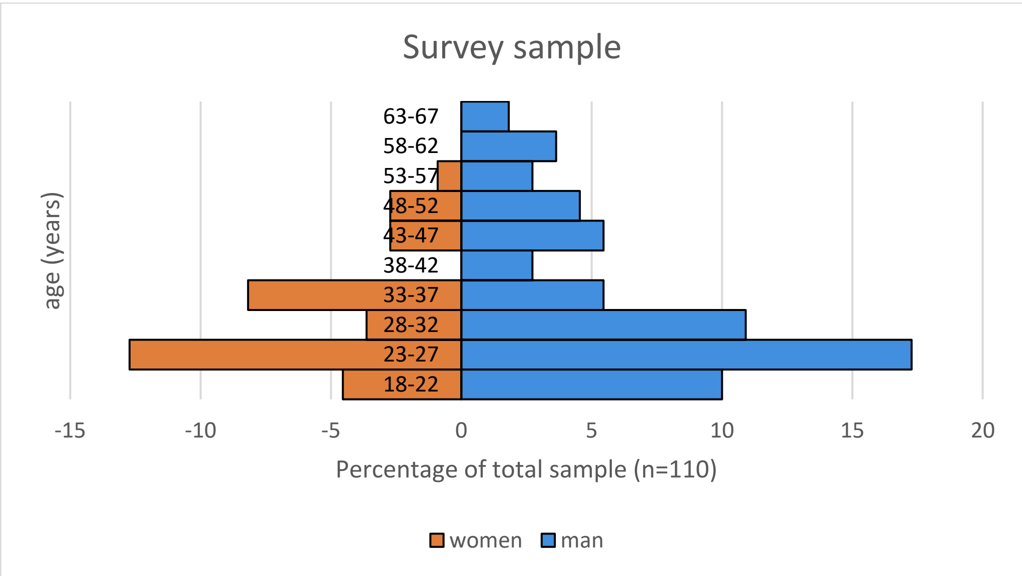

Figure 8-1: population pyramid survey sample

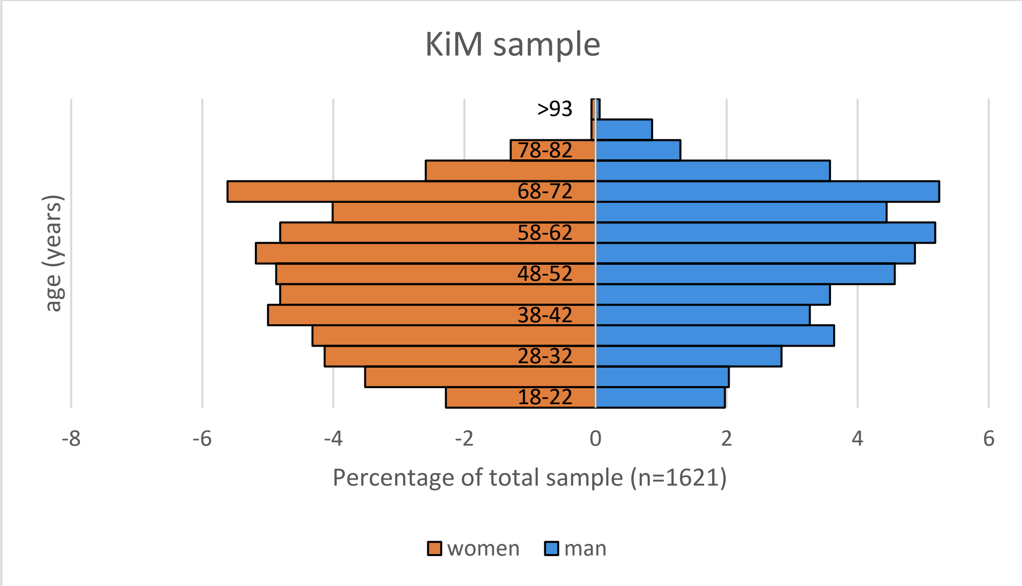

Figure 8-2: population pyramid KiM sample

Travel frequency and modes

Figure 8-3 shows the travel frequencies as found in the survey sample. Not all respondents have used a shared e-scooter in the past year. These respondents are still considered as the exposure granted by the use of the scooters is the relevant criteria of selection.

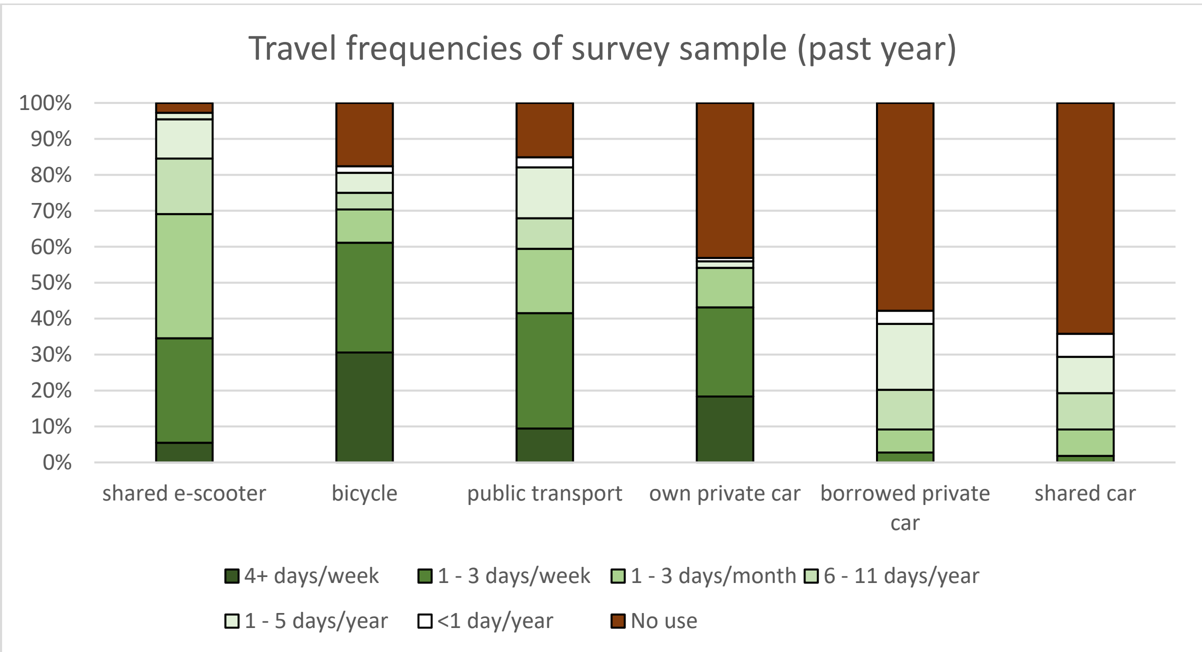

Figure 8-3: travel frequencies survey sample

The likelihood of using any car is much higher in the South Holland general population than the shared scooter group (Figure 8-4). The shared scooter users more frequently use public transport than the average person in South Holland. Data from South Holland is chosen in this comparison since it is most like Den Haag and Rotterdam; most residents of this province live in these two cities. Though this comparison is not very accurate, it serves to give an indication.

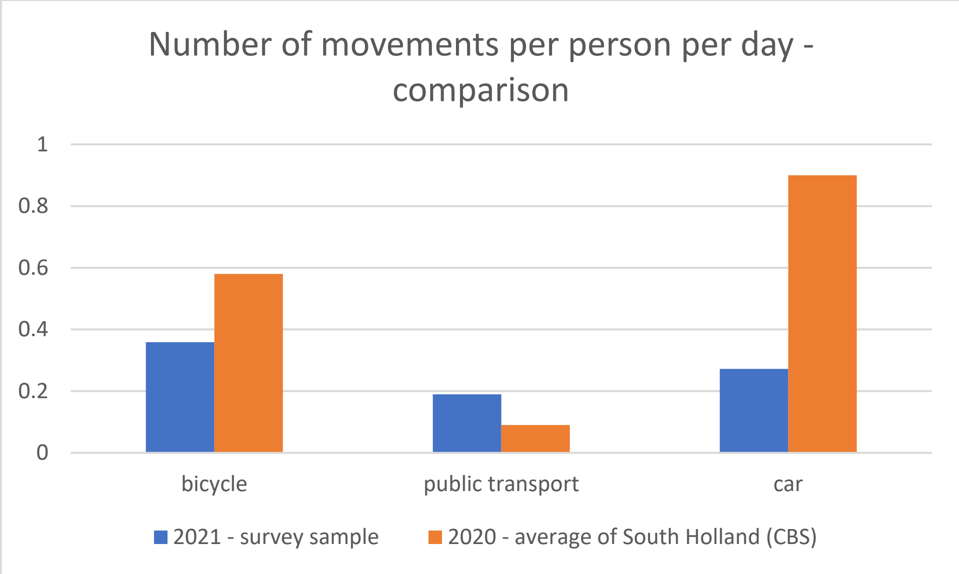

Figure 8-4: number of movements per person per day – comparison

The effect of the pandemic measures is quite significant; most respondents either travelled less or much less frequently than before the pandemic (Figure 8-5). However, this is also the case for the average travel data of South Holland, which was sampled in 2020, the year the corona measures were initiated.

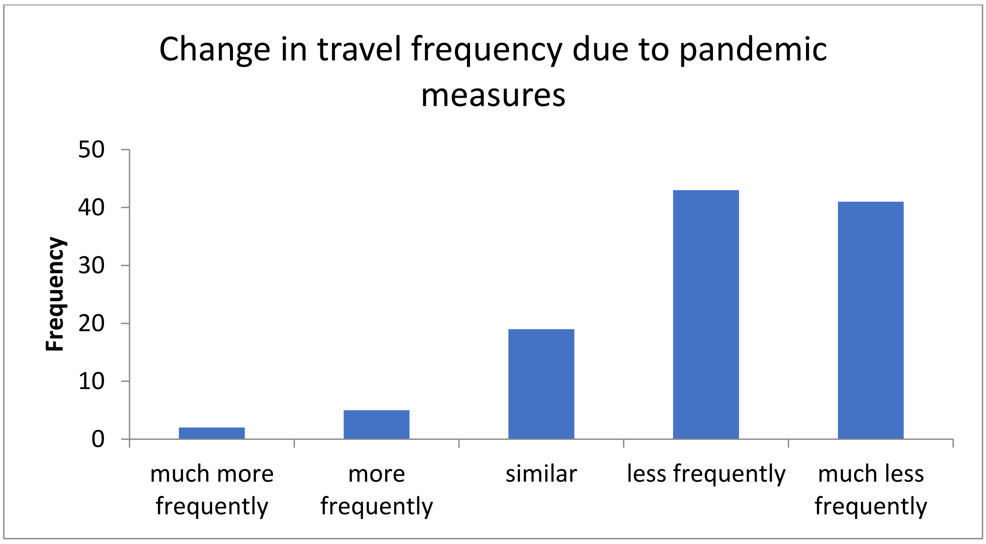

Figure 8-5: change in travel frequency due to pandemic measures

Figure 8-6 shows the postal code of respondents. Most respondents are either from Rotterdam or Den Haag, as was the goal of distributing the survey. However, some respondents live in the wider metropolitan area of these cities, not in their centre. The centre of Rotterdam sticks out; eight respondents are from this postal code.

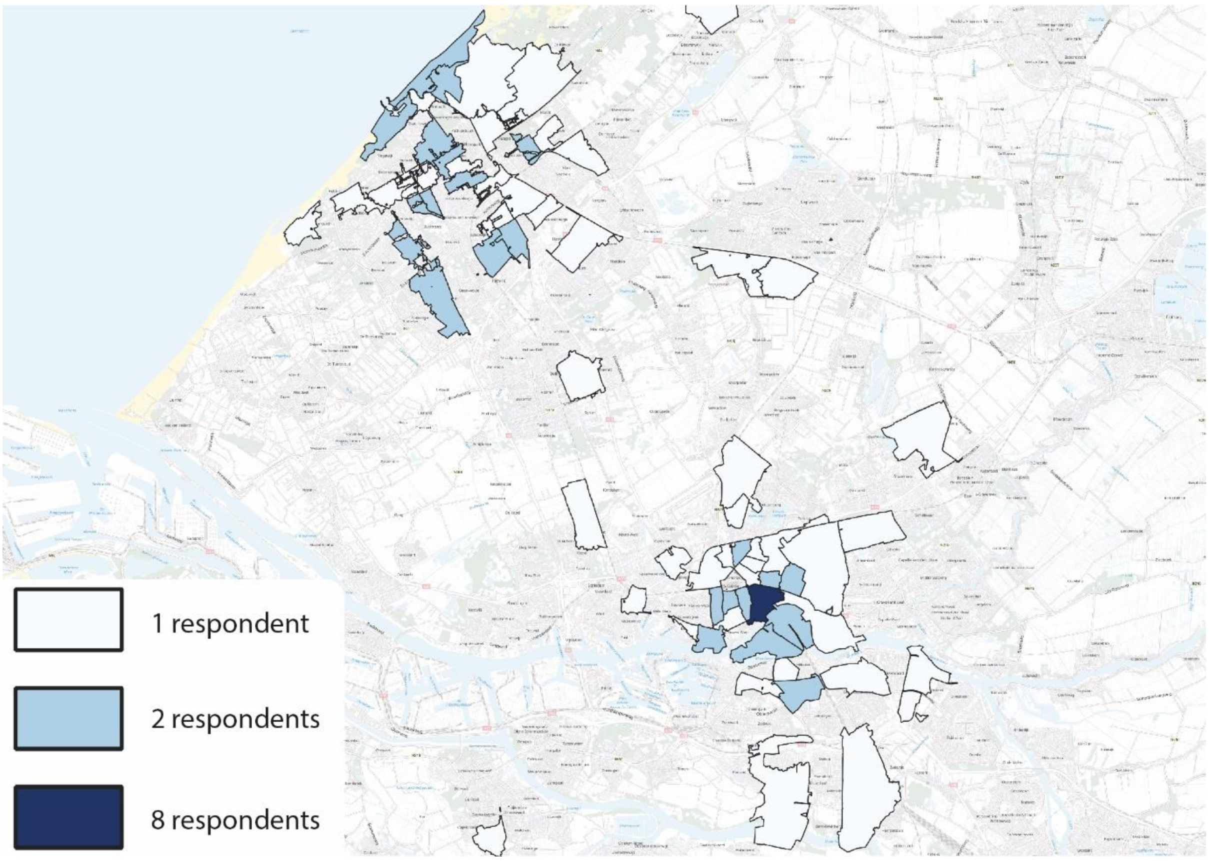

Figure 8-6: Overview of respondents' home location per postal code

Conclusions of representativeness

The survey sample is dominated by younger males, whereas the KiM population is close to the Dutch population. The split at around ~35 years characterises the age distribution of the survey sample. Most respondents fall in the younger group; a smaller set is in the older. The survey sample sees frequent use of shared e-scooters, public transport and the bicycle by most respondents. Shared cars are used infrequently, and so is the borrowed private car of a relative. Compared to the average person from South Holland, the survey sample more frequently uses public transport. Car use is much less, and so is the use of the bicycle. Travel frequency is much lower than last year, which is expected. Finally, most respondents are from the centre of Rotterdam, Den Haag follows. Some respondents live outside of the cities in the metropolitan area.

8.2 Expected use of private and shared cars (sub-question 1)

The first sub-question is answered by compiling the results from the expected car use and distilling them into user groups, as defined in chapter 2. Respondents were asked to report on the likelihood of using either car in a given year interval; 1 year in the future, 2-3 years in the future, and 4-5 years. The likelihood was in a Likert item format; very likely, likely, neutral, unlikely, very unlikely. Figure 8-7 shows a very likely expectation dominates the private car in all three-time intervals. In later years, the positive expectation for private cars even increases.

In contrast, the results for shared cars resemble a normal distribution. In addition, expected shared car use is less confident when looked further ahead. This is not the case for private cars, which expectation becomes more confident.

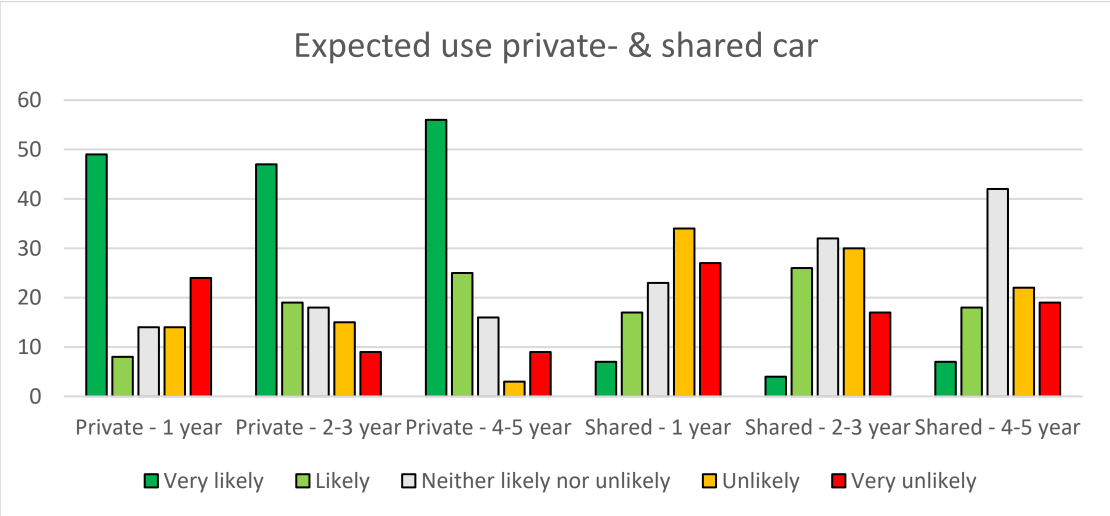

Figure 8-7: overview Likert scores of expected car use

Using the groups as defined in chapter 2, the group of private car users is the largest (n=53), after which the potential car sharers follow (n=48). No expected use of a car at all is the smallest (n=9).

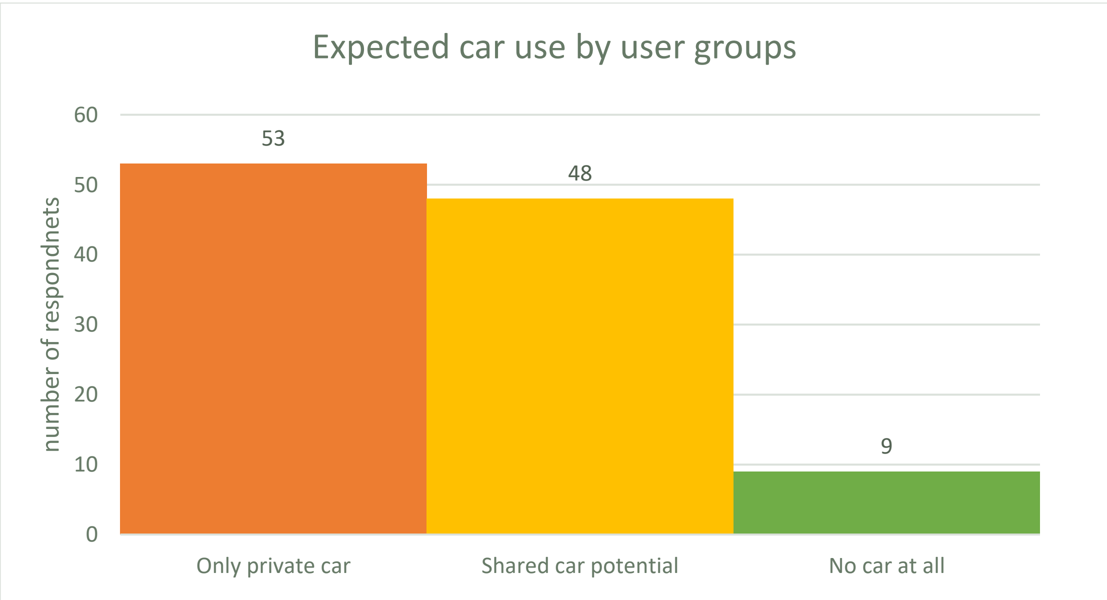

Figure 8-8: Expected car use by group

Household composition, as defined in the literature, is comprised of four groups: Single parent family, single household, one-person household, together with child(ren), together with without child(ren). Although Figure 8-9 shows few respondents are single-parent families, most of them expect to use a shared car. Partners with children, on the other hand, are much more likely only to use private cars. The findings above align with typical reasons given (by the respondents) for and against the use of carsharing. Frequently mentioned is the impact of children as a barrier to use a shared car. However, it seems that in some cases, this barrier becomes an opportunity for single-parent families.

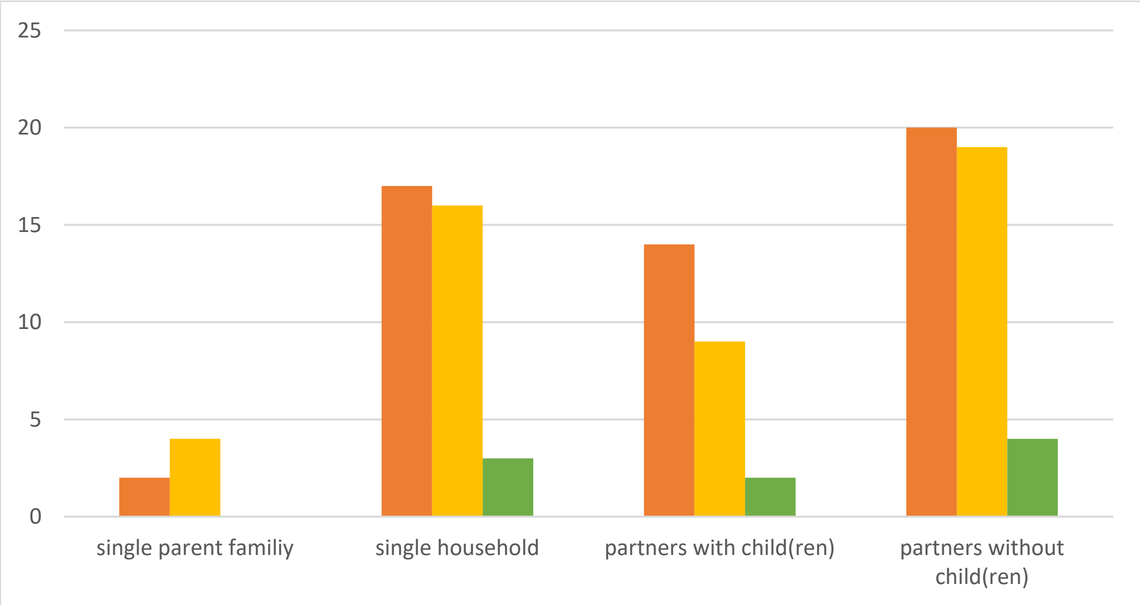

Figure 8-9: expected car use – household composition

Occupation can be either student or working. Students are categorised as either: MBO, HBO, WO bachelor, and WO master. Two options employment options were given; self-employed and on payroll. Of these only self-employed was used. WO master and self-employed results are similar as they both have a large share of private car users.

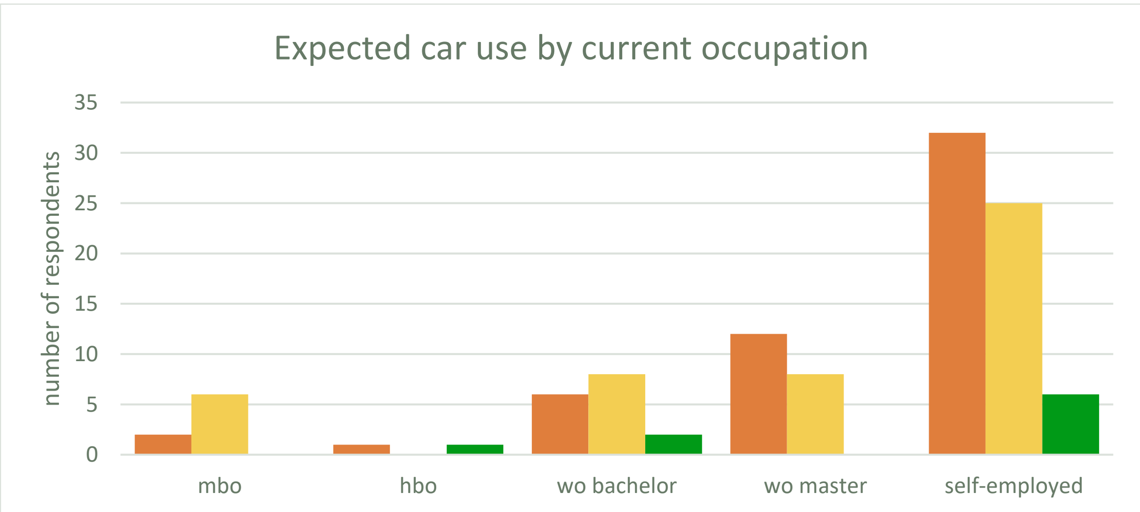

Figure 8-10: expected car use – occupation

The year of graduation in Figure 8-11 indicates whether these differences in car-use could be related to life events. Four "life event" groups can be made; future graduates, transition period & young adults, early career and family life, established career & past 37 years old. Unfortunately, the grouping of the time-bound data is not perfect – borders of these groups were arbitrarily defined.

The first group of future graduates is comprised of young adults aged 18 to 22. Of which the majority are still enrolled in some educational institute. Most respondents in this group expect to use the private car exclusively. However, there is still decent potential for shared cars.
The second group, who find themselves transitioning between education and work, seems divided between private and shared car use. The year of graduation defines this group and is between 2018 and 2022. Shared car potential is highest in this group; private and shared car expectations are high, while no car use is not expected. The private car dominates the third group; these people are somewhat advanced in their careers and settling down with young children. Expected shared car use among those who graduated between 2008 and 2017 is unlikely. Relatively many in this group find them expecting to use no car at all—lastly, the fourth group of respondents with an established career. There are many outliers within this group. However, shared car potential seems high.

Respondents were also asked to state other reasons for car use. The group of potential shared car users frequently mentioned the ability of a shared car to fill the gaps in public transport consistency and accessibility. Some regions are simply out of reach for public transport or take too long. On the other hand, this very reason to use shared cars can also be inverted; those who expect to use private cars mention the high cost of shared car use when driving long distances. In terms of access, shared cars are not a complete replacement for private cars, but an addition to public transport. The use of public transport and shared e-scooters are higher among potential car sharers, see Table 2. Other reasons include young children and their required seats, a need for cargo capacity, work requirements, and intense car use.

Conclusions of sub-question 1: expected car use

Those who were shorter educated expect to use the shared car disproportionately often. Household composition plays a significant role; primarily, children are a boundary to shared car use in couples. Whereas single-parent families overwhelmingly report a preference for shared cars. Younger students expect to use a shared car relatively often compared to those about to graduate and those already working. Self-employment was the only type of work found among respondents.
Summarising the results of four "life-event" groups: Students expect to use private cars over shared ones. Those transitioning from education to the labour market have high sharing potential. Short to medium term workers report a strong preference for private cars. Finally, respondents with established careers are likely to use shared cars instead of only using private cars

Table 2: Kendall's tau-b of user groups

p = 0.1	Sex	Age	Education	Shared e-scooter	Bicycle	Public transport	Private car ownership	Shared car use	Change in travel frequency (corona)	student	children
Only private car	0.046	-0.011	0.071	-0.271	0.005	**-0.155**	**0.311**	**-0.344**	0.061	-0.042	0.043
Shared car potential	-0.001	-0.020	-0.080	**0.253**	0.075	**0.200**	**-0.306**	**0.322**	0.026	0.071	-0.021
No car at all	-0.083	0.055	0.015	0.036	**-0.145**	-0.079	-0.015	0.045	**-0.159**	-0.051	-0.039

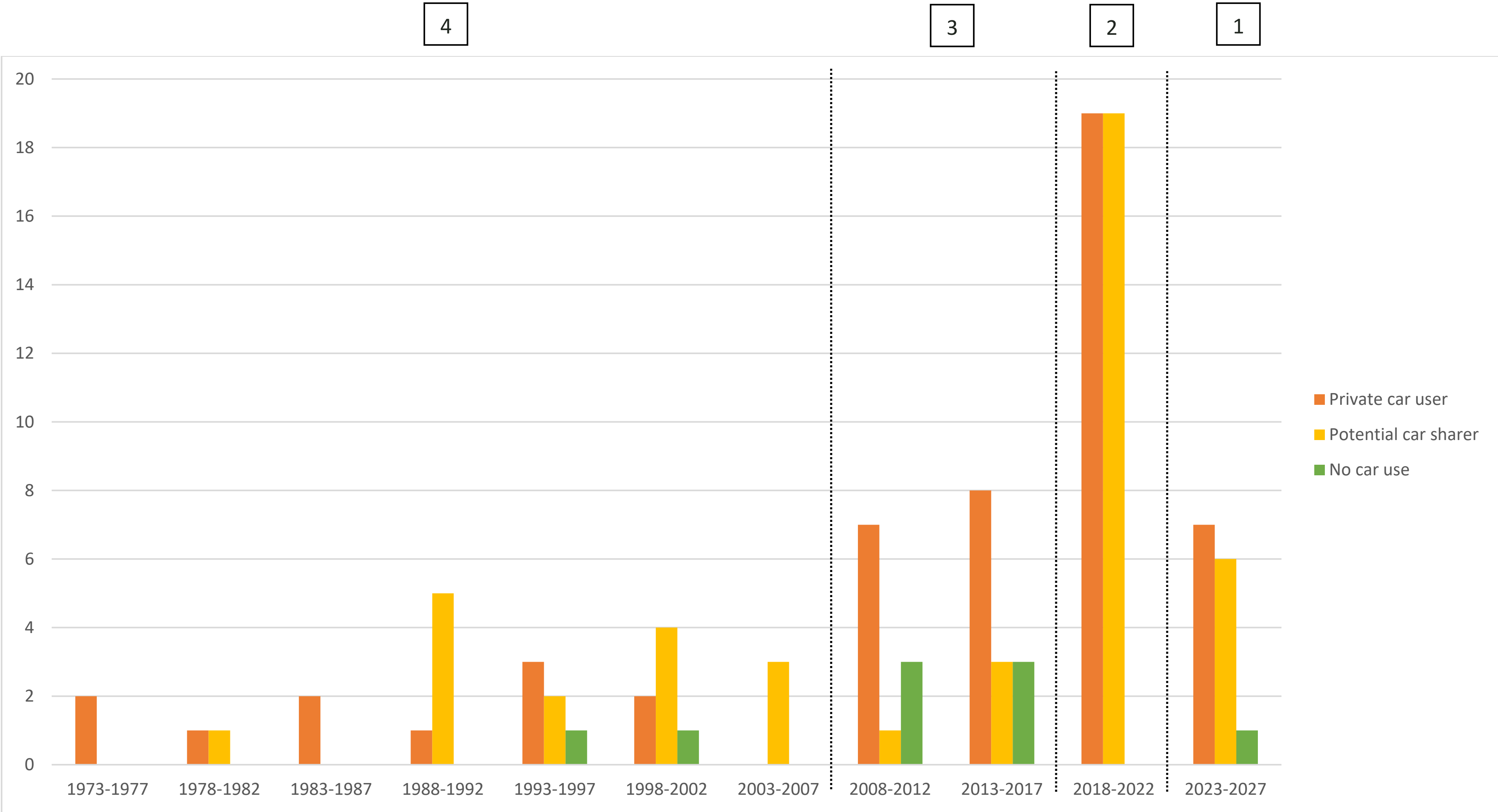

Figure 8-11: expected car use – year of graduation

8.3 Preference for type of provider & system of carsharing

Preferences for the type of provider and system of carsharing give insight into the required system set up to fulfil this group of respondents' carsharing potential.

8.3.1 Preference for the type of carsharing provider

In this section, the preference for the carsharing service provider is set out. As introduced in the theoretical framework, there are three carsharing providers; professional, Peer 2 Peer sharing (P2P) and cooperative sharing models.

When asked about the openness to use a particular type of provider, most respondents prefer professional carsharing service providers over peer-2-peer and cooperative sharing (Figure 8-12).

Figure 8-12: openness to type of car sharing provider

Table 3 shows that the private car user is not open to professional and P2P sharing, whereas the potential car sharer is. Furthermore, those who own a private car are more open to cooperative sharing than are those who are part of the private car user group, despite the strong correlation between the private car user group and car ownership.

Table 3: Kendall's tau of type of carsharing provider

p = 0.1	Only private car	Shared car potential	No car at all	sex	age	education	
Professional	**-0.227**	**0.197**	0.058	-0.058	0.063	-0.142	
P2P	**-0.178**	**0.150**	0.053	0.056	-0.012	-0.025	
Cooperative	-0.064	0.003	0.110	-0.071	-0.001	-0.035	
	Shared e-scooter	Bicycle	Public transport	Private car ownership	Shared car use	children	student
Professional	-0.075	-0.033	-0.063	-0.055	-0.023	0.104	-0.041
P2P	-0.087	-0.051	-0.018	-0.008	0.018	0.029	0.076
Cooperative	-0.106	0.038	-0.064	**0.132**	-0.101	0.133	0.015

8.3.2 Preference for system of carsharing

Table 4 shows the results for the six questions; the number of responses for each of the dichotomies is larger than the sample size since a respondent can have a positive answer on the Likert scale for both questions. However, the calculated results of the preferred system add up to the sample size (see Table 5). Out of the three dichotomies, results of “where to start the trip” are least divisive. Many still want to start their journey at a set location rather than looking for a shared car.

Table 4: Preferences for system of carsharing

	Where to start the trip		**Where to end the trip**		**Two-way vs one-way**	
	Start trip in station	**Start trip in area**	**End trip in station**	**End trip in area**	**Two-way**	**One-way**
n	53	90	24	87	22	99
percentage	37.1%	62.9%	21.6%	78.4%	18.2%	81.8%

Almost all respondents have positive answers for the parts that make up free-floating. Whereas very few exclusively favour a stationbased system. Therefore, 64% of respondents favour free-floating above the other options. Incomplete results are mostly found among younger respondents without car.

Table 5: the preferred system of carsharing

	Station-based	**Free-floating**	**Hybrid**	**Incomplete**	
n	4	70	13	23	110
percentage	4%	64%	12%	21%	100

Stationbased is preferred by older respondents (Table 6). At the same time, free-floating correlates negatively with P2P sharing and having no car at all. However, these results may not be representative as the no car user group is tiny (n=9). Furthermore, free-floating is preferred by those who have kids, and stationbased is not.

Table 6: Kendall’s tau for system of carsharing

p = 0.1	Professional	P2P	Cooperative	Only private car	Shared car potential	No car at all	sex	age
Stationbased	0.041	0.029	-0.019	-0.090	0.123	-0.058	-0.144	**0.180**
Freefloating	-0.049	**-0.167**	-0.038	0.010	0.132	**-0.257**	0.086	0.029
Hybrid	0.027	0.057	-0.050	-0.015	-0.095	**0.199**	0.082	0.083
Incomplete	0.018	0.138	0.094	0.041	-0.137	**0.173**	-0.101	**-0.183**
	education	Shared e-scooter	Bicycle	Public transport	Private car	Shared car	children	student
Stationbased	-0.002	-0.051	0.054	-0.056	-0.028	0.083	0.094	0.032
Freefloating	-0.035	-0.082	**0.253**	-0.003	0.083	-0.002	**0.179**	-0.125
Hybrid	0.122	0.040	-0.065	-0.033	-0.042	-0.033	**-0.167**	-0.082
Incomplete	-0.054	0.089	**-0.273**	0.056	-0.051	-0.009	-0.123	**0.199**

Conclusions of sub-question 2

Most respondents prefer free-floating over stationbased or a hybrid form. Although starting a journey in a station is chosen by half of the respondents. Older respondents have a preference for stationbased. Children correlate with a preference for free-floating sharing.

8.4 Attitudes & norms influence on expected car use

This chapter outlines the results of the importance of several attitudes and the influence of social norms on the choice of car solutions. Firstly results are visualised, then results of binomial logistic regressions conducted are explained.

8.4.1 Overview attitudes & norms

Figure 8-13 visualises the Likert scores of all attitudes and norms for the complete survey sample. Most attitudes are skewed positively, whereas the norms are equally divided or skewed negatively.

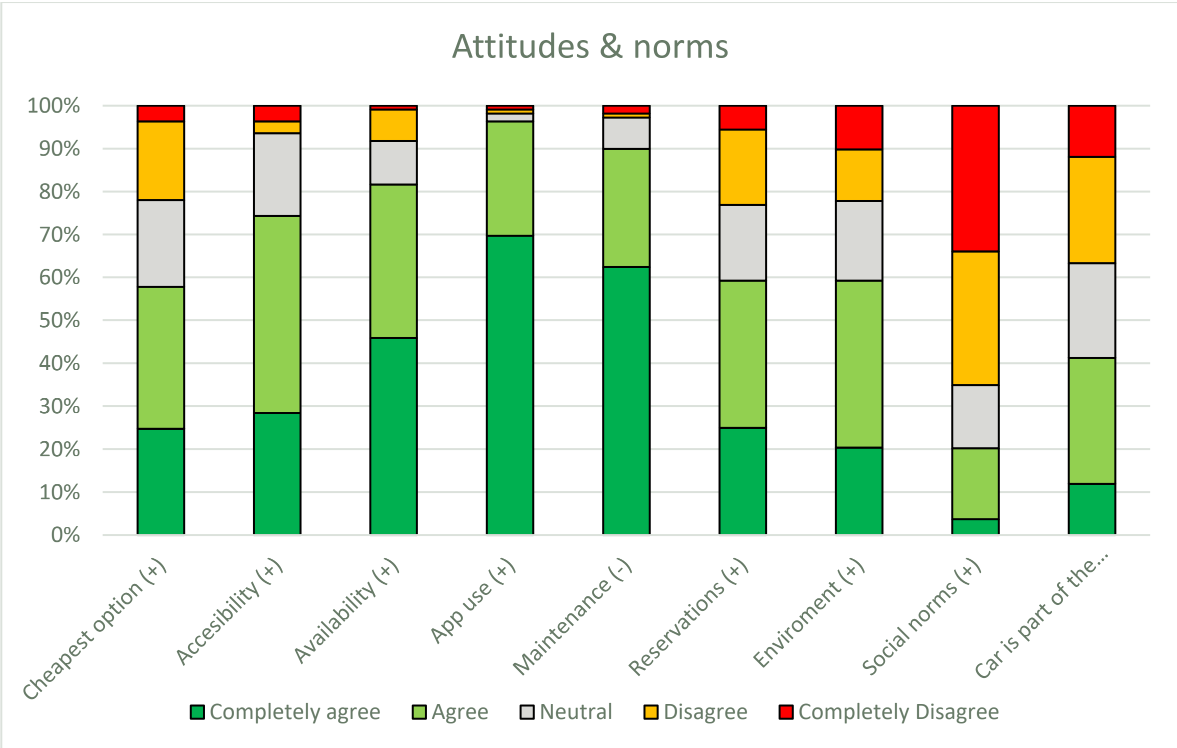

Figure 8-13: attitudes & norms

Table 7 shows that women (women coded as 2, men as 1) are more likely to choose the cheapest option. Education level is inversely related to choosing the cheapest option, which could be related to income. This could not be verified, however, since income was not included in this study. Higher educated also want to minimize the maintenance on their vehicle. Shared e-scooter users, on the other hand, do not mind the maintenance of a vehicle. Private car ownership correlates negatively with environmental concerns in choosing a car and positively with the cultural norm that a car is part of the household. Shared cars correlate negatively with social norms and cultural norms.

Table 7: Kendall's tau-b of attitudes & norms

p = 0.1	Sex	Age	Education	Shared e-scooter	Bicycle	Public transport	Private car	Shared car
A1: Cheapest option (+)	**0.164**	-0.114	**-0.195**	-0.024	-0.076	-0.076	-0.089	-0.050
A2: Accesibility (+)	0.050	-0.013	-0.023	-0.031	-0.061	-0.051	0.035	-0.070
A3:Availability (+)	-0.028	0.044	-0.026	0.069	-0.108	-0.026	0.087	-0.058
A4: App use (+)	0.023	0.028	0.136	-0.021	0.110	-0.067	-0.013	0.102
A5: Maintenance (-)	0.132	0.053	**0.195**	**-0.151**	0.086	-0.076	0.081	0.030
A6: Reservations (+)	0.099	0.048	-0.049	0.121	0.042	-0.009	-0.053	0.108
A7: Enviroment (+)	0.092	-0.001	0.071	0.051	0.092	0.056	**-0.143**	0.097
N1: Social norms (+)	0.090	-0.049	**-0.183**	0.096	-0.040	0.001	-0.112	**-0.141**
N2: Car is part of the household (+)	-0.088	0.022	-0.022	-0.068	-0.011	-0.067	**0.224**	**-0.156**

Table 8 shows that many of the attitudes and norms correlate strongly with each other. Especially app use and (reducing) maintenance frequently correlate with other variables. Though the norms rarely correlate.

Table 8: Kendall's tau-b cross correlation of attitudes and norms

p = 0.05	A1	A2	A3	A4	A5	A6	A7	N1	N2
A1: Cheapest option (+)	**1.00**	**0.19**	0.16	**0.44**	**0.37**	**0.27**	0.11	0.11	0.00
A2: Accessibility (+)		**1.00**	**0.29**	**0.28**	**0.35**	-0.02	0.00	0.03	0.09
A3:Availability (+)			**1.00**	**0.21**	**0.19**	0.04	-0.06	0.07	0.14
A4: App use (+)				**1.00**	**0.69**	**0.25**	**0.22**	-0.13	-0.01
A5: Maintenance (-)					**1.00**	**0.22**	**0.23**	-0.13	0.00
A6: Reservations (+)						**1.00**	**0.30**	0.10	-0.03
A7: Environment (+)							**1.00**	**0.25**	0.05
N1: Social norms (+)								**1.00**	**0.18**
N2: Car is part of the household (+)									**1.00**

8.4.2 binomial logistic regression

Dependent variables of belonging to the group of private car users and potential shared car users are respectively coded as 0 and 1. A positive coefficient thus corresponds to potential shared car users. In contrast, a negative coefficient is to be attributed to private car users.

The group of potential carsharers is more concerned with accessibility and the environment. In contrast, private car users are concerned with availability, reducing maintenance and influenced by the cultural norm “car is part of the household”.

p = 0.1	*Coefficients*	*Standard Error*	*t Stat*	*P-value*
Intercept	0.37489	0.489377	0.766057	0.445625
A1: Cheapest option (+)	-0.01959	0.046225	-0.42375	0.672751
A2: Accesibility (+)	**0.097521**	0.056585	1.723424	0.088208
A3:Availability (+)	**-0.14063**	0.053032	-2.65188	0.009443
A4: App use (+)	0.14411	0.120896	1.192021	0.236352
A5: Maintenance (-)	**-0.15461**	0.083764	-1.84583	0.068169
A6: Reservations (+)	0.065339	0.041337	1.580667	0.117424
A7: Enviroment (+)	**0.133224**	0.043992	3.028335	0.003199
N1: Social norms (+)	-0.01434	0.043578	-0.32901	0.742907
N2: Car is part of the household (+)	**-0.08541**	0.039626	-2.15528	0.03378

Figure 8-14: binomial logistic regression of attitudes & norms

Conclusions of sub-question 3

The group of potential car sharers is more concerned with accessibility and the environment. In contrast, private car users are concerned with availability, reducing maintenance and influenced by the cultural norm “car is part of the household”.

8.5 Shared e-scooter users compared to Dutch population (sub-question 4)

The comparison with the KiM study is made to study the differences between the general Dutch population and the shared e-scooter user. It immediately becomes clear that the shared scooter user is not like the "average" Dutch person. This difference was already shown in the representation of the survey sample. It showed a much younger, male-dominated demographic compared to the KiM sample.

8.5.1 Car ownership

Table 9 shows car ownership for the three samples as defined in chapter 2. Both groups derived from KiM data shows a high rate of car ownership. In comparison, only half of the survey respondents have one.

Table 9: car ownership

Car ownership	KiM (all)	KiM (shared car users)	Survey
yes	93%	98%	54%
no	7%	2%	46%

8.5.2 Statement 1: Life without a private car

Two statements are used to compare the KiM and survey group. The first one is whether life without a private car is impossible. Survey respondents claim this is just an inconvenience or no problem. Only thirty per cent has some difficulties. This number is smaller than the group of private car users, which is about fifty per cent. The general population, as defined by KiM (all), report greater difficulty. The group of shared car users filtered from the KiM dataset is skewed in the same direction as the survey data, though not as extreme.

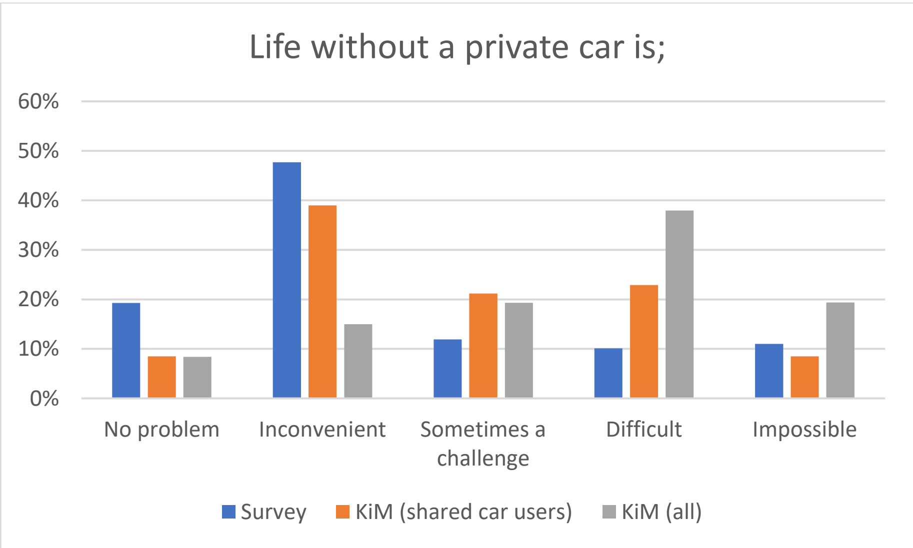

Figure 8-15: life without a private car;

Table 10 shows the chi-squared test results, used to determine if the samples are independent from each other, which is shown to be the case. Although the comparison between the survey sample and the filtered KiM data shows a closer approximation than the comparison of the survey sample with the general population.

Table 10: Chi-squared test - "life without a private car"

Life without private car	Shared car group (KiM)	General population (KiM)
crit value	13.27 (p = 0.01)	13.27 (p = 0.01)
p value	1.47E-05	2.27E-23
test statistic	27.64	112.37
	Independent (crit<test statistic)	Independent (crit<test statistic)

8.5.3 Statement 2: Convenience of a car without ownership

The second statement is whether respondents want the convenience of a car without ownership. Again, the survey sample was very positive; most either agreed or completely agreed. Ownership is not necessary to enjoy the practical benefits of a car for this group. The KiM respondent is somewhat at the opposite end. However, the divide is not as significant as with the previous statement. Similarly, the filtered group from KiM is skewed in the same direction as the survey sample.

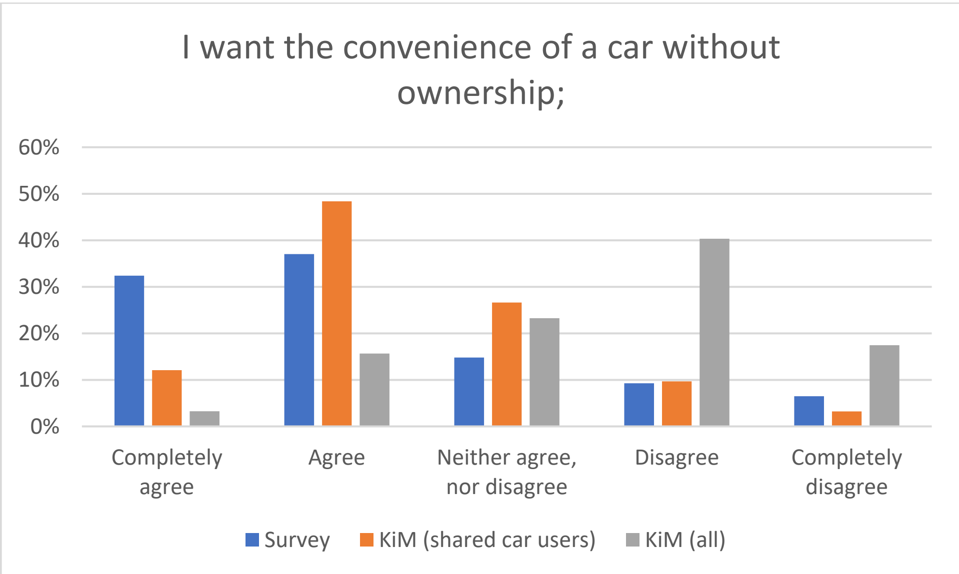

Figure 8-16: i want the convenience of a car without ownership;

The results of the chi-squared test for this statement are even more divided. P-values are extremely low; thus the likelihood that these systems or samples are the same is minimal.

Table 11: Chi-squared test - "convenience of a car without ownership"

Convenience of car without ownership	Shared car group (KiM)	General population (KiM)
crit value	13.27 (p = 0.01)	13.27 (p = 0.01)
p value	3.44E-09	1.35E-68
test statistic	45.29	#NUM! (very big value)
	Independent (crit<test statistic)	Independent (crit<test statistic)

Conclusions of sub-question 4

Car ownership is much lower among the survey respondents than the general population or those interested in shared cars. Results of the survey sample from two statements are independent of answers to the same statements of the general population and those interested in shared cars.

9 Conclusion

This study aimed to explore the carsharing potential of shared e-scooter users. This group, in particular, is attractive due to their younger age and (thus) low car ownership. Combined with a high affinity of shared mobility, they make up a group posed to delay purchasing a car and choose carsharing instead.

To put the shared e-scooter users in perspective, they are not so different from what is known about existing shared mobility users in general; who are predominantly higher educated, young(er) and male (Prieto et al., 2017). Further similarities among shared mobility users can also be found in the need to own a private car. Compared to the average Dutch person, the shared e-scooter users are much more interested in the utility of a car without ownership. Nor do they expect to experience difficulties not owning a private car. Dutch people with an interest or previous use of shared cars hold similar opinions to the shared e-scooter users in this regard. Though not as strongly.

About forty per cent of the sample studied expects to use a carsharing service within the next five years. This group uses public transport and the shared e-scooter more frequently, which aligns with earlier findings of MaaS (Kennisinstituut voor Mobiliteitsbeleid, 2019).
Fifty per cent of the sample is decided on their use of private cars; they expect to use a private car exclusively for the next five years. Moreover, 10 per cent does not expect to use a car. Reduced travel frequency due to the corona measures is associated with this group.

Students and graduates, on the whole, show good carsharing potential; these two groups are split equally between potential car sharers and use of private cars. A sharp drop in potential carsharing is seen in the ~ eight years after the graduation period. In this period after graduation, car behaviour is quickly locked in, and expectation for the next five years is what is done currently. Children are found to be an obstacle to carsharing due to practical issues (Jain et al., 2021), though young families are likely to adopt (Prieto et al., 2017). Free-floating carsharing is found to be positively correlated with children.

Next, the preferred type of provider and system of sharing was investigated. Professional providers are shown to be liked by most respondents. As expected, private car users show lower openness to all three providers. However, those who own a private car are more likely to use cooperative carsharing, even though private car ownership and expected private car use are strongly correlated. There are thus car owners who are not locked into the group of private car users. Finally, P2P carsharing was found to be liked by the potential car sharers.
Most respondents are open to the system of free-floating or hybrid carsharing. On the other hand, openness to stationbased carsharing is negligible. In this regard, the shared e-scooter users are the opposite of current car sharers who prefer stationbased over free-floating (Goudappel Coffeng, Greenwheels, 2019).

Environmental concerns are the most decisive influence to choose potential carsharing. Accessibility is another reason to choose carsharing; this could be because of the freedom and flexibility associated with free-floating sharing (Tobias, 2013); the users are used to zipping around on their mopeds. On the other hand, availability is found to be important to private car users. Low availability is one of the major obstacles to carsharing adaptation. Furthermore, reducing the maintenance of a vehicle applies to private car users. Even though annoyance by practical issues of car ownership, such as maintenance, are usually found among car sharers (Jain et al., 2021). Though the cost of carsharing is an obstacle to adaptation among young people (Burg, 2020), cost savings were not deemed necessary in and of themselves. Finally, expected private car use is associated with the norm/ideal of having a car in the household.

10 Discussion & limitations

The most notable limitation of this study is the uncertainty of representativeness. Details of the larger shared e-scooter population surveyed could understandably not be obtained. The implications of this is uncertainty in the required sample size, and insufficient knowledge to guarantee representation across demographic characteristics. For example, the sample may have relatively more older respondents than the population.

Furthermore, there is selection bias by selecting users of shared e-scooters, a form of shared mobility. Usually, users of shared mobility are younger, higher educated, and male. As such is the case in the sample. Therefore no correlations between potential shared car use and these three characteristics are found. So it might just be that expected car use among these shared e-scooter users is high, not because of exposure to shared mobility via shared e-scooters. But, because they already have an interest in shared mobility to begin, and thus irrespective of exposure to e-scooters, they would be more likely to use a shared car.
The argument can be made that the low barriers to shared e-scooter use appeal to a broader audience than carsharing would. Combine this with a high rate of carsharing adaptation found in this study (40%), and it would be obvious to place shared e-scooters everywhere to increase carsharing uptake. However, the study setup does not allow for quantitative conclusions to be made about the effect of exposure on carsharing adaptation. It is still unknown what part of the 40% carsharing potential is due to exposure or simply because they are part of the potential carsharing group in the first place. A piece of evidence that could support the effect of exposure is the shown difference in attitudes; shared e-scooter users are less likely to require car ownership than current or interested shared car users of the general Dutch population. However, to what extent this is due to the scooter riders' younger (carless) composition or a generational shift is unknown.

Expected car use is asked up to five years in the future. From the exploratory data analysis, it became clear that no matter the first year expectation, results of carsharing follow a normal distribution by the third time interval of 4-5 years. Therefore, expected car use may not be the best metric to measure future carsharing due to too much uncertainty on the respondent's end. Though expected private car use did not show such a problem, there is a clearly defined group of confident private car users. The cause of the high uncertainty of carsharing is unknown, whether that be the availability of shared cars in the future area of residence, (imagined) obstacles to carsharing due to future life events or simply a lack of information.

The results to openness to carsharing system contain many "incomplete" results, often among students without car experience. The systems were split up into lower-order attributes. Unfortunately, not every respondent was able to understand these attributes. Perhaps a short explanation, keeping in mind those without car experience, should have been included.

Despite careful selection of attitudes and norms, strong cross-correlations appear. A more representative sample of the Dutch population may not have similarly strong correlations. Looking at Table 8, it seems that the variables correlating with app use can be combined to create a narrative. High scorers on app use likely score high on availability, accessibility, the cheapest option, (reducing) maintenance (of a car), and the environment. Combined, these characterize the impatient young traveller who cares about the environment and is used to technology.

11 Recommendations

The following items are built upon the discussion and limitations and could be used further to study the carsharing potential of shared e-scooter users.

- The shared e-scooter users strongly prefer free-floating carsharing. Therefore, exposure to (free-floating) shared e-scooters looks to be a promising influence to increase the share of free-floating carsharing. Most respondents' first contact with shared mobility is in a free-floating system, using shared e-scooters. Not using shared cars in a stationbased system as was the case in the previous generation.

- To extract the most potential, shared e-scooter users should be persuaded to use carsharing before graduating. Since just after graduation, car ownership increases rapidly and the expected use of carsharing (5-year expectation) drops sharply. It looks like once a car is bought, a large share is locked into the group of private car users. However, some who own a car are open to cooperative sharing.

- The regression models of car choice fit only about thirty per cent of the data. Therefore more research is needed to fully investigate what drives the shared e-scooter user to choose either a private car or a shared car. An increase in fit can be obtained by changing the formulation and type of questions or choosing different variables altogether. In addition, an explorative study about the reasons shared e-scooter users may adopt carsharing might be helpful.

- This study only investigated effects in very urban areas. Den Haag and Rotterdam are not a representation for the remainder of the Netherlands. The use of shared scooters in densely urban areas is probably different from that in smaller cities. Studies in smaller cities outside of the Randstad may lead to different results.

- Expected shared car use shows a much greater uncertainty than expected private car use. Why is it that potential shared car users are so uncertain? Is it due to (perceived) limited infrastructure and fleet availability/ accessibility or due to incompatibility with life circumstances? If the concept of shared mobility were the problem, we would see more consistency of negative scores over the three-time intervals; already having tried shared e-scooters could take away any positive doubts about using shared cars in the future. So what causes the uncertainty in expected shared car use, especially among those familiar with shared mobility?

- The effect of exposure to shared e-scooters and subsequent carsharing adaptation is still to be studied.

12 Bibliography

Ajzen, I. (1991). The theory of planned behaviour. *Organizational behaviour and human decision processes*, 179-211.

autodelen.info. (2021). *cijfers en onderzoek*. Retrieved from autodelen.info: https://autodelen.info/cijfers-autodelen

Bardhi, F., & Eckhardt, G. M. (2021). *Access-Based Consumption: The Case of Car Sharing.* Oxford University.

Burg, J. v. (2020). *Delen of niet? voorkeur van jongeren bij autodelen.* Universiteit Utrecht.

Burghard, U., & Dütschke, E. (2018). Who wants shared mobility? Lessons from early adopters and mainstream drivers on electric carsharing in Germany. *Transportation Research D*, 96-109.

Claasen, Y. (2020). *Potential effects of mobility hubs.* Enschede: University of Twente.

Danial Jahanshahi, Z. T. (2020). Factors influencing the acceptance and use of a bicycle sharing system: Applying an extended Unified Theory of Acceptance and Use of Technology (UTAUT). *Case Studies on Transport Policy 8*, 1212-1223.

Felyx. (2021). *We verdubbelen het aantal e-scooters in Rotterdam.* Retrieved from Felyx: https://felyx.com/nl/nl/rotterdam/nieuwe-e-scooters-rotterdam#:~:text=Mag%20iedereen%20op%20een%2045,650%20e%2Dscooters%20in%20Rotterdam.

Field, A. (2009). *Discovering statistics using SPSS.* Sage.

Gemeente Rotterdam. (2020). *Deeltweewielers in Rotterdam.* Rotterdam.

Gemeente Rotterdam. (2020). *Nota beleid en vergunningen deelauto's.* Rotterdam.

Goudappel Coffeng, Greenwheels. (2019). *Hoe greenwheels steden leefbaarder maakt.* Goudappel Coffeng.

Gruijter, H. d. (2019). *Mobillity as a Service in the Paleiskwartier: Explanatory factors for the intention to use and a process evaluation.* Enschede: University of Twente.

Hansjörg Fromm, L. E. (2019). A study on Free-floating Carsharing in Europe. *Working paper series in production and energy*.

Herrmann, S., Schulte, F., & Voß, S. (2014). Increasing Acceptance of Free-Floating Car Sharing Systems Using Smart Relocation Strategies: A Survey Based Study of car2go Hamburg. *Computational Logistics*, 151-162.

Jain, T., Rose, G., & Johnson, M. (2021). "Don't you want the dream?": Psycho-social determinants of car share adoptation. *Transportation Research Part F*, 226-245.

Kennisinstituut voor Mobiliteitsbeleid. (2019). *Kansrijke groepen voor Mobility-as-a-Service.* Den Haag: Ministerie van Infrastructuur en Waterstaat.

Laa, B., & Leth, U. (2020). Survey of E-scooter users in Vienna: Who they are and how they ride. *Journal of Transport Geography*.

Laerd statistics. (2021). *Kendall's tau-b using spss statistics*. Retrieved from Lared statistics: https://statistics.laerd.com/spss-tutorials/kendalls-tau-b-using-spss-statistics.php

Machado, C. A., Hue, N. P., Berssaneti, F. T., & Quintanilha, J. A. (2018). An overview of shared mobility. *Sustainability*.

Prieto, M., Baltas, G., & Stan, V. (2017). Car sharing adoptation intention in urban areas: What are the key sociodemographic drivers? *Transportation Research Part A 101*, 218-227.

Schaefers, T. (2013). Exploring carsharing usage motives: A hierarchical means-end chain analysis. *Transportation Research Part A 47*, 69-77.

Soares Machado, C. A., Salles Hue, N. P., Berssaneti, F. T., & Quintanilha, J. A. (2018). *An Overview of Shared Mobility.* MDPI.

Ströhle, P., Flath, C., & Gärttner, J. (2019). Leveraging customer flexibility for car-sharing fleet optimization. *Transportation Science 53(1)*, 42-61.

Tobias, S. (2013). Exploring carsharing usage motives: A hierarchical means-end chain analysis. *Transportation Research Part A 47*, 69-77.

Uteng, T. P., Julsrud, T. E., & George, C. (2019). The role of life events and context in type of car share uptake:. *Transportation Research part D 71*, 186-206.

13 Appendix A: Survey questions

#	Question	Category/Variable	Measurement as in survey	Measurement as in data processing
1	For how long have you used a shared e-scooter?	Exposure/Use of shared scooters*	1= Less than 1 week 2= 1 week to 1 month 3= 1 month to 3 months 4= 3 months to 6 months 5= 6 months to 12 months 6= 12 months & longer	*Sub Q. 1&2* 1= Less than 1 week 2= 1 week to 1 month 3= 1 month to 3 months 4= 3 months to 6 months 5= 6 months to 12 months 6= 12 months & longer
2.1	**How frequently have you used a** shared e-scooter the past year	Exposure/Use of shared scooters*	1= 4+ days a week 2= 1 to 3 days a week 3= 1 to 3 days a month 4= 6 to 11 days a year 5= 1 to 5 days a year 6= less than 1 day a year 7= never	*Sub Q. 1&2* 1= never 2= less than 1 day a year 3= 1 to 5 days a year 4= 6 to 11 days a year 5= 1 to 3 days a month 6= 1 to 3 days a week 7= 4+ days a week *Sub Q. 3:* Travel frequency
2.2	**How frequently…** bicycle the past year	Exposure/Other modes*	Same as 2.1	Same as 2.1
2.3	**How frequently…** public transport the past year	Exposure/Other modes*	Same as 2.1	Same as 2.1
2.4	**How frequently…** own private car the past year	Practical/Car ownership*	Same as 2.1	Same as 2.1
2.5	**How frequently…** borrowed private car the past year	Practical/Car availability	Same as 2.1	Same as 2.1
2.6	**How frequently…** shared car in the past year	Exposure/ Use of shared cars*	Same as 2.1	Same as 2.1
3	Me or my cohabiting partner has a private car	Practical/Car ownership* & Kim variable	1= true 2= false	*Sub Q. 3*: Binary 0= no private car ownership 1= private car ownership
4	Did your travel frequency during the corona measures change?	Control	1= Much more 2= More 3= Not more or less 4= Less 5= Much less	*Sub Q. 3:* Control for summed travel frequency of all modes (see Q. 2) 1= Much less 2= Less 3= Not more or less 4= More 5= Much more

5	Which carsharing services have you used the past year?	Exposure/Use of shared cars* & Kim variable	1= No use 2= Greenwheels 3= Mywheels 4= Juuve 5= Sixt Share 6= Amber 7= SudentCar / ConnectCar 8= Snappcar 9=Other (open field)	*Sub Q. 1&2:* 1= Any answer 2-9. 0= No use
6	Life without a private car is (im)possible	KiM variable	1= No problem 2= Sometimes impractical 3= A challenge 4= Difficult 5= Impossible	*Sub Q. 4:* 1= No problem 2= Sometimes impractical 3= A challenge 4= Difficult 5= Impossible
7.1	Do you expect to use a private car in the next: **year**	Expected private car use/Expected private car use in the next year	1= Very likely 2= Likely 3= Equal chance 4= Unlikely 5= Very unlikely	*Sub Q. 1*: As in survey (define user groups)
7.2	Do you expect to use a private car in the next: **2-3 year**	Expected private car use/Expected private car use 2–3 years	Same as 7.1	Same as 7.1
7.3	Do you expect to use a private car in the next: **4-5 year**	Expected private car use/Expected private car use 4–5 years	Same as 7.1	Same as 7.1
8.1	I would like the convenience of a car without ownership	KiM variable	1= Completely agree 2= Agree 3= Ambivalent 4= Disagree 5= Completely disagree	*Sub Q. 4:* 1= Completely agree 2= Agree 3= Ambivalent 4= Disagree 5= Completely disagree
8.2	I am open to become user of a **professional** car sharing provider	Type of carshare offering/openness to services of professional provider	Same as 8.1	*Sub Q. 2:* 1= Completely disagree 2= Disagree 3= Ambivalent 4= Agree 5= Completely agree
8.3	I am open to become user of a **P2P** sharing platform	Type of carshare offering/openness to services of peer 2 peer platform	Same as 8.1	Same as 8.2
8.4	I am open to become user of a **cooperative** car sharing provider	Type of carshare offering/openness to services of cooperative provider.	Same as 8.1	Same as 8.2

9.1	Do you expect to use a shared car in the next: **year**	Expected shared car use/Expected shared car use in the next year	1= Very likely 2= Likely 3= Equal chance 4= Unlikely 5= Very unlikely	*Sub Q. 1*: As in survey (define user groups)
9.2	Do you expect to use a shared car in the next: **2-3 year**	Expected shared car use/Expected shared car use 2–3 years	Same as 9.1	Same as 9.1
9.3	Do you expect to use a shared car in the next: **4-5 year**	Expected shared car use/Expected shared car use 4–5 years	Same as 9.1	Same as 9.1
10.1	When I start my journey, I want to find the shared car in a **set location**	Location/Pick-up at set location	1= Completely agree 2= Agree 3= Ambivalent 4= Disagree 5= Completely disagree	*Sub Q. 2:* 1= Completely disagree 2= Disagree 3= Ambivalent 4= Agree 5= Completely agree
10.2	When I start my journey, I want to find the shared car **in a given area**	Location/Pick-up in area	Same as 10.1	Same as 10.1
11.1	After my journey I want to leave the shared car in a **set location**	Location/Return at set location	Same as 10.1	Same as 10.1
11.2	After my journey I want to leave the shared car **in a given area.**	Location/Return in area	Same as 10.1	Same as 10.1
11.3	After my journey I want to return the shared car to where I started my journey.	Retour/Two-way	Same as 10.1	Same as 10.1
11.4	After my journey I want to return the shared car elsewhere.	Retour/One-way	Same as 10.1	Same as 10.1
12.1	**In consideration of a private car and the broad shared car offering** I choose the cheapest option	Attitude/Cost saving	1= Completely agree 2= Agree 3= Ambivalent 4= Disagree 5= Completely disagree	*Sub Q. 3*: 1= Completely disagree 2= Disagree 3= Ambivalent 4= Agree 5= Completely agree
12.2	**In consideration of…** Walking time to a car should be minimised	Attitude/Accessibility	Same as 12.1	Same as 12.1
12.3	**In consideration of…** I want 24/7 availability to a car	Attitude/Availability	Same as 12.1	Same as 12.1
12.4	**In consideration of…** I don't mind using an app to locate a shared car	Attitude/App use & Kim variable	Same as 12.1	Same as 12.1
12.5	**In consideration of…** Administration and	Attitude/Effort	Same as 12.1	Same as 12.1

	maintenance should be minimised			
12.6	**In consideration of…** I don't mind constraints such as: needing to place reservations and return periods for a shared car	Attitude/Peace of mind & Kim variable	Same as 12.1	Same as 12.1
12.7	**In consideration of…** I am environmentally conscious	Attitude/Environment	Same as 12.1	Same as 12.1
12.8	**In consideration of…** I am considerate of the opinion from friends and family	Norms/Influence by others	Same as 12.1	Same as 12.1
12.9	**In consideration of…** I believe a shared car is part of the household	Attitude/Privacy	Same as 12.1	Same as 12.1
13	What is your sex?	SocioDemo/Gender	1= male 2= female 3= other	*Sub Q. 1&2&4:* Binary 1= Male 2= Female
14	What is your age?	SocioDemo/Age	Fill-in field	*Sub Q. 1&2&3:* As in survey
15	What is your highest completed education?	SocioDemo/Highest completed eductation	1= Elementary, VMBO or MBO-1 2= MBO-2 t/m MBO-4, HAVO or VWO 3= HBO or WO	*Sub Q. 1&2&3:* As in survey
16	What is your current occupation?	Current occupation	1= On payroll 2= Self-employed 3= MBO 4= HBO 5= WO Bachelor 6= WO Master and higher	*Sub Q. 1:* As in survey
17	Which year did you graduate or expect to?	(expected) Year of graduation	Fill-in field	*Sub Q. 1:* As in survey
18	What is your household composition?	Household composition	1= Single person household 2= Cohabiting without kid(s) 3= Cohabiting with kid(s) 4= Singe parent family	*Sub Q. 1:* As in survey
19	What is your postal code?	Postalcode	Fill-in field	For further studies

14 Appendix B: Operationalisation of variables

Category	**Variable**	**Operationalisation**	**Correlation**
SocioDemo	Age	Number	Negative
SocioDemo	Gender	-Male -Female -Other	Males more likely
SocioDemo	Highest completed eductation	-Elementary, VMBO, MBO-1 -MBO-2 t/m MBO-4, HAVO, VWO -HBO, VWO	Positive
SocioDemo	Current occupation	-On payroll -Self-employed -MBO -HBO -WO bachelor -WO Master and higher	Positive
SocioDemo	Family composition	-Single household -Cohabiting without kids -Cohabiting with kids -One parent family	Depends
Attitude	Cost saving	Likert Item 1 – 5 (Importance of statement)	Depends
Attitude	Effort	Likert Item 1 – 5 (Importance of statement)	Positive

Attitude	Peace of mind	Likert Item 1 – 5 (Importance of statement)	Negative
Attitude	Environment	Likert Item 1 – 5 (Importance of statement)	Positive
Attitude	Privacy	Likert Item 1 – 5 (Importance of statement)	Negative
Attitude	Accessibility	Likert Item 1 – 5 (Importance of statement)	Negative
Attitude	Availability	Likert Item 1 – 5 (Importance of statement)	Negative
Attitude	App use	Likert Item 1 – 5 (Importance of statement)	Positive
Norms	Influence by othersh	Likert Item 1 – 5 (Importance of statement)	Depends
Exposure	Use of shared scooters	-Frequency of use -Length of use	

Exposure	Use of shared cars	-Previously used a shared car (if applicable) -Frequency of use	Positive
Exposure	Other modes	Frequencies of use	Positive
Practical	Car ownership (	-Yes / No -Frequency of use	Negative
Practical	Car availability	Frequency of use	

Category	Variable	Operationalisation
Expected private car use	Expected private car use in the next year	Likert Item 1 – 5 (probability of statement)
Expected private car use	Expected private car use 2–3 years	Likert Item 1 – 5 (probability of statement)
Expected private car use	Expected private car use 4–5 years	Likert Item 1 – 5 (probability of statement)
Expected shared car use	Expected shared car use in the next year	Likert Item 1 – 5 (probability of statement)
Expected shared car use	Expected shared car use 2–3 years	Likert Item 1 – 5 (probability of statement)
Expected shared car use	Expected shared car use 4–5 years	Likert Item 1 – 5 (probability of statement)
Type of car share offering	Openness to B2C offering	Likert Item 1 – 5 (applicability of statement)
Type of car share offering	Openness to P2P offering	Likert Item 1 – 5 (applicability of statement)
Type of car share offering	Openness to cooperative offering	Likert Item 1 – 5 (applicability of statement)
Retour	One-way	Likert Item 1 – 5 (preference for statement)
Retour	Two-way	Likert Item 1 – 5 (preference for statement)
Location	Pick-up at set location	Likert Item 1 – 5 (preference for statement)
Location	Pick-up in area	Likert Item 1 – 5 (preference for statement)
Location	Return at set location	Likert Item 1 – 5 (preference for statement)
Location	Return in area	Likert Item 1 – 5 (preference for statement)

15 Appendix C: Original (Dutch) versions of used KiM questions

KiM - id	KiM - label	Survey - id	Survey - label
V20	Is er in uw huishouden een auto aanwezig?	3	Ikzelf of mijn samenwonende partner heeft een eigen privéauto.
V109_5	Een leven zonder eigen auto is voor mij ondenkbaar.	6	Op dit moment is een leven zonder eigen privéauto voor mij;
V109_6	Ik zou graag het gemak van een auto willen hebben, zonder dat ik zelf een auto bezit.	8_1	Ik zou graag het gemak van een auto willen hebben, zonder dat ik zelf een auto bezit.
V119_4	Ik heb de afgelopen 12 maanden gebruik gemaakt van een deelauto, zoals Greenwheels of Snappcar.: Kunt u aangeven in hoeverre u onderstaande mogelijkheden gebruikt?	5	Van welke deelautoaanbieders heb je afgelopen jaar gebruik gemaakt?

16 Appendix D: Screenshots from Survey

Deelmobiliteit: deelscootergebruikers & autovoorkeur

Huidig reisgedrag

1. Hoe lang maak je al gebruik van (elektrische) deelscooters zoals die van Felyx?

- Minder dan 1 week
- 1 week tot 1 maand
- 1 maand tot 3 maanden
- 3 maanden tot 6 maanden
- 6 maanden tot 12 maanden
- 12 maanden en langer

2. Hoe vaak heb je de volgende vervoersmiddelen gebruikt in het afgelopen jaar?

	4 of meer dagen per week	1 tot 3 dagen per week	1 tot 3 dagen per maand	6 tot 11 dagen per jaar	1 tot 5 dagen per jaar	Minder dan 1 dag per jaar	Nooit
Elektrische deelscooter	○	○	○	○	○	○	○
Fiets	○	○	○	○	○	○	○
Openbaar vervoer	○	○	○	○	○	○	○
Eigen privéauto	○	○	○	○	○	○	○
Geleende privéauto van een bekende	○	○	○	○	○	○	○
Deelauto	○	○	○	○	○	○	○

3. Ikzelf of mijn samenwonende partner heeft een eigen privéauto.

- Ja
- Nee

4. Ben je meer of minder gaan reizen door de coronamaatregelen?

- Gemiddeld veel meer
- Gemiddeld meer
- Ik ben niet meer of minder gaan reizen
- Gemiddeld minder
- Gemiddeld veel minder

5. Van welke deelautoaanbieders heb je afgelopen jaar gebruik gemaakt?

- [ ] Ik heb geen deelauto gebruikt.
- [ ] Greenwheels
- [ ] Mywheels
- [ ] Juuve
- [ ] Sixt Share
- [ ] Amber
- [ ] StudentCar / ConnectCar
- [ ] Snappcar

Een andere aanbieder, namelijk:

6. Op dit moment is een leven zonder eigen privéauto voor mij;

- ○ geen probleem.
- ○ soms onhandig.
- ○ een uitdaging.
- ○ moeilijk.
- ○ onmogelijk.

Wat is de reden (kort) hiervoor?

Vor. Volg.

Deelmobiliteit: deelscootergebruikers & autovoorkeur

Door jou verwacht gebruik van privéauto & deelauto

7. Verwacht je in de toekomst een **privéauto** te gebruiken?

	Zeer waarschijnlijk	Waarschijnlijk	Om het even	Onwaarschijnlijk	Zeer onwaarschijnlijk
In het komende jaar heb- of lease ik een privéauto.	○	○	○	○	○
In 2 à 3 jaar heb- of lease ik een privéauto.	○	○	○	○	○
In 4 à 5 jaar heb- of lease ik een privéauto.	○	○	○	○	○

Dit tekstje en de volgende vragen gaan over **deelauto's**

Het aanbod van deelauto's kan gesplitst worden in <u>drie catagorieën</u>:
1. De voertuigen zijn eigendom van een **professionele aanbieder**; anoniem. Bijvoorbeeld **Felyx.**
2. De voertuigen zijn eigendom van **particulieren** die hun eigen auto aanbieden; je ontmoet de verhuurder van de auto (Peer2Peer).
3. De voertuigen zijn eigendom zijn van een **coorperatieve aanbieder**; je deelt de auto's met een besloten groep, bijvoorbeeld je buren.

8. Wat is jouw deelautovoorkeur?

	Helemaal mee eens	Mee eens	Niet mee eens en niet mee oneens	Niet mee eens	Helemaal niet mee eens
Ik zou graag het gemak van een auto willen hebben zonder dat ik zelf een auto bezit.	○	○	○	○	○
Ik sta er voor open gebruiker te worden van een **professionele deelautoaanbieder** (zie 1). Bijvoorbeeld Greenwheels, Amber, of Mywheels.	○	○	○	○	○
Ik sta er voor open gebruiker te worden van een "peer 2 peer" deelautoplatform, en te autodelen met **particulieren** (zie 2). Bijvoorbeeld Snappcar.	○	○	○	○	○
Ik sta er voor open gebruiker te worden van een **coorperatieve deelautoaanbieder** (zie 3).	○	○	○	○	○

9. Verwacht je in de toekomst gebruik te maken van een deelauto?

	Zeer waarschijnlijk	Waarschijnlijk	Om het even	Onwaarschijnlijk	Zeer onwaarschijnlijk
In het komende jaar maak ik structureel gebruik van een deelauto.	○	○	○	○	○
In 2 à 3 jaar maak ik structureel gebruik van een deelauto.	○	○	○	○	○
In 4 à 5 jaar maak ik structureel gebruik van een deelauto.	○	○	○	○	○

De volgende twee vragen gaan over het in gebruik nemen en het terugbrengen van de deelauto.

10. Wanneer ik een deelauto **in gebruik** neem wil ik deze;

	Helemaal mee eens	Mee eens	Niet mee eens en niet mee oneens	Niet mee eens	Helemaal niet mee eens
altijd kunnen vinden op een vaste plaats.	○	○	○	○	○
kunnen vinden in een aangegeven gebied. *Zoals bij Felyx.*	○	○	○	○	○

11. **Na gebruik** van de deelauto wil ik deze;

	Helemaal mee eens	Mee eens	Niet mee eens en niet mee oneens	Niet mee eens	Helemaal niet mee eens
achterlaten op een vaste plaats.	○	○	○	○	○
achterlaten in een aangegeven gebied. *Zoals bij Felyx.*	○	○	○	○	○
terugbrengen naar waar ik deze in gebruik heb genomen en daar uitchecken.	○	○	○	○	○
op een andere plek uitchecken dan waar ik deze in gebruik heb genomen. *Zoals bij Felyx.*	○	○	○	○	○

12. In de afweging tussen een privéauto en het brede aanbod deelauto's;

	Helemaal mee eens	Mee eens	Niet mee eens en niet mee oneens	Niet mee eens	Helemaal niet mee eens
ga ik voor de goedkoopste optie.	○	○	○	○	○
wil ik een zo kort mogelijke looptijd naar een auto.	○	○	○	○	○
wil ik dat een auto 24/7 beschikbaar is.	○	○	○	○	○
vind ik het niet erg een app te moeten gebruiken om een deelauto te vinden.	○	○	○	○	○
wil ik zo min mogelijk te maken hebben met onderhoud en administratie van een auto.	○	○	○	○	○
vind ik het niet erg om rekening te houden met het reserveren en op tijd terugbrengen van een deelauto.	○	○	○	○	○
houd ik rekening met de impact die een auto heeft op het milieu.	○	○	○	○	○
houd ik rekening met de meningen van familie en vrienden.	○	○	○	○	○
vind ik dat een auto onderdeel uitmaakt van het huishouden.	○	○	○	○	○

Overige afwegingen (geef nadere toelichting)

Vor. Volg.

Deelmobiliteit: deelscootergebruikers & autovoorkeur

Socio-demografische kenmerken

13. Wat is jouw geslacht?

- ◯ Man
- ◯ Vrouw
- ◯ Anders

14. Wat is jouw leeftijd?

15. Wat is jouw hoogst voltooide opleiding?

- ◯ Basisonderwijs, VMBO of MBO-1
- ◯ MBO-2 t/m MBO-4, HAVO of VWO
- ◯ HBO of WO

16. Wat is jouw huidige beroep of studie?

- ◯ Werkzaam in loondienst
- ◯ Zelfstandig ondernemer
- ◯ MBO
- ◯ HBO
- ◯ WO Bachelor
- ◯ WO Master en hoger

17. Welk jaar ben je afgestudeerd, of verwacht je af te studeren?

18. Wat is de samenstelling van jouw huishouden?

- ◯ Eenpersoonshuishouden
- ◯ Samenwonend zonder kind(eren)
- ◯ Samenwonend met kind(eren)
- ◯ Eenoudergezin

19. Wat is jouw postcode? (Deze wordt uitsluitend gebruikt om het deelautoaanbod in jouw wijk te bekijken.)

Dit is het einde van de enquéte. Bedankt voor het invullen!

Houdt voor de conclusies van het onderzoek de website van Over Morgen in de gaten (medio juli)! https://overmorgen.nl/

Vor. Gereed

17 Appendix E: Attitudes and norms from the theory of planned behaviour

Factors found using theory of planned behaviour	Attitudes (**Advantages/ disadvantages of car ownership**)	Cost savings	Users	Infrequent car usage
				Cheaper than owning a car
			Non-Users	Cars are an essential expense
				People really do not like montly fees
		Convenience	Convenience	Not needing to worry about insurance, maintenance, cleaning
			Inconvenience	Planning fatigue
				Freedom (can park in front of my own door)
		Enviroment	Resources	Why own car but not use it.
			Sustainable transport	Walking, cycling, public transport & shared car
		Community vs Privacy	Community	More interaction with other people
			Privacy	Car is an escape from other people
		Technology and variety	Cool factor	Unlocking a car with your phone is a new experience
			Up to date cars	Newer cars are safer among other benefits
			Variety of cars	Being able to drive different cars
		Health	More active modes	Reconsideration for car use due to lower accesibility (car is not on your doorstep)
		Minimizing posessions	Security	Those who move often/ are about to move may not want to invest in a car
		Cleanliness & personal space	Cleanliness	The possiblity of a dirty car is undesirable
			Personal space	Want for personal belongings in private car
	Social norms	Active coercion	Friends and family	
		Passive coercion	World around you	Status
	Percieved control	Access & Availability	Access	How far away
				Comfortability of route
			Availability	Will there be a car when needed
				How far ahead to place a reservation
		Practical difficulties	Practical difficulties	Refueling of the car
				Stationbased (will need to walk twice)
				Rigid booking/ planning fatigue