ERASMUS UNIVERSITY ROTTERDAM
Erasmus School of Economics

BSc Business Economics Thesis

Mobility sharing services – How do they impact the city of Rotterdam, and its society?

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Date: July 18th, 2019

I Preface

The work contained in this thesis has not been previously submitted for a degree or diploma at any other higher education institution. To the best of the author's knowledge and belief, the thesis contains no material previously published or written by another person except where due references are made

Data collection of this thesis is was performed via two different surveys. The data gathered by the Omnibus Enquête is distributed to the author of this thesis and for the purpose of this thesis only. Reproduction and distribution of the data is not permitted, only with the authorisation of the authors of the Omnibus Enquête. Also, the data gathered by the distributed survey is for the purpose of this thesis only. The information of the respondents will be used by the staff of ESE for examination only.

II Executive Summary

Mobility sharing is part of the exponentially growing Sharing Economy. It is one of the innovations that might reduce traffic-related problems in cities. Currently, many studies have identified advantages and disadvantages of mobility sharing. However, few studies have attempted to identify advantages and disadvantages of mobility sharing in the city of Rotterdam, and for its citizens. This thesis used existing studies to identify advantages and disadvantages in general, and used a survey conducted by the municipality of Rotterdam to determine traffic-related problems in Rotterdam. Besides that, a survey was distributed among people that live in or near Rotterdam to assess how mobility sharing is used in Rotterdam. The results of the literature review show that mobility sharing has four advantages. Namely, decreased vehicle ownership, decreased vehicle usage, decreased use of space and environmental sustainability. Besides that, mobility sharing has two disadvantages: nuisance and additional use of vehicles. Also, the survey conducted by the municipality of Rotterdam identified that parking possibilities and traffic flow are the most pressing traffic-related problems. In addition, from the results of mobility sharing survey it can be concluded that non-users of mobility sharing fail to estimate the price of mobility sharing correctly. Further, this thesis shows that ownership of a vehicle does not have a significant effect on either usage of mobility sharing or monthly spending on mobility sharing. This thesis concludes with a recommendation for the municipality of Rotterdam with regard to policymaking for mobility sharing.

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Section 1 Introduction

In the last few decades, urbanisation has led to more people living in cities than ever before. By 2050, it is expected that 68 per cent of the global population is urbanised (United Nations, 2018). This is causing the development of increasing traffic, which is a problem all large cities have to deal with. The European Conference of Ministers of Transport (1990) identified the following problems caused by increasing traffic: traffic congestion, traffic accidents, traffic noise, pollution and parking problems. In Europe, congestion costs are estimated at 110 billion euro per year (Christidis & Ibáñez Rivas, 2012). Road accidents kill 25,600 people and leave 1.4 million people injured (European Road and Safety Observation, 2018). Besides, the impact of traffic on external factors such as noise, climate, pollution and habitat damage are estimated at 375 billion euro (van Essen, 2018). Additionally, as car ownership increases, parking supply and demand are disrupted (Ibrahim, 2017). This results in a shortage of parking spaces in cities (Guo, 2013). Some European governments are looking for new ways to reduce traffic congestion. Traditional approaches, such as adding new traffic infrastructure are merely short-term solutions

Short-term solutions for traffic problems tend to solve the problem for a short period of time, after which the problems worsen. For instance, reducing road space for cars to deter drivers from using the road, will initially decrease the density of the traffic (Cairns, Hass-Klau, & Goodwin, 1998). However, after the initial reduction of the density, drivers will change their driving style for example by driving more closely to each other, leading to the initial vehicle density of the road. When road space for cars is reduced even further, drivers will use neighbourhood streets or change their travel time by leaving earlier or later. These reactions create new problems for traffic management and do not solve the problems it was initially intended to solve (Cairns, Hass-Klau, & Goodwin, 1998). Another example is adding road capacity. Adding road capacity will lead to an increase in traffic flow with the same level of traffic density. However, after a period of time, traffic density will rise even further, and traffic flow will decrease again. This phenomenon can be explained by the supply and demand theory. Because traffic flow increases, travel time will improve as well. Shorter travel time lead to a decrease in the cost of travelling. In turn, travel demand will increase and the situation with regard to traffic flow is at its initial level. Thereby taking into account that the traffic density is increased (Handy, 2015).

As described above, conventional short-term solutions tend to backfire; it worsens the problems it was initially intended to solve. Instead, European governments should invest in long-term solutions (Jones & Hervik, 1992). In this current era, various long-term solutions are available. Some examples which are used around the globe are: optimisation of traffic-light management, monitoring of road

conditions by CCTV, enforcing existing road traffic laws, enhancing road pricing and improving the infrastructure for public transport, cycling and walking (Leigh, 2016). According to Heinen, Panter, Mackett, & Ogilvie (2015), the availability of new sustainable modes of transport decreases commuting trips by car and car ownership. Therefore, it makes sense for a government to add new sustainable travel possibilities, such as mobility sharing services to its transport infrastructure in order to decrease the negative effects caused by traffic, and especially cars. Mobility sharing services are rental services that makes it is possible to rent a vehicle for short periods of time and the tenant is billed for the time or distance it is using the vehicle One of the cities that might benefit from adding these new travel possibilities to its transport infrastructure is the city of Rotterdam

Rotterdam is one of the cities that experiences negative effects of exponentially growing traffic. According to the Omnibus Enquête 2018 - which is a survey conducted amongst citizens of Rotterdam to identify problems in Rotterdam - traffic-related problems are the most pressing (de Graaf, 2018). Over 60 per cent of the citizens of Rotterdam indicate traffic flow is (extremely) negative and 51 per cent of the citizens indicate they have problems with regard to parking their vehicle (de Graaf, 2018). Both of these problems might be reduced with the use of mobility sharing because it can decrease car ownership and vehicle population, leading to less congestion and less parking-related problems (Martin, Shaheen, & Lidicker, 2010). Also, it can supply the increasing demand for sustainable transport (Luè, Colorni, Nocerino, & Paruscio, 2012), tackling environmental issues such as pollution, noise and climate change.

The goal for this research is to identify what factors influence the use of mobility sharing and how mobility sharing services impact the society of Rotterdam. As mentioned earlier, the use of mobility sharing services impacts congestion and parking-related problems (Martin et al., 2010). Also, users of mobility sharing services decrease their environmental footprint with approximately 51 per cent (Donna Chen & Kockelman, 2016). Therefore, the main research question used in this thesis is:

- *What factors influence the use of mobility sharing services and how do they impact the society of Rotterdam?*

The research question above is too broad to be answered individually. Therefore, prior to answering the main research question, three sub-questions will be answered. Firstly, below 12,000 kilmetres per year, vehicle sharing is less expensive than owning a vehicle (ANWB, n.d.). Despite this, it is likely that users of mobility estimate the prices of mobility sharing services too high. Therefore, they might withhold from using mobility sharing because of financial reasons. Thus, the first sub-question is:

- *How do citizens of Rotterdam estimate the price of mobility sharing when they do not participate in mobility sharing?*

Secondly, according to (de Graaf, 2018), parking problems are the second most pressing matter in Rotterdam. However, mobility sharing might have an effect on parking problems since mobility sharing services decrease the vehicle population (Martin et al., 2010). Eventually, this could lead to an improvement of traffic problems - such as parking - in Rotterdam. A proxy is used to estimate use of the different sorts of mobility sharing. This proxy is the amount of money spent on mobility sharing. Hence, the second sub-question is:

- *How does ownership of a vehicle affect monthly spending on mobility sharing?*

Lastly, in comparison with conventional vehicle use, mobility sharing services have a positive effect on the environment. However, the true effect of mobility sharing services on the environment of Rotterdam is hard to measure. Therefore, instead of measuring environmental effects, the effect of different sorts of vehicle ownership on the use of mobility sharing services are measured. In this manner, it is possible to discover if usage of mobility sharing services decreases vehicle ownership. Hence, the third sub-question is:

- *How do different sorts of vehicle ownership affect the frequency of the use of mobility sharing?*

The ultimate goal for this research is to identify the advantages and disadvantages of mobility sharing and how these factors influence the city of Rotterdam. To identify the advantages and disadvantages, a literature review will be conducted. To connect these factors to the city of Rotterdam, two surveys will be used. The surveys as data collection will help this research to examine the different factors of mobility sharing in the society, and thereby answer the research questions. The first one identifies traffic problems in Rotterdam and the second one focusses on mobility sharing and how it is being used by the citizens of Rotterdam. Altogether, the surveys and the literature review will provide the required knowledge to answer the research questions and thereby accepting or rejecting the hypotheses.

This research is divided into sections. First, the literature review will be discussed which will present all the necessary insights into mobility sharing as well (section 2). Then, the statistical methods to answer the research questions will be discussed, accompanied by the hypotheses (section 3). After,

the descriptive statistics will be presented which will provide an overview of the traffic problems in Rotterdam (section 4). This overview will be created, using the data gathered by the surveys. Next, the hypotheses will be tested in the results section (section 5). This will be tested with the data, gathered by the survey that is aimed at mobility sharing. Lastly, all the useful results will be discussed to answer the research questions (section 6).

Section 2 Mobility sharing

2.1 The Sharing Economy

The Sharing Economy is growing in term of size and is divided into different categories. Also, The Sharing Economy has three drivers which enabled growth. In the following section, these drivers and categories will be discussed. The section will be concluded with the various motives to participate in The Sharing Economy.

Due to growing attention for sustainability, businesses are aiming to adapt to a more sustainable strategy. Their goal is to design a strategy that creates long-term value while taking into account their ecological, social and economic footprints. This strategy is built on the idea that sustainability creates company longevity (Haanaes, 2016). Besides this, consumers desire a sustainable manner of consuming as well (Young, Hwang, McDonald, & Oates, 2009). Therefore, companies have an additional incentive to move towards a sustainable business strategy. These sustainable changes have led to various new start-ups, and ideas within already existing companies. Altogether, this created The Sharing Economy.

2.1.1 Drivers

A sharing economy is an economy driven by digitalisation that involves the peer-to-peer exchange of tangible and intangible assets. This peer-to-peer exchange reduces transaction costs by replacing third parties and exchange intermediaries with digital platforms (Felländer, Ingram, & Teigland, 2015). Puschmann and Alt (2016) identify three main drivers for the increased popularity of The Sharing Economy. Firstly, changing consumer behaviour has led to business models changing its focus from ownership to temporary usage. Secondly, social networks and electronic markets are an important factor in matching consumers who want to share goods. Additionally, electronic markets facilitate the reduction of transaction costs. Thirdly, mobile devices and electronic services increase the accessibility for consumers to the 'app-market'. The underlying factor for all three drivers that increased the

popularity of The Sharing Economy is the growth of the internet as of the late nineties; IT is seen as the main enabler of The Sharing Economy (Puschmann & Alt, 2016) (Figure 1).

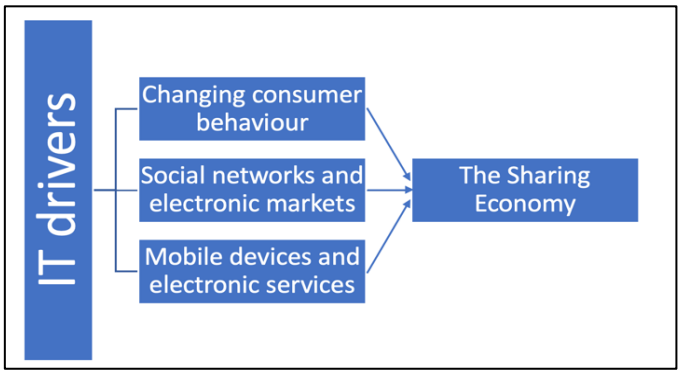

Figure 1: IT drivers of The Sharing Economy.

Based on Puschmann &Alt (2016)

2.1.2 Categories

According to Schor (2016), The Sharing Economy can be divided into four categories: recirculation of goods, increased utilisation of durable assets, exchange of services, and sharing of productive assets. The first category mainly consists of companies such as eBay and provides consumers with an online marketplace. The platform dates from 1995 and facilitates recirculation of unwanted goods (eBay, n.d.). The second category, identified by Schor (2016), are platforms that facilitate increased use of expensive and durable goods such as lawnmowers, spare-rooms or cars. Pioneer in this sector was Zipcar that placed cars in densely populated areas. Due to the economic crisis in 2009, attractiveness of renting services became clear and start-ups like Uber and Lyft enriched the transportation sector with a substitute for taxi-services. Additionally, the company Couchsurfing innovated the lodging sector. Couchsurfing matches travellers (i.e. backpackers) with room owners that want to share their room for free. Nowadays, Airbnb – which adopted the matching strategy as well – is market leader in the lodging sector in terms of yearly stays (Statista, n.d.).

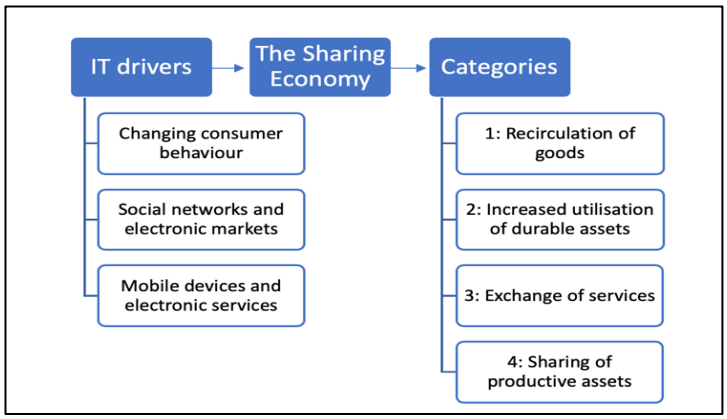

Figure 2: Overview of IT drivers and categories in The Sharing Economy

Based on Puschmann &Alt (2016) and Schor (2016)

The third category is the share of services and started in the 1980s. It is derived from the concept of time banks, which provided unemployed people with opportunities. Time banks were community-based organisations and matched unemployed people with people who wanted to get a job done. It was based on the principle that everyone's time was worth the same (Dubois, Schor, & Carfagna, 2014). However, time banks did not grow enough to survive. The principle of equally valued time, as mentioned before, was also to blame for this lack of growth. These days, comparable companies (i.e. Rabbit) – albeit with online platforms – face the same lack of growth (Schor, 2016). The last category consists of initiatives that share assets or space that facilitate production instead of consumption. Examples are maker spaces, co-working spaces or communal offices (Schor, 2016). An overview can be found in Figure 2

2.1.3 Motives

Hamari, Sjöklin, & Ukkonen (2015) identify four motives for consumers to participate in a sharing economy, namely: sustainability, enjoyment, reputation and economic benefits. Their research pinpoints that enjoyment and economic benefits have a significant effect on consumers to participate in a sharing economy. Sustainability and reputation merely have an effect on their attitude towards a sharing economy. Mobility sharing services are textbook examples of services that thrive on the growing popularity of a sharing economy. Therefore, just as in a sharing economy, mobility sharing services also have the same motives for joining a service (e.g. sustainability, enjoyment, reputation and economic benefits).

2.2 Mobility sharing

As mentioned by Schor (2016), the second category of The Sharing Economy aims to facilitate shared use of durable and expensive assets. All businesses in this category with the goal to transport people are called mobility sharing services. Mobility sharing is a rental service that makes it is possible to rent a vehicle for short periods of time and the tenant is billed for the time or distance it is using the vehicle. Also, mobility sharing is an alternative for owning a car. The vehicles are spread around the service area and are also available after office hours (Automotive Technologies, n.d.). Sharing services have a broad variety of available vehicles. The best-known mobility sharing services are car sharing, bicycle sharing and scooter sharing. In the following section the three different mobility sharing services and their sharing possibilities will be discussed.

2.2.1 Cars

Currently in the Netherlands, shared vehicles are offered by several providers. The shared car fleet in 2018 counted 41 thousand cars, which is an increase of 25 per cent compared to last year. These 41 thousand cars are distributed by 39 providers. The providers have one of five different strategies with regard to the rental systems (Kennisplatform CROW, n.d.a). Firstly, the most commonly used rental system is 'roundtrip carsharing'. In this rental system, the rental ends at the place of departure and it is available for B2C and B2B. Besides this, the 'roundtrip carsharing' providers manage their own fleet of shared-cars which are 24/7 available on fixed parking spaces. In the Netherlands, Greenwheels supplies 71 per cent of 'roundtrip carsharing' trips and is, therefore, market leader. 14 per cent of roundtrips is facilitated by ConnectCar and 8 per cent by MyWheels. The remaining 7 per cent is distributed across several small roundtrip providers (e.g. CareCar, Deelootoo, Drive, Elektrip, Flexcar, Free2Go, Hertz 24/7, Hoppa, MobielGedeeld, SharedWheels, Stapp-In en StudentCar) (Kennisplatform CROW, n.d.b).

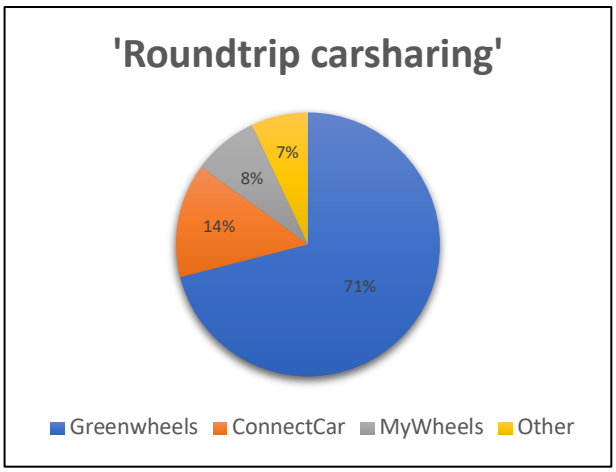

Figure 3: The market of 'Roundtrip carsharing'

Secondly, 'one-way carsharing' makes it possible to conduct one-way trips. In this manner, location of departure is not necessarily the same as location of arrival. In both 'roundtrip carsharing' and 'one-way carsharing', it is possible that cars are 'free-floating'. For 'one-way carsharing', this opens up the possibility to park the car anywhere within their service area on public parking spaces. This makes it a solution for 'last-mile' transport in combination with public transport. In the case of 'roundtrip carsharing', the car does not have a fixed parking space, but a fixed parking area (i.e. a street). Similar to 'roundtrip carsharing', 'one-way carsharing' is also available for B2C and B2B. Currently, in the Netherlands, Car2Go is market leader in terms of 'one-way carsharing' trips. It has a fleet that consists of 350 electrically powered Smarts that are, however, only available in Amsterdam (Kennisplatform CROW, n.d.b).

Thirdly, the rental system using carsharing platforms is commonly known as ‘peer-to-peer carsharing’ (P2P). Via this open-source platform, consumers can share their own cars with other consumers (e.g. C2C). The tenant can pay for renting the car based on usage. This rental system started in 2011 in the Netherlands and has increased in size since. Compared to previous mentioned rental systems, this system can grow more easily. The main reason is that no investment is needed in cars for their own fleet. SnappCar is currently market leader and is supplier of 90 per cent of the P2P-cars. The runner up is MyWheels and supplies 9 per cent of the P2P-cars. DayCar, TrexCar and ParkFlyRent supply the last per cent of P2P-cars (Kennisplatform CROW, n.d.b).

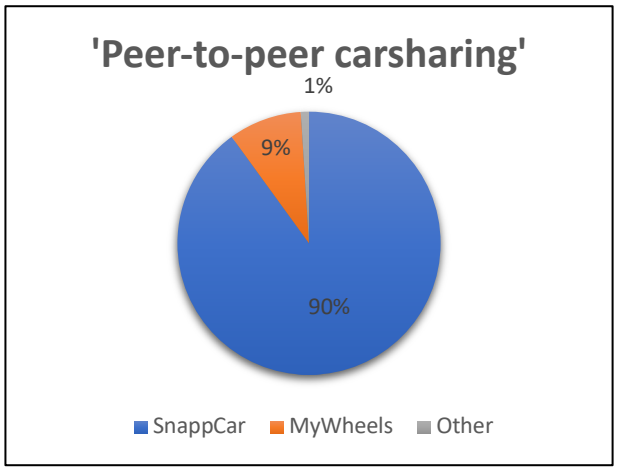

Figure 4: The market of 'Peer-to-peer carsharing'

Fourthly, cars can be shared via ‘local communities’. Neighbours, friends or family can use this system to buy and use a car together without the interference of a platform or organisation (e.g. C2C). In most situations, they orchestrate a legal arrangement with regard to usage of the car. Two examples of platforms that offer this type of rental are Buurauto and WeDriveSolar. Both platforms offer ‘local community’ carsharing for a monthly fee and, according to the platforms, are interesting for people who need a car “more than occasionally”. Their business strategy is based on offering people the opportunity to share the high initial costs of purchasing a car (Kennisplatform CROW, n.d.b).

Lastly, ‘business carsharing’ is a rental service designed for the B2B market. It can be used in several different ways. For instance, it can be used to share a company-owned car among co-workers for business trips. Also, it can be used to share leased cars with other different companies. Besides that, employees can share their leased car with consumers through car sharing platforms. Lastly, employers can offer their employees, company-owned cars for business trips which they can rent occasionally for after-business-hours (Kennisplatform CROW, n.d.b).

2.2.2 Scooters

Besides the growth of carsharing in the Netherlands, scooter sharing is quickly advancing in terms of size as well. Currently, Felyx is the single supplier of shared scooters and the scooters are only available in major cities (i.e. Amsterdam, Rotterdam, Den Haag). Even though Felyx is single supplier of the shared scooter in the Netherlands, it is growing in popularity. In 2018 the Felyx app was downloaded 50 thousand times by people who used the scooter at least one time (Bouma, 2019). Amsterdam, Rotterdam and Den Haag currently have a combined population of 700 electric Felyx scooters (Stooker, 2019). Felyx is offering shared scooter to consumers (e.g. B2C) via their app and it is mainly used by young urban professionals, freelancers and students. However, the average age is increasing (Stooker, 2019). Also, the scooters are 'free-floating', meaning they can be parked anywhere within Felyx's service area (Felyx, s.d.)

2.2.3 Bikes

With regard to the shared bike, no concrete numbers are available. However, according to multiple sources, bike sharing services are growing in popularity and size all across the globe and the Netherlands is no exception (Meddin, 2019). Similar to the rental systems of carsharing, bike sharing has three different rental systems. Firstly, the 'back-to-one' rental system. It is equal to the 'roundtrip carsharing' method and it requires the user to arrive and depart at the same location. The best-known example of this system in the Netherlands, is the 'OV-fiets' which has a fleet of 20,500 bicycles (Tweewieler, 2018). Secondly, the 'back-to-many' rental system. It has, compared to the 'back-to-one' rental system one benefit; the departure and arrival point are not necessarily the same and the user can return its bike to many different fixed stations. Lastly, the 'free-floating' rental system. The user of the bike can, similar to Felyx, park their bike anywhere in the service area of the provider (van Waes, Münzel, & Harms, 2017). Because of the substantial number of different providers, it is hard to identify all the providers and their corresponding rental systems. Therefore, the most-used systems and, if available, their fleet size has been collected in (Table 1).

Non-free-floating				Free-floating	
Back-to-one	Fleet size	Back-to-many	Fleet size	Free-floating	Fleet size
Ov-fiets	20,500	GoBike	600	Mobike	n.a.
Urbee	1,150	FlickBike	n.a.	(Ofo)	n.a.
		Donkey Republic	n.a.	(Obike)	n.a.
		Hello-bike	n.a.		
		Uw deelfiets	n.a.		
		Nextbike	n.a.		
		Hopper	n.a.		

Table 1: Overview of shared bike providers

2.3 Advantages of mobility sharing

Currently, 55 per cent of the global population lives in urban areas. It is expected that this number will rise to 68 per cent in thirty years. This is caused by the increase in global population combined with the shift from rural to urban areas (United Nations, 2018). In other words, the major part of global growth is happening in the cities. Eventually, this could lead to tense real estate markets and pressure on existing infrastructure, public spacing and the environment (While & Whitehead, 2013; Scott, 2008). Besides that, by 2030, the Netherlands is expected to have declined its CO2-emission by 49 per cent (Klimaatakkoord, s.d.). Mobility sharing might be a solution to problems created by urbanisation through decreasing pressure on cities and the environment. In the following section four advantages of mobility sharing will be discussed.

2.3.1 Decrease of vehicle ownership

As stated by the European Environment Agency (EEA), vehicles ownership is: "The number of vehicles per 1,000 inhabitants; passenger cars refer to motor vehicles other than two-wheelers, intended for the carriage of passenger and designed to seat no more than nine people (including the driver)" (EEA, n.d.). For the purpose of this thesis, vehicle ownership is defined as the number of vehicles per household. In addition, this thesis recognises that consumers can own a vehicle, lease a vehicle, sometimes have the availability of a vehicle, share a vehicle or have no availability of a vehicle. These sorts of vehicle ownership are frequently referred to in this thesis as the different sorts of vehicle ownership. Furthermore, according to Kennisinstituut voor Mobiliteitsbeleid (KiM) (2015), carsharing has an effect on car ownership. KiM has conducted a before-after survey in 2015 to identify the effect of carsharing on car ownership. Their research pinpoints that, initially, the average household owns 0.85 cars. After they started to use carsharing, that number decreased to 0.72. This is a decrease of 0.13 cars per household. Besides that, a large share of carsharing users state that carsharing is an alternative for the purchase of a private-owned car (KiM, 2015). Additionally, 37 per cent state that they would have bought an extra car in the absence of carsharing.

2.3.2 Vehicle usage

Besides the effect on car ownership, carsharing has an effect on car usage as well. The before-after survey conducted by KiM (2015) indicates that before car sharing, each year their respondents drove, on average, 9,100 kilometres. When they started to use carsharing, this number declined to 7,500 kilometres. This is a decrease of 1,600 kilometres. The decrease is mainly caused by people who have sold their car and, therefore, did not use their car anymore. Of the 7,500 kilometres, driven by each respondent, 1,500 kilometres were driven by shared cars. As can be seen in Figure 5, 38% of private-

car usage is replaced with shared cars. The reason for this replacement is that people have to be conscious about car usage; their car is no longer on their front porch and the car has to be reserved prior to the planned trip (Meijkamp & Aarts, 1997).

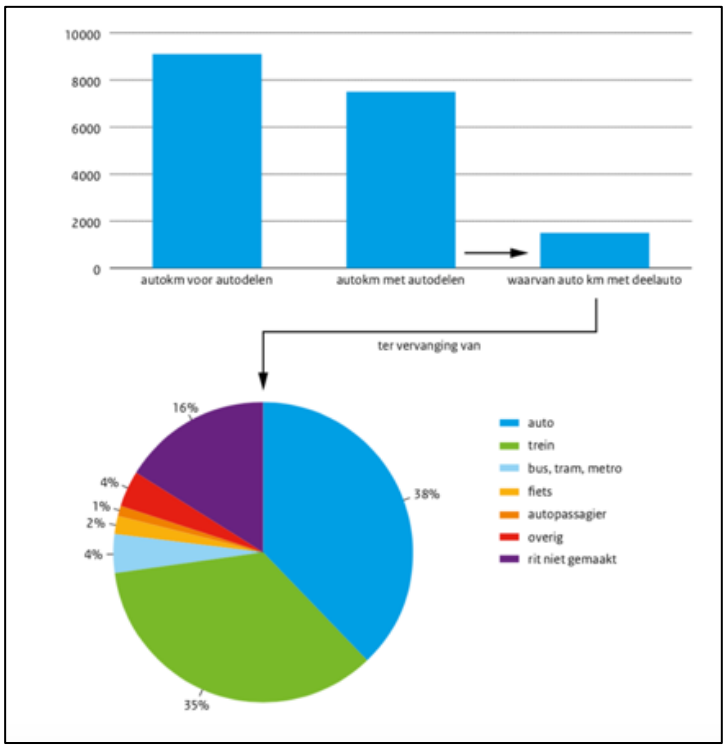

Figure 5: Car replacement by shared cars. Source: Nijland et al. (2015)

Bike sharing also has an effect on car usage. Qiu & He (2018) indicate that bike sharing could contribute to last-mile transport and decrease overall private car use. To emphasize, bike sharing systems create a possibility which is faster through city traffic than usage of cars. Therefore, private car use becomes less attractive. Futhermore, Fishman, Washinton and Haworth (2014) have estimated that in the cities Melbourne, Brisbane, Washinton D.C. Minnesota and London, on average, the car was substituted in 14 per cent of the cases by a shared bike. In other words, bike sharing systems led to a reduction of 14 per cent in car use.

2.3.3 Environmental

A decrease in car usage is beneficial for the environment. A reduction in kilometres travelled by car leads to a reduction in emission of pollutants such as CO2, NOx and PM10. According to KiM (2015), as a result of carsharing, users of carsharing reduce their kilometres travelled by car with 1,600. This is a reduction of 250 kilograms of CO2. However, carsharing platforms also create additional car use demand; car sharers are less likely to use public transport. This results in an induction of 160 kilograms of CO2. Nonetheless, production and salvage of cars emit CO2 as well. The use of shared cars leads to

less production and salvage of privately owned cars. Therefore, car ownership results in an additional CO2 reduction of 85 to 175 kilograms (Nijland, van Meerkerk, & Hoen, 2015). To sum up, car sharing is reducing CO2-emission with 175 to 265 kilograms compared to privately owned cars.

Besides this study, there are more studies that indicate car sharing is beneficial for the environment. For instance, Loose (2010) conducted a study in different European countries. This study compared the CO2-emission of shared cars to privately owned cars and its findings show that shared cars emit 20 per cent less CO2. The reason shared cars emit less CO2 is because the fleet of shared car providers mainly consists of new, light, fuel-efficient cars. These cars have less impact on the environment compared to older, privately owned cars (Meijkamp, 2000).

2.3.4 Use of space

As reported by Mingardo, (2019) the flow of traffic is: “the quantity of traffic that passes from one point to another” and the density of traffic is: “the concentration of vehicles in the length of a roadway”. Both concepts are affected by reduction of car use; decreasing car use (and car ownership) lead to improved flow and density of traffic. Also, because shared cars require fewer parking spaces, there is a gain of public space around cities (Meijkamp, 2000). This could lead to an improvement of the earlier reported parking and traffic problems.

2.4 Disadvantages of mobility sharing

A decade ago, The Sharing Economy was reported as the saviour of the economic markets after the economic crisis in 2008. The utopic idea of sharing mobility, services or tools without the interference of (large) companies should result in improvement of profit, people and planet. Sharing cars, services and tools lead to more profit, more human interaction and it sustains the environment (Hermanides, 2017). However, exponential growth of The Sharing Economy has led to negative externalities. Two examples of these externalities will be discussed in the following section.

2.4.1 Nuisance

Regarding shared bikes, the vast number of services and bikes available is creating a nuisance for cities. The free-floating Obike – which used to operate in Rotterdam – initially deployed two thousand bikes across Rotterdam. However, the bike was parked in public places where it created problems for the citizens. Additionally, because of the lack of social regulation, the bike was vandalised often and used to vandalise other public facilities. To make matters worse, the company went bankrupt early 2018, and it abandoned its bikes across the city (Keunen, 2018).

Shared taxi services such as Uber and Lyft create a different sort of nuisance. Uber treats her drivers as independent contractors resulting in the drivers being "ineligible for minimum wage, overtime, worker's compensation insurance and other benefits" (Wong, 2019). In order to earn sufficiently, Uber operators (e.g. taxi drivers) work long shifts leading to a decrease in focus (Bergeijk, 2017). This, in turn, will degrade road safety and lead to casualties or fatalities.

2.4.2 Additional car use

As mentioned earlier, mobility sharing services create additional car use. Before, the user would have chosen public transport, an environmentally friendlier mode of transport or not travelling at all (Nijland, van Meerkerk, & Hoen, 2015). As stated by Bondorová and Archer (2017), carsharing for long distances competes with inter-urban public transportation. In the US, mass transportations systems for long distances are a substitute for carpooling via digital platforms. However, peer-to-peer carsharing and ridesharing do not pose a thread for public transport. Also, bike sharing services are not a substitute for public transport, rather for walking (Finger, Bert, Kupfer, Montero, & Wolek, 2017).

2.5 Pricing of mobility sharing

Having a privately-owned car is convenient. However, for the average owner of a car holds; its car is not used for 95 per cent (CBS, n.d.a). Therefore, for most car owners it might be beneficial to share a car. Mobility sharing services have the benefit that it requires no initial purchase costs. Rather, the user is billed for the time it uses the vehicle. The price of cars, scooters and bikes differs in terms of time, distance and price.

2.5.1 Cars

In the Netherlands, the peer-to-peer carsharing services bill their customers according to a daily fee which is different for each car and range from 20 euros to 500 euros. For this price, the user is allowed to drive a number of kilometres, depending on the owner's preferences. Additional kilometres are billed and cost on average 20 eurocents. Besides, the user is expected to fully fill up the fuel tank when the car is returned to its owner (SnappCar, n.d.).

Carsharing via digital platforms (i.e. Greenwheels) is more expensive than peer-to-peer sharing. The user is billed for the number of hours that car is used. This price ranges from 3 euros to 11 euros, depending on the car and whether the user has a subscription on the service. In contrary to peer-to-peer sharing, the user is billed for all kilometres driven. This price varies from 12 eurocents to 39

eurocents, depending on the car and subscription as well. Compared to peer-to-peer sharing, the price for fuel consumption is included in the price for kilometres driven (Greenwheels, n.d.).

2.5.2 Scooters and bikes

The billing system for scooters is similar to the billing system for bikes. As indicated earlier, Felyx is the only provider for shared scooters in the Netherlands. The billing system it uses is simpler compared to carsharing. The user is billed 30 eurocents for each minute the scooter is used (Felyx, s.d.). Most bike sharing providers bill their customers based on minutes used as well. Users of Mobikes are billed 50 eurocents per 30 minutes and Gobikers have to pay 3 eurocents per minute. Also, users of both services have to pay a registration fee or deposit (Mobike, n.d.; Gobike, n.d.). The reason for the simplification of the billing system is, scooters and bikes are used for short periods of time and distances; the user is not willing to pay an upfront fee for each short period of time it uses the scooter or bike.

2.6 Mobility sharing in Rotterdam

Mobility sharing in Rotterdam might solve the before mentioned traffic problems. In the following section, some factors that have played a part in the increase of traffic problems in Rotterdam and the market for mobility sharing will be discussed. Rotterdam is the second largest city in the Netherlands and is best known for its city-sized port that is, according to the AAPA World Port Ranking (2016), the sixth largest port in the world. It has a population size of 647,147 and a population density of 2,920 per square metre at the end of March 2019 (CBS, n.d.b). The average disposable household income is 35.5 thousand euros per capita, which is slightly below the average of the Netherlands (CBS, n.d.c). The vehicle population of Rotterdam includes 195,695 cars for passenger transportation (maximum of nine persons) and 35,045 scooters. On average, in Rotterdam, households own 0.6 cars. Despite being below the nationwide average of 0.9, the number of parked cars in Rotterdam is increasing. (CBS, n.d.d). With regard to mobility sharing providers, the companies Greenwheels, Snappcar, Felyx, MoBike, Obike are most used in Rotterdam. Also, ‘the OV-fiets’, which is provided by the Nederlandse Spoorwegen (NS), is used very often.

Section 3 Methodology

The methodology section presents a clarification of the surveys. The surveys are used to gather data sets to answer the research questions. First, the survey that gathered the data set that is used to create an overview of the situation in Rotterdam - with regard to traffic problems and vehicle use - is discussed. Then, the survey that gathered the data set that is used to answer the research question is addressed. The section concludes with the presentation of the hypotheses of the research questions. The hypotheses aim to provide preliminary answers for the research questions in order to perform statistical tests. Furthermore, the statistical tests that are used in this research are presented in this section as well.

3.1 Omnibus Enquête

The Omnibus Enquête is a yearly survey, conducted by the municipality of Rotterdam to identify the most pressing topics in the city. Their target audience were the residents of Rotterdam. The topics of the survey vary from politics to care and wellbeing (Gemeente Rotterdam, n.d.). The survey in 2017 identified that traffic problems are the most pressing topics in Rotterdam (de Graaf, 2018). Therefore, the number of questions regarding traffic problems in the survey of 2018 is expanded. This research used the data set that included all questions related to traffic. This resulted in a total of 258 different variables. The traffic section of the survey is enclosed in the Omnibus Enquête as of 2001 and has collected 24,569 respondents in the years up to 2018. Important questions in the data set regarding traffic use are: the number of cars available in a household, car usage, opinions on parking problems and traffic flows, and reasons for travelling. As mentioned before, this data set is used to create an overview of the problems in Rotterdam regarding traffic. To create this overview, five questions will be analysed.

Firstly, the age distribution of the Omnibus Enquête from 2001 to 2018 will be analysed to examine whether ages are equally distributed among respondents. Age distribution is an important driver for indicating the plan of development of the economic and cultural life in the society of a city; in this case the city of Rotterdam (Vostrikova, 1970). Secondly, car ownership of the respondents from 2001 to 2018 will be analysed to identify the number of cars owned in each household. The data will be used to determine whether respondents have 0, 1, 2 or 3 cars and if this number has increased or decreased in the years used in the survey. Thirdly, car usage from 2003 to 2018 is analysed. Respondents are questioned about their car usage and whether they use it: '(almost) every day', '4-to-5 days', '2-to-3 days', '1-day', 'occasionally' or 'never'. Car usage is an important driver in this thesis since it affects society greatly (de Graaf, 2018). Fourthly, respondents' opinions on traffic flow in Rotterdam from

2003 to 2018 are analysed. The respondents have the following answering options: 'very positive', 'positive', 'negative' and 'very negative'. Lastly, the respondents' opinions on parking possibilities from 2003 to 2018 are analysed. Similar to previous question, respondents have the following answering options: 'very positive', 'positive', 'negative' and 'very negative'. Even though the results of the last two questions are subjective, they are of explanatory value for creating an overview of the problems in Rotterdam. The results of all above-mentioned questions will be presented in the descriptive statistics section.

3.2 Mobility sharing survey

The mobility sharing survey is a survey conducted especially for this thesis with respondents living in and near Rotterdam. The survey begins with the selection process which gathered data from 79 different respondents. However, 4 respondents are below 18 years of age. These respondents are deleted from the data set for privacy reasons. After the question that filters out minors, the respondents are asked to specify if they live in or near Rotterdam. Living 'near' Rotterdam is referred to as 'living in one of the following cities: Alblasserdam, Albrandswaard, Barendrecht, Capelle aan den IJssel, Krimpen aan den IJssel, Lansingerland, Nieuwerkerk aan den IJssel, Rhoon, Ridderkerk, Schiedam, Spijkenisse, Vlaardingen or Zwijndrecht'. These cities were selected based on being 'near' Rotterdam. Besides that, it is important that respondents who live 'near' Rotterdam, have visited Rotterdam at least once in the past twelve months. If respondents answer one of the two previous questions negatively, they are filtered out of the survey. This concludes the selection process. All remaining respondents are included in the data set.

After the selection process, a control variable question is included in the data set. This question aims to determine whether the respondent has participated in The Sharing Economy in the past twelve months. The available answering options are: Netflix, Videoland, Peerby, Thuisafgehaald.nl, Filedelen and Airbnb. These companies are examples of companies that operate in The Sharing Economy. Besides the control variable, it is important for the analysis that the data sample can be separated into users of mobility sharing and non-users of mobility sharing. To perform this separation, the respondents have to answer a question of whether they have used mobility sharing in the past twelve months. After this division, the two different types of respondents (e.g. users and non-users) are routed through a different version of the survey for most of the questions. Ultimately, they will end up with the same question regarding vehicle ownership, before finishing the survey. The complete overview of the mobility sharing survey can be seen in Appendix M.

3.2.1 Mobility sharing survey – non-users of mobility sharing services

The first question for non-users of mobility sharing services is a question regarding motives not to use mobility sharing. The respondents are asked to opine why they do not use mobility sharing services. The available answering options are: practical reasons, environmental reasons, financial reasons or other reasons. These answering options are derived from the study conducted by Hamari, Sjöklin, & Ukkonen (2015). The second question for non-users of mobility sharing services aims to determine the respondents' estimation of prices of three different sorts of mobility sharing services. The respondent can answer this question by moving a slider between 0.00 and 1.00. These values refer to the cost of mobility sharing, expressed in euros per minute (Figure 6). After this question, non-users will be routed back and presented with the same question regarding vehicle ownership which concludes the survey.

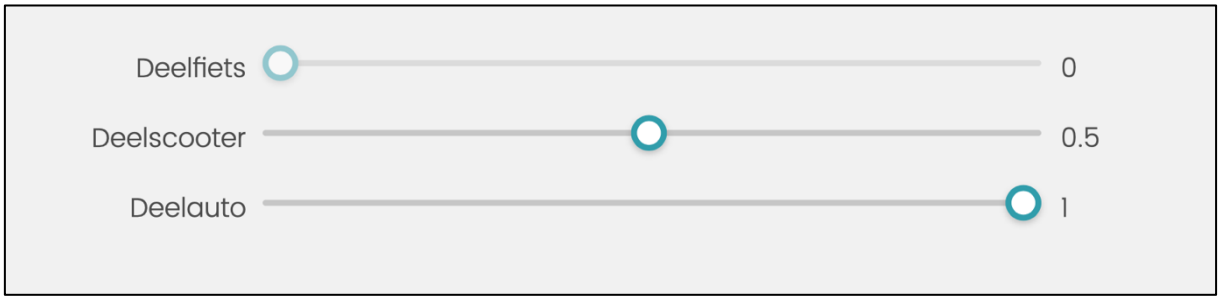

Figure 6: Costs slider Mobility sharing survey

3.2.2 Mobility sharing survey – users of mobility sharing services

The first question that is presented to users of mobility sharing services is a question regarding different sorts of mobility sharing. The respondents are presented with a question that determines what sorts of mobility sharing they use. This question is related to the next question, since this question determines usage of mobility sharing. The respondents can answer for each sort of mobility sharing service if they use it daily, weekly, monthly, yearly or never. Additionally, respondents have to fill in their monthly spending on a shared bike, scooter and car separately. This will serve as a nominal proxy variable for vehicle usage later in this research. The third question the users of mobility sharing are required to answer is regarding motives to use mobility sharing. Similar to the question concerning motives for non-users – which are discussed in section 3.2.1 – the answering options are derived from a study conducted by Hamari, Sjöklin, & Ukkonen (2015). The fourth question, which respondents are required to answer, aims to determine what alternatives for mobility sharing are. The alternatives the respondents can choose from are: walk, (own) bike, (own) scooter, (own) car, public transport, cancel the planned trip and not applicable. The respondent is supposed to fill in their alternative for each mobility sharing service separately (e.g. bike, scooter, car).

The previous question is the last question that is different for users and non-users. After this question, the groups are merged, and the final question regarding vehicle ownership is presented. This question

aims to determine availability in terms of vehicles for each respondent. The respondent is asked whether they have availability of a bike, scooter and/or car. The possible answering options can be seen in Table 2. In the descriptive statistics, all of the results gathered by the mobility sharing survey will be presented. However, in the analysis to answer the research questions, only some results will be used.

Bike	Scooter	Car
"I own a bike"	"I own a scooter"	"I own a car"
"I am leasing a bike"	"I sometimes have the availability of a scooter"	"I sometimes have the availability of a car"
"I sometimes have the availability of a bike"	"I make use of a shared scooter"	"I make use of a shared car"
"I make use of a shared bike"	"I do not have the availability of a scooter"	"I do not have the availability of a car"
"I do not have the availability of a bike"		

Table 2: Different sorts of vehicle ownership

3.3 Hypotheses

As mentioned by various studies, mobility sharing is beneficial for the society of Rotterdam. Due to the shift from rural areas to cities, the density of residents, cars and housing within cities increases. In turn, this might cause overuse of infrastructure, public spacing and the environment (While & Whitehead, 2013; Scott, 2008). As part of the 'City Deal', the province of Zuid-Holland and the municipality of Rotterdam are aiming to use (electric) mobility sharing services to unload the use of cars and to address parking problems in public spaces (City Deal, 2018). This indicates that the municipality of Rotterdam and other parties are actively pursuing possible solutions for their problems.

The first sub-question identifies whether citizens of Rotterdam – when they do not participate in mobility sharing - estimate the price of mobility sharing appropriately. Mobility sharing has intrinsic and extrinsic motivations (Hamari, Sjöklin, & Ukkonen, 2015). However, Hars & Ou (2001) pinpoint that motives for participating in an open-source development (i.e. sharing economy) are mainly extrinsic and, therefore, for economic benefits only. If a citizen of Rotterdam does not participate in mobility sharing, even though vehicle sharing is less expensive (ANWB, n.d.), it might be the case that citizens of Rotterdam fail to estimate the price of mobility sharing appropriately. Hence, the first hypothesis is:

- *H_0: Citizens of Rotterdam who do not participate in mobility sharing, do not estimate the price of mobility sharing appropriately.*

This hypothesis will be tested by calculating the mean of the estimation – given by the citizens of Rotterdam - of each shared mobility service. This value will be compared to the actual price of the respective mobility sharing service. The actual price will be calculated by computing the average price of the most-used companies for each mobility sharing service individually.

The second sub-question aims to determine how ownership of a vehicle affects monthly spending on mobility sharing. According to Bondorová & Archer (2017), each added shared car replaces 5 – 15 privately owned cars. Meaning, shared cars are substitutes for privately owned cars. Therefore, if a citizen of Rotterdam does not have the availability of a privately owned car it might be more inclined to use a shared car. This results in increased monthly spending on a shared car. The same might occur with monthly spending on shared bikes and shared scooters by the citizens of Rotterdam. Hence, the second hypothesis is:

- *H_0: Owning a vehicle (e.g. bike, scooter or car) has a negative effect on monthly spending on mobility sharing.*

The hypothesis will be tested using three linear regressions. These regressions assume monthly spending on a shared bike, shared scooter and shared car as dependent variables. The independent variables are dummy variables of the different sorts of vehicle ownership (Table 2). However, these variables are combined into dummy variables of owning a vehicle or not owning a vehicle in order to create a more explanatory regression. In Table 3 the combination of these dummy variables are presented.

Bike		Scooter		Car	
Owning	Not owning	Owning	Not owning	Owning	Not owning
"I own a bike"	"I sometimes have the availability of a bike"	"I own a scooter"	"I sometimes have the availability of a scooter"	"I own a car"	"I sometimes have the availability of a car"
"I am leasing a bike"	"I make use of a shared bike"		"I make use of a shared scooter"		"I make use of a shared car"
	"I do not have the availability of a bike"		"I do not have the availability of a scooter"		"I do not have the availability of a car"

Table 3: Creation of dummy variables out of vehicle ownership

Except for the dependent variables, regressions for monthly spending on a shared scooter and shared car are equal to the regression of monthly spending on a shared bike. Addionally, the regression regarding monthly spending on a shared bike assumes that owning a bike can be either privately owned, or a leased bike. Below, all three regressions are presented.

$$MonthlySpendingSharedBike = Owning\ a\ bike * \beta_1 + Not\ owning\ a\ bike * \beta_2 + Owning\ a\ scooter * \beta_3 + Not\ owning\ a\ scooter * \beta_4 + Owning\ a\ car * \beta_5 + Not\ owning\ a\ car * \beta_6 + \varepsilon$$

$$MonthlySpendingSharedScooter = Owning\ a\ bike * \beta_1 + Not\ owning\ a\ bike * \beta_2 + Owning\ a\ scooter * \beta_3 + Not\ owning\ a\ scooter * \beta_4 + Owning\ a\ car * \beta_5 + Not\ owning\ a\ car * \beta_6 + \varepsilon$$

$$MonthlySpendingSharedCar = Owning\ a\ bike * \beta_1 + Not\ owning\ a\ bike * \beta_2 + Owning\ a\ scooter * \beta_3 + Not\ owning\ a\ scooter * \beta_4 + Owning\ a\ car * \beta_5 + Not\ owning\ a\ car * \beta_6 + \varepsilon$$

The third sub-question aims to identify how the frequency of the use of mobility sharing is affected by different sorts of vehicle ownership. As mentioned before, Bondorová and Archer (2017) state that car sharing services decrease the total amount of kilometres driven in cars. The total amount of kilometres driven could be correlated to car use in terms of days (e.g. daily, weekly, monthly, yearly). The same effect might be observed in scooter and bike usage. Therefore, the hypothesis of the third sub-question is:

- *Owning a vehicle (e.g. bike, scooter or car) has a negative effect on the frequency of the use of mobility sharing.*

This hypothesis will be tested by using three different crosstab analyses for bike sharing, scooter sharing and car sharing. This will be presented with percentages of each sort of vehicle ownership for each mobility sharing service.

Section 4 Descriptive statistics

In this section of the research, the descriptive statistics of the data set and the survey will be presented. The descriptive statistics will provide an overview of all demographic characteristics of the respondents and variables of interest for this research. This section is divided in descriptive statistics gathered from the omnibus Enquête, and descriptive statistics gathered from the mobility sharing survey.

4.1 Omnibus Enquête

The data set produced by the Omnibus Enquête is used to identify problems in the city of Rotterdam. By conducting the 'Omnibus Enquête', a data set is gathered with 24,587 respondents divided over the years 2001 to 2018.

4.1.1 Omnibus Enquête – Age

The age of the respondents in the Omnibus Enquête 2001 to 2018 range from 13 to 102. The mean of the respondents is 47.82 and the data is normally distributed across all age groups. Besides that, age differs 17.94 years from the mean on average (e.g. standard deviation) (Table 4). As can be seen in Figure 7, the ages between 25 and 65 are best represented. The remaining ages are less represented. An overview of all ages can be found in Appendix A.

	N	Minimum	Maximum	Mean	Standard deviation
Omnibus 2001 - 2018	24,569	13	102	47.82	17.94

Table 4: Omnibus Enquête - Age

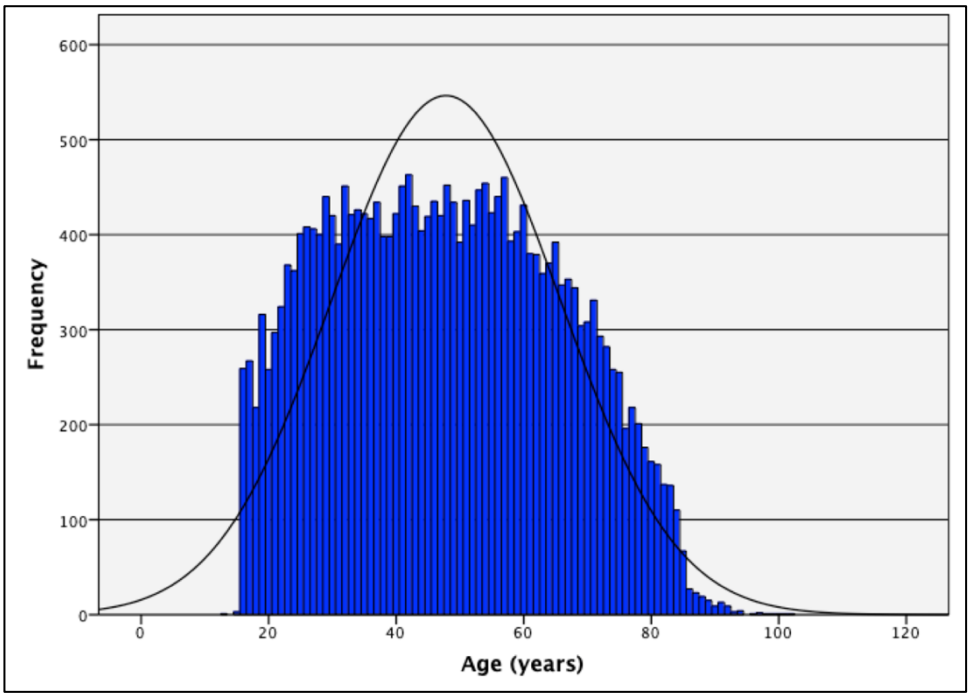

Figure 7: Omnibus Enquête - Age distribution

4.1.2 Omnibus Enquête – Car ownership

The differences in car ownership from 2001 to 2018 can be seen in Figure 8. It can be determined that most respondents own one car, and this remains approximately the same in the years from 2001 to 2012. After 2012, the line fluctuates more and has an outlier in 2016 where it increases to 57.4 per cent. The group that owns no cars has increased in 2018 compared to 2017. However, this group used to be slightly above 30 per cent and since 2016 it decreased slightly below 30 per cent. The line that represents owners of two cars, fluctuates from 2001 to 2018. Additionally, in 2016 the line decreases to its minimum (e.g. 11 per cent) and the next year it increases to its maximum (e.g. 19 per cent). Despite this, the group that owns two cars has decreased over the past two years. It is possible that car owners shifted from owning two cars to one car. The group that owns three cars or more, has remained similar in the years up to 2016. After 2016 it increased from 2 per cent to 3 per cent on average. The data output can be found in Appendix B.

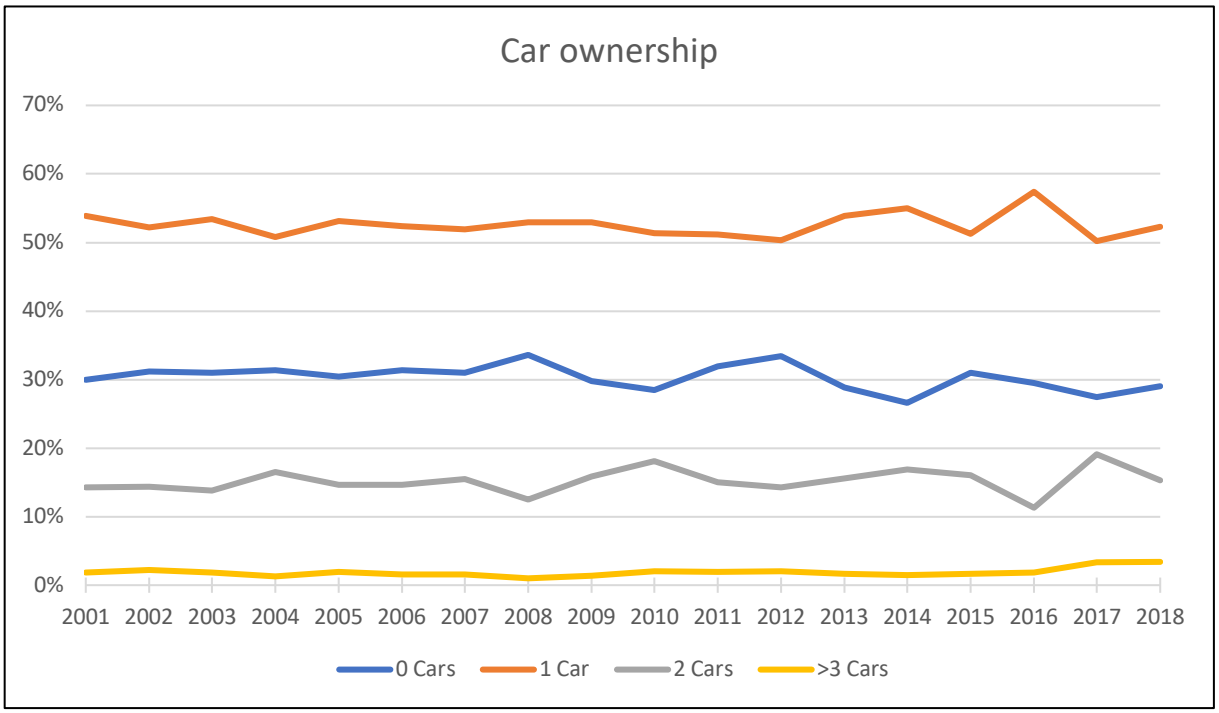

Figure 8: Omnibus Enquête - Car ownership Rotterdam

4.1.3 Omnibus Enquête – Car usage

In Figure 9, car usage of the respondents from the Omnibus Enquête from 2003 to 2018 is presented. '4-to-5-day car use', 'occasional car use' and '1-day car use' increased as of 2010 compared to the other categories. Except from the years 2007, 2008, 2010, 2015 and 2016, most respondents use their car 'almost every day'. In before mentioned exceptional years, the group that never uses their car is the largest. However, in this group, respondents without an answer are included as well. This might lead to biased outcomes. Additionally, when comparing 2003 to 2018, the different categories of car use converged over the years. The full data output of car usage can be found in Appendix C.

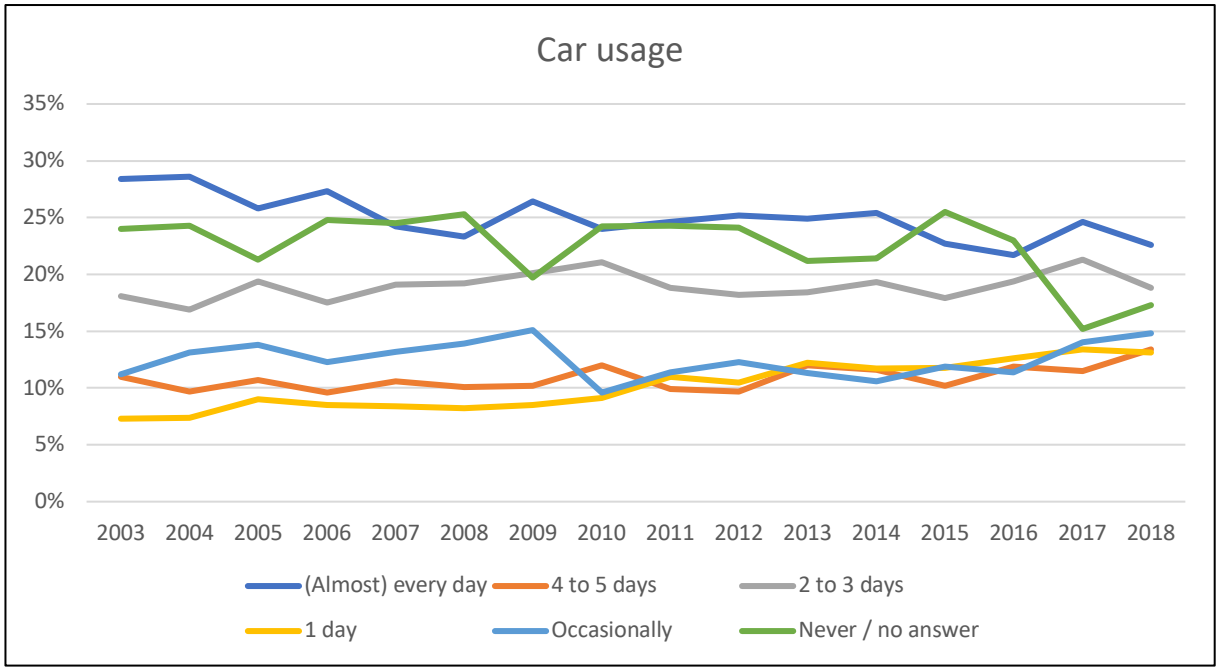

Figure 9: Omnibus Enquête - Car usage Rotterdam

4.1.4 Omnibus Enquête – Car flow in Rotterdam

In Figure 10 the opinion of the respondents on car flow in Rotterdam from 2003 to 2018 can be observed. Except from the years 2013 to 2016, most respondents argue that the flow of traffic in Rotterdam is negative. On average, 40 per cent of the respondents opine that traffic flow in Rotterdam is positive. Comparing 'very negative' and 'very positive', it can be observed that a larger part of the respondents argue that traffic flow is 'very negative'. Additionally, since 2016 the differences between 'negative' and 'positive', and 'very negative' and 'very positive' have diverged. The full output can be found in Appendix E.

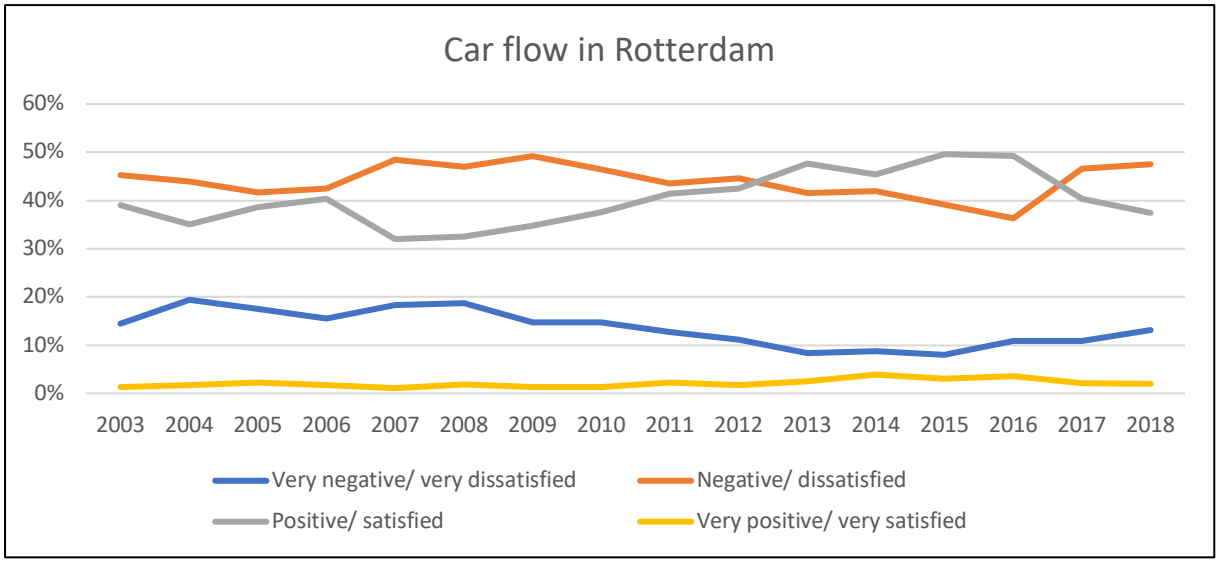

Figure 10: Omnibus Enquête - Car flow Rotterdam

4.1.5 Omnibus Enquête – Parking possibilities in Rotterdam

In Figure 11, the opinion of respondents with regard to parking possibilities is presented. This opinion is, compared to the car flow in Rotterdam, more positive. In 2003 most respondents opine that parking in Rotterdam is 'very negative'. From 2004 to 2016, this group of respondents reduced. However, most respondents still consider parking possibilities to be 'negative'. Despite that, the group of respondents that consider parking possibilities to be 'positive', is growing. Moreover, after 2016 most respondents argue that the possibilities are 'positive'. Furthermore, the group of respondents that consider parking possibilities to be 'very positive' is increasing in size as well. The full data output can be found in Appendix F.

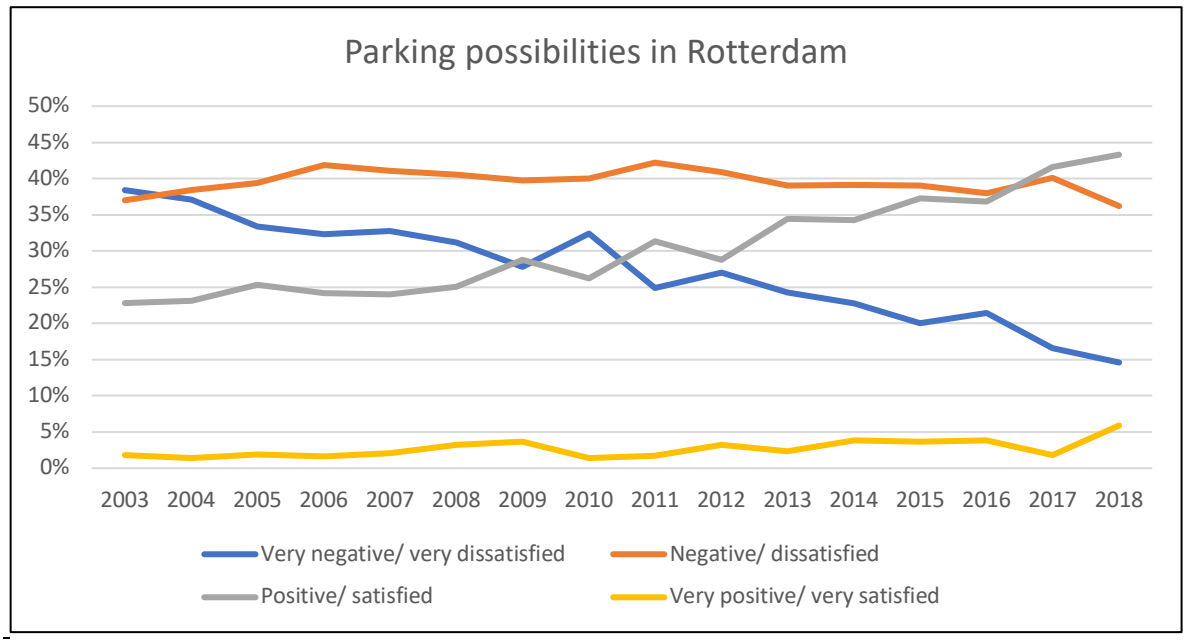

Figure 11: Omnibus Enquête - Parking possibilities Rotterdam

4.1.6 Omnibus Enquête - Conclusion

The previous section aims to identify the problems in the city of Rotterdam. The key takeaways are that the age of the respondents in the Omnibus Enquête is equally distributed. Besides that, from 2001 to 2018, there is no significant difference in cars owned by respondents. Also, car usage has converged to one point. This means that there are less evident individual habits in car usage of the respondents. In addition, opinions on the flow of cars in Rotterdam have worsened and opinions of parking possibilities in Rotterdam have improved.

4.2 Mobility sharing survey

The second part of this section discusses the descriptive statistics of the mobility sharing survey. Some of these questions will be used to answer the research questions and others will be used merely for the purpose of describing the data set.

4.2.1 Mobility sharing survey – Age

The age of the respondents in the mobility sharing survey range from 20 to 54 years – with a mean of 28.32 years. The standard deviation is 9.92, meaning that the average age differs 9.92 years from the mean of the data sample (Table 5). Besides, not all ages are represented equally; a large gap between the ages of 33 and 44 can be observed, and above 44 merely a few ages are represented. Therefore, the ages of 20 to 25 are abundant compared to the other ages. This results in a distribution that is right-skewed (Figure 12). The data output of all ages can be found in Appendix D.

	N	Minimum	Maximum	Mean	Standard deviation
Mobility sharing survey	75	20	54	28.32	9.92

Table 5: Mobility sharing survey - Age

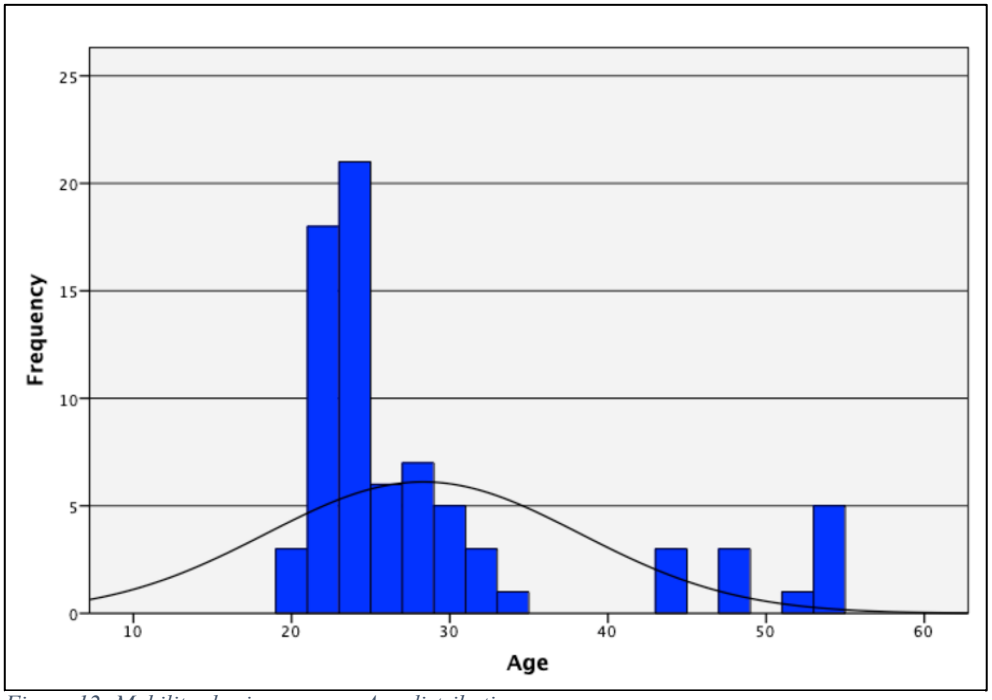

Figure 12: Mobility sharing survey - Age distribution

4.2.2 Mobility sharing survey – Residency

The mobility sharing survey collected data from 76 respondents. Of 76 respondents, 27 indicated they do not live in Rotterdam. These 27 respondents are asked whether they live near Rotterdam (e.g. Alblasserdam, Albrandswaard, Barendrecht, Capelle aan den IJssel, Krimpen aan den IJssel,

Lansingerland, Nieuwerkerk aan den IJssel, Rhoon, Ridderkerk, Schiedam, Spijkenisse, Vlaardingen or Zwijndrecht) or not. 12 respondents indicated they do not live in one of the beforementioned cities. Because this research aims to discover the impact of mobility sharing on Rotterdam, these respondents are filtered out of the data sample. Besides, one respondent generated a missing value. Therefore, the number of respondents for the mobility sharing survey is reduced to 63 (Table 6).

Question:	Yes	No	Missing
"Do you live in Rotterdam?"	49	27	1
"Do you live in one of these cities?" (see above)	15	12	0
Total	63	39	1

Table 6: Mobility sharing survey - Question regarding residency

4.2.3 Mobility sharing survey – Mobility sharing

In the survey, respondents are divided in two groups, based on whether they used mobility sharing services in the past twelve months. Both groups filled out different versions of the survey. In Table 7, the results for this division can be found. 73 per cent of the respondents used mobility sharing services in the past twelve months and 27 per cent of the respondents did not use the service in the past twelve months.

Question:	Frequency	Per cent
"Did use mobility sharing services in the past 12 months "	46	73
"Did not use mobility sharing services in the past 12 months"	17	27
Total	63	100

Table 7: Mobility sharing survey - Question regarding use of mobility sharing

4.2.4 Mobility sharing survey – Distribution of services

Table 8 shows that 23 respondents used a shared bike in the past twelve months. This is 50 per cent of all respondents who indicated they used mobility sharing services. With regard to shared scooters, 82.60 per cent of the respondents used the service. This is a significant part of the users of mobility sharing services. Furthermore, none of the respondents used a shared car in the past twelve months.

	Frequency	Per cent
Shared bike	23	50.00
Shared scooter	38	82.60
Shared car	0	0.00

Table 8: Mobility sharing survey - Distribution of services

Evidently, when asked how much a shared car is used, all respondents answer 'never'. In 54.30 per cent of the cases, the shared scooter is used monthly. When comparing this to the shared bike, the largest group is the yearly user. Therefore, it can be determined that a shared scooter is used more often than a shared bike (Figure 13). The full data output can be found in Appendix G.

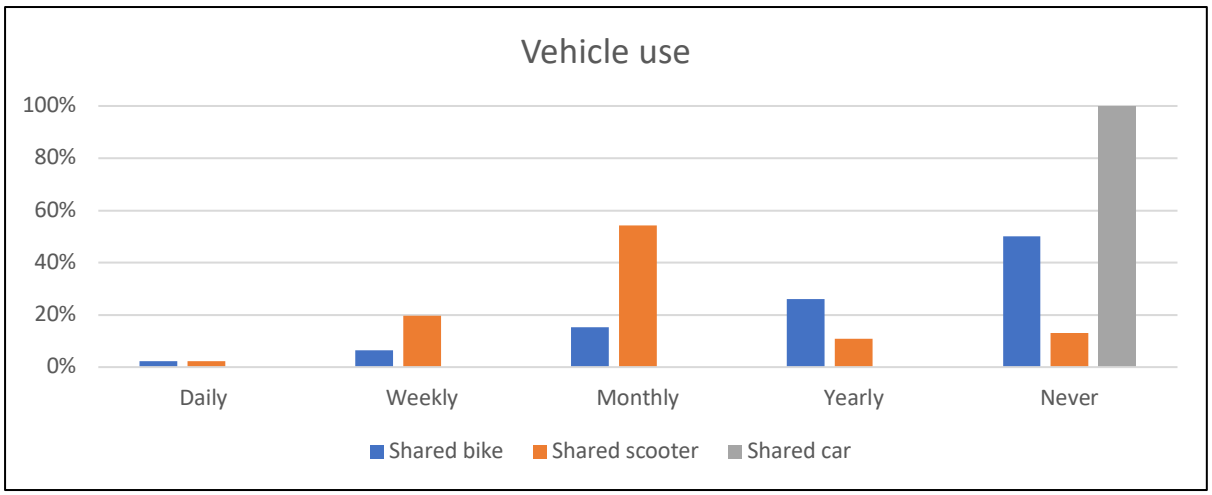

Figure 13: Mobility sharing survey - Usage of services

4.2.5 Mobility sharing survey – Price

One of the differences between the survey for people who use mobility sharing services, and people who do not, is a question regarding price. Respondents who did not use mobility sharing services the past twelve months, are asked what they expect the prices of mobility sharing is. Respondents who used mobility sharing services in the past 12 months are asked how much they spent monthly on mobility sharing services.

	N	Minimum	Maximum	Mean	Standard deviation
Bike	17	0.04	0.34	0.12	0.08
Scooter	17	0.11	0.50	0.29	0.11
Car	17	0.20	1.00	0.59	0.21

Table 9: Mobility sharing survey – Price estimation

Respondents who never used mobility sharing services assume that bikes are most inexpensive. The mean of scooters is slightly higher than bikes, however, it is considerably lower than cars. The standard deviations of bikes and scooters are relatively low, meaning the average answer does not differ substantially from the mean. Cars, however, have a significantly higher standard deviation compared to bikes and scooters. This means the answers of the respondents are less alike (Table 9).

Respondents who have used mobility sharing services, spent, on average, 9.29 euro on scooter sharing. The mean of bike sharing is 1.91. This is significantly less than the amount spent on scooter sharing. Considering that bike sharing is cheaper, it can be determined that bikes are used less than scooters. Besides that, on average 0.04 euro is spent on car sharing and it is, therefore, the least used sharing service compared to scooters and bikes (Table 10).

	N	Minimum	Maximum	Mean	Standard deviation
Bike	45	0.00	12.00	1.91	3.32
Scooter	45	0.00	35.00	9.29	9.20
Car	45	0.00	2.00	0.04	0.30

Table 10: Mobility sharing survey - Monthly spending

4.2.6 Mobility sharing survey – Motives

There is another difference between the survey for people who use mobility sharing services and people who do not. Namely, the users of mobility sharing services are asked what their motives are to use the service. The other respondents are asked why they do not use the services. Firstly, the users of mobility sharing services have the following answer options: practical reasons, environmental reasons, financial reasons or other reasons. In Figure 14a it can be seen that nearly 95 per cent of the respondents use mobility sharing services for practical reasons. Also, 22 per cent of the users use it because it is less expensive than owning a vehicle (e.g. financial). Only 4 per cent of the respondents use a shared vehicle for environmental reasons. The remaining respondents indicate they use a shared vehicle for other reasons.

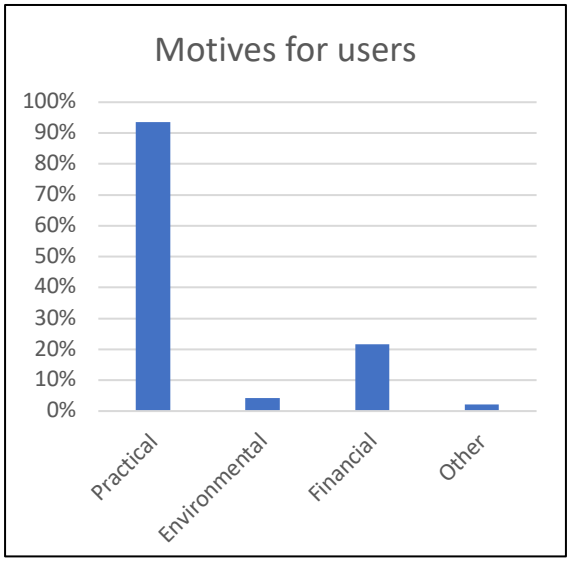

Figure 14a: Mobility sharing survey - Motives for users

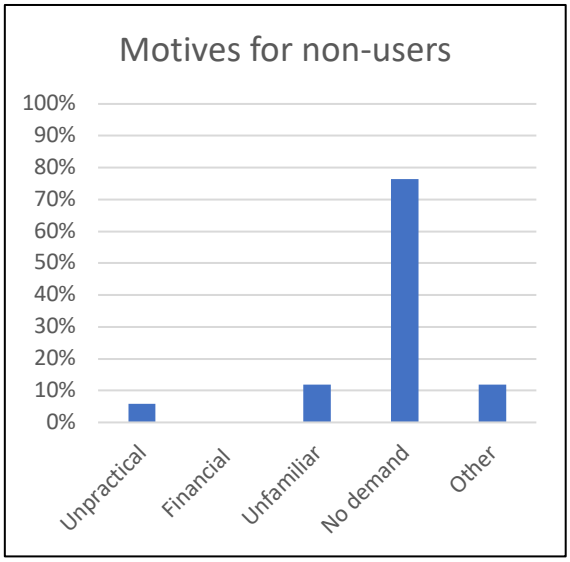

Figure 14b: Mobility sharing survey - Motives for non-users

Secondly, respondents who do not use mobility sharing services have the following answers options: not practical, too expensive (e.g. financial), unfamiliar, no demand for or other. In Figure 14b it can be seen that over 75 per cent of the respondents do not use mobility sharing services because they indicate they do not need them (e.g. no demand). 12 per cent of the respondents point out they are not familiar with mobility sharing services, and another 12 per cent has other reasons for not using the services. Additionally, 6 per cent opine that mobility sharing services are not practical and that they, therefore, not use them. Besides, none of the respondents indicate they do not use the services because it is too expensive. The full data output of both groups can be found in Appendix H.

4.2.7 Mobility sharing survey – Vehicle ownership

With regard to vehicle ownership, 71 per cent of the respondents own a bike and 59 per cent owns a car. The group that owns a scooter is considerably smaller in terms of size. Also, 9 per cent of the respondents leases a bike (e.g. SwapFiets). However, for leasing scooters and cars, no data is available. Additionally, over 40 per cent of the respondents do not have a scooter available. Furthermore, similar to other descriptive statistics, it can be determined that none of the respondents use a shared car (Figure 15). The full data output for vehicle ownership can be found in Appendix I.

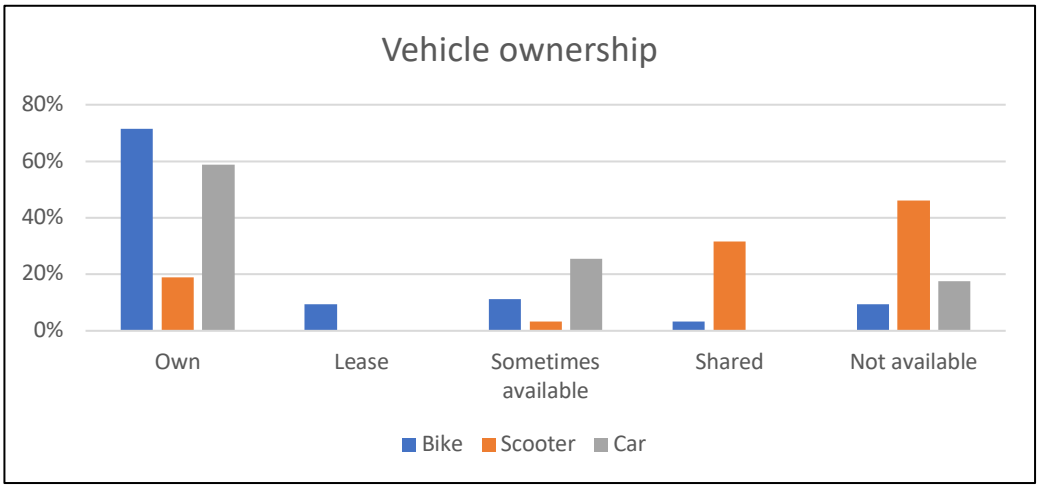

Figure 15: Mobility sharing survey - Vehicle usage

4.2.8 Mobility sharing survey – Substitutes

The results of Figure 16 show for each shared vehicle the most likely substitute. It can be determined that most respondents would substitute their shared vehicle for public transport. Also, 25 per cent of the respondents indicate they would substitute their privately-owned bike for either a shared bike or a shared scooter. Furthermore, a shared bike is the best substitute for both a scooter and for walking. The full data output can be found in Appendix J.

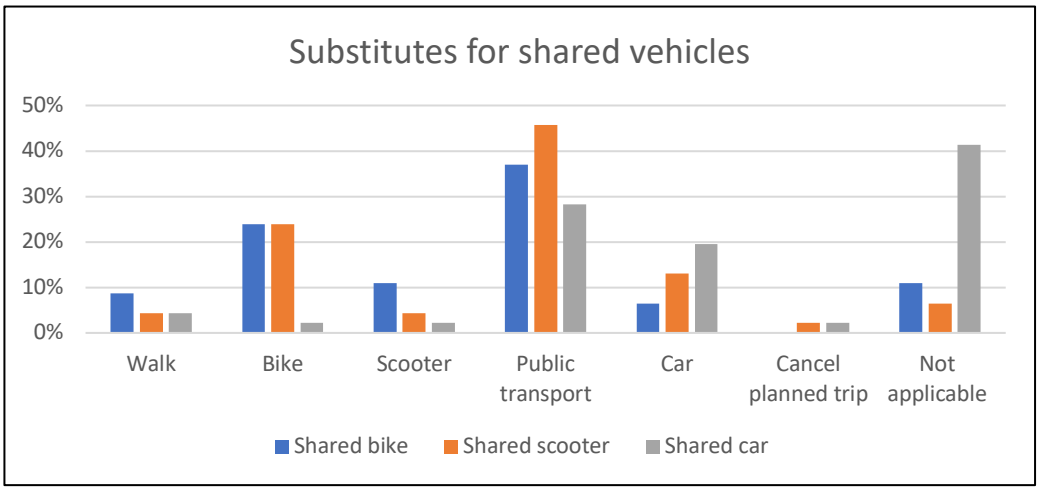

Figure 16: Mobility sharing survey - Substitutes

Section 5 Results

In the following section the results with regard to three sub-questions will be presented. Firstly, the price estimation will be discussed. Then, the regression of the monthly spending on mobility sharing will be presented. Lastly, the crosstab analysis of usage of mobility sharing will be examined.

5.1 Price estimation for non-users

As mentioned before, respondents of the survey are separated based on whether they have used mobility sharing services in the past twelve months or not. This led to a separation of 27 per cent who did not use mobility sharing services and 73 per cent who did use mobility sharing services (Table 5, section 4.2.3). Both groups were presented with a different version of the question regarding motives.

The 27 per cent who did not use mobility sharing services were asked: “What are your reasons for not using mobility sharing services?”. The respondents had the available answers: not practical, too expensive (e.g. financial), unfamiliar, no demand for, or other. In Figure 14b in section 4.2.6, it can be observed that none of the respondents indicated they did not use mobility sharing services for financial reasons (e.g. it was too expensive). To identify why none of the respondents indicated that price is a motive for not using mobility sharing services, a question regarding the estimation of the price is analysed. Namely, “How much do you estimate mobility sharing services to cost?”. The mean of this question for all three sharing services can be found in Table 11.

To compare the mean of the estimation to the actual price, the average costs of the actual price of mobility sharing services are computed. For this computation, the average costs for the most-used suppliers of mobility sharing services are used. The list of most-used shared bike suppliers can be found in Table 1 in section 2.2.3. Besides that, the costs for shared bikes are calculated based on euros per minute. Shared scooters only have one supplier, so no additional calculation of the average costs is required. The list of most-used shared car suppliers is presented in section 2.1.1. The price of sharing cars has a fixed part and a variable part. The average price for using a shared car in this calculation is based on using a car for one hour and a distance of fifty kilometres. The complete computation of the average costs for bikes and cars can be found in Appendix K.

	Mean respondents’ estimate (€)	Average costs (€/min)	Difference (€)
Bike	0.12	0.04	0.08
Scooter	0.29	0.30	- 0.01
Car	0.59	0.33	0.26

Table 11: Respondents' estimation of mobility sharing services

As shown in Table 11, on average, respondents estimate the costs per minute for bikes to be 12 eurocents. The actual average price is actually three times less. Therefore, the estimation of respondents is 8 eurocents higher than the actual price of bike sharing per minute. The estimation of the price of shared scooters is accurate. Respondents estimate the price for shared scooters to be 29 eurocents and the actual costs are 30 eurocents. Therefore, the difference is merely 1 eurocent and can be neglected. With regard to shared cars, respondents estimate the price to be 59 eurocents. However, the actual average price of shared cars per minute is limited to 33 eurocents. This results in a difference of 26 eurocents per minute, which is approximately 50% higher than the actual price.

5.2 Monthly spending of users

As described earlier, 73 per cent of the respondents did use mobility sharing services in the past twelve months (Table 7, section 4.2.3). For these respondents, the question regarding price changes into: "What do you spent monthly on mobility sharing services?". To analyse whether monthly spending on mobility sharing services is affected by ownership of either cars, scooters or bikes, three linear regressions are produced. In this regression, monthly spending on cars, scooter and bikes are dependent variables and the different sorts of vehicle ownership are independent dummy variables. For these independent variables it must be taken into account that individual dummy variables have been combined into dummy variables of owning a vehicle or not.

Model	Unstandardized Coefficients		Standardized coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	-15.997	4.481		-3.570	0.001**
Owning a bike	4.041	2.255	0.529	1.792	0.081*
Not owning a bike	3.679	2.144	0.508	1.716	0.094*
Not owning a scooter	1.799	1.402	0.186	1.283	0.207
Owning a car	11.726	3.233	1.781	3.627	0.001**
Not owning a car	12.230	3.258	1.861	3.753	0.001**

*Table 12: Regression with dependent variable monthly spending on a shared bike. * 0.10 & ** 0.05*

In Table 12, the results of the regression with monthly spending on shared bikes as the dependent variable and ownership as independent variables can be seen. Considering that 'owning a scooter' is the reference variable, the beta of the constant indicates that respondents who own a scooter monthly pay -15.997 for shared bikes. This value is negative because for every vehicle, one of the dummy values must be added to this value. Ultimately, this value will end up positive. Furthermore, when comparing the betas of scooter ownership, the betas point out that owners of a bike pay - compared to not owning

a bike – 0.362 euros more for a shared bike. However, owners of a scooter pay monthly 1.799 less on a shared bike. Similar, when comparing the betas of car ownership, owners of a car monthly pay 0.504 less on a shared bike. However, the significance of 'Not owning a scooter' is below the confidence level of 10%. Therefore, no statistical conclusions can be drawn from this variable. With regard to significance of the rest of the betas, the betas are significant on either 10% or 1%-confidence level. Despite that, the key insight from this regression is that owning a scooter or car has a negative effect on monthly spending on a bike.

Model	Unstandardized Coefficients		Standardized coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	19.640	14.015		1.401	0.169
Owning a bike	-1.583	7.052	-0.075	-0.224	0.824
Not owning a bike	4.417	6.705	0.220	0.659	0.514
Not owning a scooter	-1.446	4.386	-0.054	-0.330	0.743
Owning a car	-7.886	10.111	-0.432	-0.780	0.440
Not owning a car	-10.171	10.191	-0.559	-0.998	0.324

Table 13: Regression with dependent variable monthly spending on a shared scooter

In Table 13, the output of the regression with monthly spending on shared scooters as the dependent variable and ownership as independent variables can be seen. The reference variable of the regression is 'Owning a scooter'. Therefore, the beta of the constant indicates that users of a shared car spent, on average, 19.640 each month on shared scooters. When comparing the betas of bike ownership, it can be determined that owners of a bike monthly pay 6.000 euros less on shared scooters than respondents who indicate they do not own a bike. Despite that, owners of a scooter pay monthly 1.446 euros more on a scooter – taking into account that the reference variable is 'Owning a scooter'. In addition, owners of a car also pay more for a shared scooter. When comparing betas, it can be determined that owners pay 2.285 euros more on a shared scooter. However, significance levels of all betas are above a usual significance level of 10%. Therefore, no statistical conclusions can be drawn from these outcomes.

As mentioned before, none of the respondents indicated that they have used a shared car. Therefore, the third regression with monthly spending on shared cars as the dependent variable and the different variables of ownership as independent variables produced no outcomes. Thus, this regression will not be discussed.

5.3 The effect of ownership on shared vehicle usage

In Figure 17, a crosstab analysis is presented to examine the effect of different sorts of vehicle ownership on the use of a shared bike. It can be seen that owning a bike has a clear effect on shared bike usage; 50 per cent of the respondents indicate they never use a shared bike when they own a bike. If respondents lease a bike, the group that never uses a shared bike decrease in terms of size. Additionally, the group of weekly users of a shared bike increase in size. However, leasing a bike and owning a bike is similar. Therefore, it should not change the results regarding shared bike use. Moreover, the largest group of daily bike users can be seen in relation to respondents who indicate they sometimes have the availability of a bike. However, in contradiction to beforementioned, 83 per cent of the respondents that indicate they do not have the availability of a bike, never use a shared bike. Figure 13 also shows that 83 per cent of scooter owners never use a shared bike and 17 per cent uses a shared bike weekly. Comparing the different sorts of bike ownership to the different sorts of scooter ownership, scooters are less likely to be replaced by a shared bike. Therefore, it can be determined that bike ownership has a larger effect on shared bike usage.

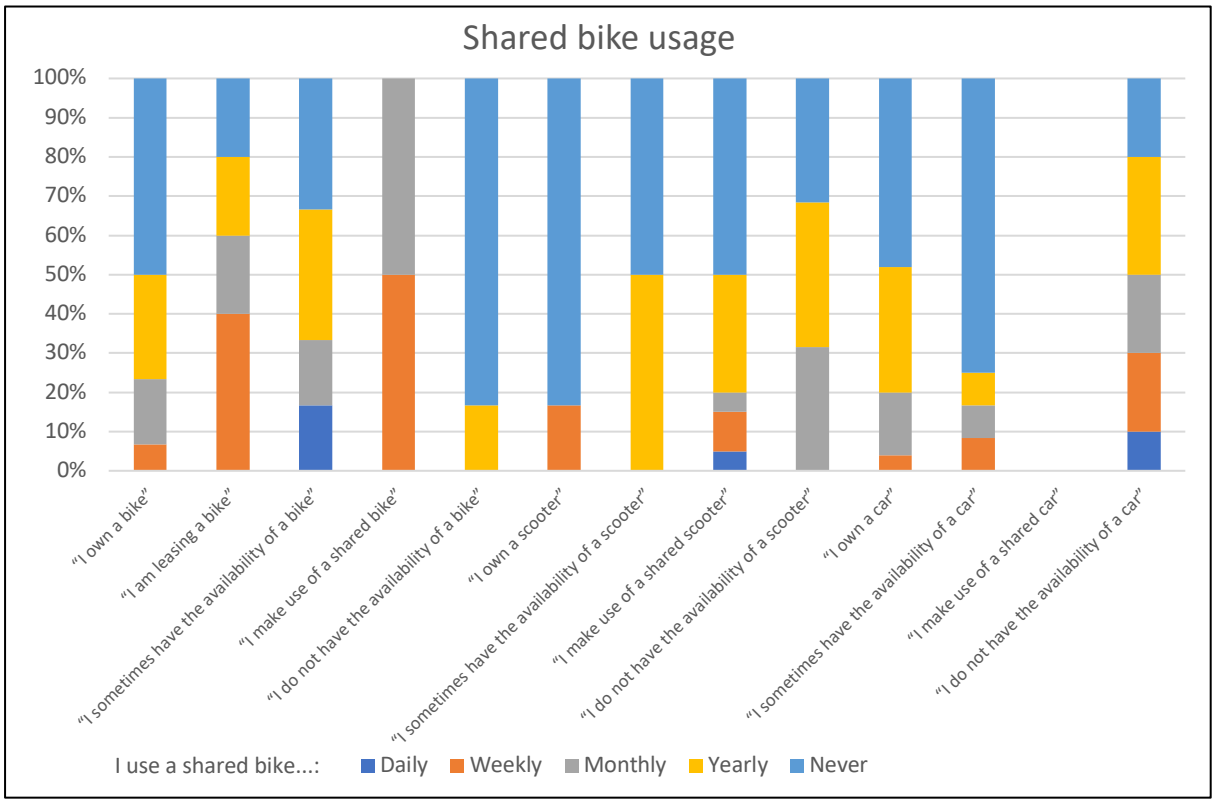

Figure 17: Crosstab analysis shared bike usage

With regard to car ownership, owning a car seems to have a smaller effect on never using a shared bike than owning a scooter. This is a contradiction of the fact that scooters cannot be replaced with shared bikes, as mentioned before. Respondents that indicate they sometimes have the availability of a car or no availability of a car show different outcomes. In Figure 17, it can be seen that a large group never use a shared bike when they sometimes have the availability of a car. Furthermore, when respondents have no availability of a car, 10 per cent uses a shared bike on a daily basis.

In Figure 18, a second crosstab analysis is presented. This shows the effect of different sorts of vehicle ownership on the use of a shared scooter. The effects of owning a bike and leasing a bike on the use of a shared scooter are similar. Besides that, monthly shared scooter use is 50 per cent on average, regardless of the sort of bike ownership. However, weekly shared scooter use varies between 2 per cent and 50 per cent. Furthermore, 83 per cent of the scooter owners, indicate they use a shared scooter monthly. Besides that, 100 per cent of the respondents that sometimes have a scooter available, use a shared scooter weekly. In addition, merely 5 per cent of the shared scooter users, use a shared scooter on a daily basis. With regard to car ownership, the group that never uses a shared scooter is 15 per cent. The size of this group decreases to 8 per cent when respondents indicate they sometimes have a car available. However, in case respondents do not have a car available, the size increases to 10 per cent.

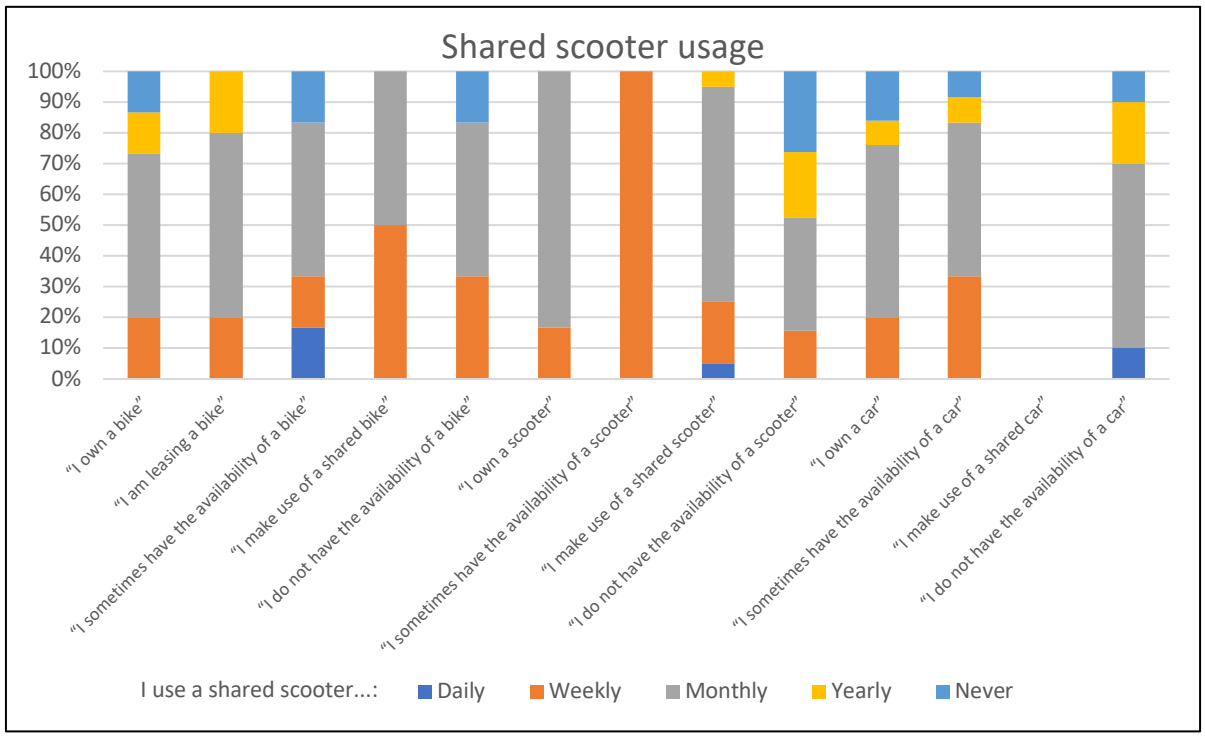

Figure 18: Crosstab analysis shared scooter usage

Despite this, the group that uses a shared scooter on a daily basis increases in terms of size as well. Overall, this crosstab analysis suggests that monthly shared scooter use does not change significantly for the different sorts of car, scooter and bike ownership. However, weekly shared scooter use seems to be affected by car, scooter and bike ownership. The full data output for both crosstab analyses can be found in Appendix L.

Section 6 Conclusion

The aim of this Bachelor Thesis is to identify factors that influence the usage of mobility sharing services and how they impact the society of Rotterdam. Hence, the following research question was proposed:

"*What factors influence the use of mobility sharing services and how do they impact the society of Rotterdam?".*

However, this research question was too broad to be answered individually. Therefore, in order to answer the main research question, three sub-questions were proposed and assessed in this research, led by literature review, descriptive statistics, hypotheses and an analysis. First, a literature review was conducted to assess the situation with regard to transportation in- and outside Rotterdam. Additionally, data was used to strengthen the assessment of the situation in Rotterdam. This data is gathered from the Omnibus Enquête, conducted with citizens of Rotterdam. Secondly, the data gathered by the mobility sharing survey was used for answering the three sub-questions. This section will conclude with the limitations of this research and a recommendation for the private and public sector with regard to mobility sharing.

6.1 Results of the literature review

In the literature review, the rise of The Sharing Economy was described. This economy is built on two concepts. Firstly, the idea that businesses want to adapt to a more sustainable business strategy to create company longevity, while taking into account their ecological footprint (Haanaes, 2016). Secondly, consumers desire a more sustainable manner of consuming (Young, Hwang, McDonald, & Oates, 2009). Combining these two concepts led to the creation of The Sharing Economy. Besides the concepts that created this economy, The Sharing Economy is enabled by IT drivers that increased its ability to grow (Puschmann & Alt, 2016). According to Hamari, Sjöklin, & Ukkonen (2015), there are four motives for people to participate in a sharing economy. These motives are sustainability, enjoyment, reputation and economic benefits. They were used throughout this research and will support answering the research question.

The Sharing Economy can be divided in four categories. The second category is increased utilisation of durable assets and includes mobility sharing (Schor, 2016). In the Netherlands three different vehicles used for mobility sharing are available. Firstly, cars are shared by a variety of providers which uses five

different manners of sharing. Namely, 'roundtrip carsharing', 'one-way carsharing', 'peer-to-peer carsharing', 'local community carsharing' and 'business carsharing' (Kennisplatform CROW, n.d.b). 'Roundtrip carsharing' is most commonly used and operates with a same pick-up point and drop-off point for their vehicles. Secondly, scooters are being shared by merely one provider called Felyx. Felyx scooters are 'free-floating', meaning they can be parked anywhere within their service area (Felyx, s.d.). Thirdly, bike sharing is the most voluminous in terms of providers and shared bikes. They are shared via three different sharing methods: 'back-to-one bike sharing', 'back-to-many bike sharing' and 'free-floating bike sharing'. However, it is hard to assess the volume of this market, because providers do not share data.

To identify the effects of mobility sharing on the society of Rotterdam, it is of importance to discover the advantages and disadvantages of mobility sharing. This research identified four advantages and two disadvantages. According to KiM (2015), car sharing results in a decrease of 0.13 cars owned per household and car sharing decreases vehicle usage. Additionally, KiM (2015) states that car sharing has decreased average number of kilometres driven each year with 1,600. Both decrease of car ownership and car usage results in an improvement of environmental sustainability. Namely, as reported by KiM (2015) and Nijland, van Meerkerk and Hoen (2015), carsharing reduces CO2-emission with 175 to 265 kilograms each year. Additionally, Loose (2010) pinpoints that the fleet of car sharing providers consists of new, light, fuel-efficient cars that have less impact on the environment compared to older cars. The last advantage of mobility sharing, identified in this research, is a decrease in use of space. Meijkamp (2000) reports that mobility sharing requires fewer parking spaces. This results in a gain in public space and could lead to an improvement in parking and traffic problems.

In this research two disadvantages are identified. Firstly, nuisance across cities in terms of vehicles. The vast number of shared bikes has led to an overpopulation of bikes in cities. Additionally, some providers went bankrupt and abandoned their bikes in Rotterdam (Keunen, 2018). Secondly, additional car use because of substitute effects from shared cars. Bondorová and Archer (2017) state that carsharing systems compete with mass transportation systems. This results in decreased use of public transport, which is proven to be more beneficial for the environment. However, this disadvantage only relates to car sharing. Bike sharing and scooter sharing are no substitutes for public transport, rather for walking (Finger, Bert, Kupfer, Montero, & Wolek, 2017).

Prices of mobility sharing are different for all vehicles. Firstly, cars are most expensive. 'Peer-to-peer' carsharing uses a daily fee, which ranges from 20 euros to 500 euros. Additionally, the user is billed 20 eurocents per kilometre on average. Secondly, users of shared scooters and bikes are billed in the

same manner; they have to pay for used time. For example, Felyx charges its users 30 eurocents per minute and Mobike charges its users 50 eurocents per 30 minutes.

6.2 Results of the Omnibus Enquête

To further assess the situation in Rotterdam with regard to traffic-related problems, results of four different questions in the Omnibus Enquête were analysed. Firstly, results of car ownership from 2001 to 2018 were examined. The data shows that most people own one car, followed by zero cars, two cars and three cars. Even though there are some fluctuations in car ownership between 2016 and 2017, the differences over the years 2001 to 2018 are minor. Secondly, results of car usage from 2003 to 2018 were examined. It was observed that 'every day' car usage has decreased. However, the group of respondents who 'never' use their car has decreased as well. Therefore, key insight from this analysis is that car usage has converged and that there are less habits with regard to car usage. Thirdly, the opinions regarding car flow in Rotterdam from 2003 to 2018 were examined. Car flow in Rotterdam has been more negative than positive up to 2012. In 2012 this opinion changed to more positive than negative. However, as of 2017, these opinions have returned to more negative than positive. This implies that car flow in Rotterdam has worsened. The cause of this traffic-related problem might be increased car ownership, leading to more congestion in Rotterdam. Lastly, opinions regarding parking possibilities were examined. These opinions have been predominantly negative in the years from 2003 to 2016. Despite this, as of 2017, most opinions are positive. This might be the merits of regulatory changes, initiated by the municipality of Rotterdam to change parking possibilities in the city. However, the negative opinions are still present among residents of Rotterdam

6.3 Results of the mobility sharing survey

As mentioned earlier, the main research question was too broad to be answered individually. Therefore, three different sub-questions were proposed. In the following sections, all three sub-questions will be discussed, and the hypotheses will be rejected or accepted. The first sub-question is:

"How do citizens of Rotterdam estimate the price of mobility sharing when they do not participate in mobility sharing?"

The hypothesis of this sub-question is that non-users fail to estimate the price of mobility sharing correctly. Data from the mobility sharing survey shows that estimation of the costs for sharing bikes and cars is incorrect. The respondents estimated the price, respectively, three times and two times higher than the actual price. On the other hand, estimation of shared scooters is correct. This might

be a motive for non-users to not participate in mobility sharing. Despite this, when respondents are asked for their motives to not participate in mobility sharing, financial motives are not present. Therefore, their actual motives are up for discussion. Concluding, the hypothesis is partially true. Therefore, the hypothesis will not be rejected.

"How does ownership of a vehicle affect monthly spending on mobility sharing?"

The hypothesis for the abovementioned second sub-question is that ownership of a vehicle has a negative impact on monthly spending on mobility sharing. However, the results from the regression analyses show that bike ownership does not have a negative impact on the amount of money spent on a shared bike. Nevertheless, scooter and car ownership do have a negative effect on money spent on a shared bike. Similarly, bike ownership has a negative impact on monthly spending on a shared scooter as well. However, scooter ownership and car ownership do not have a negative impact on monthly spending on a shared scooter. Therefore, it can be stated that the results of this sub-question are ambiguous, and the hypothesis will be rejected.

The third sub-question is similar to the second sub-question in terms of the effect it aims to measure. It used a crosstab analysis to assess the effect of multiple sorts of vehicle ownership on the frequency of the use of mobility sharing. Hence, the third sub-question is:

"How do different sorts of vehicle ownership affect the frequency of the use of mobility sharing?"

The hypothesis of this sub-question is that owning a vehicle has a negative effect on the frequency of the use of vehicle sharing. In terms of shared bike usage, owning a bike or scooter represents the largest groups of respondents that indicate they never use a shared bike. This implicates that bike and scooter ownership does have a negative effect on shared bike usage. However, car owners do not represent the largest group of respondents that indicate they never use a shared bike. Therefore, car ownership does not necessarily have a negative effect on shared bike usage. In terms of shared scooter usage, owning a bike, scooter or car does not result in never using a shared scooter. Rather, the groups of daily-, weekly-, monthly-, yearly- and non-users remain approximately the same for the different sorts of vehicle ownership. Due to the fact that owning a bike or scooter has a negative effect on shared bike use, the hypothesis can be partially accepted. However, with regard to shared scooter usage, the hypothesis will be rejected.

Combining the results from the literature review, Omnibus Enquête and the mobility sharing survey, it is possible to answer the main research question. This research identified vehicle ownership to be one of the main factors that influence mobility sharing. Namely, vehicle ownership does have a negative effect on monthly spending on mobility sharing and on the usage of mobility sharing. However, the effects on monthly spending are ambiguous and the effect on usage of mobility sharing is merely partially negative. Therefore, with the data gathered in this research, it can be concluded that vehicle ownership does not have an effect on mobility sharing. With regard to the impact on the society of Rotterdam, mobility sharing is proven to have a negative effect on car usage, car ownership, use of space and a positive effect on sustainability of the environment. All those four effects are beneficial for the city of Rotterdam (KiM, 2015; Nijland, van Meerkerk and Hoen, 2015). Moreover, the Omnibus identified parking and traffic flow to be problematic in Rotterdam and decreased use of space, car usage and car ownership might improve the severity of these problems. Therefore, it can be concluded that mobility sharing services are beneficial for the society of Rotterdam.

6.4 Recommendations

The results of this research might be useful for policymakers for mobility sharing services. The following section discusses recommendations for the public sector and the private sector in Rotterdam. Firstly, mobility sharing services are proven to be beneficial for the city. The municipality could stimulate growth of mobility sharing services by funding mobility sharing start-ups or facilitating the efficient deployment of their vehicles. However, the municipality should aim for controlled growth. As mentioned, exponential growth of mobility sharing services might result in nuisances such as overpopulation of mobility sharing vehicles. The responsibility for the municipality is to investigate actual demand and set barriers for mobility sharing providers to prevent the city from overpopulation of sharing vehicles. Secondly, the private sector (e.g. mobility sharing providers) could benefit from the fact that non-users of mobility sharing services estimate the price incorrectly. They can either advertise with their prices in such a way that non-users estimate the price appropriately, or simply increase the price. The former might lead to an increase in demand - since a new target group is addressed which, in turn, results in an increase in revenue - and the latter might lead to increased revenue through the currently existing users. However, for the city of Rotterdam, the former is more beneficial, because the latter might lead travellers away from using mobility sharing services due to increased price.

6.5 Limitations and directions for further research

Even though this research possibly developed some useful insights, it also contains some limitations. The most important limitation of this research is the low number of respondents in the mobility sharing survey. The survey gathered data from merely 75 respondents, of which only 63 contained useful data. This led to a low N and resulted in a decrease in significance for the performed regressions. Therefore, for further research it is advised to use a larger sample size to increase N and the significance. Also, the ages of the respondents in the mobility sharing survey are not equally distributed. This could lead to an inadequate rendition of the population of Rotterdam. Another limitation – which might be enlarged by the low number of respondents – is the lack of respondents who have used a shared car. Therefore, important analyses, such as regression and crosstab analysis with data from shared car users could not be performed, and this decreases the overall relevance of the study. For further research it might be valuable to include other cities. This thesis was aimed merely at the city of Rotterdam, which might harm the external validity of the study; all finding in this study might not be valid for other cities in, and outside the Netherlands. Lastly, mobility sharing services is a recent development, which causes less scientific research to be available. Therefore, some of the sources used in this thesis, are not scientific.

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Appendix A

Age in years – Omnibus Enquête				
Age	Frequency	Per cent	Valid Per cent	Cumulative Per cent
13	1	0.0	0.0	0.0
15	3	0.0	0.0	0.0
16	259	1.1	1.1	1.1
17	267	1.1	1.1	2.2
18	218	0.9	0.9	3.0
19	316	1.3	1.3	4.3
20	258	1.1	1.1	5.4
21	297	1.2	1.2	6.6
22	324	1.3	1.3	7.9
23	368	1.5	1.5	9.4
24	362	1.5	1.5	10.9
25	401	1.6	1.6	12.5
26	408	1.7	1.7	14.2
27	406	1.7	1.7	15.8
28	400	1.6	1.6	17.5
29	440	1.8	1.8	19.2
30	420	1.7	1.7	21.0
31	390	1.6	1.6	22.5
32	451	1.8	1.8	24.4
33	421	1.7	1.7	26.1
34	426	1.7	1.7	27.8
35	422	1.7	1.7	29.5
36	417	1.7	1.7	31.2
37	434	1.8	1.8	33.0
38	398	1.6	1.6	34.6
39	398	1.6	1.6	36.2
40	422	1.7	1.7	38.0
41	451	1.8	1.8	39.8
42	463	1.9	1.9	41.7
43	430	1.8	1.8	43.4
44	404	1.6	1.6	45.1
45	419	1.7	1.7	46.8
46	435	1.8	1.8	48.6
47	420	1.7	1.7	50.3
48	452	1.8	1.8	52.1
49	434	1.8	1.8	53.9
50	392	1.6	1.6	55.5
51	436	1.8	1.8	57.2
52	410	1.7	1.7	58.9
53	447	1.8	1.8	60.7
54	454	1.8	1.8	62.6
55	423	1.7	1.7	64.3
56	440	1.8	1.8	66.1
57	460	1.9	1.9	68.0
58	393	1.6	1.6	69.6

59	403	1.6	1.6	71.2
60	431	1.8	1.8	73.0
61	380	1.5	1.5	74.5
62	379	1.5	1.5	76.0
63	359	1.5	1.5	77.5
64	370	1.5	1.5	79.0
65	392	1.6	1.6	80.6
66	347	1.4	1.4	82.0
67	353	1.4	1.4	83.5
68	344	1.4	1.4	84.9
69	304	1.2	1.2	86.1
70	308	1.3	1.3	87.3
71	331	1.3	1.3	88.7
72	293	1.2	1.2	89.9
73	282	1.1	1.1	91.0
74	258	1.1	1.1	92.1
75	255	1.0	1.0	93.1
76	196	0.8	0.8	93.9
77	218	0.9	0.9	94.8
78	201	0.8	0.8	95.6
79	176	0.7	0.7	96.3
80	161	0.7	0.7	97.0
81	158	0.6	0.6	97.6
82	137	0.6	0.6	98.2
83	136	0.6	0.6	98.8
84	110	0.4	0.4	99.2
85	67	0.3	0.3	99.5
86	27	0.1	0.1	99.6
87	23	0.1	0.1	99.7
88	19	0.1	0.1	99.8
89	15	0.1	0.1	99.8
90	9	0.0	0.0	99.8
91	13	0.1	0.1	99.9
92	9	0.0	0.0	99.9
93	3	0.0	0.0	100.0
94	4	0.0	0.0	100.0
96	1	0.0	0.0	100.0
97	2	0.0	0.0	100.0
98	1	0.0	0.0	100.0
99	1	0.0	0.0	100.0
100	1	0.0	0.0	100.0
101	1	0.0	0.0	100.0
102	1	0.0	0.0	100.0
Total	24,569	100.0	100.0	

Appendix B

Car ownership						
Year	0 Cars	1 Car	2 Cars	>3 Cars	Total	Sanity
2001	30.0%	53.9%	14.3%	1.8%	1591	100%
2002	31.2%	52.2%	14.4%	2.2%	1745	100%
2003	31.0%	53.4%	13.8%	1.8%	1810	100%
2004	31.4%	50.8%	16.5%	1.3%	1734	100%
2005	30.4%	53.1%	14.6%	1.9%	1561	100%
2006	31.4%	52.4%	14.6%	1.6%	1631	100%
2007	31.0%	51.9%	15.5%	1.6%	1487	100%
2008	33.6%	52.9%	12.5%	1.0%	1436	100%
2009	29.8%	52.9%	15.9%	1.4%	1435	100%
2010	28.5%	51.4%	18.1%	2.0%	1296	100%
2011	31.9%	51.2%	15.0%	1.9%	1263	100%
2012	33.4%	50.3%	14.3%	2.0%	1304	100%
2013	28.8%	53.9%	15.6%	1.7%	1225	100%
2014	26.6%	55.0%	16.9%	1.5%	1068	100%
2015	31.0%	51.3%	16.0%	1.7%	1092	100%
2016	29.5%	57.4%	11.3%	1.8%	926	100%
2017	27.4%	50.2%	19.1%	3.3%	943	100%
2018	29.0%	52.3%	15.3%	3.4%	1022	100%

Appendix C

Car usage							
Year	(Almost) every day	4 to 5 days	2 to 3 days	1 day	Occasionally	Never/ no answer	Sanity
2003	28.4	11.0	18.1	7.3	11.2	24.0	100%
2004	28.6	9.7	16.9	7.4	13.1	24.3	100%
2005	25.8	10.7	19.4	9.0	13.8	21.3	100%
2006	27.3	9.6	17.5	8.5	12.3	24.8	100%
2007	24.2	10.6	19.1	8.4	13.2	24.5	100%
2008	23.3	10.1	19.2	8.2	13.9	25.3	100%
2009	26.4	10.2	20.1	8.5	15.1	19.7	100%
2010	24.0	12.0	21.1	9.1	9.6	24.2	100%
2011	24.6	9.9	18.8	11.0	11.4	24.3	100%
2012	25.2	9.7	18.2	10.5	12.3	24.1	100%
2013	24.9	12.0	18.4	12.2	11.3	21.2	100%
2014	25.4	11.6	19.3	11.7	10.6	21.4	100%
2015	22.7	10.2	17.9	11.8	11.9	25.5	100%
2016	21.7	11.9	19.4	12.6	11.4	23.0	100%
2017	24.6	11.5	21.3	13.4	14.0	15.2	100%
2018	22.6	13.4	18.8	13.1	14.8	17.3	100.0

Appendix D

Age in years - mobility sharing survey				
Age	Frequency	Per cent	Valid Per cent	Cumulative Per cent
20	3	3.9	3.9	3.9
21	11	14.5	14.5	18.4
22	7	9.2	9.2	27.6
23	14	18.4	18.4	46.1
24	7	9.2	9.2	55.3
25	4	5.3	5.3	60.5
26	2	2.6	2.6	63.2
27	1	1.3	1.3	64.5
28	6	7.9	7.9	72.4
29	3	3.9	3.9	76.3
30	2	2.6	2.6	78.9
31	2	2.6	2.6	81.6
32	1	1.3	1.3	82.9
33	1	1.3	1.3	84.2
44	3	3.9	3.9	88.2
48	3	3.9	3.9	92.1
51	1	1.3	1.3	93.4
53	1	1.3	1.3	94.7
54	4	5.3	5.3	100.0
Total	76	100.0	100.0	

Appendix E

Opinions car flow Rotterdam				
	Very negative/ very dissatisfied	Negative/ dissatisfied	Positive/ satisfied	Very positive/ very satisfied
2003	14.4	45.2	39.0	1.3
2004	19.4	43.9	35.0	1.7
2005	17.5	41.7	38.6	2.3
2006	15.5	42.5	40.3	1.7
2007	18.3	48.5	32.0	1.1
2008	18.7	47.0	32.5	1.8
2009	14.7	49.2	34.8	1.3
2010	14.7	46.5	37.5	1.3
2011	12.8	43.5	41.4	2.2
2012	11.2	44.6	42.5	1.7
2013	8.3	41.5	47.7	2.5
2014	8.7	42.0	45.4	3.9
2015	8.0	39.2	49.6	3.1
2016	10.9	36.3	49.2	3.6
2017	10.9	46.6	40.4	2.1
2018	13.2	47.5	37.4	2.0

Appendix F

Opinions parking possibilities Rotterdam				
	Very negative/ very dissatisfied	Negative/ dissatisfied	Positive/ satisfied	Very positive/ very satisfied
2003	38.4	37	22.8	1.8
2004	37.1	38.4	23.1	1.4
2005	33.4	39.4	25.3	1.9
2006	32.3	41.9	24.2	1.6
2007	32.8	41.1	24	2.1
2008	31.2	40.5	25.1	3.2
2009	27.8	39.7	28.8	3.7
2010	32.4	40	26.2	1.4
2011	24.9	42.2	31.3	1.7
2012	27	40.9	28.8	3.2
2013	24.3	39	34.4	2.3
2014	22.8	39.1	34.3	3.8
2015	20	39	37.3	3.7
2016	21.4	38	36.8	3.8
2017	16.6	40.1	41.6	1.8
2018	14.6	36.2	43.3	5.9

Appendix G

Vehicle usage						
	Bike		Scooter		Car	
	Frequency	Per cent	Frequency	Per cent	Frequency	Per cent
Daily	1	2.2	1	2.2	0	0.0
Weekly	3	6.5	9	19.6	0	0.0
Monthly	7	15.2	25	54.3	0	0.0
Yearly	12	26.1	5	10.9	0	0.0
Never	23	50.0	6	13.0	46	100.0

Appendix H

Motives for users		
	Frequency	Per cent
Practical reasons	43	93.50
Environmental reasons	2	4.30
Financial reasons	10	21.70
Other	1	2.2

Motives for non-users		
	Frequency	Percent
Unpractical	1	5.9
Financial (too expensive)	0	0.0
Unfamiliar	2	11.8
No demand	13	76.5
Other	2	11.8

Appendix I

Vehicle ownership						
	Bike		Scooter		Car	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Own	45	71.4	12	19.0	37	58.7
Lease	6	9.5	n.a.	n.a.	n.a.	n.a.
Sometimes available	7	11.1	2	3.2	16	25.4
Shared	2	3.2	20	31.7	0	0.0
Not available	6	9.5	29	46.0	11	17.5

Appendix J

Alternatives for mobility sharing						
	Shared bike		Shared scooter		Shared car	
	Frequency	Per cent	Frequency	Per cent	Frequency	Per cent
Walk	4	8.7	2	4.3	2	4.3
Bike	11	23.9	11	23.9	1	2.2
Scooter	5	10.9	2	4.3	1	2.2
Public transport	17	37.0	21	45.7	13	28.3
Car	3	6.5	6	13.0	9	19.6
Cancel trip	0	0.0	1	2.2	1	2.2
Not applicable	5	10.9	3	6.5	19	41.3

Appendix K

Average price per minute – Bikes			
Company	Indicated price on website (time slots variate)	Price per minute	Source
Ov-fiets	€ 3,8500	€ 0,0027	Ovshop, n.d.
Urbee	€ 3,0000	€ 0,0500	Urbee, n.d.
GoBike	€ 0,0300	€ 0,0300	GoNike, n.d.
FlickBike	€ 1,0000	€ 0,0333	FlickBike, n.d.
Donkey Republic	€ 1,5000	€ 0,1000	Donkey Republic, n.d.
Hello-bike	€ 0,0500	€ 0,0500	Hello-bike, n.d.
Uw deelfiets	€ 2,0000	€ 0,0667	Uw Deelfiets, n.d.
Nextbike	€ 1,5000	€ 0,0500	Nextbike, n.d.
Hopper	€ 9,0000	€ 0,0063	Hopperpoint, n.d.
Mobike	€ 0,5000	€ 0,0167	Mobike, n.d.
(Ofo)	n.a.	n.a.	n.a.
(Obike)	n.a.	n.a.	n.a.
Average		€ 0,0406	

Average price per minute – Cars				
Company	Indicated price on website - fixed	Indicated price on website - variable	Price per minute	Source
Greenwheels	€ 6,000	€ 0,340	€ 0,383	Greenwheels, n.d.
ConnectCar	€ 3,050	€ 0,260	€ 0,268	ConnectCar, n.d.
MyWheels	€ 5,000	€ 0,270	€ 0,308	MyWheels, n.d.
SnappCar	€ 6,000	€ 0,320	€ 0,367	Snappcar, n.d.
Average			€0,331	

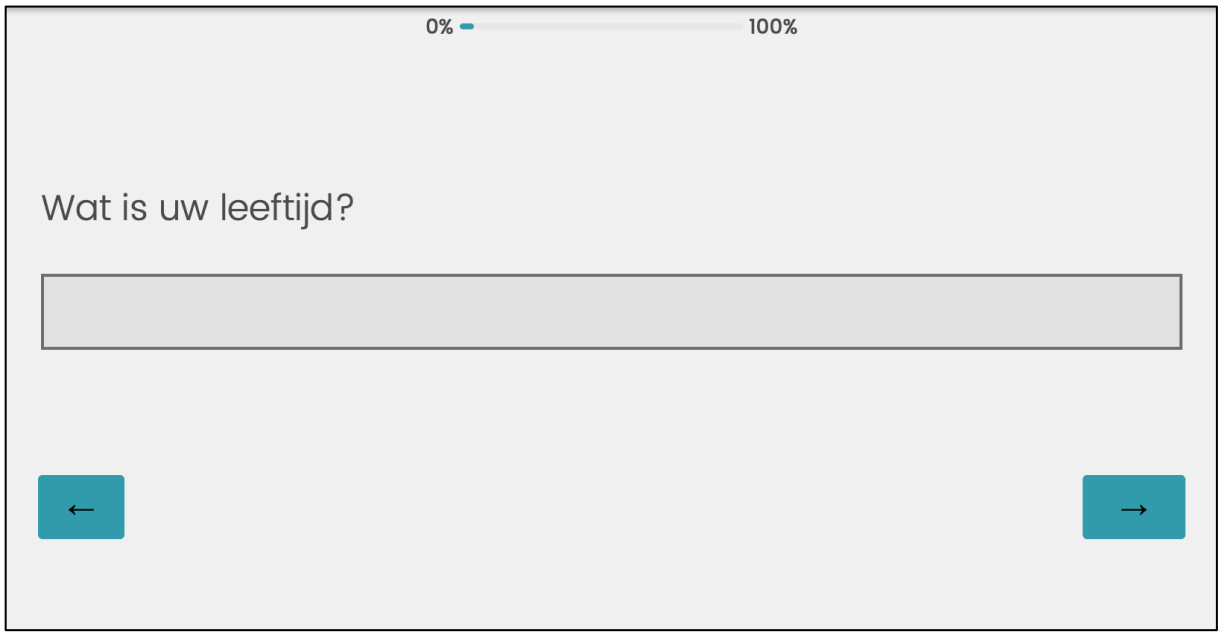
Appendix L

Crosstab analysis – Shared bikes					
	I use a shared bike…				
	Daily	Weekly	Monthly	Yearly	Never
"I own a bike"	0.0%	6.7%	16.7%	26.7%	50.0%
"I am leasing a bike"	0.0%	40.0%	20.0%	20.0%	20.0%
"I sometimes have the availability of a bike"	16.7%	0.0%	16.7%	33.3%	33.3%
"I make use of a shared bike"	0.0%	50.0%	50.0%	0.0%	0.0%
"I do not have the availability of a bike"	0.0%	0.0%	0.0%	16.7%	83.3%
"I own a scooter"	0.0%	167%	0.0%	0.0%	83.3%
"I sometimes have the availability of a scooter"	0.0%	0.0%	0.0%	50.0%	50.0%
"I make use of a shared scooter"	5.0%	10.0%	5.0%	30.0%	50.0%
"I do not have the availability of a scooter"	0.0%	0.0%	31.6%	36.8%	31.6%
"I own a car"	00%	4.0%	16.0%	32.0%	48.0%
"I sometimes have the availability of a car"	0,0%	8.3%	8.3%	8.3%	75.0%
"I make use of a shared car"	0,.0%	0.0%	0.0%	0.0%	0.0%
"I do not have the availability of a car"	10.0%	20.0%	20.0%	30.0%	20.0%

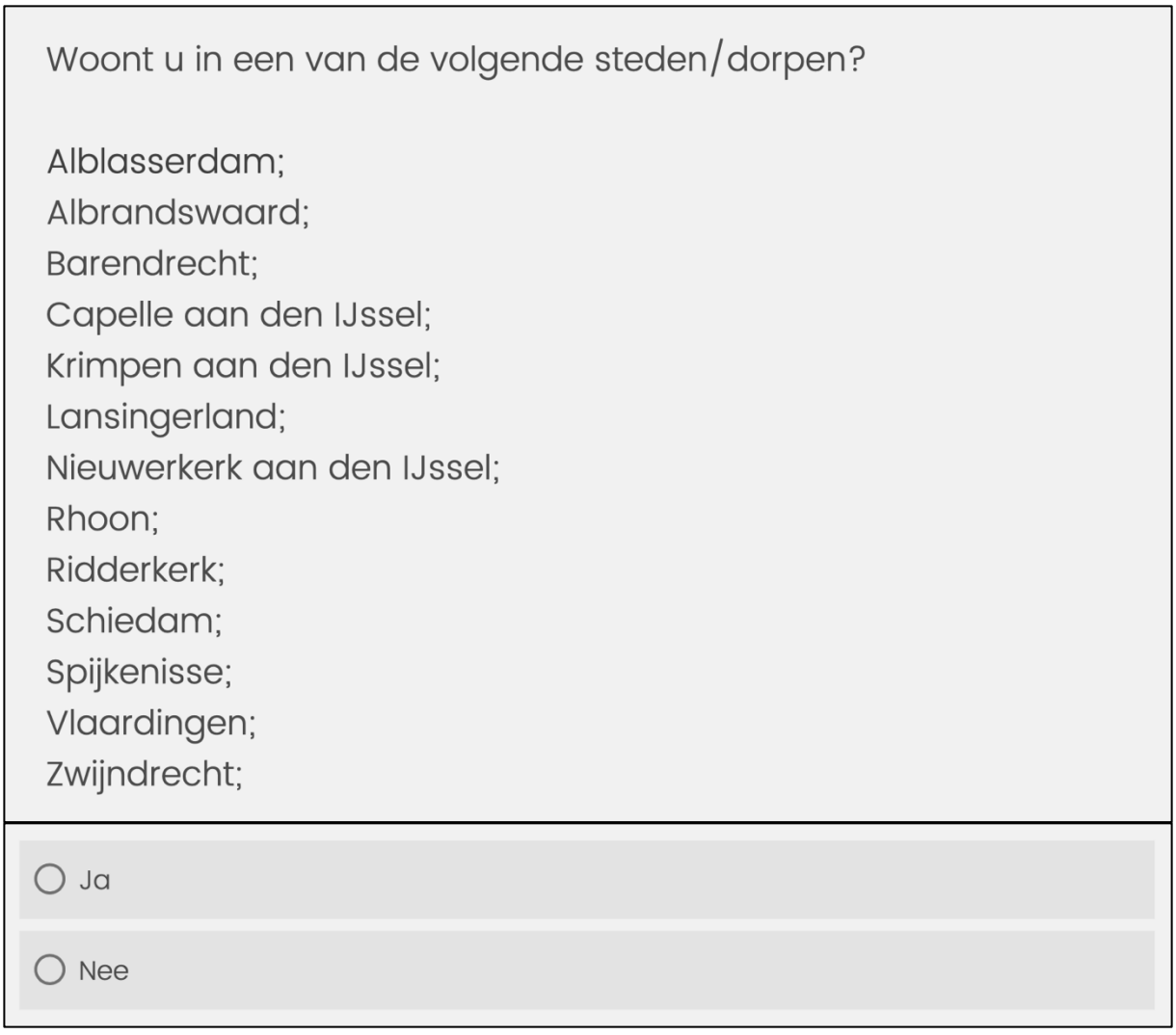
Crosstab analysis – Shared scooters					
	I use a shared scooter…				
	Daily	Weekly	Monthly	Yearly	Never
"I own a bike"	0.0%	20.0%	53.3%	13.3%	13.3%
"I am leasing a bike"	0.0%	20.0%	60.0%	20.0%	0.0%
"I sometimes have the availability of a bike"	16.7%	16.7%	50.0%	0.0%	16.7%
"I make use of a shared bike"	0.0%	50.0%	50.0%	0.0%	0.0%
"I do not have the availability of a bike"	0.0%	33.3%	50.0%	0.0%	16.7%
"I own a scooter"	0.0%	16.7%	83.3%	0.0%	0.0%
"I sometimes have the availability of a scooter"	0.0%	100.0%	0.0%	0.0%	0.0%
"I make use of a shared scooter"	5.0%	20.0%	70.0%	5.0%	0.0%
"I do not have the availability of a scooter"	0.0%	15.8%	36.8%	21.1%	26.3%
"I own a car"	0.0%	20.0%	56.0%	8.0%	16.0%
"I sometimes have the availability of a car"	0.0%	33.3%	50.0%	8.3%	8.3%
"I make use of a shared car"	0.0%	0.0%	0.0%	0.0%	0.0%
"I do not have the availability of a car"	10.0%	0.0%	60.0%	20.0%	10.0%

Appendix M

Mobility sharing survey



Residency selection process



Komt u tenminste één keer per jaar in Rotterdam?

- ◯ Ja
- ◯ Nee

→

The Sharing Economy control variable

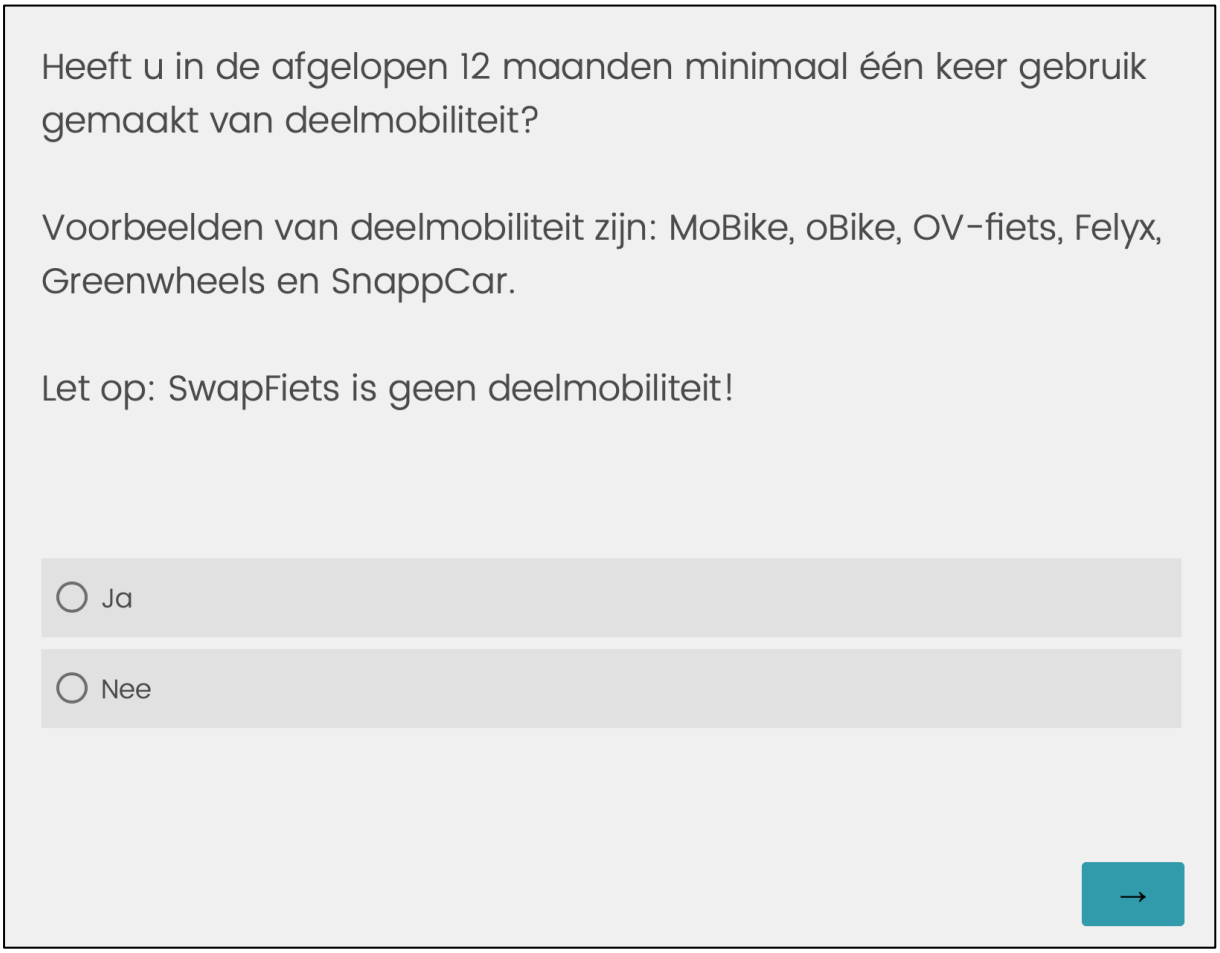
Een deeleconomie is een economisch systeem waarin consumenten collectief consumeren. Hierbij moet u denken aan het delen van diensten en materialen d.m.v. een abonnement of gebruikskosten.

Van welk van de volgende diensten heeft u in de afgelopen 12 maanden minimaal één keer gebruik gemaakt?

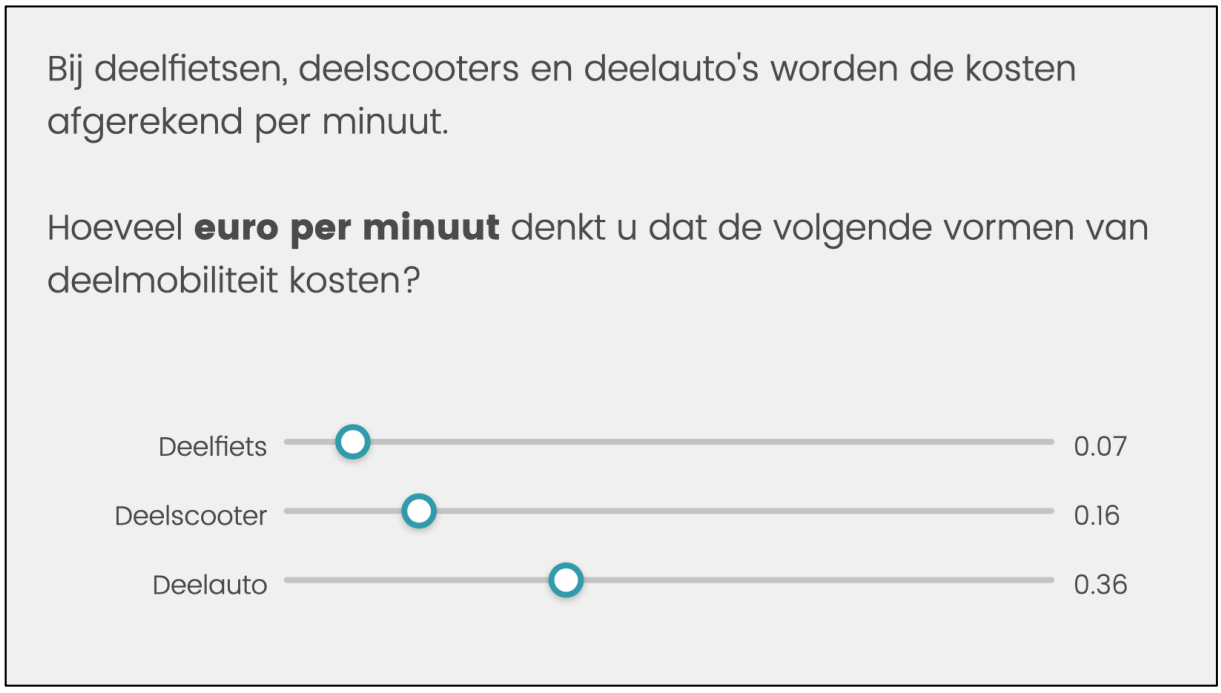
Er zijn meerdere antwoorden mogelijk

- ☐ Netflix
- ☐ Videoland
- ☐ Peerby
- ☐ Thuisafgehaald.nl
- ☐ Filedelen
- ☐ Airbnb

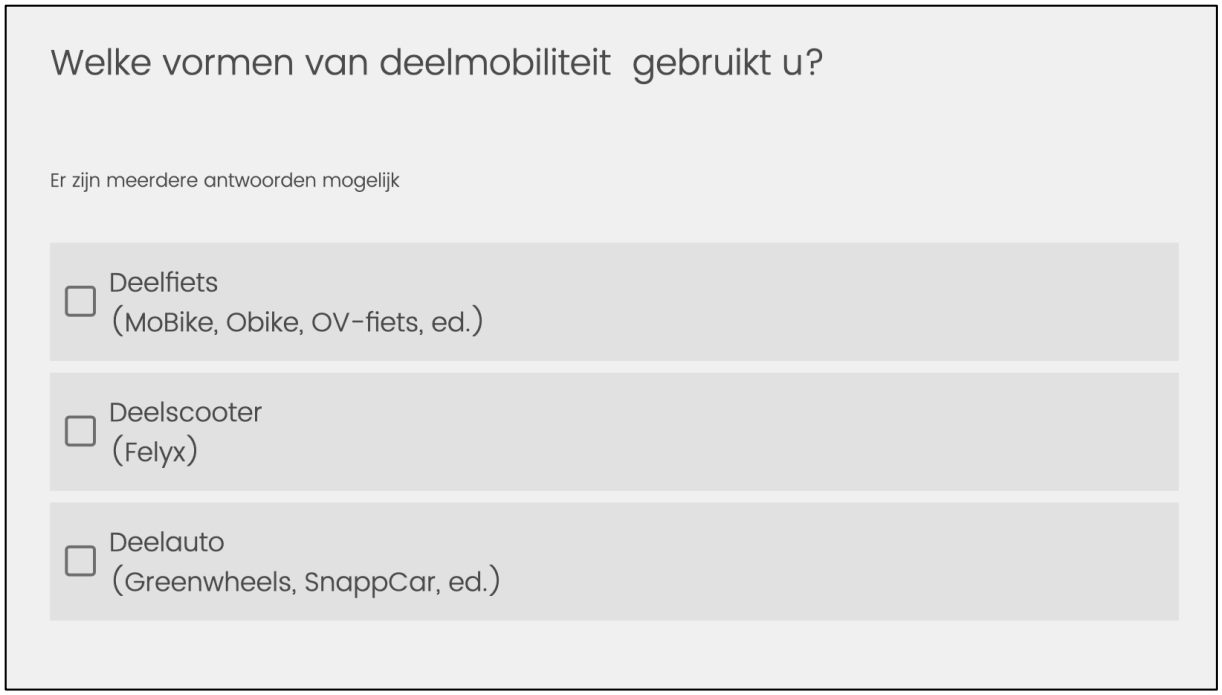
Mobility sharing selection process



Separate questions for non-users of mobility sharing



Separate questions for users of mobility sharing



Een deel**scooter** gebruik ik:

- ○ Dagelijks
- ○ Wekelijks
- ○ Maandelijks
- ○ Jaarlijks
- ○ Nooit

Een deel**fiets** gebruik ik:

- ○ Dagelijks
- ○ Wekelijks
- ○ Maandelijks
- ○ Jaarlijks
- ○ Nooit

Hoeveel euro betaalt u gemiddeld per maand voor de volgende vormen van deelmobiliteit?

Indien u geen gebruik maakt van een van de vormen van deelmobiliteit, voldoet "0" ook als antwoord.

Deelfiets	€ 0
Deelscooter	€ 0
Deelauto	€ 0
Totaal	€ 0

Waarom maakt u gebruik van deelmobiliteit?

Er zijn meerdere antwoorden mogelijk

- ☐ Praktische redenen
- ☐ Omwille van het millieu
- ☐ Goedkoper dan het hebben van een fiets, scooter en/of auto
- ☐ Anders

In de afwezigheid van een deelsfiets, welk vervoersmiddel zou u normaal gesproken gebruiken?

- ◯ Lopen
- ◯ Eigen fiets
- ◯ Scooter
- ◯ Openbaar vervoer
- ◯ Auto
- ◯ De geplande reis niet maken
- ◯ Niet van toepassing

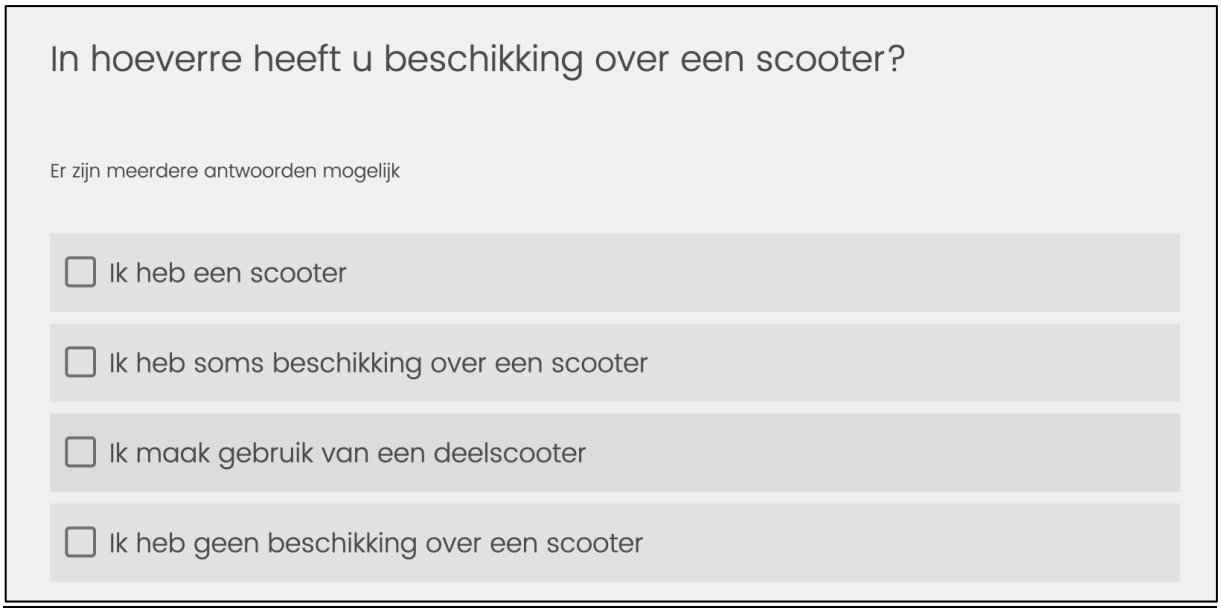
In de afwezigheid van een deelscooter, welk vervoersmiddel zou u normaal gesproken gebruiken?

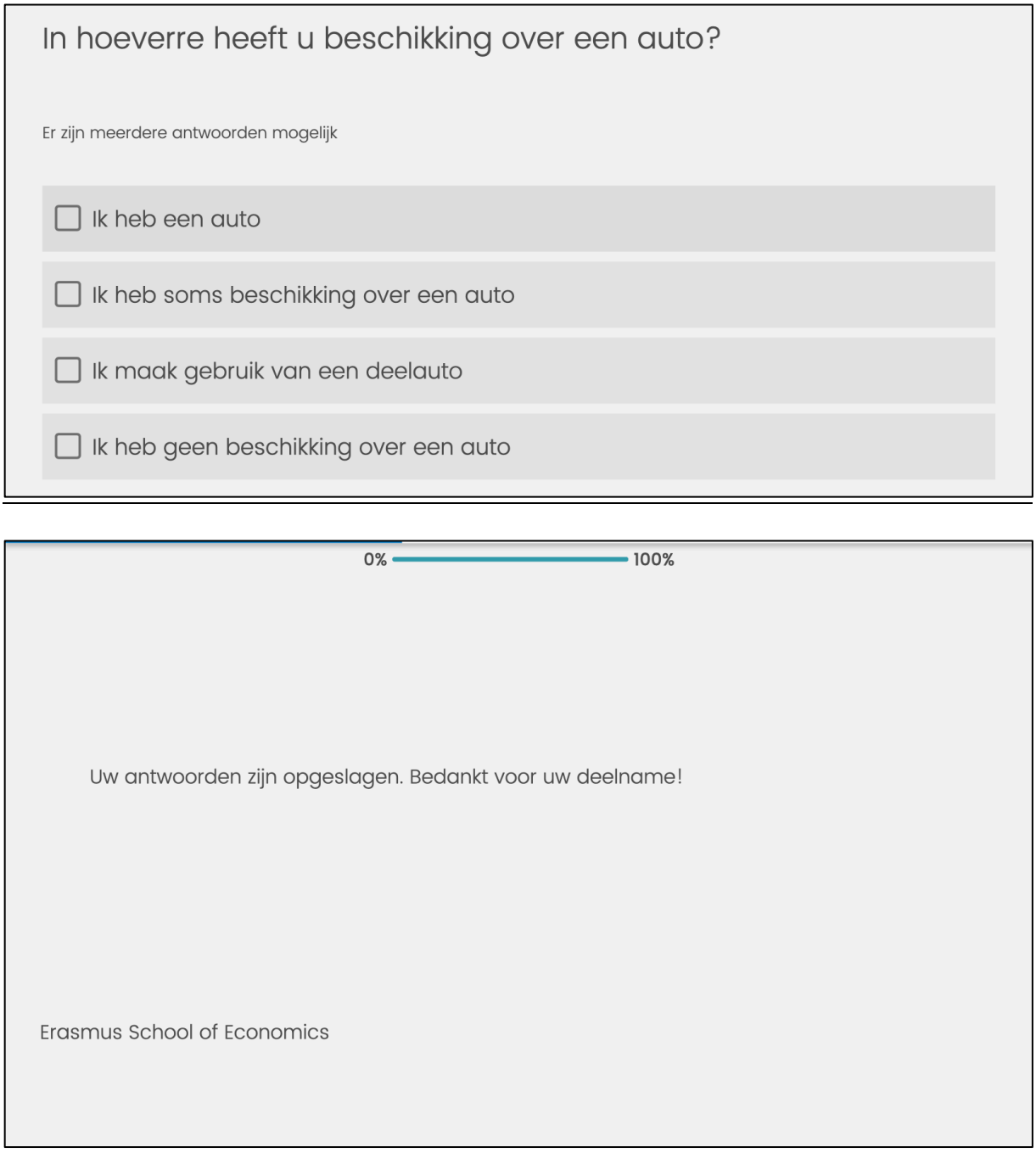
- ◯ Lopen
- ◯ Fiets
- ◯ Eigen scooter
- ◯ Openbaar vervoer
- ◯ Auto
- ◯ De geplande reis niet maken
- ◯ Niet van toepassing

In de afwezigheid van een deelauto, welk vervoersmiddel zou u normaal gesproken gebruiken?

- ◯ Lopen
- ◯ Fiets
- ◯ Scooter
- ◯ Openbaar vervoer
- ◯ Eigen auto
- ◯ De geplande reis niet maken
- ◯ Niet van toepassing

Combined questions for users and non-users




In hoeverre heeft u beschikking over een auto?
Er zijn meerdere antwoorden mogelijk
Ik heb een auto
Ik heb soms beschikking over een auto
Ik maak gebruik van een deelauto
Ik heb geen beschikking over een auto
0%
100%
Uw antwoorden zijn opgeslagen. Bedankt voor uw deelname!
Erasmus School of Economics