The sustainable urban transportation system transition: how shared e-scooters are perceived and used.

A case study on Felyx scooters in the city of Groningen, the Netherlands.

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Abstract

The current urban transportation systems ask for a more sustainable alternative due to climate change and increasing financial uncertainty. A solution would be the electrification of transportation modes such as shared e-scooters for short distance trips. These shared e-scooters allow for more flexibility, less traffic congestion and lower parking costs in cities. However, municipalities in Dutch cities are also experiencing nuisance caused by these shared e-scooters in terms of safety, vandalism and parking issues. So how successful are these shared e-scooters? The literature shows a gap as it mainly focuses on (shared) electric cars and the first shared e-scooters in Dutch cities were only introduced in 2020. This research is a case study on the city of Groningen and focuses on how shared e-scooters are perceived in three different neighbourhoods: Schildersbuurt, Reitdiep and Lewenborg-Zuid. By collecting data on accessibility, perception and the socio-economic characteristics of citizens on shared e-scooters by distributing surveys, doing observations and a GIS analysis, this research tries to provide an answer to the question: *How can shared EV contribute to the urban transportation system transition in the city of Groningen and how successful is it in different neighbourhoods?* The results show that there is potential for shared e-scooters to gain popularity and decrease private motorized vehicles, as people do think it can contribute to more liveable cities as it is a relatively cheap option. However, shared e-scooters sometimes lack availability as their location is dependent on the destination of their previous user. Furthermore, my findings suggest that the Dutch biking culture and non-users of shared e-scooters are more attached to their car causing it to be a less popular mode of transport.

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1. Introduction

1.1 Background

The current urban transportation systems are a large contributor to air pollution, greenhouse gas emissions, and traffic congestion (Curtale et al., 2021). The Sustainable Development Goals (UN, 2015) aim towards sustainable cities and communities, which ask for changes in society including urban mobility and thus a shift in the urban transportation system (Luna et al., 2020). And with the ongoing desire for the densification of urban areas, traffic congestion and emissions are likely to only increase, as densification does not necessarily imply lower private vehicle use (Schmidt-Thomé, 2013). A solution to the pollution caused by urban transportation systems is the electrification of public and private transportation modes which is gaining popularity. Municipalities and countries are implementing policy instruments to encourage electric vehicle (EV) adoption such as financial incentives (Egnér & Trosvik, 2018). And in 2020 1 in 6 registered privately owned cars were electric vehicles in Europe (RTLnieuws, 2021). The Netherlands is seen as a frontrunner in EV adoption, where in 2020 at least 25% of the sold cars were electric (RVO, 2022). Not only private electric vehicles are increasing, but public transport is also electrifying. The province of Groningen and Drenthe are frontrunners as 47% of public busses are electric (Ebusco, 2020).

Additional to the electrification of vehicles, sharing EVs could further reduce traffic congestion and air pollution (Curtale et al., 2021). However, the current research in shared electric vehicles is particularly done in the focus of electric (shared) cars as it is more likely to reduce private vehicle ownership (Lokhandwala & Cai, 2020; Jenn et al., 2018; Egnér & Trosvik, 2018; Luna et al., 2020; Habla et al., 2020). Moreover, a new concept of shared vehicles for short distances is introduced in cities: shared micro-mobility which includes e-bikes and e-scooters. These are lightweight shared vehicles that are only paid for when used, accessed through an app, available throughout the day and are free-floating meaning that they can be parked almost everywhere (Flores & Jansson, 2021). Since 2020, higher populated Dutch cities introduced such shared e-scooters. This may be the result of a policy adopted by many cities, to make the inner cities inaccessible to cars and more accessible via more sustainable modes of transport (Voermans, 2019). In the Netherlands, there are three shared e-scooter providers: GO, Felyx and Check, and is the fastest-growing shared transport mode (Maas Communities, 2021). Additionally, many municipalities encourage shared mobility to keep the liveability in cities, reduce private vehicle ownership and decrease CO2 emissions.

However, the target group of these providers is relatively limited, focusing on ‘young professionals’, freelancers and students, providing an addition to public transport especially in solving the last-mile problem (Stooker, 2019). Whereas, Yang et al. (2021) indicate that it is important that climate-friendly services should be accessible to all citizens to prevent that individuals who are excluded, due to high costs or limited opportunities, and causing them to be more vulnerable to climate change. According to Ku et al. (2021), exposure to these emissions and their additional health impacts are more frequent in lower socio-economic communities. Additionally, shared e-scooters cause parking nuisance and decrease traffic safety due to a lack of regulations (Flores & Jansson 2021). Overall, shared e-scooters are still new in the context of Dutch cities and research needs to be done to identify their potential.

This thesis is a case study on the city of Groningen, where these shared e-scooters were adopted in the summer of 2020. The municipality encouraged the introduction of shared e-scooters when safety and nuisance were kept in mind. However, this was not the case and in November 2020 the municipality adopted an APV (Algemene Plaatselijke Verordering) where the providers had to have a license with the additional rules to prevent nuisance caused by the shared e-scooters. Since the implementation only two providers with every 200 vehicles were allowed, there were parking areas assigned, they prohibited the use during the night and increased the allowed age to drive a shared e-scooter from 16 to 18 (Pastoor, 2020). But how do residents of Groningen perceive shared e-scooters? And is there an opportunity to diversify the user group? To reach the greater goal of a more sustainable urban transportation system and a more liveable city.

1.2 Research problem

This paper aims at describing the perception and use of shared e-scooters in different neighbourhoods in the city of Groningen. The research question is: *How can shared EV contribute to the urban transportation system transition in the city of Groningen and how successful is it in different neighbourhoods?*

To answer this central question, several secondary questions must be answered first:

- How is shared EV defined? And what type of shared EV is implemented in Groningen?
- What is the urban transportation system transition?
- How do different neighbourhoods perceive and use shared e-scooters in the city of Groningen?
- What are the opportunities for e-scooters in different neighbourhoods in the city of Groningen?

1.3 Reading guide

In this thesis, I will first describe the relevant concepts such as mobility justice, shared mobility and the sustainable urban transportation system transition in the theoretical framework and visualized in the conceptual model. After which, the methodology is framed on how to answer the research questions and data collection. Consisting an elaboration on the three identified neighbourhoods Followed by the results in which the findings of the data collection are described. And lastly, the conclusion where the research questions are answered.

2. Theoretical framework

2.1 Sustainable urban transportation system transition

To reach the Sustainable Development Goals (UN, 2015) a paradigm shift from sustainable urbanism to climate urbanism is necessary, regarding urban climate action. This transition is caused by the ongoing and increasing environmental threats admits increasing financial uncertainty. Climate urbanism has two main features according to Long & Rice (2019): carbon management and climate-resilient infrastructure. The last feature implies a transition to a more environmental-friendly transportation system, which "provide access to safe, affordable, accessible and sustainable transport systems for all…" (Makarova et al., 2017: p. 89). Ways to transform transportation systems into sustainable ones are, a decrease in private vehicles, increase usage of public transport and an increase in non-motorized mobility (Makarova et al., 2017). Long & Rice (2021) argue that investing in climate-resilient infrastructure is most suitable as a response to climate change challenges and can promote economic growth as well as social/mental well-being. When linked to shared e-scooter use, it can act as a righteous alternative to private, motorized vehicles for short-distance mobility and solving the last-mile problem. Anderton et al. (2019) note that e-scooters can enhance mental/social well-being, as people feel more connected to their surroundings as it is an easy and cheap mode of transport. They also highlight that e-scooters can contribute to a cleaner and less congested cities which can lead to more liveable cities. The addition of shared e-scooters could contribute to the sustainable urban transportation system transition, with the consideration of mobility/climate justice which will be explained in the following sections.

2.2 Shared electric e-scooters

The addition of shared electric mobility within the transportation system is emerging in many Dutch cities and is defined as the sharing, at the same time or overtime, of a transportation mode. Sharing of vehicles can contribute to an increase in public transport use, as it allows users more flexibility in time and route (Friedman, 2020). Shared mobility offers social and economic benefits, as it adds an extra mobility mode, while users do not have to own a private vehicle and are more flexible than other public transit (Cheyne & Imran, 2015).

Shared e-scooters are especially aiming at the substitution of private vehicle use for short distance travel and in solving the last-mile issue (Abduljabbar et al., 2021). The last-mile issue explains the issue that the exact location of the destination cannot be reached with public transport and walking is often not the most efficient way to get to your exact location (Stigo, 2017). But shared e-scooters allow for no parking costs, flexibility in parking locations, and lesser traffic jams (Almaradi, 2020). However, problems such as vandalism, dangerous traffic behaviour, and parking issues are things most municipalities did not take into consideration when adopting shared e-scooters (Almaradi, 2020). Moreover, they argue that the short-life span of e-scooters questions the environmental friendliness of e-scooter companies. The e-scooter company Felyx, the company researched in this thesis, claims however that their e-scooters are powered by 100% green energy and they recycle old batteries and tires (Felyx, n.d.). Shared e-scooters can therefore, when coupled with clean energy generation, create climate-resilient transportation systems. But on the other hand, can also cause problems for both users and non-users of e-scooters in traffic. Within the realm of shared e-scooters, climate/mobility justice has to be considered to create a shift towards sustainable urban transportation and is explained in the following section.

2.3 Mobility/climate justice

The sustainable transportation system transition should thus not only focus on providing sustainable mobility such as shared e-scooters but also focus on accessibility and freedom of movement for all to reduce environmental burden (Sheller, 2018). She argues that people's feelings towards mobility are fixed within geographically and historically grounded patterns which are not easily changed. And thus must be considered within a broader context of mobility justice. Some of the mobility justice principles she identifies are regarding socio-economic characteristics of users such as gender and race,

accessibility to all modes of public transport and information and communication technologies regarding the use of the type of public transport and perception regarding safety of users and non-users and the multi-modality of transportation modes.
In addition to mobility justice, the concept of climate justice is also important to consider. Ku et al. (2021) highlight that lower-income and marginalized groups of society are often more exposed to transportation emissions and have lesser accessibility to climate-friendly transportation modes. As environmental threats are increasing and becoming more severe, individuals who have limited access to climate-friendly services are likely to be affected more (Yang et al., 2021). Therefore society and government are responsible to ensure environmental equity for all members of society. A concept that comes into play with urban climate justice and mobility justice is inclusivity. Yu and Choi (2017) describe the concept of an inclusive city as a city that provides social, physical and spatial elements to all citizens, disregarding their social class, and their daily urban activities. Additionally, they argue that the transportation system should be accessible, provided to the public and considering providing equal opportunities. Therefore mobility/climate justice has to be considered in the transition of the transportation system. And it is influenced by, as stated before by Sheller (2018), accessibility, perception and socio-economic characteristics which are explained in the following sections.

2.4 Accessibility

The first concept influencing mobility/climate justice is accessibility and can be defined in different ways. One definition is the distance between a person and a public transport stop, in this case, the proximity of an e-scooter, and can differ per person (Cheng & Chen, 2015). This differs especially for e-scooters as the location is determined by the destination of users (Tuncer & Brown, 2020). This causes shared e-scooters to not always be available within a certain proximity of 5 minutes which is approximately the maximum walking distance to a certain public transport stop (Ivan et al, 2019). Additionally, advanced technology is necessary as Friedman (2020: p. 197) argues: “technology is a precondition to using many shared mobility services by allowing individuals to request, track and purchase trips through their phones.” Access to the use of these vehicles is primarily done via an app on a smartphone (Flores & Jansson, 2021). And people should feel confident by using this type of technology and the app should be clear for people to use it.
Another subject related to accessibility is the price you pay for shared e-scooters. The willingness to pay and the ability to pay which is based on the Environmental Kuznets Curve suggests that environmental degradation increases to a certain income level. When the income further increases, concerns for environmental protection increase and cities have more access to sustainable technologies (Gara, 2018). The price you pay should be at a level, or perceived as, where people think that it is cheaper than using the car or normal scooter. Eboli & Mazzulla (2008) argue that to increase the willingness to pay, a reduction in walking time and improvements in the level of comfort is necessary.

2.5 Perception

The second concept related to mobility/climate justice is the perception of shared e-scooters of users and non-users. Flores & Janssion (2021) argue that the perception of shared e-scooters as a green mode of transport is an important notion when adopting shared e-scooters in a city. The motivation to use them should be primarily out of environmental considerations as opposed to functional. As the (e-)bike is a dominant mode of transport in the Netherlands, an e-scooter is not always the better option in terms of health benefits but can be considered as the easy option as it is faster than a bike. Furthermore, citizens can perceive shared e-scooters as a nuisance in terms of safety and the blocking of streets caused by parking (Friedman, 2020). Users of e-scooters are more vulnerable and more likely to be harmed seriously than pedestrians or cyclists when a city includes cars and busses (Tuncer & Brown, 2020). In the case of Dutch cities, which are bike-dominated, shared e-scooters increase the number of traffic participants on bike lanes. This can create more dangerous situations for both cyclists and e-scooter users. Additionally, for motorized private vehicle ownership to reduce, it is

important to change people's perceptions and attitudes towards sustainable modes of transport (Beirão & Sarsfield Cabral, 2007).

2.6 Socio-economic characteristics

The last aspect that influences mobility/climate justice is the socio-economic characteristics of both users and non-users such as age, gender, educational status and income (Bozzi & Aguilera, 2021). Studies have shown that the majority of users are young, male and of a higher income level (Laa & Leth, 2020; Curl & Fitt, 2020). According to a study by Belk (2010), some people have a more open attitude to sharing whereas some people are more materialistic. Another aspect that influences preferences of e-scooters over other modes of transport is the possession of a motorized private vehicle such as a car or scooter. As the car is a preferred mode of transport, due to its speed, individual freedom and comfort (Beirão & Sarsfield Cabral, 2007). When these three concepts are taken into consideration in policy instruments of cities, the attitude of residents can be changed and accessibility towards shared e-scooters can be increased.

2.7 Conceptual model

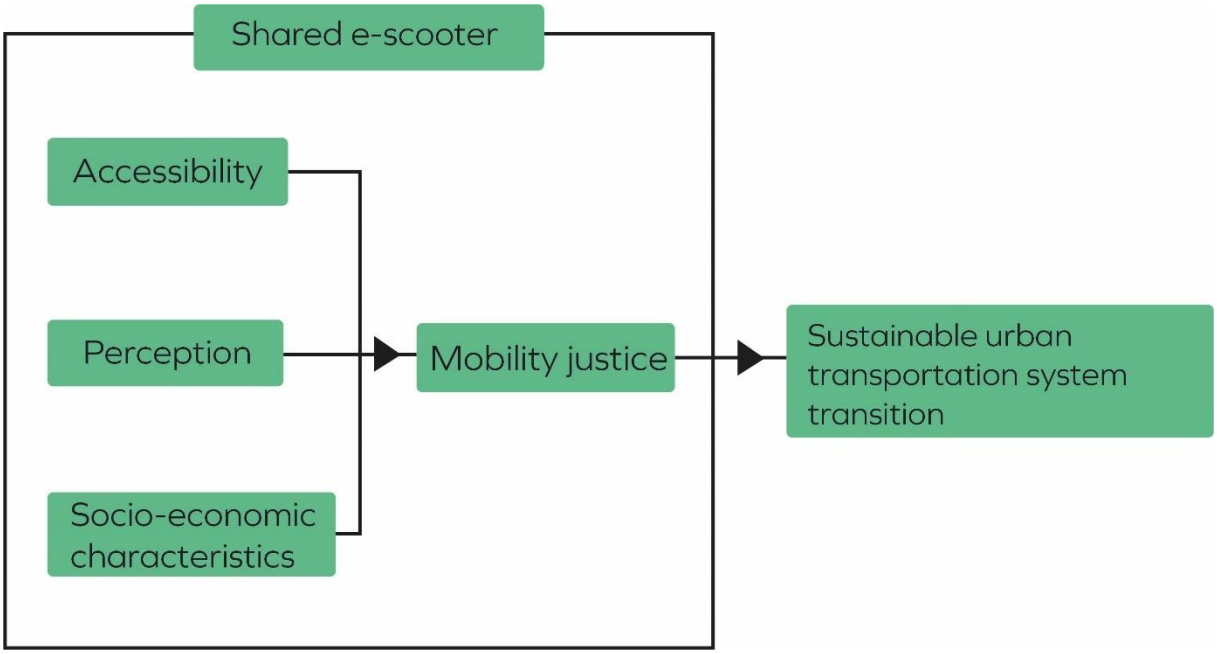


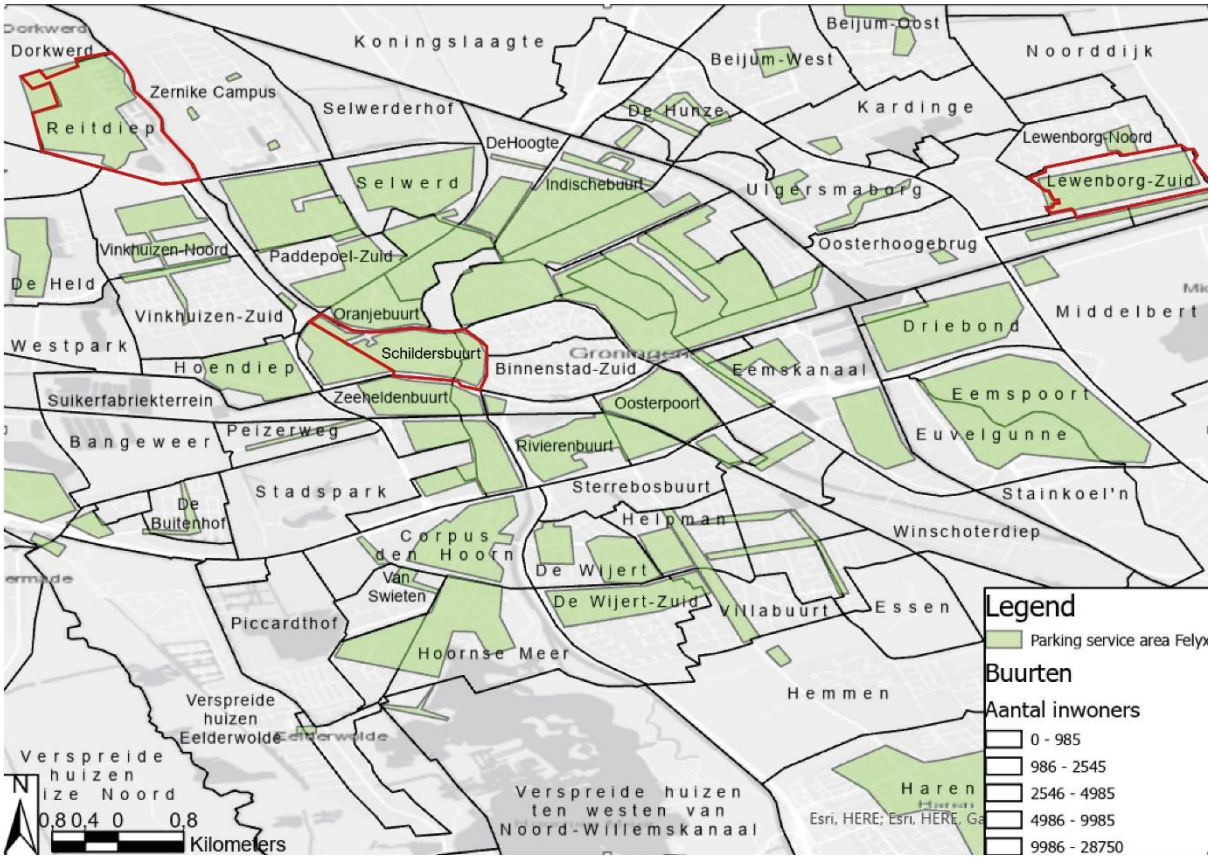
Figure 1: Conceptual model
source: created by author (2021)

The conceptual model shows how shared e-scooters can contribute to the sustainable urban transportation system transition. As it should allow to being a mode of transportation that is accessible to all levels of society while being a sustainable option. As argued before by Sheller (2018), accessibility, perception, and socio-economic characteristics of users and non-users will have an influence on shared e-scooter use in different neighbourhoods. By identifying socio-economic characteristics, changing people's perception, and improving accessibility, it would be expected that shared e-scooter use will increase by diversifying the target group and substituting privately owned motorized vehicles such as cars for short-distance trips. And it then could result in an urban environment where shared e-scooters are an addition to the public transport system and solve the last-mile issue, making public transport more attractive (Flores & Jansson, 2021).
Finally, both an improvement in mobility justice and an increase in shared e-scooter use could contribute to the sustainable transportation system transition in the city of Groningen, with an eye on the plans for excluding motorized private vehicles in Dutch cities and promoting sustainable transportation modes.

3. Methodology

3.1 GIS analysis

This research will consist of a mixed methodology: a GIS analysis and statistical analysis of questionnaires coupled with observations. The first step is to conduct a GIS analysis and compare characteristics of the population of Groningen (CBS, 2018, 2019) based on income, education, age, gender with a dataset on the use of shared electric-scooters (Felyx) in the city of Groningen to identify 3 different neighbourhoods (Geodienst, 2021). The data of Geodienst (2021) is for September, as it is the start of the academic year and people were allowed again to go to on-campus lectures and work due to less strict COVID-19 measures. The dataset consists of data points of the location of parked e-scooters, from which the frequency of e-scooter use in a specific neighbourhood can be assumed. The parking service areas are drawn in by hand in the map, to indicate how large the service area per neighbourhood is. By comparing the neighbourhoods with fewer or more scooters to their socio-economic characteristics (CBS, 2018/2019), three neighbourhoods (outlined in red in map 1) were selected: Schildersbuurt, Reitdiep, and Lewenborg-Zuid (see table 1) and are explained in the following section.



Map 1: Research area (Reitdiep, Schildersbuurt & Lewenborg-Zuid outlined in red).
Source: Created by author (Arcgis Pro) (2021).

3.2 Socio-economic characteristics neighbourhoods

The Schildersbuurt houses a lot of students, which causes the large percentage of the age group 15-25 (44,9%), the percentage of high educational level (47,3%), and the relatively lower average income (€23.300). The proximity to the city centre is 1,6 km and the average private vehicle ownership can be considered as low (0,3). Whereas in the neighbourhood of Reitdiep, the average private vehicle ownership is one of the highest in Groningen (1,2) and the proximity to the city centre is 6,7 km. Additionally, the largest age group is 0-15 and 25-45 (28,4% and 32%) which indicates that there are a lot of families with young children. And, the average income is relatively high compared to the other two neighbourhoods (€32.100) and it has a higher percentage of a high educational level (59,1%).

Despite the large parking service area, the frequency of e-scooters is low with a small concentration near the shopping centre. And are therefore reasons why this neighbourhood was chosen. The neighbourhood of Lewenborg-Zuid has a more evenly distribution of age levels, with a small tilt of higher age groups. The average income of the neighbourhood is relatively low, compared to Schildersbuurt and Reitdiep, of €19.200. Similar to Reitdiep, Lewenborg-Zuid also has higher private vehicle ownership of 0,8 and its proximity to the city centre is 8,8 km. Additionally, the parking service area includes the whole neighbourhood but similar to Reitdiep the frequency of e-scooter use is low.
Comparing the different neighbourhoods gives an idea of the opportunities of shared e-scooters in the city of Groningen. As they are differently characterized in terms of frequency of use, age, income, educational level, private vehicle ownership, and proximity to the city centre.

	Schildersbuurt	**Reitdiep**	**Lewenborg-Zuid**
Age			
0-15	4,2%	28,4%	20,4%
15-25	44,9%	8,2%	11,1%
25-45	28,1%	32%	29%
45-65	13,9%	25,6%	25,3%
65+	8,9%	5,8%	14,2%
Gender			
Male	49,2%	50,9%	48,1%
Female	50,8%	49,1%	51,9%
Income (x 1000)			
Number of earners	4,7	1,8	2,7
Average	€23,3	€32,1	€19,2
Education level			
Low	4,6%	14,2%	34,8%
Middle	40,1%	26,7%	44%
High	47,3%	59,1%	21,2%
Private vehicles			
Total	1240	1225	1285
Per household	0,3	1,2	0,8
Distance to inner-city			
In km	1,6	6,7	8,8

Table 1: Neighbourhood characteristics.
Source: CBS (2018, 2019).

3.3 Data collection

The second part of the methodology aims at answering the questions about the perception of accessibility of shared e-scooters in these neighbourhoods. This is done in two ways: the first method is distributing a questionnaire (Appendix C) and the second method is based on observations/interviews with users in selected neighbourhoods. First, the questionnaire divides the sample into users and non-users similar to Flores & Jansson (2021), and is also set up in different parts. It sketches an image on the perception and usage pattern of an individual in one of the selected neighbourhoods. The set-up of the questionnaire is based on a question matrix (Appendix B). It covers the three concepts from the conceptual model and links them to topics such as safety, price, distance, use, and neighbourhood. Similar to the method of Tuncer & Brown (2020), the other method is based on observations and short interviews with users. While walking through the neighbourhood observing e-scooters users and people in the neighbourhood was to talk to people and ask them if they wanted to respond to the questionnaire and ask them some questions on their perception of e-scooters. Other questionnaires were distributed randomly in mailboxes of people. The observations are done in a time frame of 2-2,5 hours, walking through the neighbourhood and talking to people and is done 2 times

per neighbourhood. With the use of the answers of the survey, a statistical analysis was carried out to find a significant differences between the neighbourhoods and users and non-users concerning the different concepts. As the amount of cases was low (43) and the distribution was not normally distributed, two non-parametric tests were used: the Mann-Whitney test and the Kruskal-Wallis.

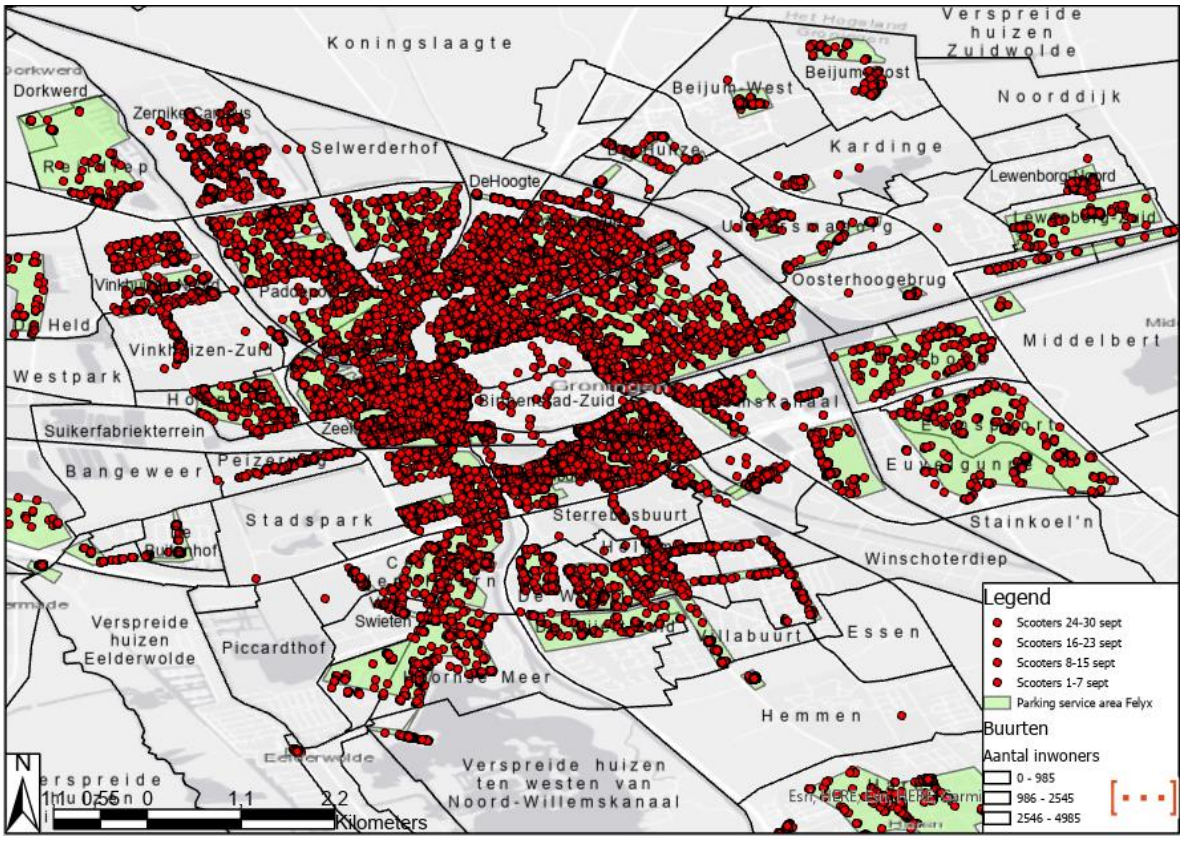
3.4 Ethics

To ensure respondents that their information will be handled with care, the questionnaire starts with a small notion of consent. They are asked to agree for me to use their answers in this research. When they click “No, I do not agree”, the questionnaire automatically closes. Because I am an outsider, this may cause a problem, as people from those particular neighbourhoods do not necessarily feel engaged to answer those types of questions. A solution would be to send out surveys both by post and hang up poster with QR codes to make it easier for the respondent to respond while including both older and younger respondents. Another way is to observe users of e-scooters in those neighbourhoods and ask them a few questions on their perception, accessibility, and socio-economic characteristics.
Another aspect to take into consideration are the COVID-19 measures in effect in the Netherlands. Some people may not feel at ease to get in contact with me and thus people may not feel as willing to fill in the questionnaire when this is sent to them with the post. Therefore, mixed methods for data collection are chosen, where the observations/interviews are supported by the answers of the surveys.

4. Results

4.1 GIS analysis

The GIS analysis provides a better image of e-scooter use in the city of Groningen, as it shows a visual representation of where e-scooters are parked, including the parking service areas (Appendix A), and thus the frequency of e-scooter use in different neighbourhoods. Map 2 shows clearly that there is a concentration around the inner-city, possibly because users cannot park the scooters in the inner-city and therefore park them just outside the inner-city and continue their trip walking. The Schildersbuurt is part of this concentration however, this neighbourhood overall has a high frequency of shared e-scooters. Furthermore, looking at neighbourhoods with a lower frequency and a larger distance to the inner-city, there are two other neighbourhoods stand out: Reitdiep and Lewenborg-Zuid. When looking at the characteristics of the neighbourhood (CBS, 2018, 2019), in table 1, the 3 neighbourhoods all have different characteristics. With exception of the distribution of males and females, which is evenly distributed.



Map 2: Map on frequency e-scooter use in Groningen in September.
Source: created by author (Arcgis Pro) (2021)

4.2 Observations and surveys

A total of 43 responded to the survey and during the observation, 8 people agreed on a small interview (See D and E). By comparing the answers to the surveys with the observations and small interviews with people during these observations, a few differences are found between the neighbourhoods, especially between users and non-users. Table 2 shows the descriptive statistics of the questionnaires and shows a more or less equal distribution in users and non-users, users typically use the shared e-scooters about once or twice a week and the mean walking distance to a shared e-scooter is 5,4 minutes.

Total amount of respondents	43 (100%)
Total amount of users	20 (46,5%)

Total amount of non-users	23 (53,5%)
Mean age of respondents	31
Minimum age	20
Maximum age	76
Use per week (mode)	1-2 times per week
Mean walking distance to shared e-scooter (in min)	5,40

Table 2: Descriptive statistics questionnaire.
Source: Created by author (SPSS) (2021).

4.2.1 Accessibility

In terms of accessibility, non-users in Reitdiep answered more often that there were e-scooters available more frequently in their neighbourhood. Whereas, according to respondents, in the Schildersbuurt e-scooters were not as often available. During the observations however, only 3 e-scooters were counted in total in Reitdiep and Lewenborg-Zuid 0 during one of the observations and 1 during the other one, with a few more e-scooters parked near the shopping centre just outside the neighbourhood. Whereas in the Schildersbuurt, a total of 7 and 10 e-scooters were observed. By using the Kruskal-Wallis test, no statistical difference was found in the availability of shared e-scooters between the different neighbourhoods (see table 3). However, when the Kruskal-Wallis test is done with the grouping variable usage, there is a significant difference (see table 4). Meaning that the 'location' of users and non-users is different.

	Sig.
Kruskal-Wallis test	0,905[a]
	0,042[b]

a. Grouping variable: neighbourhood
b. Grouping variable: use

Table 3: SPSS results from Kruskal-Wallis; availability.
Source: Created by author (SPSS) (2022).

Respondents stated that they had to walk around 5,4 minutes on average to an e-scooter. With a maximum of 15 minutes observed in Reitdiep. This is supported by comments made during the interview, indicating that the proximity of shared e-scooters matters for the decision to use one. Additionally, the exclusion of parking in the inner-city, resulted in residents not using the e-scooter while they were interested. And there could be an opportunity for the company of Felyx and the municipality could work together, to increase popularity among citizens and improve shared e-scooters use while excluding the car more from the city.
Another subject related to accessibility is related to the appurtenant technology, which most of the respondents experience no problems with as they agreed with the statement: *"I find it easy to use the app."* However, because most users are relatively young this would be expected as younger people feel more confident using this type of technology.

"*I usually decide spontaneously if I want to use the e-scooter and then I look if there is one available not too far from my location. If not, I often decide to just go by bike or walk*." (Respondent S1, 07/12/21).

"Last Summer, me and my husband wanted to use an e-scooter to go to the inner-city. However, we decided not to because it's not allowed anymore to park them there. Which made us decide to just go by bike." (Respondent R1, 15/12/21).

Furthermore, the respondents were asked their opinion on the price paid for shared e-scooters separately for Check and Felyx. And most respondents (30) perceived the prices as normal (see figure 2), which indicates that there is a sense of ability to pay for both lower-income and higher-income groups. However, especially in the neighbourhoods of Reitdiep and Lewenborg-Zuid, the willingness to pay is relatively low according to the survey, while they perceive the price as normal.

"I feel like an e-scooter is as convenient as a bike, which is basically free. Which is why I therefore choose my bike over an e-scooter." (Respondent R1, 15/12/21).

Figure 2: Opinion on the price of shared e-scooters.
Source: created by author (SPSS) (2022).

4.2.2 Perception

In this section, the perception of shared e-scooters of respondents is described. Respondents were asked about their opinion on if e-scooters could contribute to a more liveable city compared to motorized vehicles.

"Yes, I think if people use e-scooters more often than cars this could be, especially in the inner-city because it is so crowded with all these people." (Respondent S2, 07/12/21).

Supporting this statement are the answers to the survey. However, table 4 shows that there is no statistical difference found between the perception of residents on the contribution of shared e-scooters to liveability between users and non-users and neighbourhoods (p = 0,077 and p = 0,494).

	Sig.
Kruskal-Wallis	0,494[a]
	0,077[b]

a. Grouping variable: neighbourhoods
b. Grouping variable: use

Table 4: SPSS results from Kruskal-Wallis; liveability.
Source: Created by author (SPSS) (2022).

Yet, when looking at the perception of people, in terms of liveability in the survey, there would be opportunities for e-scooters, as 65,1% of the respondents agreed on the contribution of shared e-scooters as a sustainable mode of transport to the liveability of the city.

However, addressing some problems the municipality of Groningen has experienced are concerned with safety and traffic increase by e-scooters and its parking, which caused them to remove the e-scooters from the inner-city (Pastoor, 2020). Respondents were then asked about their experiences in terms of safety with shared e-scooters, including traffic nuisance caused by parking and by traffic increase, more dangerous traffic situations, and if they felt confident to use a shared e-scooter.

Respondents did not experience more traffic nuisance or dangerous situations due to shared e-scooters as the cumulative percent for the three questions of strongly disagree and disagree was: 58,1%, 65,1% and, 37,2%. A Mann-Whitney test was done to identify if there was a significant difference between users and non-users and their perception of safety issues. No statistical difference was found with the first three questions (see table 5), though there was a difference between users and non-users in terms of confidence level (0,0001). Hence, a Two-Samples Number-of-Runs test was done (Table 6) showing a lot of difference between the minimum and maximum value number of runs, meaning a lot of cases with the same value spread across the two groups. And a significant result with minimum and insignificant with maximum, meaning that the overall test is insignificant of no equal distribution between users and non-users.

Mann-Whitney[a]	Sig.
Traffic nuisance caused by parking	0,259
More dangerous traffic situations	0,103
Traffic nuisance caused by traffic increase	0,662
Confidence to ride a shared e-scooter	0,0001

a. Grouping variable: use

Table 5: SPSS results from Mann-Whitney; safety
Source: Created by author (SPSS) (2022).

	Number of runs	Sig.
Two-Samples Number-of-Runs Test[a]		
Minimum	4[b]	0,000
Maximum	26[b]	0,899

a. Grouping variable: use
b. There are 2 inter-group ties involving 31 cases

Table 6: SPSS results from Two-Samples Number-of-Runs test; confidence
Source: Created by author (SPSS) (2022)

4.2.3. Socio-economic characteristics

In terms of socio-economic characteristics, some findings that could explain the frequency of e-scooters usage in the neighbourhoods. The first one made during the observations in Reitdiep was that many houses had 2 to 3 cars in their driveway. Similar to Lewenborg, the parking spots were almost all taken, which give insight into the availability of cars in the neighbourhood. Respondents in the Lewenborg and Reitdiep responded that they were more attached to their car and gives them some sort of status:

"I like driving my car and everyone in our neighbourhood has 1 or 2 cars." (Respondent R2, 15/12/21).

"Having a car feels like a priority." (Respondent L1, 02/01/22).

A Mann-Whitney test was carried out to identify a significant difference between the private vehicle owners and the use of shared e-scooters (table 7). The result was significant (p = 0,016) and the sum of ranks of private vehicle owners is lower (458) indicating that private vehicle owners less frequently use a shared e-scooter.

Ranks

	Private Vehicle Ownership	N	Mean Rank	Sum of Ranks
Use of shared e-scooters	Yes	17	26,94	458,00
	No	26	18,77	488,00
	Total	43		

	Sig.
Mann-Whitney	0,016[a]

a. Private vehicle ownership

Table 7: SPSS results from Mann-Whitney; Use – Private vehicle ownership
Source: Created by author (SPSS) (2022).

Additionally, the majority of users in the survey were younger than 30 (90%) and living in the neighbourhood of the Schildersbuurt (80%). Who used the e-scooters mainly for social, recreational reasons and to go to the university. As the target group of Felyx and Check mainly focuses on "young professionals", freelancers, and students (Stooker, 2019), people of older age or different backgrounds don't necessarily feel engaged with the concept of shared e-scooters. This indicates that these students are more open to such transport modes and as they often lack accessibility to a private motorized vehicle.

"I think it's primarily intended for younger people. I don't see myself necessarily using a shared e-scooter." (Respondent L1, 02/01/22).

"I think it's easier for younger people to use the app." (Respondent L2, 02/01/22).

"Sometimes it just faster to take an e-scooter than going by bike and during the summer it's nice to take the e-scooter for a ride to the Hoornse Plas or just drive around." (Respondent S2, 07/12/21).

5. Discussion & conclusion

5.1 Discussion

For shared e-scooters to contribute to the sustainable urban transportation system transition, three concepts have to be considered: accessibility, perception, and socio-economic characteristics.
Appeared from this research is that, in terms of accessibility, users perceived a lower availability of shared e-scooters than non-users. As explained by Tuncer & Brown (2020), this could be the result of a higher demand causing lower availability within a certain proximity. When available in their proximity however, the average walking distance was 5,4 minutes which is similar to the findings of Ivan et al. (2019). Demonstrated by the statements of interviewees, was that the walking distance plays a role within the decision-making process of using a shared e-scooter. To provide shared e-scooters within proximity but not overcrowd the streets, providers could differentiate the number of e-scooters between neighbourhoods with higher or lower demand. Moreover, the price also plays a role within the decision however, not necessarily the ability to pay but the willingness. As 30 respondents perceived the price as normal but their willingness to pay is lower. And could be explained by the fact that Groningen is characterized as a biking culture, where cycling is embedded in Dutch culture which is free (Pelzer, 2010). A way to increase the willingness to pay is to increase the convenience of usage and provide higher availability of service (Eboli & Mazzulli, 2008).
For perception, no difference was found between users and non-users and between neighbourhoods and the contribution of shared e-scooters to liveability. Yet, 65,1% of the respondents thought that the addition the shared e-scooters could contribute to liveability as opposed to motorized vehicles. As Almaradi (2020) also argues shared e-scooters allow for lesser traffic jams and an additional mode of public transport. Additionally, access to climate-resilient infrastructure such as shared e-scooters can improve social/mental well-being and can promote economic growth (Long & Rice, 2021), and could lead to more liveable cities. Concerning safety, respondents did not experience more traffic nuisance or dangerous situations and mostly felt confident enough to use a shared e-scooter. Thus for more people to start using shared e-scooters, a shift in their perception and attitude against shared e-scooters has to be changed as non-users were not as familiar with shared e-scooters (Beirão & Sarsfield Cabral, 2007).
Lastly, concerning socio-economic characteristics, neighbourhoods located more remote from the inner-city are more attached to their car. And the majority of non-users did own a private motorized vehicle meaning that most households always had the accessibility to a car, which is supported by Beirào & Sarsfield Cabral, (2007) that the car is a preferred mode of transport due to freedom of choice, speed, and comfort. Moreover, the target group of Felyx is focused on 'young professionals', freelancers, and students (Stooker 2019), which limits it to a younger group of users and could be broadened to reach larger target groups.

5.2 Conclusion

This thesis aimed at finding an answer to the research question: "*How can shared EV contribute to the urban transportation system transition in the city of Groningen and how successful is it in different neighbourhoods?*" Shared e-scooters are mode of shared EV and is defined as the sharing of micro-mobility and allowing for more flexibility and solving the last-mile issue.
Concluding, e-scooters could contribute to the sustainable urban transportation system transition as they provide an extra sustainable mode of transport for people to choose from. It can encourage non-motorized mobility and demotivate private vehicle use. However, in Groningen, the concept of shared e-scooters is still relatively new and thus its contribution remains small. Additionally, adjustments in attitudes and perceptions towards shared e-scooters are necessary to allow accessibility for all residents and allow for a greater acceptance of shared e-scooters.
A limitation of the research is the low response rate on the surveys thus reaching a small part of the population. Future research could capture a larger part of the population and by doing in-depth interviews get a more detailed picture of how people perceive shared e-scooters and what their

reasoning is behind their use or non-use. Secondary, some mistakes were made within the survey which caused some responses on socio-economic characteristics not being captured. Future, more in-depth, research needs to be done for shared e-scooters to gain popularity, and have the company of Felyx/Check and the municipality work on a clear policy framework.

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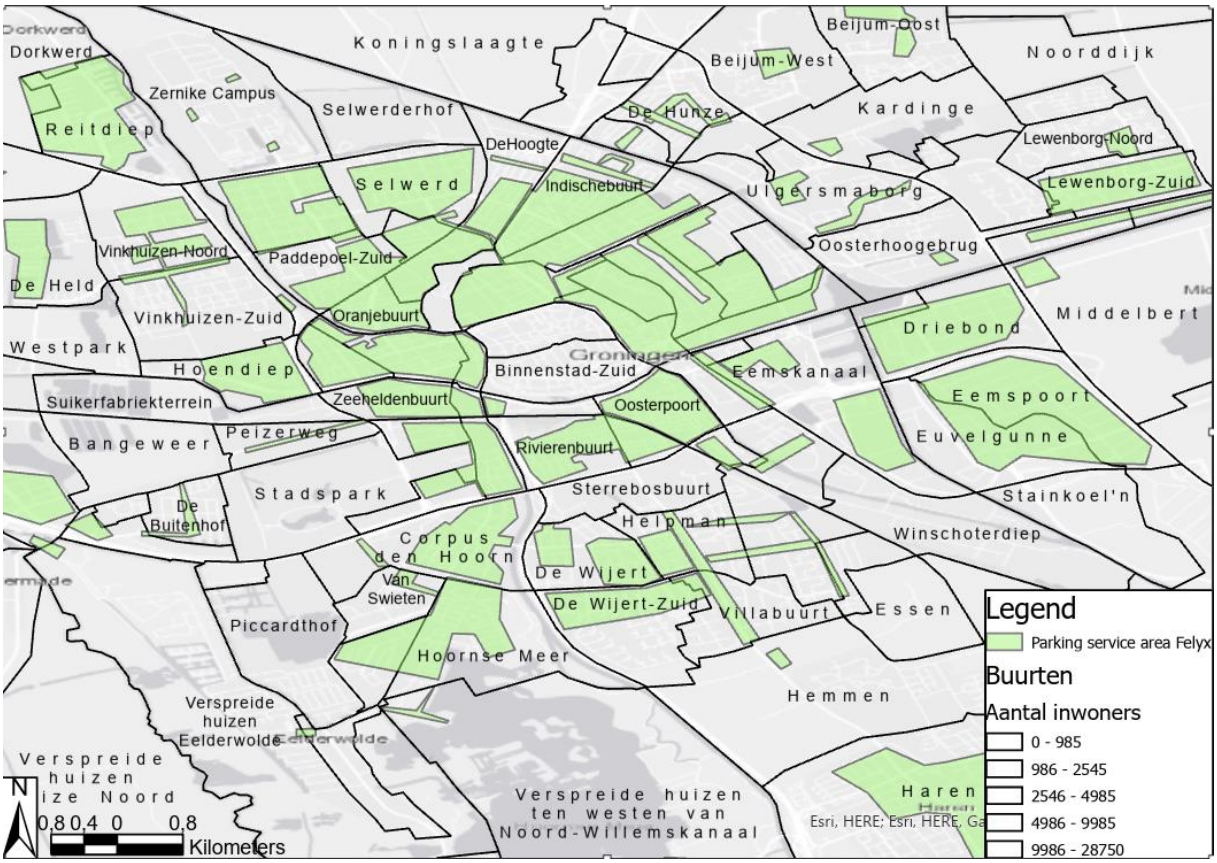
7. Appendix

Appendix A



Map on parking service areas Felyx.
Source: This paper

Appendix B

Questionnaire appendix

	Characteristics	Perception	Accessibility
Neighbourhood	In which neighbourhood do you live?	Which transport mode is most popular within your neighbourhood?	Are there often shared e-scooters available in your neighbourhood?
Price	How often do you use an e-scooter on average per week?	To what extent are you willing to pay for more sustainable transport modes such as shared e-scooters?	Do you think shared e-scooters are affordable?
Safety	What is your most frequently used mode of transport?	Have you ever encountered an unsafe situation with a shared e-scooter?	Do you feel confident enough to use an e-scooter?
Use	Have you ever used a shared e-scooter?	Did you ever experience nuisance caused by e-scooters?	Do you think the app is easy to use?
Distance	What is your most frequent destination with an e-scooter?	Do you think shared e-scooters are a sustainable alternative to short-distance trips, compared to motorized vehicles?	How long do you usually have to walk to an e-scooter?

Appendix C

Questionnaire

Hello,

I am a Spatial Planning & Design student at the Rijksuniversiteit of Groningen and I am currently doing research for my bachelor thesis. In this questionnaire, I will ask you a few questions about your perception and use of shared e-scooters such as Check and Felyx. Your personal information will be handled with care and privacy. This means that these will only be used for this research alone and your information will be processed anonymously within the research. Filling in this survey will take no longer than 5 minutes of your time.
Thank you in advance.

1. I permit using my answers in this research.
    - I agree
    - I don't agree

Since May 2020, Groningen provides shared e-scooters. These are electric scooters available for everyone within a certain service area. The scooters are often used for short-distance trips (<3km). You reserve a scooter via an app and you pay a certain price per minute. When you arrive at your destination, you can park it in one of the assigned parking areas visible in the app. After parking, you take a picture of the e-scooter and somebody else can use it. At the moment there are two providers of shared e-scooters in Groningen: Felyx and Check. These shared e-scooters could contribute to a more sustainable and liveable city. As it could demotivate motorized private vehicle ownership. Nevertheless, these scooters can also cause a nuisance as parking for e-scooters is not allowed anymore in the inner-city.

2. Do you use shared e-scooters?
    - Yes
    - No

3. How often do you use an e-scooter on average per week?
    - _____

4. To what extent do you agree with the statement below?
   "I find it easy to use the app."
    - Strongly disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly agree

5. How long do you need to walk on average to an e-scooter? In minutes
    - _____

6. For what reason do you use an e-scooter the most? Multiple answers possible
    - To school/work
    - Social contact
    - Transfer to another mode of transport
    - Recreational
    - Other, namely _____

7. To what extent do you agree with the following statements?

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
There are often e-scooters parked in my street/neighbourhood.					
I experience traffic nuisance due to parked e-scooters.					
I experience more often dangerous traffic situations caused by e-scooters.					
I experience nuisance due to an increase in traffic because of e-scooters.					
I feel safe/confident enough in traffic to use e-scooters.					

8. In what neighbourhood do you live?
    - Schildersbuurt
    - Reitdiep
    - Lewenborg-Zuid
    - Other, namely _____

9. What mode of transport do you most often use for short-distance trips?
    - Walking
    - Bike
    - (E)bike
    - Car
    - Bus
    - Scooter
    - E-scooter

10. What mode of transport is most often used in your neighbourhood for short-distance trips?
    - Walking
    - Bike
    - (E)bike
    - Car
    - Bus
    - Scooter
    - E-scooter

11. What is your age?
    - _____

12. What do you think of the price you pay for e-scooters?
    - Felyx:
        - Expensive
        - Normal
        - Cheap
    - Check
        - Expensive

- Normal
- Cheap

13. To what extent do you agree with the following statements?

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I am willing to pay for more sustainable transport modes such as shared e-scooters.					
I think shared e-scooters are a sustainable alternative to short-distance trips, compared to motorized vehicles. And thus could increase liveability in the city.					

This was the last question. If you have any questions regarding the research, please feel free to contact me (d.a.h.brookhuis@student.rug.nl). Thank you for answering this questionnaire.

Appendix D

Table of observations

Schildersbuurt	Time
07-12-2021	15:30 – 17:30
03-01-2021	11:00 – 12:30
Lewenborg-Zuid	
30-11-2021	10:30 – 12:00
02-01-2022	15:00 – 17:00
Reitdiep	
23-11-2021	14:30 – 16:30
15-12-2021	11:00 – 12:30

Appendix E

Short interviews with passers-by

Schildersbuurt 1: Male (22 years old) (07/12/21)

Maak je wel eens gebruik van Felyx of Check?
Ja, soms wanneer ik haast heb en er staat er eentje in de buurt dan pak ik weleens eentje.

En waarvoor gebruik je hem dan?
Vaak naar Zernike wanneer ik haast heb. En soms om gewoon rond te rijden maar dat is meestal spontaan en wanneer er geen in de buurt staat, ga ik toch wel vaak fietsen of wandelen.

Staan er vaak scooters in je buurt?
Ik zie er redelijk vaak wat staan maar dan wanneer je hem nodig bent, zijn ze ineens allemaal weg.

En wat vind je van de prijs?
Opzich prima, maar ik gebruik hem wel vaker wanneer er kortingscodes zijn.

Schildersbuurt 2: Female (24 years old) (07/12/21)

Maak je wel eens gebruik van Felyx of Check?
Ja, niet heel vaak

Wat vindt je van het concept van de scooters?
Wel goed, het is toch wat sneller dan de fiets

Wanneer verkies je de e-scooter dan over de fiets?
Bijvoorbeeld in de zomer om naar Hoorse plas te gaan, wat echt ver is met de fiets, of gewoon rondrijden.

Ervaar je dan wel eens overlast door de scooters?
Soms in de binnenstad op drukke plekken zoals de Brugstraat, dan hoor je ze niet echt aankomen.

Denk je dat deze e-scooters kunnen bedragen aan de leefbaarheid in de stad vergeleken met auto's?
Ik denk het wel, wanneer mensen vaker zo'n scooter pakken in plaats van de auto het wel rustiger kan worden in de nu zo drukke binnenstad.

Schildersbuurt 3: Female (20 years old) (03/01/22)

Maak je wel eens gebruik van Felyx of Check?
Nee, ik heb nog geen rijbewijs.

Ervaar je dan wel eens overlast door deze scooters?
Soms, ik hoor ze niet altijd. Maar over het algemeen zijn het net fietsen.

Denk je dat zulke e-scooters kunnen bijdragen aan de leefbaarheid in de stad vergeleken met auto's?
Ja, ik vind auto's in de stad vervelender dan e-scooters.

Reitdiep 1: Female (age unknown) (15/12/21)

Maakt u wel eens gebruik van Felyx of Check?
Nee

Waarom niet?
Mij lijkt zo'n scooter net zo makkelijk als de fiets, alleen is de fiets gratis. En dan kies ik liever voor een fiets.

Wat vind u van het concept van deze scooters?
Wel goed, afgelopen zomer hebben mijn man en ik wel nagedacht om een scooter te gebruiken. Alleen mag je dus niet meer parkeren in de binnenstad dus kozen we toch voor de fiets.

Reitdiep 2: Man (45 years old) (15/12/21)

Maakt u wel eens gebruik van Felyx of Check?
Nee

Ziet u zichzelf zo'n deelscooter gebruiken?
Ik denk het niet, maar je weet het maar nooit.

En waarom niet?
Ik gebruik mijn auto graag omdat het makkelijk is, vooral omdat we hier wat verder van de stad zijn. En verder heeft iedereen in de buurt 2 á 3 auto's dus staat er altijd wel eentje thuis.

Reitdiep 3: Man (29 years old) (15/01/21)

Maak je wel eens gebruik van Felyx of Check?
Ik heb er wel eens eentje gebruikt maar over het algemeen niet.

Wat vind u van het concept van de e-scooters?
Ik vind het idee erachter wel goed, het is alleen niet altijd even handig. Ik vind hem alleen niet veilig genoeg om hem te gebruiken met mijn kinderen. Dan pak ik liever de fiets of auto.

Ervaart u wel eens overlast van deze scooters?
Hier eigenlijk niet, wel eens toen ze nog geparkeerd stonden in de binnenstad. Daar stonden ze wel eens in de weg.

Lewenborg-Zuid: Male (age unknown) (02/01/22)

Maakt u wel eens gebruik van Felyx of Check?
Nee, ik pak meestal gewoon de fiets of de auto.

Wat vind u van het concept van de deelscooters?
Ik denk dat vooral bedoeld is voor jongeren. Ik zie me zelf niet zo snel op zo'n scooter rijden.

Heeft u wel eens overlast door deze scooters?
Nee, ik zie ze wel staan in de wijk maar geen overlast.

Lewenborg-Zuid: Female (40 years old) (02/01/22)

Maakt u wel eens gebruik van Felyx of Check?
Nee

Waarom niet?
Ik vind de auto of de fiets makkelijker. Want zo'n scooter heb je niet altijd bij huis staan terwijl je dat met je auto of fiets wel hebt.

Denkt u dat zulke scooters kunnen bijdragen aan de leefbaarheid in de stad?
Ja, het is wel minder vervuilend dan een auto. En je hebt minder parkeerruimte nodig.

Ziet u uzelf zo'n scooter gebruiken?
Niet zo snel, ik denk dat het meer voor de generatie onder mij is die makkelijker met apps kan omgaan.