Neighbourhood mobility hubs

Exploring the potential users, their perceptions and travel behaviour effects

D.M.E. van Rooij
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Neighbourhood mobility hubs

Exploring the potential users, their perceptions and travel behaviour effects

by

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Cover image is a picture of the Hely hub in Delft, made by the researcher

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Preface

The document that lies before you is the result of eight months of hard work. It is the final requirement to conclude the master program Transport, Infrastructure and Logistics at the Delft University of Technology, and obtain the title Master of Science. This research is conducted at the consultancy firm Mobycon where I was an intern from June 2019 to February 2020.

The subject of this thesis is the neighbourhood mobility hub. It explores the potential users, how they perceive the hub and how they are influenced by it. For this research I have spoken with experts in the field of mobility, held focus groups of potential users of the hub and distributed a survey among residents of neighbourhoods with an active hub. The results of this work can be found in this document.

I would like to thank my supervisors from the TU Delft, Dr. Eric Molin, Dr. Kees Maat and Prof. dr. Bert van Wee, for their help during the whole process. Giving critical, yet very helpful comments and steering me in the right direction. Furthermore, I would like to thank my two supervisors at Mobycon, Eveline de Jong en Hélène van Heijningen, without whom this thesis would not have been finished at all. My thanks also to all the people who were willing to help me with my research: the experts, the focus group participants and the people who filled in the survey. Finally, I would like to thank my girlfriend, my friends, my family and my colleagues at Mobycon who supported me throughout the process.

D.M.E. van Rooij
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Executive summary

The proportion of the Dutch population living in cities is steadily increasing. The EU expects that in thirty years over 90% of the Dutch residents live in urban areas. The increasing urbanisation of the Netherlands leads to increased transportation needs, which leads to three main problems: financial losses due to congestion, high local emissions due to the increasing number of car trips, and public space scarcity due to the space needed for roads and parking spaces.

To solve these problems, municipalities are experimenting with the introduction of shared mobility. Users of shared mobility are able to access vehicles on a short-term basis. They do not own the vehicles and are typically charged on a pay-as-you-go or subscription basis. Shared mobility could in theory result in a decrease in number of car trips and number of owned cars. Having a direct effect on the three problems faced by the municipalities.

There are two main ways to provide shared mobility: free floating services, where the vehicles can be parked anywhere in a certain area, and station-based services, where vehicles have to be parked at a station. Municipalities in the Netherlands have had negative experiences with free floating shared mobility in the past. They are therefore focusing more and more on station-based services, also called mobility hubs. Mobility hubs and are central locations where users can access the shared mobility.

The subject of this research is the relative new phenomenon of the neighbourhood mobility hub. These hubs are central points in a neighbourhood were shared cars, (e-)bikes and or e-cargo bikes are offered to the residents. These hubs are seen by municipalities as an interesting way of offering shared mobility, as it reduces problems associated with free-floating shared mobility. The neighbourhood hub also introduces shared mobility into the neighbourhood, in theory increasing the visibility and use of shared mobility.

Information about these neighbourhood mobility hubs is scarce, the circumstances under which they will be used and who will use them is unknown. This is also true for the effects of these hubs on the neighbourhoods and the travel behaviour of the users. Before introducing neighbourhood mobility hubs, municipalities should know if and how the hubs help to solve their problems. The research objective of this research is therefore to explore the potential users, their perceptions of the hub and how the hub effects their travel behaviour. As a result, the main research question answered in this study is formulated as:

How do potential users perceive a neighbourhood mobility hub and what effect does the hub have on their travel behaviour?

To answer this research question, multiple steps are taken. First, extensive literature research and interviews with experts in the field of shared mobility are used to provide a definition of a neighbourhood mobility hub. Experts are also used to define the theoretical potential users and the theoretical travel behaviour effects of the hub. Next, focus groups among the theoretical hub users are organised to research if the theoretical findings are correct. First perceptions of potential users are also explored within the focus groups. Finally, a survey is distributed among potential hub users to further define the potential user, their perceptions of the hub and the potential travel behaviour changes.

A neighbourhood mobility hub is defined by its attributes and goal. This means that there is no fixed definition of the neighbourhood mobility hub. A hub should be tailored to the neighbourhood, taking into account the wishes and demands of the residents and the goal it aims to achieve.

All neighbourhood mobility hubs have two universal aspects; they are a central point in the neighbourhood and offer shared mobility. This base can be expanded upon by defining the following fourteen important design attributes: diversity, availability, ease of use, visibility, safety of the hub and vehicles, state of the hub and vehicles, distance to the hub, costs of the hub and vehicle, sustainability of the

hub and vehicles and if the hub is part of a network. In addition, three important context variables were found: parking pressure, other services offered at the hub (e.g. parcel delivery point) and if the hub creates free space in the neighbourhood due to decreased car ownership. Which and how these attributes should be implemented depends on the neighbourhood, its residents and the goal of the hub.

The goal of the hub depends on the actor. For this study the goals of municipalities are leading: decreasing local emissions, congestion and private car ownership. This led to the following definition used in this study: a neighbourhood mobility hub is a central point in the neighbourhood where shared mobility is offered, with the goal of decreasing local emissions, congestion and car ownership.

According to the literature study and expert interviews the theoretical hub user is not fully defined by his socio-demographic characteristics. Equally important is the parking pressure as experienced by the potential user. The theoretical potential user is someone who experiences a high parking pressure. He or she is probably living in the city, as this is the location were parking pressure is highest.

Important socio-demographics that are named in literature and by the experts are age, income, and having a sustainable mindset. Young persons are more likely hub users. However, experts also note that relatively older people could also be tempted to use shared mobility, given the right motivation.

Using shared mobility is in many cases more expensive than using private mobility. Income is therefore important as a person needs to have a certain level of disposable income to be able to afford shared mobility use. However, having a relatively high income will probably decrease the likelihood of hub use.

Having a sustainable mindset could be the motivation to switch regardless of the added financial costs. For sustainability to be a relevant factor, hubs should be considered sustainable compared to private transportation. Offering e-cars could motivate these persons to use the hub.

The hub could lead to two important travel behaviour changes: a change in car trips and a change in car ownership. The hub could in theory both increase or decrease the number of car trips. The number of trips decreases as users use the hub to replace private car trips with trips by shared bike or scooter. The opposite could also be true, as the hub makes the car accessible for persons without car access. This could lead to them replacing public transport or bike trips with car trips via the hub. The experts expect that e-(cargo)bikes could have a large impact on short incidental trips, e.g. groceries, bringing kids to school.

The impact on car ownership is similar, hub modes could in theory replace the private car. However, it is unlikely that the hub will replace the first car according to the literature and experts. The first car is usually used for the daily commuter trips, while the second or third car is used for incidental trips. This makes the second or third car more disposable, increasing the chance those are replaced by shared modes. While most literature and experts think the hub will reduce car ownership, there is also a chance the hub will increase car ownership. People introduced to the shared car could decide to buy their own car if this has increased benefits.

The effect of the hub on travel behaviour depends on the hub attributes. Hubs who are integrated in a hub network are more likely to structurally replace car trips. The network makes it possible to travel from hub to hub, preventing paying for a car you do not use. Stand alone hubs are expected to replace mainly incidental trips.

Two focus groups among theoretical hub users were held, one focus group consisting of students and one consisting of residents of Delft city centre. The students are chosen because they are young and used to using public transport and shared mobility. The residents of Delft city centre are chosen because of the high parking pressure in Delft. Both focus groups are used to find if the theoretical hub users are likely to use a hub, how they perceive hubs, and how they think the hub would change travel behaviour.

While considering the potential hub user, the students did see themselves as potential hub users, while the Delft city centre residents did not. Both focus groups did not see the added value of neighbourhood hubs in city centres. This opinion was especially strong with the residents of Delft city centre, as a car rental company already provides them with easy car access without the need to own a car. Other services offered by the hub are also already present in the city centre. While they did agree that parking pressure could increase hub use, the focus groups saw hubs add more value as extension of

the existing public transport networks.

While discussing potential travel behaviour changes, the focus groups indicated that the hub would probably lead to more car trips and less car ownership. The focus groups saw the hub mainly as a flexible alternative to public transport. Meaning that the hub would mainly replace public transport trips. They further indicated that it will be really difficult to persuade a private car user to switch to a shared car, let alone another mode. Car users are intertwined with their car, it is experienced as a home away from home. The focus groups do see the hubs prevent this 'home away from home' factor for the upcoming generation of car user. Preventing someone purchasing a car is seen as a likely effect of the hub.

The focus groups agreed that the hub attributes identified during the literature research and expert interviews are the most important hub attributes. They perceived availability, flexibility, diversity, costs as especially important. They further agreed that a hub network with point-to-point trips would be preferable over stand alone hubs. They were also enthusiastic about the idea of a hub offering other services.

The focus groups further showed that for someone to form an opinion, some knowledge of the hub is important. This means that randomly surveying theoretical potential users is not useful. This resulted in the decision to distribute surveys in neighbourhoods with an active neighbourhood mobility hub.

The survey was distributed door-to-door in six neighbourhoods: Buiksloterham, De Werf, the Schoemaker Plantage, Bezuidenhout, the Scheepmakerswijk and the Schildersbuurt. By distributing the surveys door-to-door only residents with knowledge about the hub were asked to participate. The survey consisted of questions about the users' perceptions, their trip characteristics with and without the hub, their car ownership changes due to the hub and their socio-demographics. The measured variables make it possible to answer the research questions.

The survey resulted in 44 fully completed data sets, with 9 user and 35 non-user sets. The low number of respondents is partly due to the limited knowledge of the residents about the existence of the hub in their neighbourhoods. On average only 63% of the residents knew that the hub was located in their neighbourhood. The low number also means that the results of the analyses can not be generalised, the analyses give only an indication of which relations are likely.

A binary logistic regression model is estimated to find how socio-demographic variables influence the chance of hub use. All socio-demographics are taken into account, giving the effect of the variable in relation to all the other variables. The model finds that living with a family, with or without children, drastically increases the chance of hub use, compared to living alone. Having a low level of education, limited access to a car and previous experience with shared mobility use increases the chance of hub use even further. A higher income reduces the chance of hub use significantly. Age, gender and having a car license have a limited influence on hub use. With increasing age, people are slightly less likely to use the hub. Females and people who have a drivers license could also be less likely to use the hub.

The most likely hub user found by the model can be described as a young male with a low education level and income, living with his family. He has used shared mobility before and does not own, or have access to, a car.

While the data analysis does not point directly to parking pressure as a motivation for hub use, indirectly it could be of influence. Parking pressure could influence the number of owned cars and car access, which have a large influence on the chance of hub use. Increasing parking pressure could decrease the number of owned cars or the ease of car access, which leads to an increased chance of hub use.

In conclusion, the result of the regression model reflects the theoretical hub user found during the expert interviews and focus groups. There is no fixed type of hub user. However, relatively young households with restricted car access and experience with shared mobility are more likely to use the hub. While the data analysis did not find a direct influence of car parking pressure on the chance of hub use, it could play an indirect role.

The hub is perceived positive among the neighbourhood, with hub users having a more positive perception. Users are positive to very positive about the hub, while non-users are more neutral to positive. In order from highest perceived attribute to lowest: distance to the hub, diversity in vehicles, sustainability

of vehicles, availability of vehicles, sustainability of the vehicles, visibility of the hub, state of the hub, hub costs, ease of use, safety of the hub, safety of the vehicles, state of the vehicles, vehicle costs and finally the round-trip nature of the hub.

The data does not show if a more positive perception leads to an increased chance of hub use, or that hub use leads to a more positive perception. However, the largest differences in perception are found in those attributes of which non-users have limited knowledge (e.g. state of the hub, safety of the hub). The perception of these attributes probably becomes more positive due to hub use.

None of the attributes are perceived negatively, both by users and non-users, with the lowest score being a neutral perception for the round-trip nature of the hub. The fact that the round-trip nature is perceived the most negative indicates that a point-to-point hub network would be an improvement. This matches the focus groups, who also prefer a point-to-point hub network.

Another attribute that stand out is the distance to the hub. Experts used a range of 300 to 500 metres for the catchment area of the hub. Distance to the hub is the highest scoring perception, which all user perceive very positive. All respondents live in a range of maximum 400 metres from the hub. This confirms the range indicated by the experts.

The focus groups indicated that adding other services, like a parcel delivery point, to the hub would be of added value. The survey confirmed this, both users and non-users think that these kind of services would improve the hub. This means that adding other services to the hub is a good idea, especially because the experts and focus groups note that it will probably attract neighbourhood residents to the hub.

According to the experts it is important that residents see the positive effects of the hub. Free space created by the decreasing number of parked cars should be noticed and used by the neighbourhood. When asked about the effect of the hub on the free space in their neighbourhood, both groups indicated that they did not really see changes. This is partly due the fact that a large part of the surveyed households have private car parking spaces. The limited size and usage of the hubs further limits its effect on car ownership.

Considering the change in travel behaviour, the most important conclusion from the data analysis is that the hub decreases car ownership but increases the number of car trips. This is comparable with the effects of shared mobility found in the literature study, and the expectations of the focus groups.

Because of the hub, 33% of the users sold or did not buy an (extra) car. More surprisingly, 6% of the non-users sold their car or did not buy an (extra) car as well. In total, 11% of the respondents indicated that they had actually decreased their car ownership. When looking at the potential for car ownership change, the most important conclusion is that almost all hub-users at least think about decreasing their car ownership. Not surprisingly, the percentage of non-users who are thinking about changing their car ownership is smaller. In total 20% of the respondents have decreased, or are thinking about decreasing, their car ownership.

The effect of the hub on car ownership is in line with the expectations of the experts. The hub replaces second or third cars, as expected by the experts, none of the car changes concerned first cars. The focus groups indicated that it would be hard to get people to sell their car, they suggested that prevention of car use would be more successful. The data analysis shows that this is not the case in the sample, as the decrease in car ownership came mainly from people selling their car.

The hub leads to more car trips, because the hub substitutes bike and train trips with car trips. 75% of the trips users undertake via the hub is a car trip. Before the hub opened only 25% of these trips were made by car. The non-users thought about using the hub mainly for car trips as well. Increasing their number of car trips from 41% to 56%. This confirms the results of the focus groups.

The experts expected that the hub could motivate users to switch from car to bike, as both are offered at the same hub. They especially had high hopes for the e-cargo bike as a replacement of grocery trips by car. The data does not show this effect, the e-(cargo)bikes offered by the hub only replace the private bike. There is however a potential for growth in e-(cargo)bike use, as non-users are relatively more likely to choose these modes.

Experts and the focus groups think that a hub with e-cars could motivate users to try the e-car, decreasing local emissions. This assumption is partly confirmed, 20% of the car trips are replaced by e-car trips. There could be potential shift to e-cars as non-users mainly think about using the e-cars. It is however uncertain if they, when push comes to shove, really will use the (relative expensive) e-car.

At the moment, the hub does not decrease local emissions. The number of trips made with e-cars does not compensate the increase in the total number of car trips. However, the non-users will potentially decrease their emissions. Only 12% of their trips would be made by a gas powered car, compared to 41% without the hub. If the non-users would actually use the hub as they think they would, local emissions would decrease.

Finally, the hub is mostly used for incidental trips like visits and doing groceries. 89% of the users use the hub for visits, and 67% for groceries. The hub is least used for commuter trips, with 33% of the users. Non-users think about using the hub in the same pattern, with the emphasis on visits. However, the majority of the non-users (67%) do not think about using the hub at all. These results match the expectation of the experts and focus groups that the hub would mainly replace incidental trips.

This study shows that the neighbourhood mobility hub could certainly contribute to the problems faced by an ever more urbanising society. It is already decreasing car ownership, freeing up public space to use for other purposes. While the hub does not decrease car trips at this time, it could do so in the future if users are motivated to use non-car modes. There is also a potential for a decrease in emissions, as the e-car has the potential to replace the gas powered car. It is however important to understand that the hub is no golden ticket. To really reduce car ownership and especially car trips, neighbourhood mobility hubs should be part of a greater mobility plan. Well designed neighbourhood mobility hubs, embedded in and tailored to the neighbourhood could certainly play their part in solving the transportation problems of the future.

Further research into neighbourhood mobility hubs is needed. The most important research direction is the validation of the results found in this study. While this study found interesting connections, low number of respondents make generalising the results not possible. By repeating the data analysis with a larger data set significant relations can be found and more precise predictions can be made.

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Introduction

1.1. Problem Definition

According to the United Nations (2018), in 2018 55% of the world's population lived in urban areas. This proportion is expected to increase to 68% in 2050. For some countries, like the Netherlands the proportion is expected to increase to over 90% in 2050 (European Commission, 2017). This increase is no problem in itself, however it will lead to challenges in meeting, among others, the need for housing and transportation. Increased urbanisation leads to increased transportation needs, which leads to three main problems: Financial losses, high emissions and public space scarcity.

Increased car traffic in town and city centres results in chronic congestion, leading to a 1% loss of the EU's GDP every year (European Commission, 2017). In the Netherlands 0.5% of the GDP, between €3.3 and €4.3 billion, is lost due to congestion on the road network (KiM, 2019). Urban traffic is also responsible for 40% of (CO_2) emissions and 70% of emissions of other pollutants arising from road transport (European Commission, 2017). The infrastructure needed for road transportation, e.g. roads and parking spaces, is also responsible for land-use opportunity costs (Homem de Almeida Correia, Milakis, Arem, & Hoogendoorn, 2016). Research commissioned by the Dutch Ministry of home affairs, municipalities and provinces shows that on the researched building sites circa 20% less houses were realised due to parking norms. The research also showed that a total of 17 million euros was invested in parking spaces that are not used (Provincie Zuid-Holland, 2017b). Sustainable transportation is needed in urban areas to combat these issues. The United Nations (2018) find that sustainable urbanisation is key to successful development of growing cities.

The need for sustainable transportation is not new. In the Netherlands increasing traffic has been seen as a challenge since the introduction of the car, and probably before. Since its introduction around 1900, car use and the accompanying traffic problems steadily increased. In the Netherlands of the 1920s the traffic problems where already described as "The most burning issue in the public interest." (NTR/VPRO, 2019). The difference between today and the 1920s is that environmental concerns are gaining more and more importance among the urban population (Machado, De Salles Hue, Berssaneti, & Quintanilha, 2018). In turn, governments are made more aware that urgent solutions are needed. Internationally the Paris Accords ask for fast emission reduction (United Nations, 2015). This led to national rulings about CO_2 and nitrogen (N) emissions in respectively the Urgenda (Urgenda, 2019) and PAS case (Korbee, 2019), forcing the Dutch government to decrease emissions. A part of these emissions can be decreased by sustainable transportation.

The latest plan to cope with the above mentioned mobility problems in the Netherlands is called Deltaplan 2030 (Mobiliteitsalliantie, 2019). A coalition of parties from the Dutch car, bike, freight transport and public transport sectors are drafting a plan to overcome the mobility problems facing the Netherlands in the near future. One of their focus points is the use of shared mobility. "Shared mobility is the shared use of a vehicle, bicycle or other low-speed mode that enables users to have short-term access to transportation modes on an 'as-needed' basis." (Shaheen, Chan, Bansal, & Cohen, 2015, p. 4). According to Machado et al. (2018) shared mobility has the disruptive potential to create a shift towards social, environmental and economic efficiency through the use of technology. The vision of the

future is one service integrating shared mobility with other forms of mobility for a seamless door-to-door travel experience.

1.1.1. Shared mobility

The rise of technology, especially the internet, led to a rise in sharing economy concepts. The shared economy is projected to grow substantially from $15 billion in 2014 to $335 billion in 2025 (PwC, 2014). Shared mobility is part of this shared economy and consist of traditional public transport like bus or train and the fast growing new sharing services (WSP, 2017). These new services are the sharing of cars, personal vehicles, bikes, scooters and traditional ride sharing, ridesourcing and e-Hail (taxi) (Shaheen & Chan, 2016). Users of shared mobility are able to access vehicles on a short-term basis. Users do not own the vehicles and are typically charged on a pay-as-you-go or subscription basis (WSP, 2017).

Shaheen and Chan (2016) state that one-way car sharing and bike sharing are effective and efficient first- and last-mile solutions. Shared mobility can therefore be a flexible option for the first- ans last-mile of a multimodal public transport journey. This flexibility could encourage travellers to use public transport, as, according to Machado et al. (2018), transportation users are increasingly demanding in terms of reliability, flexibility, availability, comfort, and cost of their transport mode choices.

One of the most researched forms of shared mobility are car sharing systems. A literature review by Ferrero, Perboli, Vesco, Caiati, and Gobbato (2015a) found studies stating car sharing could reduce private car ownership and car mileage, as well as studies indicating increased car ownership and use by former public transport users.

This shows that car sharing could be an answer to the problems arising with increasing transportation needs, or that it could increase the problems. The Dutch government, provinces and municipalities see shared mobility as (part of) the answer to their problems. To expand their knowledge they therefore stimulate shared mobility (Provincie Zuid-Holland, 2017a). The best way to organise shared mobility is however dependent on multiple factors. There is no one 'right' way to provide shared mobility.

Ferrero et al. (2015a) distinguish two main ways of providing car sharing services: free floating services and station-based services. Free floating cars are freely parked in public spaces within an operational area and journeys can start and finish in any point in this area. Station-based services operate from fixed stations where the trips must start and end. All shared mobility services are in essence organised in one of these two ways.

In the Netherlands there has been negative experiences with free floating shared bike services. Shared bikes were clustering around public transport hubs, taking up parking space. Because the bikes were not owned by the users, they felt less responsible for them. This resulted in bikes being parked illegally on sidewalks and other public space. This led to forced station-based services in Amsterdam (Nijssen, 2018) and reluctance of other cities to introduce the services (De Jonge, 2018). Municipalities now want to regulate shared services and seem to focus on station-based services where different modes of transport are offered at the same location. This should make it possible for municipalities to accurately plan for parking spaces. It should also deter people parking illegally, as they have to park the vehicle near a station to return it. These stations, where users switch between different modes, are called mobility hubs.

1.1.2. Mobility hubs

Mobility hubs, also named transport interchange or transport hubs, are places where intermodal transfers can take place. The concept of the mobility hubs is not new but the use is changing. In the past a mobility hub was a place where you arrived and parked your own bike or car and switched to public transport. Examples are Park & Ride or Bike & Ride facilities at stations, but also transferia at the edge of city centres. In the mobility hub of tomorrow shared mobility is the norm, leading to a different design approach for hubs (Loo & du Verle, 2017).

Extensive research has been done into mobility hubs, from location problems (Nickel, Schöbel, & Sonneborn, 2001) to effective hub design (Pitsiava-Latinopoulou & Iordanopoulos, 2012; Monzón, Hernández, & Di Ciommo, 2016) to user perceptions (Hernandez & Monzón, 2016; Miramontes, Pfertner, Rayaprolu, Schreiner, & Wulfhorst, 2017) and integration in the local urban environment (Daudén, Carpio-Pinedo, & García-Pastor, 2014). What all this research has in common is that it focuses on medium to large mobility hubs with public transport connections, e.g. central train stations or P+R facil-

ities at the edge of cities. A new form of mobility hubs, the small neighbourhood mobility hub, is not yet represented in scientific literature. The neighbourhood mobility hub is a hub without public transport connections offering shared transport modes. These hubs bring together (e-)bikes, (e-)cargo bikes, (e-)scooters and/or (e-)cars in a central location in the neighbourhoods. They bring shared mobility into the neighbourhood, in theory increasing the visibility and use of shared mobility. The hubs potential benefits for the neighbourhood range from freeing up public space due to a lower local demand for parking spaces, to a safer neighbourhood due to a decrease in car trips.

While not represented in scientific literature, research on small neighbourhood mobility hubs is expanding. This is done mainly by implementing pilot hubs, examples are the eHubs and the Hely hubs.

eHUBS are multimodal hubs where shared electric mobility is the norm. The concept was introduced by an international European cooperation between different cities, universities and shared mobility providers (Interreg, 2019). They have chosen to only use electric mobility, as one of their goals is creating cleaner and more liveable cities. This will not be obtained by switching privately owned gasoline cars for shared gasoline cars. A concrete result of this project is the planned introduction of the so called 'eBuurthubs' in Amsterdam. These small neighbourhood hubs will offer shared electric mobility (e.g. bikes, cargo bikes, cars) to the local population. They plan to realise 10-15 of these hubs between 2019 and 2021 (Gemeente Amsterdam, 2019).

These hubs proposed by Amsterdam are similar to hubs developed by Hely, a company with multiple hubs located in the Netherlands. Since opening the first hub in Delft, in February 2019, Hely hubs were introduced in Amsterdam, the Hague, Haarlem, Rotterdam and Utrecht (Hely, 2019). The Delft hub is located in a newly developed residential area at the edge of Delft, the Schoemaker Plantage, and provides users with (e-)bikes, (electric) carrier bikes and (electric) cars (BAM infra, 2019; Hely, 2019). The thesis by Knippenberg (2019) researched Hely hub users. It shows that in these hubs the shared car is the dominant choice and that other modalities are hardly used. He concludes that multimodality is not the motivation for use of the Hely hub. He does however find that Hely hub users would decrease their car ownership if shared mobility was a viable replacement in their neighbourhood.

When talking about hub users, not much is known. (Knippenberg, 2019) describes the Hely hub user as a balanced group of relatively young men and women. They tend to have a relatively high education and income. These are characteristics of people already using a neighbourhood mobility hub, they can therefore not be directly translated to a potential mobility hub user group. The effects the hub could have on the neighbourhood are also unknown, (Knippenberg, 2019) only noted potential car ownership changes. Travel behaviour changes are not made instantly, they take time (Goodwin et al., 2004). This means that changes in behaviour are hard to detect and should be measured over a longer time. This is difficult for neighbourhood hubs as they are relatively new service.

The above mentioned research and examples show that neighbourhood mobility hubs are seen as part of the answer to the three main problems due to increased transportation needs. The Dutch municipalities see them as a good method to decrease parking needs while offering relevant alternatives, making them part of solving the public space scarcity problem. They also see them as a part of solution for congestion and emissions caused by car traffic. However, there is very little known about the potential hub user, or the effects a neighbourhood mobility hub could have on their travel behaviour. More research is therefore needed in order to say if neighbourhood hubs really offer these solutions.

1.2. Research Objective and questions

The previous section and the literature study show that the current urban transportation situation leads to financial losses, high emissions and public space scarcity. Municipalities want to handle this problem by stimulating shared mobility. One way to organise the shared mobility that municipalities, researchers and companies see as promising is hub based shared mobility. Research on hubs focuses mainly on medium to large hubs while small scale hubs are already being implemented (Gemeente Amsterdam, 2019; Schreier et al., 2018; Hely, 2019). Information about these neighbourhood hubs is scarce, the circumstances under which they will be used and who will use them is unknown. This is also true for the effects of these hubs on neighbourhoods, shared mobility use and travel behaviour of the users. There are many questions surrounding neighbourhood hubs and its potential users. The research objective of this research is therefore to explore the potential users, their perceptions of the hub and

the hubs effect on their travel behaviour. This research will lay a theoretical base for further research into neighbourhood mobility hubs.

Municipalities and companies want to implement neighbourhood hubs but they do not know what preferences potential users of these hubs will have before they are ready to use them. This can result in hubs being implemented with no one using them, or increased car use by former non-car users. The societal objective is therefore to give municipalities and companies a base from which to start with neighbourhood mobility hub development, so that it may meet their objectives in terms of a reduction in car trips and car ownership. The research and societal objectives lead to the following main research question:

How do potential users perceive a neighbourhood mobility hub and what effect does the hub have on their travel behaviour?

To answer this question it is divided into the following sub-questions:

1. What defines a neighbourhood mobility hub?
2. Who are the potential users of a neighbourhood mobility hub?
3. What are the perceptions of the potential users of a neighbourhood mobility hub?
4. How does the neighbourhood mobility hub influence the travel behaviour of the potential user?

1.3. Research approach

To answer the research sub-questions exploratory research is carried out. Exploratory research is appropriate for understanding phenomena still in early stages of theory development (Edmondson & McManus, 2007). It further helps define problems more clearly, which will in turn help determine research designs better. Rather than providing solutions to a problem, exploratory research helps prioritise desired outcomes and measures more accurately (Thornhill, Saunders, & Lewis, 2009).

The sub-questions are answered using a combination of research methods. In total four research methods are used: a literature study, expert interviews, focus groups of potential users and a data analysis of data collected by a survey among residents of a neighbourhood containing a hub. These four methods will be briefly explained in this section, but first the boundaries and scope of the research will be noted.

1.3.1. Scope

This research focuses on neighbourhood mobility hubs in the Netherlands. The hub in this research is a small neighbourhood mobility hub that offers shared use of mobilities. Other attributes of this hub are subject of the research. The research is conducted within the Netherlands, interviewed experts, focus group participants and survey respondents are all Dutch residents.

1.3.2. Methods

Each of the four research methods is explained and justified briefly in this section, a more in-depth explanation and justification is given in the chapters dedicated to each method. Table 1.1 shows an overview of what methods answers which research sub-questions.

The literature research is used to find the state of the art research into shared mobility hubs. The research is carried out mostly via the computer. Google Scholar, the TU Delft repository and Scopus are searched for relevant literature. This is done by searching the following key words: shared mobility, mobility hubs, Mobility-as-a-Service and synonyms of these words. By (reversed)snowballing even more literature is accessed. Literature is the foundation on which this study is build, it provides information for sub-questions 1, 3 and 4.

The research will provide a preliminary definition of a neighbourhood mobility hub as well as a theoretical description of the potential hub user. It also provides the current travel behaviour of Dutch residents and the theoretical travel behaviour effects of the hub. The information gathered during the literature study is further used to design the expert interviews.

To expand on the information found in the literature study, semi-structured interviews with experts in the field of shared mobility and mobility hubs are held. Interviewing is a good way to gather the latest data used by experts in the field. During the interviews experts are asked about possible hub attributes, potential users and possible travel behaviour effects. Providing further information for sub-questions 1, 2 and 4.

The combined information from the literature research and expert interviews will result in a definitive answer to what defines a neighbourhood mobility hub. It further results in a description of a theoretical potential user and the theoretical travel behaviour effects of the hub. The theoretical potential users is invited for the focus groups.

Focus groups are depth group interviews for qualitative research that have been used by social scientists and marketing research for decades (Stewart & Shamdasani, 2014; Morgan, 1996). Focus groups are used to find ideas and opinions about a certain subject. To make sure all relevant ideas and opinions about neighbourhood mobility hubs, two focus groups are held. The focus groups provide preliminary answers to sub-questions 2, 3 and 4.

The focus groups answer the question if they are indeed the potential users. They further indicate which of the theoretical travel behaviour effects are likely to occur. Finally, they will give a first indication of how the neighbourhood mobility hub is perceived. The preliminary answers to the sub-questions are used to design a survey.

The short survey is distributed among residents in a neighbourhood with an active neighbourhood mobility hub. Surveys are fine methods for measuring attitudes and orientations of a large population (Babbie, 2013). The survey measures actual travel behaviour changes due to the hub, the perceptions of the potential users on the most important hub attributes, and the characteristics of the potential users. The resulting data is analysed with statistical software. The results of these analyses give answers to the second, third and fourth sub-question. The combination of the theoretical and empirical answers to the questions answers the main research question.

Table 1.1: Overview of how the different methods answer the different sub-questions

		Sub-question			
Method	Chapter	1	2	3	4
Literature research	2	x	x		x
Expert interviews	3 & 4	x	x		x
Focus groups	5 & 6		x	x	x
Survey data analysis	7 & 8		x	x	x

1.4. Thesis structure

This report further consist of eight chapters. Chapter 2 presents the state of the art literature about neighbourhood mobility hubs, shared mobility and MaaS. It further gives an overview of the current travel behaviour of Dutch residents, and how this could be influenced. The chapter ends with an overview of all important actors concerning the neighbourhood mobility hubs.

The expert interviews, focus groups and survey method are all explained in their own chapter, followed by a chapter containing the results. The design of the expert interviews is noted in chapter 3 followed by its results in chapter 4. The setup of the focus groups is discussed in chapter 5 followed by the results in chapter 6. Chapter 7 presents the design of the survey followed by the results in chapter 8. Finally chapter 9 contains the key findings of this study, their implications and limitations, and recommendations for further research.

2

State of the art literature

A neighbourhood mobility hub is defined by its attributes and goals. To find the possible attributes an overview of the 'state of the art' knowledge about hubs, shared mobility, Mobility-as-a-Service and travel behaviour is needed. This is combined with an actor analysis to find the goals for all relevant actors involved. This information is used to find a preliminary definition of a neighbourhood mobility hub. It further shines a light on the theoretical potential users and the possible effects of neighbourhood mobility hubs on travel behaviour. This results in a preliminary conceptual model describing the relations between potential users, hub use and travel behaviour effects. This chapter will lay the foundation on which the study is build.

2.1. Mobility hubs

A mobility hub, also called the transport hub or transport interchange, is a place where intermodal transfers can take place. It is a combination of two of the five visions of sustainable transportation proposed by Litman and Burwell (2006). Their visions are: technical, demand management, economic reform, alternative modes and land use/community design changes. The mobility hub is a combination of the last two visions, it offers alternative modes and it should be embedded into the design of its surroundings.

There are two main sort of hubs: cargo hubs and passenger hubs. The neighbourhood mobility hub is a passenger hub. When focusing on passenger hubs, public transport hubs are the most recognisable as hubs, however a parking lot is technically also a hub for private transport.

2.1.1. Different kind of mobility hubs

There is no fixed number of different kind of hubs. To get a view on the kind of hubs that are possible, seven main kind of hubs are distinguished. Six of those are described in the Deltaplan 2030 (Mobiliteitsalliantie, 2019):

1. A hub on the edge of the city where national and regional public transport, car traffic, shared mobility and bicycle come together. A current example is a Park and Ride facility that facilitates public transport into the city (Karamychev & Van Reeven, 2011). However, at the moment these facilities are mostly focused on car and public transport and not on bike or shared mobility.

2. A hub inside a city as public transport node including (area) efficient shared mobility. A current example: The transit centre in San Francisco does not only accommodate a switch between modes but also has a rooftop citypark, a public art program and room for offices and retail (Transbay Program, 2019).

3. A hub in a rural area where it is mainly a transfer point from public transport, car and bicycle, possible with shared mobility. A current example is a regional train station, these could be improved with shared mobility.

4. A hub in a business district with shared mobility for the businesses. A current example is business-to-business (B2B) car sharing, where a member of staff is provided access to a car sharing organisation's fleet through their employer (Clark, Gifford, Anable, & Le Vine, 2015).

5. A logistic cargo hub at the edge of the city to establish emission free last-mile transport, e.g. a distribution centre from where the city is supplied.

6. Temporary hubs, for example during construction work, to keep the areas reachable during construction.

The seventh kind of hub is not mentioned in the Deltaplan 2030, it is a hub without any public transport connection. This is a small scale hub in a neighbourhood at a distance of around 2 km of a public transport point where residents can use shared mobility to traverse the first-mile to a public transport connection or use shared mobility for an entire journey. An example of this 'neighbourhood mobility hub' is the Hely Hub (BAM infra, 2019). These kind of hubs are not represented in scientific literature but they are already being implemented (Gemeente Amsterdam, 2019; Schreier et al., 2018; Hely, 2019). This implementation without good research into the effects is the reason to focus this study on these neighbourhood mobility hubs.

2.1.2. Previous research into hubs

There has been done extensive research into hubs, from location problems (Nickel et al., 2001) to effective hub design (Pitsiava-Latinopoulou & Iordanopoulos, 2012; Monzón et al., 2016) to user perceptions (Hernandez & Monzón, 2016; Miramontes et al., 2017) and integration in the local urban environment (Daudén et al., 2014). What all this research has in common that it focuses on medium to large mobility hubs with public transport connections.

As hubs become a more integral part of urban regions it is important to note the user perceptions of these hubs. Hernandez and Monzón (2016) conclude that an efficient urban transport interchange should fulfil four essential principles, as defined by the users. Reducing waiting time, making it easier to interchange and reduce the users' stress levels, making the stay more comfortable and improving the use of time in the interchange. Directly linked to the overall performance of the interchange are safety and security as psychological features that are indispensable to users. They finally conclude that current urban transport interchanges can host other type of activities and act not only as transport nodes, but also as meeting places within cities. Miramontes et al. (2017) conclude that there is a demand for more mobility hubs, at least for users of the mobility station in Munich. The preferable locations for these hubs are central places in the city centre, at public transport nodes along high capacity public transport axes, and in residential areas.

2.1.3. Downsides of hubs

While hubs are a part of solving mobility problems they won't solve all problems, and even cause new ones. Maat (2012) notes that the attitudes of residents should be taken into account when making policy changes. Concluding that households should not be forced to change. He advises to provide multiple types of neighbourhoods, e.g. car, bike or public transport oriented, so people have a choice. This selecting of neighbourhoods based on travel abilities, needs and preferences is called residential self-selection. Residential self-selection results usually from attitudes and socio-demographic traits. The problem of residential self-selection is that it can give false relations. E.g.: A low income, zero-vehicle household chooses to live in a neighbourhood with good public transport connections. The researcher may conclude that they are attracted by the good public transport, this is however a false relation, as the financial constraints have a direct effect on the choice for public transport (Cao, Mokhtarian, & Handy, 2009). It should be noted that the effects of neighbourhood mobility hubs on this residential self-selection are not known. It does mean that placing a hub in a neighbourhood without thorough research will probably not lead to the desired outcome. This also means that hubs should be tailored to the neighbourhood, and that research into the expectations of users of, and residents near, hubs is critical. This to make sure the hub is a success and has the intended effects on the local mobility choices and patterns.

Mobility hubs could also decrease the mobility of the less mobile or technical adapt. Because a hub is located in a central point users have to traverse to it by their own means, mostly by walking. When

someone can not do this due to a disability or old age the hub has no value. The same is true for people who are not able to use the technology used by the hub. Especially small hubs will probably not have personnel on site to assist people who experience problems with the technology. The hubs and the vehicles are accessed with a mobile phone app.

While the goal of hubs is often to decrease car use, in reality mobility hubs do not have this effect. Ferrero et al. (2015a) show that car sharing could lead to more car use by people who used to use public transport. Car sharing makes it easier for non-car owners to use a car, which could lead to them purchasing their own car if they think that it is cheaper or easier. This possible effect on the hub user should not be neglected.

2.1.4. Possible hub characteristics

A mobility hub has many characteristics: Its location, the kind and quantity of modes being offered, the availability of the mode you need, accessibility of the hub, services offered, owner of the hub and modes, the one taking the initiative, e.g. government, users, or other parties. These are but a few of the possible characteristics of a mobility hub.

The characteristics of an ideal mobility hub differ per user or user group and different designers offer different characteristics. Table 2.1 and figure 2.2 show the amenities different kind of mobility hubs need according to Urban Design Studio (2019) and San Diego Forward (2017) respectively. Figure 2.1 shows the elements to a successful hub according to Metrolinx (2016). These examples show that there are many different characteristics used by mobility hub designers. It is important to note that these figures and table are taken from non-scientific sources. The hub designers use these to give clients an overview about what is possible when developing a hub. While not scientific in nature, they give important information about possible hub characteristics used by developers at this time. Especially table 2.1 is interesting as it lists neighbourhood hubs specifically.
The amenities in table 2.1 and figure 2.2 are specific characteristics, the elements in figure 2.1 are high scale characteristics for a successful hub. Both are needed for hub design but the specific characteristics are more user oriented while the high scale characteristics are more hub developer oriented, the first type of characteristics are the ones that are subject in this research.

The main take away from these figures and table is that the scale of the hub should influence the available characteristics. E.g. a large inner city hub has diverse modes and a large quantity of shared modes while a small scale neighbourhood hub only has a few cars and bikes. The scale of the hub is dependent on its surroundings, from multi-storied transit hubs (Transbay Program, 2019) to the small neighbourhood hub like the Hely Hub. It confirms again that, like noted in section 2.1.3 the hub should be tailored to the needs of its users.

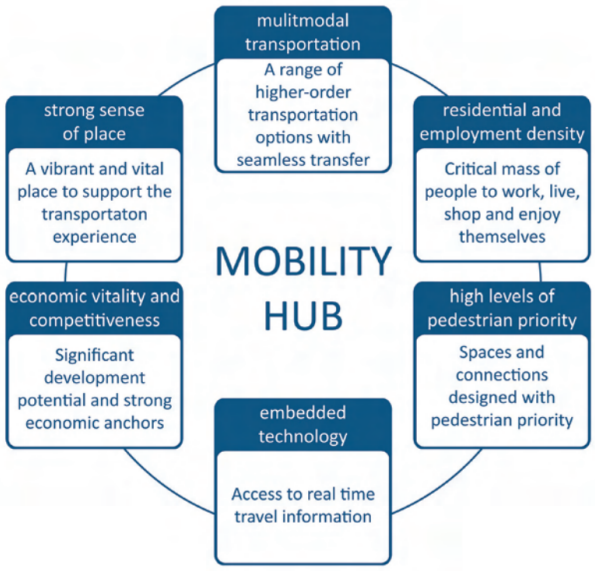

Figure 2.1: Mobility hub elements of success as noted by Metrolinx (2016, p. 4)

Table 2.1: Mobility hub amenities as noted by Urban Design Studio (2019, p. 7)

Mobility Hub Amenities	Bicycle Connections			Vehicle Connections			Bus Infrastructure		Information–Signange			Support Services				Active Uses		Pedestrian Connections	
	2.1. Bike Share	2.2. Bike Parking	2.3. Bicycling Facilities	3.1. Ride Share/Pick up-Drop off	3.2. Car Share	3.3. EV Charging Stations	4.1. Bus Layover Zone	4.2. Bus Shelters	5.1 Wayfinding	5.2. Real-time Information	5.3. Wi-Fi / Smartphone Connectivity	6.1. Ambassadors	6.2. Waiting Area	6.3. Safety and Security	6.4. Sustainable Approach	7.1. Retail	7.2. Public Space	8.1. To the Mobility Hub	8.2. At the Mobility Hub
(N) Neighborhood	●	●	■	■	○	○	■	○	●	○	○	■	○	○	○	■	■	○	○
(C) Central	●	●	○	●	●	●	○	●	●	●	●	○	○	●	●	○	●	●	●
(R) Regional	●	●	●	●	●	●	●	●	●	●	●	●	○	●	●	●	●	●	●
Legend:	Vital: ●			Recommended: ○			Optional: ■												

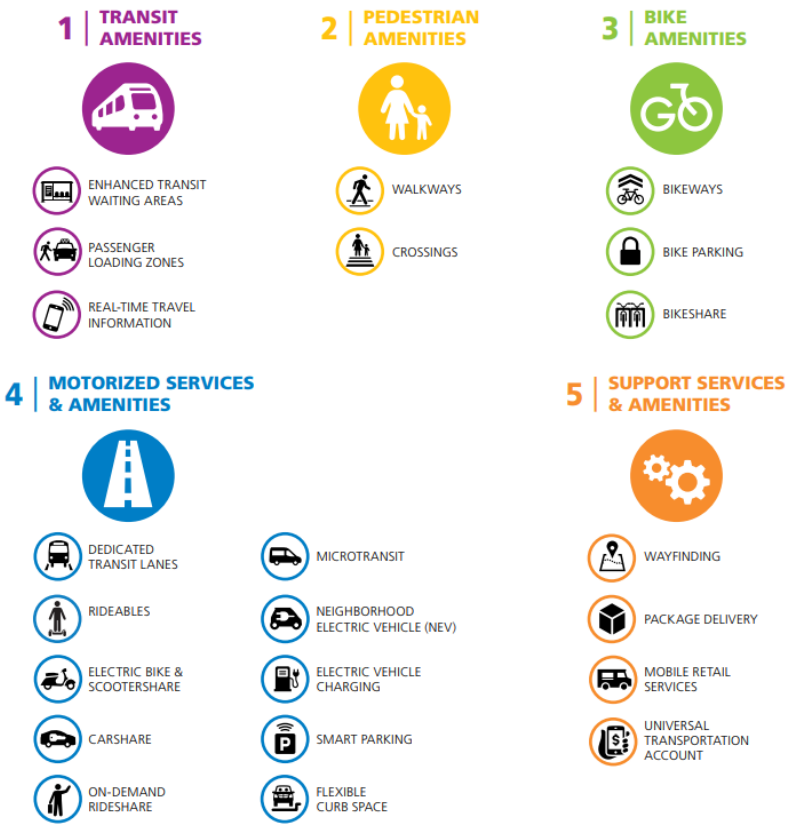

Figure 2.2: Mobility hub amenities as noted by San Diego Forward (2017, p. 3)

2.1.5. Neighbourhood mobility hubs

The literature discussed thus far discussed mobility hubs in general. Information about neighbourhood mobility hubs is much more scarce. The TU Delft master thesis by Knippenberg (2019) is the only source found to discuss small scale multimodal hubs without direct public transport connections. Because it is master thesis and not a published scientific paper information from it is checked thoroughly. It is however the only source of information about neighbourhood mobility hubs and therefore important for this study.

In his thesis he researched mobility behaviour of people who use Hely Hubs. Hely is a company who offers a MaaS service, their Hubs are small scale hubs that provide (e-)bikes, cargo bikes and (e-)cars in residential areas through the use of the Hely application (Knippenberg, 2019). Most information about neighbourhood mobility hubs discussed here is found in his thesis. It should be noted that his results are based on a small group (80 persons) of neighbourhood mobility hub users. His results can not be generalised to all Dutch mobility users. However, his research does give insight in potential users and characteristics of neighbourhood mobility hubs. His results also say something about the contextual factors and possible effects on user travel behaviour.

Characteristics

As stated before, most characteristics from table 2.1 and figure 2.2 could be used for neighbourhood mobility hubs. Urban Design Studio (2019) distinguishes the amenities of a neighbourhood mobility hub specifically in figure 2.1. In this research all user oriented amenities and characteristics are considered as neighbourhood mobility hub characteristics.

Knippenberg (2019) found that shared (e-)cars are the most popular mode with 79% of the total number of trips made by (e-)car. The use intensity of the small car is highest, followed by the MPV and the e-car. 21% of trips are made with bicycles, e-bike (17%) and cargo bike (4%). When asked directly diversity in the modes is less important to the users. This combined with the high use intensity percentages of cars leads Knippenberg (2019) to conclude that multimodality is not the motivation for the use of the hub.

Users

Knippenberg (2019) found that neighbourhood mobility users are a balanced group of men and women, mainly between the age of 25 and 35. They tend to be full-time employees who live with their partner or family. When looking to prior travel behaviour, hub users own and use the car less compared to other Dutch residents. Users expect the hub to provide mainly convenience and flexibility, costs and sustainability are also important while diversity in modes is less important.

Contextual factors

Knippenberg (2019) found that users access the hub either by foot or bike. Their average trip length via the hub is three hours. He also looked into the effects of weather and type of day into the mode choice and found that these are uncorrelated.

Knippenberg (2019) also notes that neighbourhood mobility hubs are considered best suited for inner-city neighbourhoods without parking spaces. He considers this an important external factor as it nudges people toward alternative mobility solutions.

Effects on travel behaviour

Knippenberg (2019) finds that from all users almost 60% intent to use the neighbourhood mobility hub for day-activities, and 50% for grocery shopping. A majority of users consider having less cars in their households, while 25% state that they will keep their private cars. The modes offered in the neighbourhood mobility hub are mainly seen as a replacement for a second private car. He concludes that the neighbourhood mobility hub mainly eases accessibility of cars for non-car users. In their current form the neighbourhood mobility hub increases the total number of car trips.

Connection to current study

The master thesis of Knippenberg (2019) seems to answer the questions asked in this research concerning the potential users and effects on them. It is however a limited study, only describing the users of Hely hubs. It does not show how the user and non-user differ, and what characteristics influence the chance of hub use. It also expands on his research by researching how the users and non-users

perceive the different hub attributes. This study aims to find the effects of the hub on a whole neighbourhood, including non-users. This makes it possible to say something about the potential of the neighbourhood mobility hub.

2.2. Shared mobility

As said in the introduction, the sharing economy is projected to increase with more than 2000% between 2014 and 2025. Shared mobility is also increasing with the increase of the total shared economy. Shared mobility is changing the traditional transportation industry as it has the disruptive potential to create a shift towards social environmental and economic efficiency through the use of technology (Machado et al., 2018). Statistics for the Netherlands show that the supply of all types of car sharing services are increasing. Personal vehicle sharing is even growing exponential, making up more than 80% of the total supply of 51.000 cars in 2019 (CROW, 2019).

2.2.1. Types of shared mobility

Figure 2.3 shows the key areas of shared mobility as noted by Shaheen and Chan (2016). They are categorised on what is being shared: vehicles (left), passenger rides (middle) or delivery rides (right). Delivery rides are not a focus in this paper, as the focus is the transport of persons, that branch is therefore darkened.

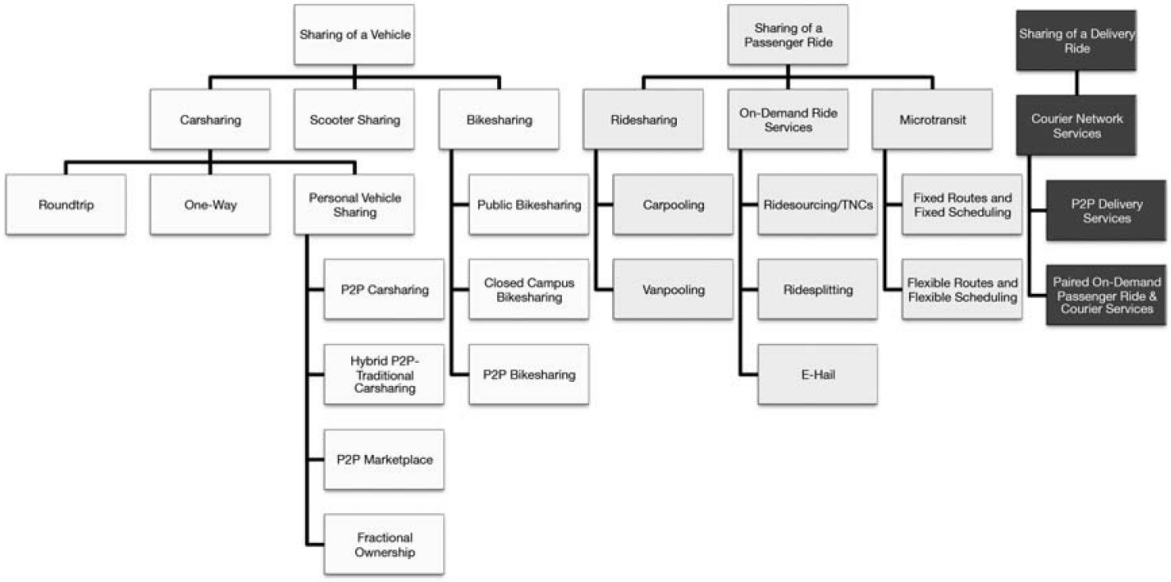

Figure 2.3: Key areas of shared mobility as noted by Shaheen and Chan (2016, p. 574)

Figure 2.3 shows that there are many different forms of shared mobility. Each of the six main forms will be shortly discussed. But first, the structure of organising sharing services will be discussed.

Vehicle sharing service structure

Ferrero et al. (2015a) distinguish two main structures of vehicle sharing: station based services and free floating services. Station based services operate from fixed stations where the trips must start and end. These could offer both roundtrips (start and end at the same stations), and one way trips (start and end at different stations).

Free floating vehicles are freely parked in public spaces within an operational area, journeys can start and finish in any point in this area (one way trips) (Ferrero et al., 2015a). Each service has its advantages and disadvantages. For example, with increased flexibility for the user (toward free floating) comes increased operational complexity, as vehicles may need to be redistributed over the network (Ferrero, Perboli, Vesco, Caiati, & Gobbato, 2015b). When looking at electric vehicles stations based services are almost always needed because of the need for charging stations (Ferrero et al., 2015b).

Carsharing
”Through carsharing, individuals can gain the benefits of private vehicle use without the cost and burdens of ownership (e.g. fuel, maintenance, insurance)”(Shaheen & Chan, 2016, p. 575). Members of a carsharing platform can access a fleet of shared vehicles on an as-needed basis they pay a membership- and/or use-based fee (Shaheen & Chan, 2016).

With personal vehicle sharing (PVS) people share their privately-owned vehicle with other individuals. The vehicle owner and the possible vehicle renters are connected via a service that makes the exchange possible. With Peer-to-peer (P2P) carsharing, the vehicles are made temporarily available for shared used by an individual member of a P2P company (Shaheen et al., 2015).

If the company offering this P2P services also maintains its own fleet of shared vehicles, they offer hybrid P2P-traditional carsharing services (Shaheen et al., 2015).

If the company only provides a place for vehicle owners and possible vehicle renters to meet and discuss the terms and conditions of the P2P carsharing among themselves it is called a P2P marketplace (Shaheen et al., 2015).

The fractional ownership model offers third party owned vehicles to be subleased to individuals. These individuals take on a portion of the operating and maintenance costs and are given rights to the shared vehicle in return (Shaheen et al., 2015).

Scooter sharing
Scooter sharing has the same principle as car sharing, as that individuals gain the benefit of a private scooter without the ownership costs. Because of the limited range and speed of scooters, these systems are mostly restricted to urban areas (Shaheen & Chan, 2016).

Bikesharing
”Bikesharing systems allow users to access bicycles on an as-needed basis from a network of stations, which are typically concentrated in urban areas” (Shaheen et al., 2015, p. 10). Free floating bikesharing is also possible within a geo-fenced area. In most cases, bikesharing operators are responsible for maintenance, storage and parking costs (Shaheen et al., 2015).

Public bikesharing is in theory accessible by everyone, requiring a membership and/or a nominal fee with a credit or debit card. Closed campus bikesharing are closed for a select group, like a students or employees on a university campus. P2P bikesharing uses the same principle as its carsharing counterpart (Shaheen et al., 2015).

Ridesharing
”Ridesharing facilitates shared rides between drivers and passengers with similar origin-destination pairings”(Shaheen et al., 2015, p. 13). This is the classic carpooling or, when considering larger groups, vanpooling.

On-Demand Ride Services
”On-demand ride services differ from traditional ridesharing, in that these services involve the passenger requesting a ride through a mobile device and a mobile app” (Shaheen & Chan, 2016, p. 581).

Ridesourcing or Transportation Network Company (TNC) services use a smartphone app to connect community drivers with passengers. Uber and Lyft are the most well known examples of TNCs (Shaheen et al., 2015).

Ridesplitting is a combination of carpooling and ridesourcing. The TNC matches riders with similar origins and destinations, these riders then split the ride and the costs. This could be done for whole and partial trips (Shaheen et al., 2015).

E-Hail services is the reaction of the traditional taxi industry on the emergence of TNC services. Traditional taxis can be reserved via the internet or a mobile app. These services are maintained either by the taxi companies or third parties (Shaheen et al., 2015).

Microtransit
”In addition to traditional fixed-route public transit, other transportation options have existed in parallel [...] Recently a form of private transit enabled by technology has emerged; known as mictrotransit it incorporates flexible routing, flexible scheduling, or both” (Shaheen & Chan, 2016, p. 583).

Fixed routes and fixed schedule can be similar to the operations of public transit and vanpool. Flexible routes and flexible scheduling more closely mirrors ridesplitting (Shaheen et al., 2015).

2.2.2. Effects of shared mobility

A hub is basically a central place in a neighbourhood where shared mobility is offered. Therefore, too understand the possible effects a hub has on a neighbourhood, knowledge about the effects of shared mobility is needed.

One of the most researched forms of shared mobility are car sharing systems. Ferrero et al. (2015a) classify 95 papers published between 2001 and 2015 about car sharing systems. They note that multiple studies show that the success of car sharing services is correlated to the presence of different transportation modes nearby the car share stations. This indicates that multimodality is important. They also conclude that higher parking costs increase the likelihood of shared vehicle use. Same is true for the number of stations offering car sharing in an area. An increase in stations leads to an increase in likelihood of shared vehicle use.

They further found studies stating car sharing could reduce private car ownership and car mileage, as well as studies indicating increased car use by former public transport users due to car sharing. One other important aspect they note is the importance of information technology relaying real time information about the service. Ferrero et al. (2015b) note that car sharing services are cheaper for users compared to private car ownership up to a certain average distance travelled per year. These distances can differ per provider, from 1000 to 7000 km/year.

Shaheen and Chan (2016) state that one-way car sharing and bike sharing are effective and efficient first- and last-mile solutions. Shared mobility can therefore be a flexible option for access- and egress-legs of a multimodal public transport journey. This flexibility could encourage travellers to use public transport, as according to Machado et al. (2018) transportation users are increasingly demanding in terms of reliability, flexibility, availability, comfort, and cost of their transport mode choices. Besides that, environmental concerns are gaining more and more importance among the urban population (Machado et al., 2018).

One of the reasons for the introduction of the neighbourhood mobility hub is to reduce emissions. However shared mobility does not necessarily decrease the emissions. Research by Santos (2018) indicates that of the above discussed types of shared mobility only the 'sharing of a passenger ride' branch decreases emissions. The other types replace personal car rides with shared car rides, which has a limited effect on emissions. She sees no direct societal benefits and asks if municipalities should encourage shared car use.

Research in the Netherlands among car sharers however, shows that car sharing can reduce car ownership, car kilometres, and emissions. An survey among 363 car sharers showed that their car ownership decreased with 30%, car kilometres around 15% - 20% and CO_2 emissions by as much as 18% (Nijland & van Meerkerk, 2017). They note that the decrease in car ownership was mostly caused by selling or not buying a second or third car. They also found that shared car mostly replaced train trips (41%), followed by personal car trips (34%). They also showed that the different kind of car sharing had different kind of impacts. Business-to-consumer (B2C) sharers were more likely to decrease their car ownership compared to peer-2-peer (P2P) sharers. Another important effect they note is that with B2C the shared cars are generally more fuel-efficient compared to the average car on the Dutch road, leading to lower emissions (Nijland & van Meerkerk, 2017). This shows that to reduce emissions it is important to keep the shared car fleet up to date. When the neighbourhood mobility hub has a fully electric car fleet the emissions would decrease even more. However costs and unfamiliarity could be hurdle for users to change to electric mobility.

2.3. MaaS and mobility hubs

Known mobility hubs like the Hely hub work on a Mobility-as-a-Service (MaaS) platform. While this study does not focus on MaaS, a short introduction is given to explain the link between MaaS and mobility hubs.

In large urban centres there is space for many mobility options, which can operate in a complementary way rather than as competitors, improving the transportation supply and expanding the range of users' choice (Machado et al., 2018). This is made possible by smart mobility and includes the smart use

of data (e.g Internet of Things), smart vehicle technology (e.g. self driving cars), smart concepts for user focused mobility (e.g MaaS) and smart use of the infrastructure (e.g. hubs) (Boshouwers, Dekker, Kandel, & Van Gils, 2019). Smart mobility is made possible by the rise of technology and the availability of fast internet everywhere with 4G/5G networks (Goodall, Dovey, Bornstein, & Bonthron, 2017).

According to Mobiliteitsalliantie (2019) it is important that all the modes used in a hub are integrated on a MaaS platform. MaaS is a transport concept that provides a single digital platform that integrates existing and new mobility services, leading to the possibility to plan and purchase a complete journey from door-to-door (Durand, Harms, Hoogendoorn-Lanser, & Zijlstra, 2018). Literature shows that MaaS has the potential to change travel patterns among travellers and decrease private car use. However the impact magnitude, the time-line and the direction of these changes is uncertain (Durand et al., 2018).

The potential MaaS users are young, with a higher education and frequent users of public transport (Zijlstra, Durand, Hoogendoorn-Lanser, & Harms, 2019). As the hubs work with MaaS it is expected that hub users share (part of) these characteristics with the expected MaaS users. This is in line with the conclusion by Knippenberg (2019) that users of multimodal Maas-hubs are mainly innovative bike- and public transport-minded young professionals that seek a flexible and convenient service.

2.4. Travel Behaviour effects

To understand the effects of a neighbourhood mobility hub on the travel behaviour of the user, travel behaviour of the Dutch residents should be understood. Therefore, the current travel behaviour of residents of the Netherlands should be considered. Data about travel behaviour of Dutch residents is collected every year by the 'Centraal Bureau voor de Statistiek' (CBS). Origin-Destination, time of travel, used modes, and motives for travel are all collected (CBS, 2019). While they do not distinguish shared mobility from regular mobility, it should give a view about which kind of trips are possibly made via a hub. The CBS also pays attention to background variables for travel patterns and choice of modes (CBS, 2019). The most recent numbers on travel behaviour found in the CBS database at the moment of writing are from 2017, these are last updated on the 3th of July 2018 (CBS statline, 2018).

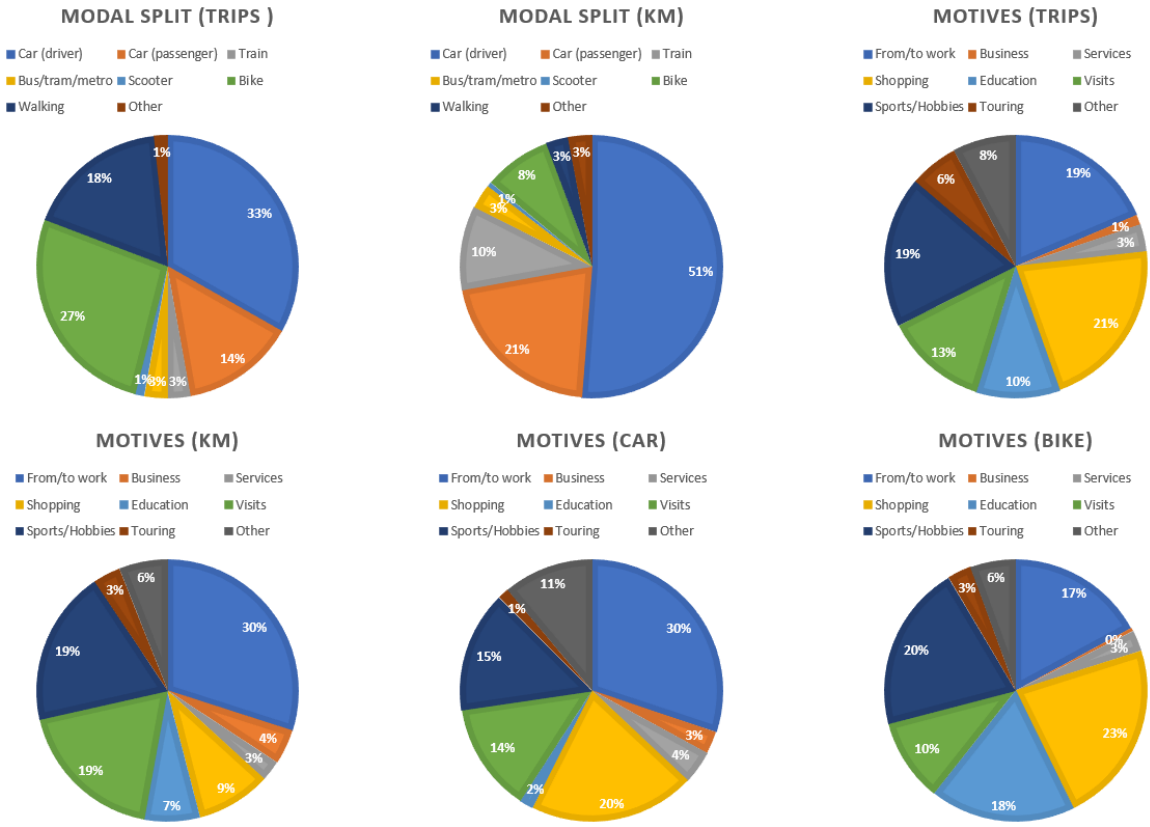

Figure 2.4: Modal split and motives for travel, for the Dutch population (CBS statline, 2018)

A Dutch resident makes, on average, 2.5 trips per day, with an average trip length of 11.6 kilometres. Since 2010 the average number of trips is decreasing (from 2.77), while the average trip length is slowly increasing (from 10.9 kilometres). Figure 2.4 clearly shows that car is the dominant mode of travel, with almost half of all trips made either as driver or passenger. When looking at the number of kilometres it is even more obvious that the car is dominant, almost three quarters of all kilometres are travelled by car. This means that car trips are relatively long distance. The same effect can be seen with train trips, while the opposite is true for bike and walking trips. Car, train and bike are the most used modes by the Dutch population when also looking at the distance travelled. They are followed at a distance by walking, bus/tram/metro, scooter and other modes.

When looking at the the motives for travel there is a similar pattern The CBS distinguishes the nine categories shown in figure 2.4. While work traffic has only 20% of the trips it has 35% of the number of kilometres. This is in a lesser extent also true for visits. The opposite is true for shopping, the relative large number of trips have a relative low amount of kilometres.

A neighbourhood mobility hub will probably have shared cars and bikes, it is therefore interesting to look at the motives for using these modes. The motives for using the car and bike are therefore also displayed in figure 2.4. These graphs show that, for both car and bike, shopping, visits and sports/hobbies take up half of the total number of trips. These are the kind of trips, not that long (shopping and sports/hobbies) or irregular (visits), Knippenberg (2019) finds Hely-hub users to undertake from the Hely-hub. At first glance, this means that shared mobility at a neighbourhood mobility hub could service 50% of the trips. However, Knippenberg (2019) only discussed persons who had already chosen to use the Hely-hub, making these kind of generalisations presumptuous.

2.4.1. Changes in travel behaviour

The last section showed the current travel behaviour of the Dutch population. The neighbourhood mobility hubs aim to change this behaviour. To understand how the hub could change travel behaviour, travel behaviour itself should be understood.

There are multiple views on travel behaviour, each gives different motivations for people to change their behaviour. Kroesen (2018) distinguishes six paradigms in travel behaviour, these are listen in table 2.2. Each of these paradigms wants to explain and predict travel behaviour in a specific way, and has a particular reason to do so (Kroesen, 2018). For each of these paradigms the underling theory and it's relation with neighbourhood hubs will be discussed.

Table 2.2: The six travel behaviour paradigms (Kroesen, 2018)

Paradigm	Conceptual notions
Econometric	Travel behaviour is the outcome of a (rational) choice process
Psychological	Travel behaviour is determined by psychological factors (habits, social norms, attitudes).
Marketing	Travel behaviour is a reflection of generic/holistic mobility styles, life styles or worldviews.
Geographical	Travel behaviour is determined by the built environment, residential self-selection
Biographical	Travel behaviour is dynamic and evolves in tandem with household/employment biographies.
Sociological	Travel behaviour is embedded in social practices, institutions and discourses. Focus on social structures instead of individuals.

Econometric

The econometric paradigm is based on the economic theory of utility maximisation: people choose the alternative that has the highest utility. In the case of the neighbourhood hub the utility is comprised

of its attributes (e.g. offered modes, costs, location). If the total utility of the hub is higher than the utility of owning and using a car people should choose for the neighbourhood hub. The utility could also work one level lower, if the utility of using a shared car offered at the hub is higher than biking with your personal bike, the person will choose the shared car. The utility theory assumes the user has full information and complete rationality, which is not always the case (Kroesen, 2018).

Psychological
The psychological paradigm aims to understand the psychological motivations of behaviour. How can behaviour be changed in desired directions. There are many theories about psychological motivations of behaviour (e.g. theory of reasoned action, theory of planned behaviour, social learning theory) (Kroesen, 2018). Multiple studies using this paradigm show that attitude, intention and habit are all important factors influencing travel behaviour (Verplanken, Aarts, Van Knippenberg, & van Knippenberg, 1994; Donald, Cooper, & Conchie, 2014).

Attitudes toward certain travel modes also influences the mode choice. A positive attitude will result in a higher use of that mode. Walking, bicycling and the use of public transport can largely be explained by travel-related attitude when compared to build environment. Attitude can be changed by focusing on improving the image of transportation modes (De Vos, Derudder, Van Acker, & Witlox, 2012). Attitude is closely related to perceptions people have, Ma and Cao (2019) show that perceptions of a service influence the interaction with the actual service.

People seem to attach additional value to things they own, like a car, just by owning them, this is called the endowment effect (Marzilli Ericson & Fuster, 2014). It does not really matter how long they own a item, or how valuable it is. The moment someone owns the item, the value increases. This suggests that preventing ownership is important.

This means for the neighbourhood mobility hub that it will be probably hard to get people to switch to the offered shared mobility. Old habits (e.g. travelling by personal car) die hard and attitudes are not changed overnight. Donald et al. (2014) suggests that it may be necessary to break those habits by using policy measures like reducing the number of parking spaces. The endowment effect suggests that preventing car ownership is easier than persuade car owners to sell their car.

Marketing
The marketing paradigm sees the population consisting of homogeneous groups with similar needs and preferences, but not necessary the same motivations (Kroesen, 2018). Travel behaviour should therefore be influenced per group. This use of groups gives the opportunity to focus travel behaviour changes on susceptible groups.

In the case of the neighbourhood mobility hub marketing research could be done to see which groups will probably use the hubs. Giving insight into these groups can help to make the hubs an success.

Geographical
The Geographical has two main hypotheses: Dense/mixed environments provide proximity between destinations, enhancing the opportunities of slow modes like walking and biking. Dense/mixed environments spatially concentrate travel demand, making public transport provision easier and more profitable, enabling a higher level of service (Kroesen, 2018). Cervero and Kockelman (1997) show that non-auto travel is encouraged by high density, diverse and pedestrian-oriented designs. The availability of (paid) parking also influences the number of vehicle trips. It is important to note the probability of residential self-selection as discussed in section 2.1.3.

In the case of the neighbourhood mobility hub it is important that the build environment encourages the use, i.e. if the surrounding neighbourhood has no cycle infrastructure then people will probably be hesitant to use the shared bikes. As the hub is also part of the build environment, it could influence the behaviour of the neighbourhood. The effect of the residential self-selection should be observed over time, to give people to move to a neighbourhood with a neighbourhood mobility hub. The effect of a neighbourhood mobility hub on residential self-selection is not known, but it stand to reason it is not as strong as e.g a train station. This because people are familiar with a train station and its benefits. Another factor is the expected time the station will be used, train stations are usually active for decades

while the future of a neighbourhood mobility hub is uncertain at this time, as the bankruptcy of Gobike in Rotterdam showed (Keunen, 2019). If people are not expecting to use the hub long term they are less likely to take it in account when selecting a neighbourhood to live in.

Biographical

The biographical paradigm assumes that travel behaviour is relatively stable, e.g. due to the existence of travel habits from the psychological paradigm. Travel behaviour change can be triggered by key life events, e.g. childbirth, employment (Kroesen, 2018).

Lanzendorf (2010) finds seven of these key life events: acquiring a driving license, finding or leaving a partner, disposal or purchase of a car, getting children, moving, job or education related events and finally incidents (e.g. fatalities in traffic of close friends, breaking down of the car). Lanzendorf (2010) found four factors influencing travel behaviour after analysing 164 of these key events: mobility resources, urban form, quality of transport modes and mediating factors like financial an time resources. The impact of key events is triggered through these mediating factors.

Considering the neighbourhood mobility hub and the four factors found by Lanzendorf (2010), shows were the mobility hub could change travel behaviour. The hub could increase the number of mobility resources, giving people other options to travel. The neighbourhood mobility hub does not change the urban form, but it could become a central place were activities like shopping take place. However, the relatively small size of the hubs, makes this less likely. The effect could however be the other way around, that the hub is placed at such a central place, making it more visible. The neighbourhood mobility hub can effect the quality of transport modes, it should make sure that the offered modes and the hub itself are of high quality. Lanzendorf (2010) includes the individual preferences of persons in the quality of transport and notes that routines en decisions are crucial in the perception of transport quality. Each person has different preferences and perceptions, as a hub would offer multiple options of different modes more persons could be willing to use the hub.

Sociological

The sociological paradigm is based on the theory that individuals do not act according to a uniform of systems of values and beliefs (as the psychological paradigm assumes), but are carriers of social practices. They have conventional and normalised ways of behaving and understanding in different situations. This paradigm does not focus on changing individual behaviour but the underlying social practices (Kroesen, 2018). These social practices influence attitudes and habits of people, so by influencing social practices the whole psychological system is effected.

The current social norm is travelling by personal vehicles or public transport, shared mobility is still relatively unknown. However, shared mobility is increasing in the Netherlands, from 10 shared cars per 100,000 residents in 2008 to 296 per 100,000 in 2019 (CROW, 2019). This is only a fraction of personal car ownership, with 49,400 cars per 100,000 residents (CBS statline, 2019). The neighbourhood mobility hub can make shared mobility more common and social acceptable on the long term. However, there are always people who will never switch from there current preferred mode of travel, despite changing social norms.

2.5. Relevant actors

The definition of a neighbourhood mobility hub depends for a part on the aim of the hub. This aim differs per actor. The relevant actors involved with neighbourhood mobility hubs should therefore be known. Their goals and interdependencies are discussed. The information in this section is gathered during the desk research, interviews and focus groups. The actor analysis is not going into to much detail, as an in depth actor analysis could be a study by itself.

Figure 2.5 shows the most important actors (boxes) and their relations (arrows). The double headed arrows show that the relations work both ways. In this section, first the reasons for leaving out certain actors are noted. This is followed by the description of each of the five important actors, their goals and their interdependencies.

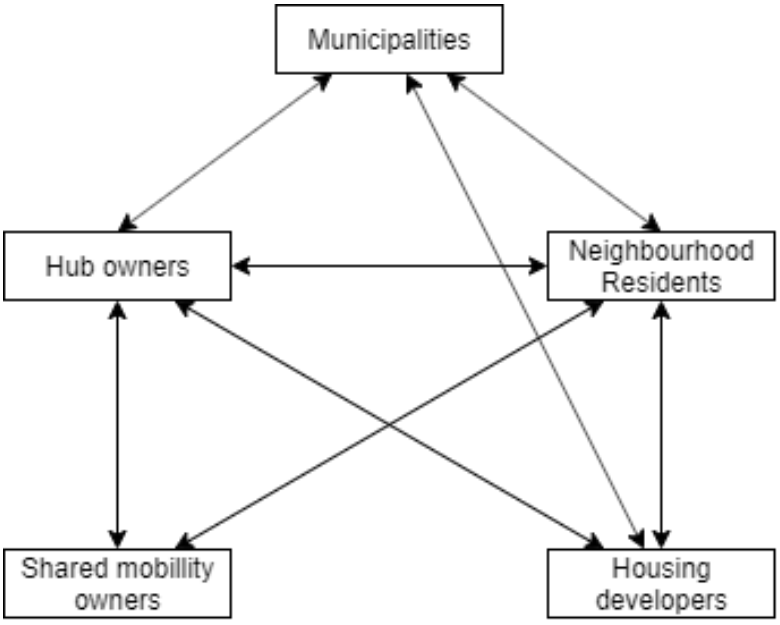

Figure 2.5: Actors and their connections

2.5.1. Excluded actors

There are a few obvious actors that are not present in figure 2.5. These actors are excluded or combined as they do not belong to the core actors, this also keeps the figure readable. The excluded actors are listed in table 2.3, each accompanied with an explanation of why they were excluded.

Table 2.3: Excluded actors

Excluded actors	Reason
National Government	The scale of the current hub process makes it that there is no direct national government influence at this time. They do support local government with rules and regulations about (sustainable) shared mobility, but the main incentive lies with local government. They are not focusing specifically on hubs.
Provinces	See National Government.
Hub users Non hub users	Combined in neighbourhood residents.
Consultant bureaus	Advise the actors in the figure, having only indirect influence, and are therefore excluded.
MaaS-providers	As there are no large scale MaaS-providers influencing hubs at the moment of writing they are excluded.
Investors	Hubs and shared mobility ask for large investments. Investors by themselves are not important for this study, they are therefore included in hub and shared mobility owners.

2.5.2. Important actors

Each of the five important actors from figure 2.5 will be described separately. Their interests, where these conflict and where they are similar with each other are discussed.

Municipalities

Municipalities are responsible for the public space withing their boundaries. In cities this public space is in short demand as more and more people want to live in the city, the public space has no room to grow. The interest of the municipality lies in the use of this public space. They have three goals: Decreasing local emissions, congestion and private car ownership. They see shared mobility as a way to do this (Provincie Zuid-Holland, 2017a).

Municipalities are directly linked to all other actors except the shared mobility owners. Their interests are similar to the housing developers, they both want to create free space. They should however keep in mind that residents need to be willing to live in the neighbourhood. They are also in a lesser extend similar to the interests of hub owners. The hubs have to be used before they will have the desired effect. However, they also need to check if the hub is not leaving certain resident groups behind. The hub could also lead to more car congestion due to increased car use, the opposite of their goal.

With the neighbourhood residents the relation is more difficult. The municipality wants to stimulate the use of the hub, and keep the residents happy. Residents in existing neighbourhoods will (at first) be hesitant to accept the changing status quo. However, without a little force nothing will change and the hub will stay a niche product. In new neighbourhoods this is easier as there are no current residents to object. Residents know beforehand that their neighbourhood is affected by the hub (e.g. less personal parking spaces).

Hub owners

Hubs could operate in many forms, however, they can all be basically divided in four layers.

1. The system to get access to the hub (e.g an app).
2. The vehicles that are offered.
3. The physical hub.
4. The ground on which it is located.

For this actor analysis the hub owners is defined as a combination of the first and third layer. The second layer is covered by the shared mobility owners and the fourth by the municipalities or housing developers. The main interest for hub owners is that the hub is used by the neighbourhood residents. The vehicles that are offered should be used and the users should be satisfied by the service the hub offers. In the end the hub should be profitable.

The hub owners are linked to all other actors. There interests are similar to the shared mobility owners on who they are also dependent to provide the vehicles. Their relation with the municipalities and housing developers is similar, the hub is located on public (owned by the municipality) or private (owned by the housing developer) land. The interests of those three parties are also mostly similar, they all want the hub to be used. Their interests do conflict with the neighbourhood residents. Every resident wants something different from the hub and the hub owners can not satisfy everyone. The hub owners wants to find a balance between offered services, the price of those services and the demands of the neighbourhood residents.

Shared mobility owners

The shared mobility owners have a contract with the hub owner to provide the hub with shared mobility. Depending on the contract, their main interest is that neighbourhood residents use their vehicles, or that the hub owner is satisfied with the offered vehicles.

Shared mobility owners are linked to the hub owners and the neighbourhood residents. Their interests are partly similar to those of the hub owners, they both want the vehicles to be used while making a profit. Their interests conflict as well, They also need to find a balance between the quality of their vehicles, their price and the demands of hub owners. This is also true for their relation with the neighbourhood residents.

Neighbourhood Residents
The main interest of neighbourhood residents is that they can travel whenever and where-ever they want, with their preferred mode. This may be via the hub but could also be with their own vehicle or public transport. The hub itself should be tailored to the neighbourhood residents and fit in the neighbourhood. Secondary to that is that they want to live in a nice neighbourhood, 'nice' being a subjective factor.

When looking specifically to users and non-users the interests divide a little. Hub users want a hub where there are always (the needed) vehicles available, against reasonable prices. Non users do not care, as long as they can still use their own modes unimpeded.

The neighbourhood residents are linked to all other actors. Conflicting interests with municipalities, hub owners and shared mobility owners are described in the section above. They also conflict with housing developers, if the theoretical freed up space is used for extra houses the residents may object. If however the space is used for parks or other services the neighbourhood residents profit.

Housing developers
Housing developers plan and build neighbourhoods. Hubs could decrease the need for parking spaces, freeing up space for more houses or green space. This will increase the number of constructed houses or the value of them, increasing the revenue of the housing developers.

Housing developers are linked to all actors except the shared mobility owners. The conflicts and similarities with them are described in each of the corresponding sections above.

2.6. Conclusions

This chapter has three goals: finding a preliminary definition of the neighbourhood mobility hub, describing the theoretical potential users and describing the theoretical travel behaviour effects of the hub. There is however no published scientific literature on neighbourhood mobility hubs. Information that does relate to these small scale hubs is non-scientific (e.g. hub developer promotion material), or not published (e.g. the masters thesis by Knippenberg (2019)). Despite this, preliminary results were found by combining published literature concerning shared mobility and Mobility-as-a-Service (MaaS), with the other information sources.

The conclusions found in this chapter are used to construct a conceptual model describing the relation between potential users, hub use and travel behaviour, figure 2.6. This model displays all relevant relations (arrows) between the potential user, hub use and travel behaviour changes discussed in this chapter. This model is used structure this study and finally to design the survey in chapter 7.

A neighbourhood mobility hub is in essence a central place where shared mobility is offered, usually with a form of MaaS to integrate the offered modes in one service. Several important attributes are found: sustainability of the hub and vehicles, availability, ease of use (containing accessibility and flexibility) and costs of the hub and vehicles. Offering of other services at or near the hub and parking pressure are seen as important context variables.

The goal of the hub depends on the actor. The five most important actors involved with neighbourhood mobility hubs are: municipalities, hub owners, shared mobility owners, the neighbourhood residents and the housing developers. Municipalities want to decrease local emissions, congestion and car ownership. Hub owners and shared mobility owners have a similar goal: a profitable hub. Neighbourhood residents want easy and accessible transportation, with or without the hub. Finally, housing developers main goal for the hub is decreasing car ownership, increasing the available building space.

This study is performed with the municipality goals in mind. This leads to the following preliminary definition: A neighbourhood mobility hub is a central place where shared mobility is offered, with the goal of decreasing local emission, congestion and car ownership.

Describing the theoretical potential user and potential travel behaviour effects suffers from the same problem as defining the hub, there is no published scientific literature. However, a neighbourhood mobility hub is basically a combination of shared mobility and MaaS. These subjects are found in the scientific literature. Combining the effects of these will give insight into the potential users and travel behaviour changes.

The theoretical potential hub user can be described as both male and female, relatively young and wealthy, and leaning away from car use. Parking problems also effect the potential user, higher parking pressure increases the chance someone uses the hub. This leads to the conclusion that potential hub users live in cities, as this is were the parking pressure is highest. These variables are displayed as socio-demographics in the conceptual model.

The main take away of the literature concerning travel behavioural changes is that the hub could lead to a decrease as well as an increase in car ownership and travelled kilometres. An increase in kilometres is caused by former public transport users switching to car use because it becomes easier and more affordable due to shared mobility. When they are used to the car and need to use them more and more it could be cheaper to buy their own car, increasing car ownership.

There is a decrease in car ownership when former car owners switch to shared mobility, a decrease in kilometres only happens if they also switch to a non-car mode. This is where a hub could be beneficial, as multiple modes are grouped together, which could make a switch more likely. Research in the Netherlands shows that overall shared mobility users decrease car ownership, car kilometres and emissions. They did however also show that shared car trips mostly replaced train trips. Car ownership is mostly reduced because shared mobility replaces the second or third car. The emissions are reduced due to the decrease in car kilometres but also because the shared fleet consist of relatively new (and green) vehicles.

Travel behaviour changes, both positive as negative, are probably limited if the hub is not connected to a network. This prevents users to travel between hubs, decreasing the attractiveness of the hub. Hubs will become relevant when there is a network of hubs, even more so if they are connected with public transport.

The current travel behaviour of the Dutch population shows that, for both car and bike, shopping, visits and sports/hobbies take up half of the total number of trips. These are the kind of trips, not that long (shopping and sports/hobbies) or irregular (visits) that could the first to be replaced by shared mobility. The trip characteristics influence if the hub is used. However, changing travel behaviour is not that straightforward. Travel behaviour research shows that the behaviour is not as easy as choosing the option with the highest utility. Attitudes, habits and perceptions all influence a persons behaviour, both knowingly and unknowingly. Perceptions could therefore have a direct effect on potential hub use. They are also influenced by external events, like getting a job, and their social structures. How these influence the decision to use a hub are uncertain.

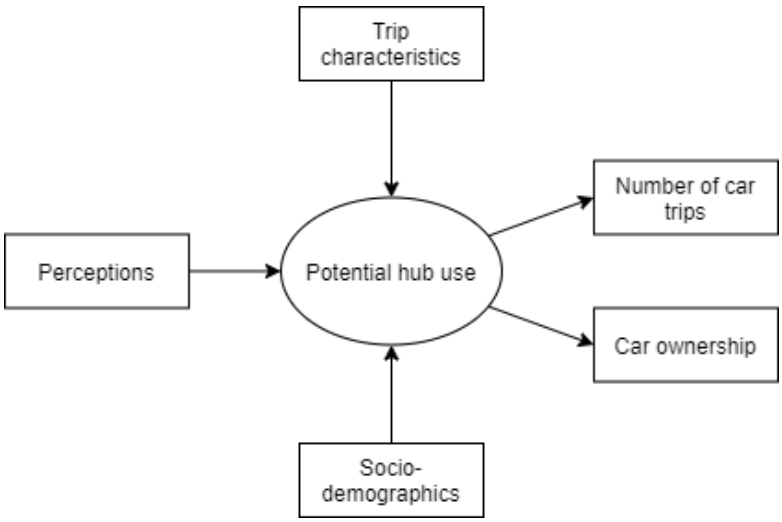

Figure 2.6: Conceptual model for potential hub use

3

Expert interviews

To expand on the information found in the literature study, interviews with experts in the field of shared mobility and mobility hubs are held. This chapter will discuss the process of the interview design. It will start with a justification of the use of expert interviews for this study in section 3.1. This is followed by the mean strengths and weakness of the method in section 3.2. Finally, the research approach, and the resulting interview guide are discussed in section 3.3.

3.1. Justification

Interviewing is one the most used data collection methods in qualitative research. Interviews could be categorised as structured, semi-structured, in-depth or unstructured. Structured interviews have a fixed questionnaire, while unstructured have no questionnaire at all with semi-structured located on the scale between the two. In-depth interviews are meant to explore a topic more in-depth (Clare Taylor, 2005).

Structured interviews are most commonly a tool for surveys due to their rigidity while unstructured interviews are used when virtually nothing is known about the subject. This leads to semi-structured interviews to be the most used form (Clare Taylor, 2005). In a semi-structured interview there is a question guide on which the researcher bases his questions, while still leaving room for improvised questions. Semi-structured interviews are popular because they have proven to be both versatile and flexible (Kallio et al., 2016).

In this study semi-structured interviews are used because of the exploratory nature of the research. Semi-structured interviews also give a chance to explore the full opinions and views of the experts while still focusing on the research subject, neighbourhood hubs. The interviews aim to expand the possible design attributes found in chapter 2 and determine the potential users of the hub (sub-question 2).

3.2. Strengths and weaknesses

The main advantages of semi-structured interviews are the success in enabling reciprocity between the interviewer and participant and enabling the interviewer to improvise followup questions based on responses. The structure rigidity can also be varied depending on the study purpose and research questions (Kallio et al., 2016). The ability to ask followup questions makes probing possible. Probing can be an invaluable tool for ensuring reliability of the data as it can clarify interesting and relevant issues raised by the participants. It also provides the opportunity to explore sensitive issues, and to explore and clarify inconsistencies within participants accounts. Probing can further elicit valuable and complete information (Barriball & While, 1994). Finally, the act of interviewing is relatively easy, requiring little specialist equipment and using the existing skills of conversation and communication (Clare Taylor, 2005).

The main weakness is the fact that interviews are time-consuming, especially transcription and analysis. It is further possible that participants behave differently during an interview compared to real life (Clare

Taylor, 2005). This is inherent to social sciences as direct involvement of the researcher could influence the participant. While interviewing is relatively easy Barriball and While (1994) mentioned the difference a skilled interviewer can make. The interviewer should be able to use and understand the specific interview schedule and be aware of the errors or bias which can arise with the interview method.

3.3. Expert interview research approach

The research approach for the expert interviews in this research consists of four steps. First, experts were selected and contacted. Secondly, a interview guide based on the framework of Kallio et al. (2016) was developed. Thirdly, the interviews were conducted with the experts. Finally, the main points are taken from the interviews and summarised in chapter 4.

3.3.1. Selecting the experts

Experts in the field of hubs and mobility were selected. An attempt was made to find experts from different fields and backgrounds. To contact the different experts Mobycon contacts were used. To make sure enough experts could be interviewed multiple experts were contacted and ask for their cooperation, this resulted in five experts willing to participate. They all agreed for their names to be used in this document.

Table 3.1: Interviewed experts

Name	Occupation	Expertise
Noor Aghina	Project developer at Synchroon	Within Synchroon she is the expert in shared mobility. She was involved in multiple development projects where shared mobility was implemented
Tarik Fawzi	Co-Founder of Hely Hubs	As head Business development involved with the strategic implementation of the Hely hub, while also involved with the design of the hubs
Maarten Markus	Project manager sustainability at AM	As project manager sustainability focused on sustainable mobility. Developed a strategy for sustainable mobility and hubs in housing developments.
Simon Drolsbach	Intern at AM	Researching new and alternative forms of mobility. Searching for the best practices and how to incorporate these in the area development strategies of AM
Nanet Rutten	Project manager Mobility & Space at Arcadis	Within Arcadis responsible for multiple projects concerning shared mobility and hubs.
Martijn Schutte	Project leader mobility at Mobycon	Within Mobycon the expert in the field of shared mobility and MaaS

3.3.2. Designing the interview guide

Figure 3.1 shows the framework developed by Kallio et al. (2016) for the design of an qualitative semi-structured interview guide. The framework consist of five steps that need to be taken, in this section each step will be discussed.

The first two steps, why a semi structured interview is the right kind of interview and the gathering of previous knowledge on the subject, are already taken in previous sections. Step one in the intro of this chapter, step two in chapter 2.

The preliminary interview guide started as two questions, what kind of hub attributes are possible and who are the potential users. These are the main themes of the interview, from where multiple

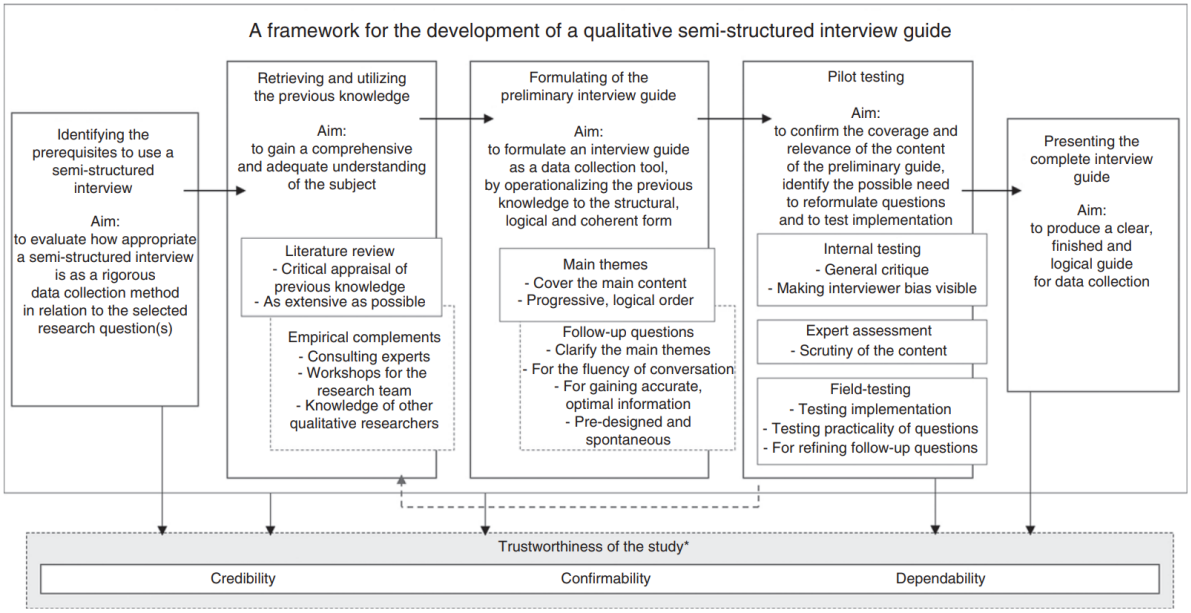

Figure 3.1: Framework for the development of a qualitative semi-structured interview guide (Kallio et al., 2016)

follow-up questions were devised, resulting in a preliminary interview guide. These core questions are preceded by background questions about the expert and a description of a neighbourhood hub as described in this study. The expert is given the chance to explain their own view of a hub, differences and similarities are discussed. This will make sure that the expert understands how the researcher views a neighbourhood mobility hub, making sure everybody is talking about the same kind of hub.

To pilot test the preliminary interview guide, internal testing was carried out. The preliminary interview guide was submitted to the two supervisors at Mobycon for review. This led to the inclusion of one question and the revision of two others. The resulting key questions are listed in table 3.2, the table also lists the aim of the questions and the sub-question they aim to answer. It should be noted that due to the nature of the semi-structured interview questions can be added during the interview. The full standard interview guide can be found in appendix A.

Table 3.2: Main interview questions from the interview guide

Question	**Aim**
How do you imagine a neighbourhood mobility hub?	Establishing the view of the expert on the hub concept.
What attributes could such a hub have?	Find a range of hub attributes (SQ 1).
Which attributes are, in your opinion, essential for a neighbourhood hub?	Find the most important attributes from the question before (SQ 1).
Where should a hub be placed, e.g. city centre, suburbs, etc.?	Find the view of the researcher on the location of the hub, also includes the travel distance to the hub by users (SQ 1 & 2).
Who are, in your opinion, the potential users?	Finding theoretical potential user (SQ 2).
What do you think are their demands?	Expanding on the potential users and hub attributes (SQ 1 & 2).
Who reap the advantages of a neighbourhood mobility hub?	Find the effects of the hubs and who will benefit from them (SQ 3).
When would you deem the neighbourhood mobility hub a success?	Find the goals of the hub, as defined by the experts (SQ 1).
Do you think the neighbourhood mobility hub will be a success?	Find if the experts enthusiastic about the hub.

3.3.3. Conducting the interviews

Interviews should be conducted in areas free from distractions and on times suitable for the participants. This will help them to relax and will result in a more productive interview (Gill, Stewart, Treasure, & Chadwick, 2008). Body language is also important, an open body language by the interviewer will lead to a more open and productive interview. Same is true for encouraging noises or the strategic use of silences (Gill et al., 2008). When an interview is conducted over the phone the researcher is limited in the use and observation of body language. The interview should be recorded as this protects against bias and provides a record of what was said or not said (Gill et al., 2008).

In this study, the interviews where held in person, except for the one with Mr. Fawzi, which was held over the phone. The locations of the other interviews were at the companies the participants worked, all interviews were recorded using audio equipment. After the interview the researcher transcribed the answers of the participants, using his notes and the audio recordings. The resulting document was send back to the participants for confirmation. Only data from this document was used in this study.

4

Interview results

The main aim of the interviews was to expand on the information uncovered during the literature research. Expanding on the definition of the hub, the theoretical potential hub user and possible travel behaviour effects. The interviews however, also uncovered information about related topics like probable demands of users and success factors. This chapter will therefore be divided in four sections. First, possible design attributes of the hubs are summarised in section 4.1, followed by information about the potential users in section 4.2. Thirdly, possible effects of the hub on travel behaviour are noted in section 4.3 and finally section 4.4 shows the possible success factors of the hub. For each section all relating information across all interviews is summarised. This chapter will result in the definitive definition of the neighbourhood mobility hub, answering the first sub-question. It will further define the theoretical potential hub user and the theoretical travel behaviour effects.

4.1. Hub design attributes

All experts agree that there is no one hub for all locations, each location should be considered separately. They also note that expected trip purpose should influence the design of the hub. However they named multiple design attributes that should be considered for all kind of hubs.

They also agree that the hub should offer multiple types of modes. Each of the experts named the 'e-bakfiets' (electric cargo bicycle) explicitly as mode that should be available. All of them see the e-cargo bike as a good way to replace short car rides, especially to the shop or bringing the kids to school or sport. Two of the experts emphasised that the hub should offer modes that are not already owned by the residents (e.g. the e-cargo bike, e-car, speed pedelec). The residents will not be motivated to use a mode they have already access to. However, the hub could provide 'standard' modes for irregular situations (e.g. visitors or breaking down of the owned car or bike). Related to the number of modes is the availability of the modes, two of the experts name it as one of the most important aspects. To ensure availability, users should be able to reserve vehicles. The availability of multiple types of modes can also give users other options if a mode is unavailable.

The hubs should be connected to other forms of transport using MaaS three of the experts note. However, one of them also note that MaaS may make hubs redundant if free floating shared mobility is efficiently integrated. In his vision hubs are a stepping stone to a nationwide MaaS network. Two of the experts do not think MaaS is crucial for these types of hubs, if they are stand alone hubs it is relatively easy for users to manage the different options themselves. Because of uncertainty about the development of MaaS, there is no fixed model for MaaS, the experts were uncertain about its effects.

Hubs offering electric mobility are preferred by the experts, however, this should be considered per location. At this time electric mobility is more expensive than non-electric options. They all agree that, especially in the early stages, diversity in the offered modes is more important. This will help persuade hesitant residents, they will be able to change their behaviour in small steps (e.g. first switch to a shared car and later switch to the e-car instead of immediately switching to a shared e-car). Inclusion of non-electric options will also give residents a cheaper option.

Visibility and accessibility is also named as important by four of the five experts. To persuade potential users to use the hub, the hub should be easy to find, access and use. This is important because accessing their personal car or bike is probably all of these things. Related to accessibility is the distance persons are willing to travel for the hub, all experts who mentioned it agree that the distance is related to the mode the user wants to use and the kind of trip he wants to make. More expensive or faster modes and larger planned trip distance will probably increase the willingness to walk a certain distance. the experts named distances from 300 to 500 meters. All experts agree that a seamless transition to the hub is crucial. Related is the need of the hub and the modes to be clean, safe and intact, one of the experts considered this the most important factor of the hub. Two of the experts also note that near the hub other services (e.g. shops, postal service) should be offered, or that the hub should be placed near existing services. This will increase the visibility and accessibility of the hub, which in turn increases the chance the hub is used.

The experts were also asked about the possible demands of users. All agreed that affordability and availability are the most likely demands. However, this is probably not enough to persuade people one expert notes, it is important the users see other advantages of the hub in their neighbourhood (e.g. parks instead of parking spaces). Other demands probably differ per user, each user wants a different combination of all attributes named in the section above.

4.2. Potential Users

All experts agree that socio-economic factors influence the potential user group. However, they all see the location of the user more important, each of the experts emphasise that hubs, at least in the early stage, should be located in neighbourhoods with high parking pressure. Therefore, the potential users are inhabitants of these neighbourhoods. When asked about the socio-economic factors all experts note that people with a green and sustainable mindset are probable early adopters. They also agree that there is probably a minimum level of disposable income before someone will switch to shared mobility, persons beneath this minimum will never switch as it is simply to expensive. What this minimum is depends on the costs of the shared mobility and personal car use. All experts agree that young people are easier to capture as users, as they are more used to the shared economy. However, they also note that older persons could be tempted to use the hub if there is enough motivation, in the form of parking pressure or cost benefits.

This realisation that the parking pressure is important means that potential users are living in cities, as these are the places were the pressure is mounting. The higher the housing density the higher the parking pressure, and the greater the total population of potential users. High population means that a smaller percentage could use the hub and still make it financially viable. This is another important point brought up by the experts, the hub should be situated as a long term solution. Financial viability, due to enough users or subsidies, will ensure the continued existence of the hub. If people can not rely on the hub for the long term they are less likely to make long term changes to their behaviour.

4.3. Effects on travel behaviour

When asked about the possible effects on travel behaviour of the users all experts agreed on one thing, the shared car will probably not replace the main car used for work. The car that has a chance of being replaced is the second or third car, the one used for incidental trips. Three of the experts also agree that a hub will probably help users discover that the car could be replaced with the e-(cargo)bike on shorter distances. That is also where the hub could have a big impact, replacing car trips with bike trips, instead of personal car trips with shared car trips.

All also agree that the effect on travel behaviour is also dependent on the kind of hub. A stand alone hub with only round trip options will only replace round trips like shopping runs, for a more structural change a network of hubs is needed. Users should be able to check out their mode at the end location (e.g. at the station or visit address). If there is no network the hubs will only be used for the incidental trips, leading to a limited change on travel behaviour and car ownership.

4.4. Success of the hub

When asked about when the hub was deemed a success, the experts gave different criteria. Four out of five experts explicitly said that the hub should lead to a decrease in car ownership. Two experts related that to the area development, when houses will be cheaper due to a lower parking norm, and the buyers are enthusiastic about shared mobility the hub is a success. Two of them expressed success as commercial success. This is not only positive for the hub owner but for the users as well, as commercial viable hubs are reliable hubs. Users should have the assurance that the hub will be there for the long term. Two of the experts note that the hub should not only replace personal car kilometres with shared car kilometres but also with other modes like bicycle and public transport. One of them thinks that the shared modes should not substitute public transport trips, while the other does not see that as a problem as the public transport can refocus to where there is demand. He does think however, that the hub will help to increase public transport use, as it will improve the first and last mile.

When asked if they see the hub becoming a success all experts answered positively. However, they all agreed that there are still a few hurdles to take along the way. One expert argues that the neighbourhood mobility hub is already a success on the local level, but he also agreed with the other experts that for a large impact a network of hubs is needed. The hub network should be integrated in the public transport network to coax users to use public transport as this is still more durable than a shared car, electric or not. The neighbourhoods are also important for the success of a hub, they should be included in the decision making from start to finish. This will prevent incompatible hubs from being constructed. Another effect on the success of the hub one expert noted is the ongoing evolution of transportation, the hub could become obsolete if self driving cars take over the streets.

4.5. Conclusions

The main goal for the interviews was to expand on the information found in chapter 2. The results are the definitive definition of the neighbourhood mobility hub, the theoretical potential hub user and the theoretical travel behaviour effects. Just like there were no scientific sources on neighbourhood mobility hub, there were no real experts on neighbourhood mobility hubs. And just like with the literature study, shared mobility and MaaS experts were used to find answers for neighbourhood mobility hubs. There was one exception, Mr. Fawzi is as Hely hub developer a neighbourhood mobility expert.

Despite this, the interviews did serve their purpose. Not only are the neighbourhood mobility hub, the theoretical potential user and the possible travel behaviour effects defined, the view of the researcher was also broadened.

The experts reiterate that there is no fixed view on neighbourhood mobility hubs. Each hub should be tailored to the target user, in the current phase of hub development experimenting and testing is key. Including the potential user in this process is key, they are the ones who will be using the hub, therefore, their wishes and demands should lead the design process.

The experts expand on the design attributes found during the literature study. They confirm that sustainability of the hub and vehicles, availability, ease of use and costs of the hub and vehicles are important design attributes. They add another twelve attributes: diversity, visibility, safety of the hub and vehicles, state of the hub and vehicles, distance to the hub and if the hub is part of a network. This brings the total number of important design attributes to fourteen. It is important to remember that this is not an exhaustive list of all possible attributes, these are however the most important.

The literature review also led to two important context variables: offering of another services at or near the hub and parking pressure. The expert confirm these and add one other context variable: creating free space due to the lower number of privately owned cars.

The preliminary neighbourhood mobility hub definition resulting from chapter 2 was: A neighbourhood mobility hub is a central place where shared mobility is offered, with the goal of decreasing local emission, congestion and car ownership. This definition is confirmed by the experts. This definition combined with the fourteen important hub attributes answers sub-question 1.

The theoretical potential hub user found in the literature is described as male or female, relatively young and wealthy, and leaning away from car use. Parking problems also effect the potential user,

higher parking pressure increases the chance someone uses the hub. This leads to the conclusion that potential hub users live in cities, as this is were the parking pressure is highest.

The expert interviews confirm this theoretical potential hub user. They think that parking pressure is one of the most important factors for hub use. The theoretical hub user is mainly motivated by parking pressure in their neighbourhood, as this makes the use of a private car cumbersome. They live therefore in cities with high parking pressure. Socio-demographic factors are less important, in general the early adopters will be young people with a sustainable mindset and experience with shared mobility. They also have to have a certain disposable income to be able to afford the hub.

The theoretical travel behaviour changes found in chapter 2 are confirmed by the experts. The hubs will in theory reduce car ownership. This will concern mainly second and third cars. A reduction in trips is less likely, however experts see a role for the e-cargo bike in replacing shorter car trips. They further agree that the effect of the hub demand on the hub attributes. A stand alone hub will probably only replace incidental trips. For a structural effect a network of hubs is needed.

5

Focus Groups

Using the definition of the neighbourhood mobility hub, the theoretical potential hub user and theoretical travel behaviour effects found in the last chapter, two focus groups are designed. This chapter will discuss the design of the focus groups. It will start with a justification of its use for this study in section 5.1. This is followed by the mean strengths and weaknesses of the method in section 5.2. Section 5.3 discusses per design attribute the theory and its application in this study. Finally, section 5.4 discusses how content analysis is used to categorise the focus group results.

5.1. Justification

Focus groups are depth group interviews for qualitative research that have been used by social scientists and marketing research for decades (Stewart & Shamdasani, 2014; Morgan, 1996). ”A focus group is a group of individuals selected and assembled by researchers to discuss and comment on, from personal experience, the topic that is the subject of the research” (Powell & Single, 1996, p. 499). Focus groups use group interaction to produce data and insights that would be less accessible without the interaction found in a group and can be used as supplementary source of data for surveys (Morgan, 1996).

According to Powell and Single (1996, p. 500) is ”a focus group especially useful when existing knowledge of a subject is inadequate and elaboration of pertinent issues or the generation of new hypotheses is necessary before a relevant and valid questionnaire can be constructed or an existing one enhanced.” This is in line with Goldman (1962, p. 68): ”The group depth interview is most frequently useful and appropriate in the developmental and exploratory phases of research. [...] it is used to make it more likely that the correct questions are asked in large sample surveys to follow.” and ”The group interview is particularly useful in the developmental phases of a research program. It establishes the range of attitudes without, however, asserting the representativeness of these attitudes.”(Goldman, 1962, p. 67)

These statements show why focus groups are a good choice to research neighbourhood mobility hubs. There is not enough knowledge of neighbourhood mobility hubs to start with large scale surveys. Both the scientific knowledge as the general knowledge about the neighbourhood mobility hub is inadequate. The possible attributes are also subject to research, the possible range is not known. Focus groups are also used in similar studies where they are used to find which attributes or factors of a service influence, or are important to, potential users (E.g. for restaurants (Koo, Tao, & Yeung, 1999), hotels (Robinot & Giannelloni, 2010) or transport modes (Simons et al., 2014)). Focus groups are used in a wide array of exploratory research and are therefore a fine method to explore the attitudes of people concerning neighbourhood mobility hubs.

5.2. Strengths and weaknesses

Focus groups have, like every method, strengths and weaknesses. According to Morgan (1996) one source of strength is the focus on the topic introduced by the researcher produces concentrated

amounts of data on precisely the topic of interest. A second source of strength he mentions is the reliance of interaction in the group. Comparisons between experiences and opinions of participants give a valuable insight into complex behaviours and motivations. Acocella (2012, p. 1132) adds that ”group synergy can favour the production of a plurality of positions and stimulate participants to remember forgotten or unconsidered details.” A third strength is the fact that focus groups are time efficient. Focus groups take less time to conduct and analyse compared to the equivalent number of needed interviews. However, if group meetings are not possible due to logistics, interviews could be more efficient (Morgan, 1996).

Morgan (1996) distinguishes two main weaknesses. The first weakness is the fact that the researchers involvement in the process can influence the outcomes, as is the case most social science methods. Because the groups are created and directed by the researchers they will be less naturalistic than observations. This can not be avoided but should be taken into consideration when using the data. The second weakness applies on the group dynamic, participants in the groups may be influenced by the group itself. Groups have a tendency towards conformity and to polarisation. In the first case participants withhold things they would not withhold in private, e.g. sensitive personal information. In the second case they express more extreme views in a group than in private.

5.3. Focus group research approach

When planning focus groups there are four main decisions that have to be taken. In decreasing order of importance: who will participate, how structured will the groups be, how large will the groups be and what is the number of needed groups (Morgan, 1996). For each decision Morgan has a rule of thumb. Important aspects flowing from these four decisions are the discussion guide and duration and location of the focus groups. Each of these decisions and aspects will be separately discussed. First the theoretical reasons are explained, followed by the decisions made in the context of this study.

5.3.1. Kind of participants

The kind of participants needed for the focus groups depends on the aim of the research. Because the relative small number of participants make it unlikely that they adequately represent the larger population. It is therefore more useful to think in terms of minimising the sample bias. Therefore, theoretic sampling should be used to select the participants (Morgan, 1996).

Morgan (1996) uses the following rule of thumb: use homogeneous strangers as participants. However, note that they should show homogeneity in background variables not in attitudes. The most common background variables are sex, race, age and social class. When designing the group composition to match chosen categories of participants it is known as segmentation. E.g. if sex differences effect the ability of participants to discuss freely, separate groups divided by sex could be held. The homogeneity within the group capitalises on peoples shared experiences. However, a diverse group could maximise exploration of different perspectives (Kitzinger, 1995). The anonymity of a group of strangers leads to a atmosphere that encourages honest reactions from participants (Powell & Single, 1996). However, focus groups with acquaintances are also possible and sometimes the only option, e.g. in an organisational setting (Morgan, 1996).

Participants in this study

Two focus groups were held, one with students and one with residents of Delft city centre. The student focus group was comprised of students known by the researcher, with the majority following a Master Transport, Infrastructure and Logistics. This means that these students were more knowledgeable about the subject of shared mobility than the average citizen. This focus group did not fully adhere to the potential user as described in section 4.2, as they did not all live in cities with high parking pressure. However, they do check the other boxes, as they are young, used to shared mobility and with a sustainable mindset. Another important factor is that five of the six students are in the final stage of their studies, meaning that the stand before a large change in their life, the change from studies to work. This is important because, as noted in section 2.4.1, travel behaviour changes can be triggered by these key life events.

The focus group of residents of Delft was held as these residents do fulfil the 'high parking pressure' criterion. A study from 2018 states that the whole city centre of Delft has high parking pressure in the evening (Belangenvereniging Binnenstad Noord, Belangenvereniging De Oude en De Nieuw Delft, & Belangenvereniging Zuidpoort, 2018). Newspaper articles also show that the residents of Delft city centre want to do something about the parking problems (Van de Stadt, 2018), and have ideas for the existing parking space (Stift, 2018). It was therefore assumed that residents of Delft were willing to participate in a study about a possible solution. The chance on participation was also increased by the fact that the location were the focus group was held was within walking distance of Delft city centre.

A total of 200 invitations were distributed in Delft city centre, of this 200 only five accepted. The exact reason why the response rate (2.5%) is so low is not known. Probable reasons are indifference of the subject and the unwillingness to invest the time. Because of the low response three additional persons, known by the researcher, were invited. These additional participants gave the chance to invite car owners, as all the Delft residents indicated that they did not had access to a car. Two of the three people invited subsequently own a car, with one more than one car. These two however, do not live in neighbourhoods with high parking pressure. A list of the participants of the focus groups can be found in Appendix B, the original names are changed to protect the privacy of the participants.

5.3.2. Group structure

Morgan (1996) uses the following rule of thumb: rely on a relatively structured interview with high moderator involvement. Structured groups are especially useful when there is a strong pre-existing agenda for the research. A standardised interview among all groups makes them more easily comparable. The group structure is described in a discussion guide, see section 5.3.5. Structured groups are usually used when the goal is to find input for other research efforts like survey content (Morgan, 1996). The disadvantages of structured groups are the relative limited data that is acquired. Less structured groups are useful for exploratory research, lively discussions within the group without much guidance could lead to new insights. This does make groups more difficult to compare, especially if topics arise in one group and not the other (Morgan, 1996).

The role of the moderator depends on the aim of the research and the level of participation of the participants. The level of involvement could change during the focus group to stimulate the discussion (Freitas, Oliveira, Jenkins, & Popjoy, 1998). In exploratory research moderators usually have a low level of involvement. This has the advantage that the moderator is able to evaluate the participants' interests. The disadvantage is that the groups are relatively disorganised and more difficult to analyse. High level involvement moderation is usually used in research where there is a clear goal (Freitas et al., 1998). High moderation leads to answers to the predefined questions, however, moderator bias could influence the data, as stated in section 5.2.

Group structure in this study

Tthere has been made a distinction between the student focus group and the Delft resident focus groups for the used group structure. Because the goal of the student focus group was not only to find preliminary answers to the research sub-questions but also partly to practise a focus group. This meant that next to information relating the sub-questions, feedback on the focus group itself was gathered. The focus group was structured around the discussion guide, each of questions was asked in order.

The feedback of the student focus group did change the structure of the Delft resident focus group slightly. It was advised not to show the questions in order to the participants, as this led in the student focus group to overlap in answers. The Delft resident focus group instead was less structured, the questions in the discussion guide were asked when they came up in the focus group. If a question did not came up naturally it was asked by the researcher. The role of the moderator was to keep the groups focused on the subject. The group structure can be seen as semi-structured, free discussions but with a few fixed questions.

5.3.3. Number of participants per group

There is no ideal number of participants per group, it depends on the research and the participants involvement. Morgan (1996) uses the following rule of thumb: have 6 to 10 participants per group. Below

6 participants it can be difficult to sustain a discussion. Above 10 participants the discussion may be hard to control. Small groups are useful when a clear sense of each participants reaction is important. Large groups can give a wider set of opinions (Morgan, 1996). The group should be small enough to give everybody the opportunity to take part in the discussion, and big enough to provide diversity in the discussion (Freitas et al., 1998). When selecting participants it is important to over-recruit, to control for no shows, 20% should be sufficient (Morgan, 1996).

Number of participants in this study
The choice went to focus groups with six participants each. These relative small groups are chosen because a clear sense of each participants opinion is important. They are also easier to manage for an inexperienced moderator. The small size also made it easier to find enough participants, as all participants need to be available at the same time. The size also gives everybody the chance to give their opinions in a relative small period of time. The two focus groups were finally held with six (student) and eight (user) participants, as two participants showed up last minute without notice at the user focus group. This did not interfere with the focus group structure or time limit.

5.3.4. Number of groups
Morgan (1996) uses the following rule of thumb: have a total of three to five groups per project. This is usually enough to reach saturation, the point that extra groups do not offer new information. However, projects of over 50 groups are also known (Kitzinger, 1995). The number of groups also depends on the aim of the project and the available resources. The design of the focus groups influences the number of groups needed to reach saturation. Unstructured group design ask for more groups because it increases the variability from group to group. When the groups are homogeneous less groups are needed because it is easier to compare the groups (Morgan, 1996).

Number of groups in this study
Two focus groups were organised. One group containing students and one containing possible users. The choice for only one resident group was involuntary, there were not enough willing participants for multiple focus groups.

5.3.5. Discussion guide
The subjects that are to be discussed during the focus groups are described in the so called discussion guide (Powell & Single, 1996). This guide could contain different subjects, statements or questions to guide the participants to the research goal (Kitzinger, 1995; Powell & Single, 1996; Freitas et al., 1998). Questions should be clearly and simply phrased, open-ended and they must draw upon concrete examples (Powell & Single, 1996). Dichotomous questions that can only be answer by yes or no should be avoided (Freitas et al., 1998).The order of questions should be from less to more sensitive, if applicable (Powell & Single, 1996). Freitas et al. (1998) classify questions in seven categories:

- Opening questions: First round of questions, introducing the participants to each other.
- Introductory questions: Introduce the general topic of discussion, this gives participants the chance to contemplate previous experiences.
- Transition questions: Move the conversation to the key questions.
- Key questions: Two to five questions that address the study, these require the most attention and analysis.
- Ending questions: Closes the discussion, they allow participants to consider all comments shared in the discussion.
- Summary question: The moderator summarises the key questions in two to three minutes. After this he asks the participants if it was an appropriate summary.
- Final question: Asks the participants if they missed something or if they have any advise. This question is especially important the first focus group, missed subject could be added in the next ones.

The key questions are the most important as they are focused on reaching the research goal. The questions should gather enough information to reach the goal within the desired time frame. The discussion guide should be the same during the series of focus groups if the aim is to obtain similar content. However, the discussion guide should be adjusted if the final question leads to the discovery of irrelevant questions or missing subjects or questions (Freitas et al., 1998).

Discussion guide used in this study
Table 5.1 displays the discussion guide used in this study. This guide was used to start the discussion, after which the interaction between participants was leading. To make sure that every participant had the same global idea of what a neighbourhood mobility hub is, the definition found in the previous chapters was used: A neighbourhood mobility hub is a central point in the neighbourhood where shared mobility, like shared cars and bikes, is offered. This definition makes sure that all participants can envision their own design attributes.

Table 5.1: Focus group discussion guide

	Question	Category
1	Introduce yourself	Opening question
2	Are you familiar with shared mobility, and have you ever used it?	Introduction question
3	Are you familiar with neighbourhood mobility hubs?	Transition question
4	When do you think you will use a neighbourhood mobility hub • What kind of trips? • In what kind of situations? • etc.	1st key question, aims to answer sub-question 4.
5	Would you travel differently with a hub nearby, and why?	2nd key question, aims to answer sub-question 4
6	What should a hub look like? • Types of offered services • External services • etc.	3th key question, aims to answer sub-question 3
7	What should a hub offer before you would use it?	4th key question, aims to answer sub-question 3
8	Would you use your personal vehicle less/not at all if a hub was nearby, and why?	5th key question, aims to answer sub-question 4
9	Why would or wouldn't you use the neighbourhood mobility hub as discussed here?	Ending question
10	Did you miss anything during this meeting, would you change anything?	Final question

5.3.6. Duration & location

A focus group duration should be between one and two hours (Freitas et al., 1998; Kitzinger, 1995). The duration is usually determined by the complexity of the subject and the number of participants. Because the relatively long duration participants should be given ample notice (Powell & Single, 1996).

The location of the session is determined by the researcher and should be on neutral ground. This will allow a frank unhampered critical discussion (Powell & Single, 1996). The location should further be easy to find and reach, free from distractions and equipped with audio or video facilities (Freitas et al., 1998). Video documentation is advised to capture not only the verbal but also the non-verbal reactions of participants.

Duration & location of the focus group in this study
The length of the meetings was scheduled to be 120 minutes, including a 15 minute walk in period. This was enough time to discuss all questions, as the subject is not overly complex and the groups were not that large. The sessions were held at the office of Mobycon, a neutral location, to ensure that the participants could be frank in their discussions. The sessions were recorded using a telephone, while important non-verbal communication was noted by the researcher.

5.4. Content analysis

The data obtained during the focus groups is analysed using content analysis. ”Content analysis is a method of analysing written, verbal or visual communication messages” (Elo & Kyngäs, 2008, p. 107). Content analysis is a method to describe and quantify phenomena in a systematic and objective way. It allows the researcher to categorise words and phrases with the same meaning, distilling the content in fewer content-related categories. These categories can be used to build a conceptual model (Elo & Kyngäs, 2008). Content analysis is been criticised as being a simplistic technique without a quantitative base, that does not lend itself to detailed statistical analysis . However, despite the criticism, content analysis is used for decades in different kind of research fields (Mayring, 2000; Elo & Kyngäs, 2008). There are two central approaches to content analysis: inductive category development and deductive category application (Mayring, 2000). The inductive approach is used when there is not enough previous knowledge or if the knowledge is fragmented. The deductive approach is used when the structure of the analysis is operationalised on the basis of previous knowledge. Inductive moves from the specific to the general while deductive moves from the general to the specific (Elo & Kyngäs, 2008).

In this study the deductive approach was used as the structure of the analysis was operationalised based on previous knowledge found during the literature review and expert interviews. The goal of the focus groups was to find preliminary answers for the different research sub-questions (contextual factors, perception and possible effects on behaviour), these are therefore the base for the analysis. Figure 5.1 shows the deductive model as designed by Mayring (2000), this model is used to analyse the focus group data.

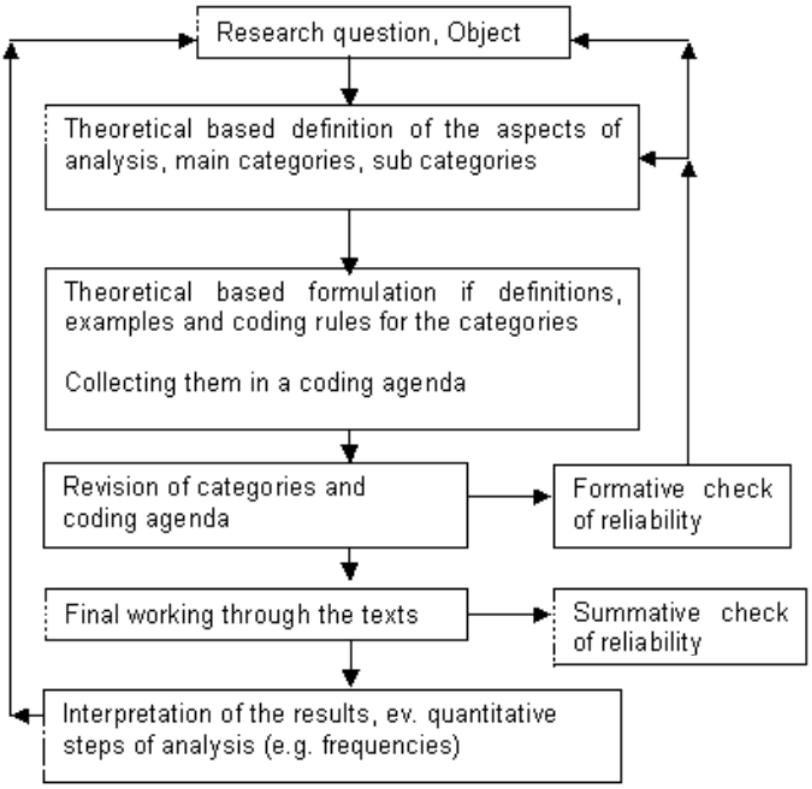

Figure 5.1: Step model of deductive category application (Mayring, 2000, p. 5)

The first step in the deductive model is to develop a coding agenda, this can be structured or unstructured. With structured coding only aspects that fit the agenda are chosen from the data, while in unstructured coding data not fitting the matrix can create new categories. For this study unstructured coding is used to be able to capture aspects that do not fit the main categories (Elo & Kyngäs, 2008; Mayring, 2000). Table 5.2 shows the coding agenda used in this study.

Table 5.2: Coding agenda

Category	**Definition**
C1: Contextual factors	Circumstances under which the participants would (or wouldn't) make use of a neighbourhood mobility hub. Circumstances under which the participants think others would make use of a neighbourhood mobility hub.
C2: Perceptions	How do the participants view the neighbourhood mobility hub, what attributes are important.
C3: Possible TB effects	Possible travel behaviour changes of the participants. Possible travel changes participants expect others to have.
C4: Other	All statements that do not fall in the other categories.

The second step is the coding of the data, while reading the data each statement made in the focus group is coded by the four categories.

The thirds step is the revision of categories, the statements that fell into the fourth category will be used to form categories. The resulting categories are checked in the feedback loop until all statements are processed.

6

Focus group results

The focus groups are used to find if the theoretical potential user is indeed the potential user, which the theoretical travel behaviour effects occur and how the hub is perceived. This chapter will provide preliminary answers to the second, third and fourth sub-question. This chapter is structured similar to the coding agenda discussed in chapter 5. First, the results about contextual factors will be discussed in section 6.1. Followed by the perceptions and possible travel behaviour effects, sections 6.2 and 6.3. Results not fitting each of these sections are discussed in section 6.4. Finally, the conclusions of the focus groups are discussed in 6.5. The results are supported with quotes from the participants, shown in italics all through the results. For an overview of all quotes and their categories see Appendix C.

6.1. Contextual factors

The main result of the resident focus group was that they did not see the added value of a neighbourhood mobility hub in Delft. Most of the services offered by the hub are already offered in city centres, especially in Delft were there is a car rental company in the centre. This company fulfilled the main function of the hub, offering shared cars. However, if the company would move from the centre to an other location they saw the hub as a good replacement. This shows that there is a reason for hubs in cities, if there are not already options there.

Henk: ”If Köhler [car rental company] had to leave the city centre, then we would need this [hub].”

One of the resident focus groups did confirm that parking pressure can influence the decision to own a car if there are other options, Köhler in this instance.

Linda: ”I didn’t want a car anymore, I was going crazy from the parking. [...] if Köhler would leave the centre I would buy a car immediately.”

The resident focus group saw two other reasons for hubs, to increase the reach of the current public transport network and to decrease incoming traffic to the city. Shared mobility hubs located at train, bus and tram stations to expand their reach and shared mobility hubs as park & ride facilities at the edge of cities to relieve city centres. They would use the hub as last mile, for the first mile they do not see to much reason to use a hub as the city centre makes it that everything is nearby.

John:”I mostly see a hub at an end station of public transport. That way, when you arrive and can not go further using public transport, you can use a bike or car.”

The maximum distance people were willing to travel to the hub was different per person but all agreed that it was depended on the type of mode that they were planning to use and the total distance of the planned trip . Some were willing to cycle to the hub to use a shared car while others wanted the hub to be within walking distance for every mode. All agreed that the shorter the trip the shorter the distance they were willing to traverse to the hub.

Renate: ”The total travel time is important, if I wanted a bike for 10 minutes, but first I had to walk 5 minutes to the bike, I would keep walking and save the money.”

6.2. Perceptions

Some people see the guarantee of availability as the most important attribute of the hub. There should always be transportation available, and if the desired mode is not available alternatives should be shown. People do not want to stress about their trips. This is also one of the reasons to have a personal car, the knowledge it is always there. This is especially so when travelling to a location far away, they want to be sure that the vehicle is available when they want to return.

Nick: "Yes, I think availability is key. I do not want to think about it, I do not want to wait for one [car or bike] to become available."

Flexibility is also an important factor. This is related to the availability and diversity, they want to choose the easiest form of transport with relation to the costs.

Nick: "You're looking for flexibility, you want to choose the easiest form of transport."
Karel: "That's why I use the OV-bike instead of the bus, flexibility."

The flexibility does not only depend on the availability and diversity. The ease of leaving your belongings in the car is also seen as part of the flexibility. From small convenient items like water bottles to large cumbersome specific items like car seats for children.

Linda: "What are you going to do with car seats for children."

People will use a point-to-point hub system different compared to a round-trip hub. If the hub only offers round-trips people say they will use the hub for short trips like groceries or visiting family for a night. Transport to sport activities with multiple persons is also brought up as an option for round-trip hubs. For trips that take more time people seem to want a point-to-point system. There is resistance to paying for the mode when it is sitting idle while the person is working or visiting family. It should be possible to check out the mode at the end destination. A network of connected hub is needed before people are willing to use the hub for these kind of trips.

David:"If there is no point-to-point network I would not want to use it for activities that take very long."

People do see the added value by adding non transport related services to the hub. Multiple people are enthusiastic about the idea of a drop off point for packages, there should also be the opportunity to drink something. This will also help to integrate the hub with the neighbourhood. They also see larger hubs with personnel to help with problems and provide a sense of safety at the same time.

Linda:"I think a parcel delivery point would really add value."

6.3. Possible travel behaviour effects

People think it will be very hard to change the travel behaviour of car drivers, the car is seen as a home away from home. People are used to have their own car with their own personal belongings. The habit of car users is hard to break they note, car use is intertwined with personal rituals.

Nick:"My car is indeed like a second living room."

The focus groups also note that this is different for the upcoming generation, the hubs could help avoid cars becoming second homes for new car users. However, to make sure of this the hubs should be as flexible as possible.

Mark:"I do have my drivers license but I never really had to use a car, this kind of hubs would make sure that the car wouldn't become my second living room."

To get car users out of their car a combination of force and good alternatives is needed people note. The use of the personal car should be made unattractive by increasing parking fees, or banning them from city centres, while the alternative should be made more attractive. Using the hub should be as easy as using a personal car.

Linda:"You want exactly the same functionalities as a car."

The hubs could also lead to extra car trips, as people who used to use public transport to move no have easy access to a car. When the shared car is close in price to public transport people are willing to switch to the car for the added flexibility.

Tim: If the shared car is cheaper than the train than it will become interesting to take the car. While the train is easy to reach here in Delft."

6.4. Other relevant information

Both focus groups commented on the fact that experts and literature think shared mobility can replace the second car. In both groups it was mentioned that the second car is also used for work related trip as traditional gender roles of the working husband and stay at home wife change.

Tim: "You should take the changing gender roles into consideration. Nowadays it is more and more so that both man and woman need a car for work."

Both focus groups see the hub as an easy way to introduce people to new forms of mobility. Provided that people are used to use a hub and someone or something is pushing them towards them. This could be an promotion via the app or as one participant said a hub employee telling them the advantages and showing them how to use the new mobility.

Linda:"If you are used to use the hub and there is a person there to convince me to use a electric car for a change, than it could be a showcase to stimulate sustainable forms of transport."

6.5. Conclusions

The goal of the focus groups is to find if the theoretical potential user is indeed the potential user, which the theoretical travel behaviour effects occur and find the first indication of how the hub is perceived.

The theoretical hub user is mainly motivated by parking pressure in their neighbourhood and live therefore in cities with high parking pressure. Socio-demographic factors are in theory less important, in general the early adopters will be young people with a sustainable mindset and experience with shared mobility. They also have to have a certain disposable income to be able to afford the hub.

The focus groups contest this theoretical picture. The do not fully recognise themselves, people living in cities, as potential hub users. Their main argument is that hubs in cities have no added value as services offered by the hub are already located in the city. Especially in Delft city centre where a car rental company already provides easy car access. They see the hub more as an extension of the public transport network. Their hub user lives at the edge of the (cities) public transport network. This would be different in cities without these services. If there are no shared mobility services available in a city, a hub would become interesting.

The focus groups do agree that parking pressure would motivate people to use the hub. They also agree with the experts that young people are more likely to use the hub, adding that the hub could provide car access to persons without a car.

Only two participants of the focus groups owned a car, this did make discussing personal travel behaviour changes harder. The discussion therefore shifted to how the hub could potentially change car ownership and number of car trips. The focus groups think that the main effect of the hub on car ownership would preventing people buying cars. They think that the hub could prevent people from buying their first car. They expect that it is harder to get car owners out of their car than preventing people from buying a car. This is a case of the endowment effect, described in the literature (section 2.4.1). This is the effect that people add value to a car just because they own it, making it harder to persuade them to sell it. They think that for car owners to use the hub external pressure, and a smooth functioning hub is needed.

The focus groups indicate that the hub will most likely lead to more car trips, as they see the hub as a replacement for public transport. This is partly due to the flexibility of the hub and the costs of public

transport, especially if you are travelling with multiple people.

The focus groups agreed that the fourteen design attributes identified during the literature research and expert interviews are the most important hub attributes. They perceived availability, flexibility, diversity and costs as especially important. They further agreed that a hub network with point-to-point trips would be preferable over stand alone hubs. They were also enthusiastic about the idea of a hub offering other services like a parcel delivery point.

The focus groups further show that for someone to form an opinion, some knowledge of the hub is important. Randomly surveying city centre inhabitants, as potential users, is therefore not useful. They do not know how they are effected by the hub as they do not know what it is or how it works.

7

Survey design

The information found during the literature research, expert interviews and the focus groups is used to construct a survey. Surveys are fine methods for measuring attitudes and orientations of a large population (Babbie, 2013). The goal of this survey is to find the perceptions and travel behaviour changes of residents living in a neighbourhood with a hub. In this chapter the survey design process will be discussed. First the conceptual model will be specified in section 7.1. Next the location where the survey will be held is selected in section 7.3. Finally, the construction process of the questionnaire is discussed in section 7.2.

7.1. The conceptual model

The conceptual model described in chapter 2 is used to design the survey. This conceptual model is expanded with all possible causal relations between socio-demographics and the other variables in figure 7.1. By including all possible relations in the model, all significant relations will be found, direct or indirect. This makes it possible to precisely test how the socio-demographics influence hub use and the resulting travel behaviour changes. Non-significant relations will be excluded during the analyses, resulting in model of how socio-demographics influence hub use.

Most relations in the model are straight forward, e.g. perceptions could be influenced by age. However, it is also possible for the socio-demographics to change the effect of the perceptions on potential hub use, this is called an interaction effect. This effect is displayed as the arrow pointing from socio-demographics to the arrow between perceptions and potential hub use. Including interaction effects in the model could tell how perceptions and socio-demographics work together to influence hub use, and if there is synergy between the two. If the interaction effect is significant perceptions and socio-demographics could strengthen (or weaken) each other more than the sum of their parts could.

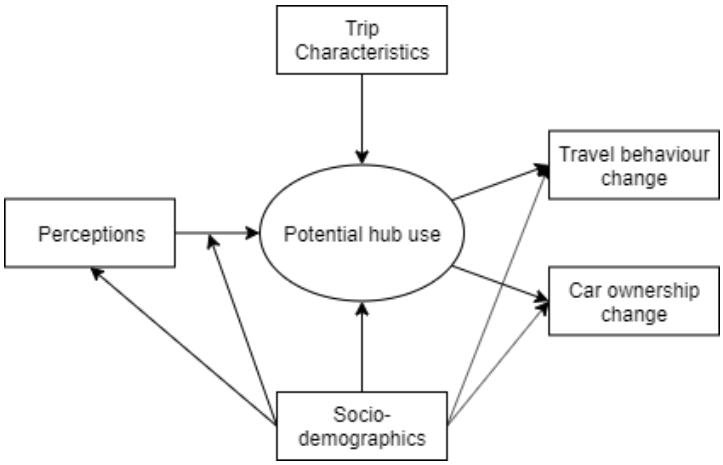

Figure 7.1: Conceptual model with the possible socio-demographic relations added

7.1.1. Variables and causal relations

The variables and their attributes are the results of the literature study, expert interviews and the focus groups. All the variables measured by the survey are listed in table 7.1. Each of these variables and why these attributes are use are explained in this section.

Table 7.1: Observable variables, attributes and their measurement scale

Variable	Attribute	Scale[1]
Perceptions	Costs for hub use	Interval
	Costs for vehicle use	Interval
	Availability	Interval
	Diversity	Interval
	Ease of use	Interval
	Sustainability of the hub	Interval
	Sustainability of the vehicles	Interval
	Other services	Interval
	Creating space in the neighbourhood	Interval
	Parking pressure car	Interval
	Parking pressure other mode	interval
	Visibility of the hub	Interval
	Distance to the hub	Interval
	Safety of the hub	Interval
	Safety of the vehicles	Interval
	State of the hub	Interval
	State of the vehicles	Interval
	Round-trip	Interval
Trip characteristics	Motive	Nominal
Socio-demographics	Gender	Nominal
	Age	Ratio
	Education	Ordinal
	Gross household income	Ratio
	Household type	Nominal
	Drivers license	Nominal
	Household car ownership	Ordinal
	Access to a car	Ordinal
	Shared mobility use	Nominal
	Hely hub use	Nominal
	Location	Nominal
Travel behaviour change	Travel mode without hub	Nominal
	Hub travel mode	Nominal
	Times used	Ordinal
Car ownership change	Change in private car ownership	Nominal
	Intention to change private car ownership	Nominal

[1]: See appendix F for an explanation about measurement scale

User perceptions

The Oxford English Dictionary defines perception as ”an idea, a belief or an image you have as a result of how you see or understand something” (Perception [Def. 3], 2019). The difference between reality and peoples perceptions of this reality is a topic of discussion among philosophers and scientist for centuries. In the 4th century B.C. Plato described the problem in the simile of the cave. In this simile he describes how prisoners in a cave can only perceive the shadows cast by objects carried along a road. Plato philosophies that, for these prisoners, the shadows are as real as the objects are. The prisoners perception of the objects, the shadows, shape their reality (Plato, 1914).

In more recent research Ma and Cao (2019) show that the perceptions of a service reflect an individual's interactions with the actual service. This means that the actual variable values are less important to users, as they will make decisions based on their perception of the variables. Reasoning from Plato's simile and this research in perceptions, there is chosen to measure the perceptions of people. The perceptions that are measured are those that came forward as the most important variables during the expert interviews and focus groups, see chapters 3 and 6.

Trip characteristics

The expert interviews and focus groups made clear that the hub use is influenced by the kind of trip that the person wants to undertake. In literature, shared mobility research measures four main trip characteristics: costs, distance, travel time and waiting time (Krueger, Rashidi, & Rose, 2016). When looking at hubs the experts and focus groups indicated that the trip purpose, the distance and travel time influences the decision to make the trip via the hub. The distance and travel time per trip are left out of the survey to avoid it becoming too complicated and time consuming for the respondents.

Socio-demographics

Socio-demographic variables are the characteristics of a population. They can be used to get more insight in the composition of the sample of respondents. Ben-Akiva and Bierlaire (1999) note that a model must include socio-demographic variables to explain the heterogeneity of preferences among decision makers. Not all the interviewed experts think that all socio-demographics significantly influence hub use, using this model they will be individually assessed.

The socio-demographics listen in table 7.1 are mostly standard demographics used in most survey studies (Kim & Ulfarsson, 2004; Krueger et al., 2016). Gender is measured to check if there are differences in hub use between the genders. Age and education are measured to check the assumption of literature and experts that hub users are relatively young and educated persons. In this study income and car ownership is measured on the household level, as decisions on car ownership are usually made on this level with household money. Household type is measured because this also influences what kind of modes are used, as households with children have different needs than single person households. The shared mobility use attribute is less standard, this is measured as it is theorised that persons who have used shared mobility, outside a hub, are more likely to use a hub. In this study there is made an distinction between Hely hub users and non-users who know about the hub in their neighbourhood. The expert interviews and the focus groups showed that the neighbourhood hub concept is not widely known. When someone does not know a concept, it is hard to get viable results from a survey. That is why persons living in the neighbourhood but do not know of the hubs existence are excluded. The location of the respondent is noted. This is done because the Hely hubs and their locations are not all identical. By noting near which hub the respondents live the results can be corrected for location.

It is expected that socio-demographics effect travel behaviour and car ownership both directly and indirectly. Research by Ma and Cao (2019) shows that socio-demographic factors influence travel behaviour directly and indirectly via perceptions. It stands to reason that this is also the case for neighbourhood mobility hub perceptions.

Travel behaviour change

The primary goal of the neighbourhood mobility hub for municipalities is decreasing car use, the hub should lead to changes in travel behaviour. These changes can be measured, both for people currently using the hub as for people not using the hub. For non-users the travel behaviour change is a hypothetical change, as they have not yet changed their behaviour.

To measure travel behaviour change a distinction is made between users and non-users. Users are straightforward, they are asked how much and for what kind trips they use the hub. This is combined with a question about how they would have made those trips if there was no hub. For non-users the structure is the same, however, they are asked if they ever considered to use the hub, and if so, how many times and for what kind of trips.

Car ownership change
Beside the goal of travel behaviour change, a decrease in car ownership is an important goal for municipalities. This change can not be measured for non-users, as the question would be to hypothetical to give viable results.

A distinction is made between first and second or third cars. Experts, literature and the focus groups agree that it is not likely that households will discard their first car. They think it more likely that a hub will decrease the ownership of second or third cars. There are two ways a decrease in car ownership can come to fruition: the sale of an owned car or a decision not to buy a new (second) car. An other option mentioned by literature and the experts is that hub use could lead non-car owners to decide to buy a car for themselves. All these options can be measured by asking yes or no questions for each option.

7.2. Construction of the questionnaire

With the completion of the conceptual model and the determination of the variables that need to be measured the questionnaire can be constructed. Each of the attributes in table 7.1 is translated into questions. In this section the survey will be briefly discussed, for the full survey see appendix E. There are two types of respondents, users and non-users, therefore two surveys are used. The difference between the two types are only textual, the questions and answers are exactly the same. The variables affected are travel behaviour change and car ownership change.

The questionnaire starts with a short introduction about shared mobility and the Hely hub. Users may have used the hub a long time ago, and non-users may have an incomplete picture about the hub. The introduction makes sure all respondents have the same basic knowledge about shared mobility and the Hely hub.

Next, the respondents' perception of each attribute is asked, they are measured on a 5-point Likert-scale. The perceptions are asked in two different ways: the current view on the hub characteristics, and their opinion on certain statements is questioned.

After these questions travel behaviour changes are measured, here there is a slight difference in questions between users and non-users. Both are asked about their travel behaviour without the hub, for users this is before they used the hub, for non-users their current travel behaviour. This question is followed by a question about hub use, for users this is their current travel behaviour. Non-users are asked if they ever thought about using the hub, and if so, how many times and with what mode. The final question about travel behaviour change pertains car ownership change.

The survey is closed by the socio-demographic questions. The resulting questionnaire is seven pages long, including two pages introduction. It took the respondents around 10 minutes on average to read and answer the whole questionnaire.

7.3. Survey location and deployment

The goal is to find perceptions, and travel behaviour changes, of residents of neighbourhoods with a hub. As already noted in chapter 2, Hely hubs are the only known operational multimodal neighbourhood hubs in the Netherlands. The surveys were therefore distributed within neighbourhoods with an operational Hely hub. Inhabitants within a radius of 400 metres around the hub are seen as the population, as Hely sees this radius as their catchment area. The survey is distributed with an increasing radius, starting with the households closest to the hub. The residents in this area have a high chance to know the Hely hub, even if they do not use the hub.

Hely hubs are located on nine locations in six different Dutch cities, see appendix D for a list. From these nine locations six are visited, the hubs that were not visited were the Rotterdam hub and two The Hague hubs. The reason for this is that the Rotterdam hub just opened a week before the surveys were handed out, making travel behaviour changes not likely. The two The Hague hubs that were not visited are hubs located in a business park and not in a residential area, making them fall outside the scope of this research. The survey was distributed only in the remaining six locations, this was done by going door-to-door in these neighbourhoods. The reason to do this is threefold:

- Only persons who know the hub should be selected as these are more likely to be effected by the hub; also, if they do not know anything about the hub it is hard to answer questions about it.
- By noting the persons who do not know about the hub's existence, it's visibility could be partly researched.
- Personal handed-out surveys further have a higher response rate (Nulty, 2008), this is important as the population is relatively small.

The respondents had two options in answering the survey, on paper on the spot or online. These two options were available because some prefer doing surveys on paper while others prefer doing them on their telephone, tablet or PC. The online version was distributed by handing out cards with a QR code and a link to the online survey. They were also given to persons who indicated that they were willing to fill in the survey at a later time.

7.4. Actual survey distribution

The resulting survey was finally distributed door-to-door in six neighbourhoods: Buiksloterham, De Werf, the Schoemaker Plantage, Bezuidenhout, the Scheepmakerswijk and the Schildersbuurt. All neighbourhoods are visited within one week, from Monday till Saturday. The Schoemaker Plantage neighbourhood is visited two times, as it is located in Delft, while all other neighbourhoods are visited once. Travel distance and time constraints made it not possible to visit the hubs multiple times on different days and times.

By distributing the surveys door-to-door only residents with knowledge about the hub were asked to participate. It did however also lead to a decrease in possible respondents as not everyone was at home at the time of survey distribution.

The survey consisted of questions about the users' perceptions, their trip characteristics with and without the hub, their car ownership changes due to the hub and their socio-demographics. The measured variables make it possible to answer all three sub-questions.

8

Survey data analysis

The data gathered with the survey of the previous chapter is analysed in this chapter. This chapter aims use the empirical data to answer to sub-questions 2, 3 and 4. This is done by testing the causal relations described in the conceptual model from the previous chapter. Potential user characteristics, their perceptions and their travel behaviour changes are all discussed. These answers are compared with the theoretical answers found in literature and during the interviews and the focus groups results. First, the overall knowledge about the existence of the hub is discussed in section 8.1. Second, the cleaning of the data is explained in section 8.2, followed by the description of the sample in section 8.3. The cleaned data is used to estimate a logistic regression model describing the hub user in section 8.4. Perceptions of users and non-users are compared in section 8.5, while travel behaviour changes are discussed in section 8.6. Finally, the conclusions are presented in section 8.7.

Because the surveys were distributed door-to-door respondents sometimes gave information about their views of the hub directly to the researcher. These views were noted and, where relevant, are used as extra information in this chapter.

8.1. Knowledge about the hub

Hely hubs are only recently placed in the neighbourhoods, with the first two in December 2018. Therefore, knowledge about them could be lacking in the neighbourhood. As said in section 7.3, knowledge about the hubs can says something about their reach and visibility and was therefore noted.

Table 8.1 shows for each neighbourhood how many of the residents who answered the door, and were willing to participate, knew about the hub. In total 61.8% of them knew about the hub in their neighbourhood. However, there are differences between the different hub locations.

Table 8.1: Number of respondents that knew and did not knew about the hub

City	**Amsterdam**		**Delft**	**The Hague**	**Haarlem**	**Utrecht**	**Total**
Hub	Buiksloterham	De Werf	Schoemaker Plantage	Bezuidenhout	Scheepmakerswijk	Schildersbuurt	
Known	16	1	41	4	10	9	81
Unknown	5	2	13	18	5	5	48
Ratio	76.2%	33.6%	73.2%	18.2%	66.7%	64.3%	62.8%

The ratio of respondents who knew that the Hely hub was located in their neighbourhood fluctuates, with the Bezuidenhout hub being the least known. One of the respondents there told the researcher that, as far as she knew, the hub was not really promoted by Hely.

The highest percentage of residents that knew the hub are found in the Buiksloterham and Schoemaker Plantage hub neighbourhoods. The probable explanation is that these two hubs are in operation the longest. Both were pilot hubs, and started in December of 2018. Hely is also actively promoting these hubs by mail and e-mail, as noted by multiple neighbourhood residents.

De Werf hub is a special case, as this is a private hub. It stands to reason that at such a hub the ratio would increase, this is however not the case. There is only a limited number of respondents at this location. One of the respondents said she saw a poster about the hub in the elevator. She however had no idea the hub was located in the parking garage of her own apartment complex.

The knowledge levels of the other neighbourhoods are around the average. It should be noted that the researcher started at the household closest to the hub and worked his way from there. The expectation was that residents living close to the hub have the highest chance that they knew the hub. Despite this, the knowledge about the hub is lacking, a prime example: The household across the street from the Bezuidenhout hub, which had the hub in full view from the living room window, did not know the hub.

8.2. Data cleaning

The data collected by the survey are not immediately usable for analysis. The responses have to be checked for missing or unusable data. Some of the data have to re-coded before statistical tests can be performed.

Because the survey was handed out by going door-to-door the number of respondents is limited, in table 8.2 the number of respondents are split into different groups. In total 156 persons answered the door, 81 of them were actually given the survey, from which 44 filled it in completely, giving a response rate of 54.3%.

Table 8.2: Respondents per group

	Online	**Offline**	**Total**
# Handouts	70	11	81
# Started	35	11	46
# Fully completed	33	11	44
Response rate	47.1%	100%	54.3%
No knowledge	-	-	48
Did not want to participate	-	-	27
Total			156

8.2.1. Missing data

The first step of data cleaning is looking at missing data. As only two entries are incomplete, they can be examined closer. The first incomplete entry only consist of answers to the first two questions, the hub closest to the respondent and if they made use of it. The other questions remain unanswered, therefore, this entry is only used when looking at the ratio of users and non-users in a neighbourhood.

The second incomplete entry misses answers to the last four socio-demographic questions, this respondent will not be included in any analysis making use of these four attributes. This means the entry is not used in the logistic regression analysis. Table 8.3 shows for each section how many respondents are included in the data analysis.

Table 8.3: Number of respondents included in each analysis

Section	#Respondents
8.3 Sample characteristics	46
8.4 Binary logistic regression	44
8.5 Perception data comparison	45
8.6 Travel behaviour changes	45

8.2.2. Re-coding data

Because of the way the questionnaire was constructed some data has to be re-coded before it can be used. The perception and statement questions need to be re-coded. These questions were asked on

a 5-point Likert-scale with an extra 'I don't know' or 'Non applicable' category.

The perception data was re-coded by coding the 'I don't know' category to 'neutral'. The statement data has a 'I don't know' option combined with a 'not applicable' option for respondents that do not own a car. Car ownership is checked before re-coding these answers, if the respondent does not own a car the response is not taken into account.

The year of birth of the respondents is also checked, as this is an open-ended question. The data file shows that two respondents filled in their date of birth, including month and day, these are re-coded to show just the year of birth. The age of the respondents is calculated by subtracting their year of birth from the year of the study, 2019. The resulting data can be grouped or used as a continues variable.

8.3. Sample characteristics

To get information about the respondents who filled in the survey socio-demographics were collected. These are shown in table 8.4. These Socio-demographics can be used to compare the sample to the population, or to compare groups within the sample with eachother. A comparison with the population is however not possible as the socio-demographics of the population is not available. (CBS neighbourhood data does not correspond with the population as stated in this research.) The socio-demographics are used to describe the potential hub user and answer the first research question, they should therefore be inspected thoroughly.

The information in table 8.4 gives insights in the neighbourhoods and its residents. The ratio users and non-users is skewed, this seems logical as a new service, like the Hely hub, does take time to attract users.

Another important note is the differences in number of respondents per location, the Schoemaker Plantage location has almost half of all respondents. The reason for this is that this location was visited two times. The other locations were visited only once due to time constraints. Location Bezuidenhout is relatively unknown, see table 8.1, leading to a low number of respondents. Location De Werf was located in a private apartment complex what made approaching inhabitants hard, which lead to the low number of respondents.

The sample is divided reasonably equal by gender, and the ages are relatively equally distributed between the 25-54 groups, with an average of 48.8 years. Most of the streets visited contained relatively expensive family houses, leading to a low number of respondents younger than 25. This is also part of the reason that the older groups do not have much respondents. Another reason can be that older people are less likely to be interested in a new mobility service, as indicated by literature and the experts. Making it less likely they know about the hub in their neighbourhood, which led to them being excluded from the survey.

The relatively expensive houses probably also influence the numbers in education, household type and income. Respondents have a relatively high education level, and mostly live with a partner, with or without children. The income is also relatively high. Living in a expensive house is more affordable with a partner and a high income, a high income is more likely for persons with a higher education level. The fact that many of the respondents lived with partner and children could also partly explain the low number of users. One of the respondents told the researcher that they used to use the hub before he had children. The extra effort of having to remove and carry all baby supplies (e.g. child seat, buggy) after each trip made them switch to a private car. Another respondents told the researcher that this was exactly the reason why he did not use the hub.

Most respondents have a drivers license and own at least one car, this leads to a high percentage of respondents with access to a car. Finally, 38% of respondents has used shared mobility outside of the hub.

Table 8.4: Socio-demographics of the sample

Socio-demographic	Category	Absolute number	Relative
Hely hub use	Yes	9	19.6%
	No	37	80.4%
	Total	46	
Location	Buiksloterham	9	19.6%
	De Werf	1	2.2%
	Schoemaker plantage	20	43.5%
	Bezuidenhout	2	4.4%
	Scheepmakerskwartier	7	15.2%
	Schildersbuurt	7	15.2%
	Total	46	
Gender[3]	Male	20	44.4%
	Female	25	55.6%
	Total	45[2]	
Age	<24	2	4.4%
	25-34	11	26.7%
	35-44	14	31.1%
	45-54	11	28.9%
	55-64	7	8.9%
	>64	0	0%
	Total	45[2]	
Education	Primary school	0	0%
	Middle school, MBO1	2	4.4%
	HAVO, VWO, MBO2-4	4	8.9%
	HBO-bachelor, WO-bachelor	19	42.2%
	HOB-master,WO-master, PhD	20	44.4%
	Total	45[2]	
Household type [1]	Living alone	4	8.9%
	Living with partner	17	37.8%
	Living with partner and children	24	53.3%
	Total	45[2]	
Gross household income (€)	< 10,000	0	0%
	10,000-19,999	1	2.2%
	20,000-29,999	3	6.7%
	30,000-39,999	2	4.4%
	40,000-49,999	1	2.2%
	50,000-59,999	2	4.4%
	60,000-69,999	1	2.2%
	70,000-79,999	1	2.2%
	80,000-89,999	4	8.9%
	90,000-99,999	5	11.1%
	> 99,999	9	20.0%
	I rather not say	16	35.6%
	Total	45[2]	
Drivers license	Yes	39	88.6%
	No	5	11.4%
	Total	44[4]	
Household car ownership	No	7	15.9%
	Yes, one	28	63.6%
	Yes, two	8	18.2%
	Yes, >two	1	2.3%
	Total	44[4]	
Access to a car	Whenever I want	17	38.6%
	In consultation with household	19	43.2%
	In consultation outside household	2	4.6%
	No, I have never access	6	13.6%
	Total	44[4]	
Shared mobility use	Yes	17	38.6%
	No	27	61.4%
	Total	44[4]	

[1]: The categories 'other' and 'rather not say' are emitted as they were never chosen.
[2]: One less respondent as one respondent only filled in the first two questions.
[3]: The categories 'alone with children' and 'living with roommates' are emitted as they were never chosen.
[4]: One less respondent as one respondent did not fill in the last four questions.

8.4. Binary logistic regression

Binary logistic regression analysis is used to predict the probability that an observation falls into one of two categories of a dichotomous dependent variable. The prediction is based on one or more independent variables that could be continuous or categorical (University of Southampton, 2019). In this study binary logistic regression analysis is used to find the relation between the different socio-demographics (independent variables) and hub use (dependent variable).

Logistic regression is used to transform the dichotomous dependent variable to a continues scale. The logistic regression results in the odds of each independent variable, odds are the likelihood of an event occurring relative to the likelihood of an event not occurring (University of Southampton, 2019). The odds can be mathematically noted as:

$$odds = \frac{P}{1-P} \tag{8.1}$$

The P in equation 8.1 stands for the probability of an event occurring. Using the natural logarithm, the logodds or logit can be expressed as follows:

$$ln\left(\frac{P}{1-P}\right) = a + bX \tag{8.2}$$

This equation converts the relation between the dependent variable and independent variables from a multiplicative to an additive relationship, this makes it similar to linear regression. The equation can be generalised to include multiple independent variables (University of Southampton, 2019).

As logistic regression tries to predict probabilities, the odds found using the model can be used to calculate probabilities. The equation of the probability is based on the logit model, and can be used to calculate the probability that a certain person will use the hub:

$$P = \frac{odds}{1+odds} \tag{8.3}$$

A P value below 0.5 indicates that that person will probably not use the hub, while a P value higher than 0.5 indicates that the person will probably use the hub. The equations above also show that a higher logit increases the probability that someone will use the hub.

8.4.1. Data

A problem with the data collected in this study is that there are few users among the respondents. This has an effect on the significance tests, which are used to find if the relations found in the sample are also present in the population.

The low number of users in the sample leads to tests that do not have much statistical power. This could result in the test incorrectly showing no significant relation within the population. This may lead to the conclusion that a relation found in the sample can not be generalised to the population, while this relation in fact does exists in the population.

The low number of users could result in biased regression coefficients, both positive and negative, and in an increase in paradoxical associations (i.e. significance in the wrong direction) (Peduzzi, Concato, Kemper, Holford, & Feinstein, 1996). Peduzzi et al. (1996) show that logistic regression analysis should have at least ten events per predicted variable (EPV) to avoid these effects. There are only nine users among the respondents, this means that an EPV of ten is not possible. The results of the logistic regression analysis are checked for these effects.

The low number of respondents further leads to an increased chance that the data is completely or quasi-completely separated. (Quasi-)completely separated means that a combination of the predictors yields a perfect or almost perfect prediction of the response variable (Lesaffre & Albert, 1989). This results in the inability to find a maximum likelihood estimate, the log-likelihood reduces to zero or a non-zero constant and the dispersion matrix becomes unbounded (Giaimo, Matranga, & Campisi, 2006). Data manipulation is used to (partly) counter these data separation issues.

The limited data has the effect that not all relations described in the conceptual model could be tested. The logistic regression model will only describe the direct causal relation between socio-demographics and hub use.

8.4.2. Re-coding data

Logistic regression independent variables need to be continues or binary. To make the clean data from section 8.2 viable for binary logistic regression some additional re-coding is needed.

Categorical variables

The categorical variables need to be re-coded into dummy variables. These are variables that only have the value 1 or 0. With dichotomous variables one of the categories is labelled 1 and the other 0, e.g gender is re-coded into male = 1, female = 0.

Categorical variables with more than two categories are re-coded by using a coding scheme like in table 8.5. This is the scheme used to re-code household type into dichotomous variables. The new variables have a value of 1 for each observation at that category and 0 in all others. The new variables are named after the category that is coded with 1. When re-coding to dummy variables there is always one less variable then there are categories. The remaining category (Partner and Children in the case of household type) is the reference, or base, category. This is the category all other categories are compared with.

Table 8.5: Coding scheme for household type

Household type	New variable (Alone)	New variable (With partner)
Alone	1	0
With Partner	0	1
Partner and Children	0	0

The 'Education' dummy variables gave a separation error when added to the model. To remedy this the variable was re-coded into a dichotomous variable. The two categories were high and low education levels, with HBO-bachelor and above re-classified as high. After the re-coding the variable produced no more errors.

Continues variables

36% of the respondents indicated that they did not want to share, or did not know, their gross household income. If these are excluded from the data set, the already small set shrinks even more. Therefore, income is re-coded to include these respondents.

The respondents could be included in multiple ways, e.g. coding them as the average value of income or add them to the category with the most respondents. This first option is usually used for normally distributed variables, however, income is not normally distributed. This is why they are added into the category with the most respondents, '>99,999'. This does result in a large increase in this category, making it 55% of the total, decreasing the predictive power of this variable. This is however preferable to excluding a large part of the data set.

The resulting income variable is re-coded further into a continues variable. Taking the class midpoint of each category as the new value (e.g. category €20,000-29,999 is re-coded as 25,000). For the group '>99,999' the value of 105,000 is used. The real midpoint could be higher, however the data set does not give any additional information.

Car ownership is also re-coded into a continues variable. The category '>2 cars' included only one respondent and is therefore combined with the '2 cars' category.

Table 8.6 shows the resulting variables and the number of users and non-users in each category. The continues variables are displayed as categorical for display purposes.

Table 8.6: Socio-demographics users and non-users

Variable	Value	Users		Non-users	
		N	%	N	%
Location	Buiksloterham	1	11.1%	7	20.0%
	De Werf	1	11.1%	0	0.0%
	Schoemaker plantage	6	66.7%	14	40.0%
	Bezuidenhout	0	0.0%	2	5.7%
	Scheepmakerskwartier	0	0.0%	7	20.0%
	Schildersbuurt	1	11.1%	5	14.3%
Gender	Male	6	66.7%	14	40.0%
	Female	3	33.3%	21	60.0%
Education	Low	1	11.1%	5	14.3%
	High	8	88.9%	30	85.7%
Household type	Alone	1	11.1%	3	8.6%
	With partner	3	33.3%	13	37.1%
	With partner and children	5	55.6%	19	54.3%
Drivers license	Yes	7	77.8%	32	91.4%
	No	2	22.2%	3	8.6%
Access to a car	Always	1	11.1%	16	45.7%
	In consultation with household	3	33.3%	16	45.7%
	In consultation outside household	1	11.1%	1	2.9%
	No access	4	44.4%	2	5.7%
Shared mobility use	Yes	6	66.7%	11	31.4%
	No	3	33.3%	24	68.6%
Age	<24	1	11.1%	1	2.9%
	25-34	3	33.3%	7	20.0%
	35-44	3	33.3%	11	31.4%
	45-54	2	22.2%	9	25.7%
	55-64	0	0.0%	7	20.0%
	>64	0	0.0%	0	0.0%
Gross household income (€)	< 19,999	0	0.0%	1	2.9%
	20,000-39,999	2	22.2%	3	8.6%
	40,000-59,999	2	22.2%	1	2.9%
	60,000-79,999	0	0.0%	2	5.7%
	80,000-99,999	1	11.1%	8	22.9%
	> 99,999	4	44.4%	20	57.1%
Household car ownership	0	5	55.6%	2	5.7%
	1	3	33.3%	25	71.4%
	2	1	0.0%	8	22.9%

8.4.3. Logistic model

This study is exploratory in nature, it is therefore interesting to describe the relations between all socio-demographic variables and hub use. The problems with power noted in section 8.4.1 also plead for addition of all variables. This means that non-significant variables are also included into the model. An additional effect is that all correlations between the variables are taken into account, resulting in more pure estimates.

To make sure the socio-demographic variables are 'independent' variables they are checked for multicollinearity. The test shows that all variables are indeed independent of each other, making it possible to add the variables in the model.

The model is build step by step by adding the socio-demographics to the model. This was done manually to check if the model was still producing realistic results. Two variables gave problems, 'education' and 'location'. Education was re-coded as described in section 8.4.2, solving that problem. 'Location' however could not be solved that way, re-coding did not solve the problem, it was therefore decided to exclude the variable from the model.

The resulting model gave extreme values for some variables. It was decided to try and avoid these extremes. This was done by first combining the dummy variables 'car access within the household' and 'car access outside the household' into the variable 'In consultation'. The model was run again including this new variable and the extreme values disappeared. No further exclusion of variables was therefore needed. The resulting model is shown in table 8.7.

Table 8.7: Logistic regression of socio-demographics on hub use

Variable	B	S.E.	Wald	Sig.
Constant	13.354	5.781	5.335	0.021
Gender:				
Male	0.836	1.610	0.269	0.604
(base = Female)				
Education:				
High	-3.605	2.546	2.005	0.157
(base = Low)				
Household type:				
Alone	-8.190	4.319	3.595	0.058
With Partner	-1.013	1.616	0.393	0.531
(base = Partner and Children)				
Has license:				
Yes	-0.403	2.166	0.035	0.668
(base = No)				
Car access:				
Always	-3.363	3.671	0.839	0.360
In consultation	-1.314	2.208	0.354	0.552
(base = No Access)				
Used shared mobility:				
Yes	2.695	1.600	2.837	0.092
(base = No)				
Age	-0.019	0.068	0.080	0.777
Income (x1,000)	-0.082	0.039	4.383	0.036
Car ownership	-3.717	2.271	2.677	0.102
Chi-square	25.170, df = 11, p = 0.009			
Nagelkerke pseudo r-square	0.684			
Hosmer and Lemeshow Test	1.986, df = 8, p = 0.981			
Classification accuracy	88,6%			

The table first shows the constant, the socio-demographics, divided in categorical and continues variables, and ends with the results of different tests at the bottom. When looking back at equation 8.2 the model can be mathematically expressed like this:

$$ln\left(\frac{P}{1-P}\right) = Constant + B * Gender + B * Education + ... + B * Carownership \tag{8.4}$$

The table shows the coefficients (B), their standard error (S.E.), the Wald statistic (Wald) and the p-value (Sig.).

The coefficient is the value with which the logit changes with an increase of the value of the variable. As said before, the higher the logit the higher the chance that a person uses the hub. A positive coefficient therefore increases the chance of someone using the hub when the variable increases,

and all other variables do not change. A negative coefficient decreases the chance when the variable increases, and all other variables do not change. How larger the coefficient, positive or negative, how stronger the influence of that variable on the chance of a person choosing the hub.

The coefficient and their S.E. are used to calculate the Wald statistic, which is used to determine if a coefficient is significant. A coefficient is significant within a 95% confidence interval if the p-value < 0.05. The Wald statistic is Chi-squared distributed with 1 degree of freedom, meaning that the coefficient is significant if the Wald statistic is larger than 3.84.

8.4.4. Interpretation

The logistic regression analysis shows the effects of the different socio-demographic variables on hub use, corrected for the other socio-demographic variables. Because of the low number of respondents and the resulting insignificant variables, no conclusions can be made about the population. However, the data does show interesting possible relations.

Before interpreting the coefficients of the variables, the model itself is discussed by using the results of the different tests noted at the bottom of table 8.7. First, the chi-square test tests if the model is an improvement compared to the baseline model without independent variables (see appendix F for further information about the chi-square test). A significant different model explains more of the variance compared to the baseline model. This is the case for this model as p = .009, which is smaller than the 0.05 limit.

Second, the Nagelkerke pseudo r-square is noted. It indicates if the model is a good fit, the higher the number (between 0 and 1), the better the model fit. This r-square value does not show how much variation in the outcome is explained by the model like the r-square in linear regression analysis. This value is only an approximation and should be treated that way. This means that this model fits approximately 68%.

Third, the Hosmer and Lemeshow test tests if the data fits the model. When the test is significant the data does not fit the model. In this case the data does fit the model as p = 0.981, which is much higher than the 0.05 limit.

Finally, the classification accuracy shows what percentage of cases is classified correctly by the model. This model classifies 88,6% of the data correct. The baseline model classifies 80% correctly, making the addition of the independent variables an improvement.

Looking at the variables, it is important to notice that most variables are not significant. This is probably due to the low number of users. The EPV of this model is 0.82 (11 variables and 9 users), this is much lower than the advised EPV of 10. This means that the values in the model should be carefully evaluated before drawing conclusions.

The constant in the model is the logit value if all independent variables are zero. This does not tell much as a baby with a age of zero will never use the hub. Important to note with the categorical independent variables is that the values are always compared to the base category (e.g. living alone decreases the logit with 8.190 compared to living with partner and children). The coefficient of the continues variables changes with each increase of decrease of the value (e.g. increase car ownership with one car, the logit will decrease with 3.717)

When looking at the signs of the variables, two variables have different signs than expected from the results of the literature study, expert interviews and focus groups: education and household type.

The experts think that high education would have a positive effect on hub use, the literature study also shows that shared mobility and MaaS is used by people with a higher education. However, the logistic regression shows that, when corrected for the other variables, education has a negative relation with hub use.

The regression model shows that households with families with children are more likely to use the hub, when corrected for the other variables. This does not match the results of the focus groups and additional information gathered during the survey distribution. The focus groups mentioned that car seats for children decrease the attractiveness of the hub. This is supported by the additional information gathered during the door-to-door survey distribution. Multiple respondents indicated that they did not use the hub because they had small children. The reason being that they had to carry all accessories in and out of the car, instead of leaving them in their own car.

Education and household type are individually checked by running a regression model with them

being the only independent variable in the analysis. With education as only variables the sign is indeed positive. This is also true for household type, households with families have a negative coefficient, compared to households with only a partner. The addition of the other variables switches the sign. The other variables are thus explaining the same variance as education and household type.

To better understand how the variables influence hub use, a small example is presented in table 8.8. The table shows three hypothetical persons, person 1 is the base from which person 2 and 3 differ in one variable. Person 2 is the female version of person 1, while person 3 is person 1 who owns one car.

Table 8.8: Example of the effect of the logit on the probability of hub use

Variable	:	Person 1	Value	:	Person 2	Value	:	Person 3	Value
Constant	:	-	13.354	:	-	13.354	:	-	13.354
Gender	:	Male	0.836	:	**Female**	0	:	Male	0.836
Education	:	Low	0	:	Low	0	:	Low	0
Household type	:	Alone	-8.190	:	Alone	-8.190	:	Alone	-8.190
Has License	:	Yes	-0.403	:	Yes	-0.403	:	Yes	-0.403
Car access	:	In consideration	-1.314	:	In consideration	-1.314	:	In consideration	-1.314
Used shared mobility	:	No	0	:	No	0	:	No	0
Age	:	25	-0.482	:	25	-0.482	:	25	-0.482
Income (€)	:	20,000	-1.649	:	20,000	-1.649	:	20,000	-1.649
Car ownership	:	0 cars	0	:	0 cars	0	:	**1 car**	-3.717
Total logit	:		2.152	:		1.317	:		-1.565
Chance uses hub	:		89.6%	:		78.9%	:		17.3%

The reason for choosing to change the gender and the car ownership is based on their coefficient value. The value of gender is relatively low with 0.836, while the value of car ownership is relatively high with -3.717. Changing these two variables shows the effect of the different coefficient values.

The table shows for each variable the logit value, the total logit value of the person and the chance that the person uses the hub. With a total logit of 2.152, there is a 89.6% chance that person 1 uses the hub. Being a female decreases the total logit with 0.836, leading to a chance of 78.9% that person 2 uses the hub.

Person 3 owns a car and therefore the total logit would decrease with 3.717 compared to person 1. This leads to a chance of 17.3% that person 3 uses the hub. This small example shows that gender is not that influential for hub use, while car ownership is very influential.

The model makes it also possible to find the profiles of the most and least likely hub users. Table 8.9 shows the values of the socio-demographic variables for these extremes. The user has a chance of >99.9% of using the hub, while the non-user has a chance close to 0.00%. Multiple variables have to be changed before persons with these profiles switch to the other side.

Table 8.9: Socio-demographic variables of the hub user and non-user

Variable	:	Most likely hub user	Least likely hub user
Gender	:	Male	Female
Education	:	Low	High
Household type	:	Partner and Children	Alone
Has License	:	No	Yes
Car access	:	No Access	Always
Used shared mobility	:	Yes	No
Age	:	Young	Old
Income	:	Low	High
Car ownership	:	0 cars	>2 cars

It is possible to compare part of the results with the data found by (Knippenberg, 2019), see appendix G. It shows that the results from the regression model are comparable with the results of the (much

larger) data set used by (Knippenberg, 2019). Both find that young males with a lower income are more likely to us the hub. He did found some differences in household type and car ownership, his data showed that living with partner is the most important household type for hub use. He also found that users own on average slightly more cars. This means that these two variables could be less strong then the model indicates. He did not measure the other socio-demographics used in this study, they could therefore not be compared.

If municipalities want to influence hub use the strength of the variable is only part of the equation. The measure in which the variable can be influenced is also important. Variables that are relatively easily influenced and have a relatively high influence on the chance of hub use, can be used to steer hub use. To increase neighbourhood hub use the most important variables coming from the data are car ownership, car access and former shared mobility use. Policies decreasing car ownership or access to a car, can greatly influence the chance of hub use. The same is true for policies increasing shared mobility use outside the hub.

The second most important variables are household type, education and income. These variables have a relatively high influence on the chance of people using the hub. However, they are not easily influenced by policies. The results indicate that it is probably not a good idea to place a hub in a neighbourhood where the majority of residents is highly educated, have a high income or live alone.

The other variables (gender, license and age) have practically no influence on the choice for hub use, compared to the other variables. The values for gender and age are in line with the results found during the literature review and expert interviews. Gender has no not much influence, and the older a person the less likely it is that he or she uses the hub.

8.5. Perception data comparison

In this section each of the perception attributes will be compared between the users and non-users. This comparison is used to find if perceptions influence hub use. The low number of users among the respondents combined with the high number of perceptions makes it impossible to do in-depth statistical tests in SPSS (e.g. the software gave errors or non logical results when a binary regression analysis is performed). It is possible to perform independent t-tests for each separate perception. This test is used to compare the mean value of user and non-user groups for each perception. (See appendix F for additional information).

The survey measured the respondents current perception on different attributes of the hub, as well as their perception about certain context variables. These two type of questions differ because the measurement scale is different. Both are measured on a 5-point Likert-scale, however the labels for the scales were different (One ranged from very negative to very positive, the other from totally disagree to totally agree). To avoid confusion the two groups are displayed separately.

8.5.1. Results of the independent t-tests

Table 8.10 shows for each perception the mean value of the sample, of the users and of the non-users. It further shows the results of the independent t-tests, displaying the differences between the user and non-user groups, and if the differences are significant. 45 respondents filled in their perceptions, as noted in section 8.2.1. However, seven of the respondents do not own a car, they are therefore removed from the car parking pressure perception.

The perceptions are sorted by the average mean value of the perception, from highest to lowest. A high perception means that the attribute is perceived positively, giving an indication how well the Hely hub is designed.

The results show that, on average, respondents perceive the different attributes of the hub neutral to positive. This indicates that the hub is designed quite well especially distance to the hub is perceived positive, indicating that the catchment area with the range of 400 metre is not too large.
When looking at the differences between users and non-users it is clear that users are on average more positive about the hub attributes. The largest differences can be found in 'user attributes', attributes only users really encounter (e.g. ease of use). The data does not make clear if hub use improves the perception, or that a better perception improves hub use. However, the largest differences are found

Table 8.10: Perception results independent sample t-tests

Perception	Mean			Std. Deviation		Difference	T	p(2-sided)
	Average	User	Non-user	User	Non-user			
Distance to the hub	4.62	5.00	4.53	0.00	0.77	0.472	3.660	0.001*
Diversity in vehicles	4.04	4.44	3.94	0.73	0.86	0.500	1.603	0.116
Sustainability of the hub	3.91	4.22	3.83	0.83	0.81	0.389	1.281	0.207
Availability of vehicles	3.78	4.33	3.64	0.71	0.83	0.694	2.297	0.027*
Sustainability of the vehicles	3.78	4.44	3.61	0.73	0.77	0.833	2.946	0.005*
Visibility of the hub	3.73	4.44	3.56	0.73	0.84	0.889	2.899	0.006*
State of the hub	3.71	4.78	3.44	0.44	0.69	1.333	7.126	0.000*
Hub costs	3.67	4.33	3.50	1.00	0.97	0.833	2.290	0.027*
Ease of use	3.67	4.56	3.44	0.73	0.65	1.111	4.472	0.000*
Safety of the hub	3.62	4.67	3.36	0.70	0.54	1.306	6.074	0.000*
Safety of the vehicles	3.60	4.56	3.36	0.73	0.59	1.194	5.170	0.000*
State of the vehicles	3.51	4.22	3.33	0.97	0.59	0.888	2.627	0.026*
Vehicle Costs	3.42	4.00	3.28	0.50	0.78	0.772	3.419	0.003*
Round-trip	3.07	3.55	2.94	1.13	0.71	0.611	1.546	0.154
Other services	3.87	4.22	3.77	1.39	1.10	0.444	1.029	0.309
Creating free space	2.87	3.33	2.75	1.11	1.08	0.583	1.441	0.157
Parking pressure car[1]	2.27	2.60	2.21	2.19	1.13	0.381	0.381	0.721
Parking pressure other vehicles	1.63	1.88	1.57	1.26	0.74	0.304	0.613	0.557

*. Correlation is significant at the 0.05 level (2-tailed)

[1]: N=38 due to removing of respondents without car

in attributes of which non-users have limited knowledge (e.g. state of the hub). This indicates that perception changes with hub use. The fact that the round-trip nature is perceived the most negative indicates that a point-to-point hub network would be an improvement. This matches the results of the focus groups, who also preferred a point-to-point hub network.

The context variables show that the respondents, on average, do not experience parking pressure. Between the two groups differences are minimal, this makes sense as they live in the same neighbourhood. It also means that parking pressure does not seem to be the reason to use the hub.

The respondents, on average, see services like a pick-up-point as added value to the hub. They do not think that the hub is creating free space in their neighbourhood due to a decrease of car ownership. The two groups do not significantly differ in their opinions.

8.6. Travel behaviour changes

Two of the main travel behaviour changes the hub aims to achieve is a decrease in car trips and car ownership. With the goal of reducing congestion and emissions and free up public space. Therefore, mode choice changes and car ownership changes were measured in the survey. The survey measured two types of changes, actual changes made by users and potential changes by non-users. To measure the potential changes non-users were asked if and how the hub could potentially change their behaviour. This makes it possible to find actual changes and potential changes. First, the mode choice changes are discussed, followed by the car ownership changes.

8.6.1. Mode choice changes

To ascertain the mode choice changes due to the hub users were asked how they travelled before and after the hub was opened. Non-users were asked if they ever thought about using the hub, and if so, how they would use it. This was asked for each of the four main trip motives found in section 2.4 (commuter trips, groceries, sport/hobby and visits).

Table 8.11 shows for what kind of trips users use, and non-users think about using the hub. It shows the percentage of respondents that use the hub for a certain trip motive (i.e. 33% of the users use the hub for commuter trips) The majority of non-users (67%) never thought about using the hub, leading to relative low percentages.

When adding the numbers of substituted trips per trip motive a total of 20 trips are made by users.

Table 8.11: Hub use per trip motive

	N	Commuter	Groceries	Sport/hobby	Visits
User	9	33%	67%	33%	89%
Non-user	36	19%	22%	22%	31%

Non-users thought about using the hub 34 times in total. Without the hub these trips were made with private car, private (e-)bike, on foot and by train. Table 8.12 shows the mode change caused by the hub. The table shows for users and non-users how with what hub mode they substitute their private modes, e.g. 80% of the users that replace a car trip substitute private car with a gas powered car from the hub.

Table 8.12: Mode choice change for users and non-users

	Private modes		Hub modes			
		N	Car	e-Car	(e-)Bike	e-Cargo bike
Users	Private car	5	80%	20%	0%	0%
	Private (e-)bike	9	33%	11%	33%	22%
	Train	6	83%	17%	0%	0%
Non-Users	Private car	14	21%	57%	7%	14%
	On foot	1	0%	100%	0%	0%
	Private (e-)bike	17	6%	29%	59%	6%
	Train	2	0%	50%	50%	0%

The data about hub use shows that the hub is mainly used for visits, followed by doing groceries. The hub is thus mainly used for incidental trips. This corresponds with the findings from the focus groups and expert interviews. If the non-users think about using the hub, it is also mainly for visits. For both users and non-users commuter trips are least undertaken via the hub. This is also a conformation from the results of the expert interviews and focus groups.

When looking at the mode change, table 8.12 shows that the hub does not decrease the number of car trips made by the users. Bike and train trips are replaced with car trips, while private car trips are replaced by car trips via the hub. Before the hub was opened 25% of the trips replaced by the hub were car trips, now 75% of the trips are car trips. One of the goals of the hub, decreasing the number of car trips, is therefore not met.

Similar results are found with the non-users, the number of car trips is increased due to replacement of bike and train trips, from 41% to 56%. The non-users do think about using (e-)bike and e-cargo bike instead of private car, this is however only the case with 21% of the car trips.

8.6.2. Car ownership changes

Hub influence on car ownership was measured in two ways. Actual car ownership and potential car ownership changes due to the hub were measured. Car ownership changes can be divided in three categories: decreasing the number of owned cars, change nothing and increasing the number of owned cars. None of the respondents increased the number of owned cars, leaving two categories.

Decreasing the number of owned car can be achieved by selling a car or not buying a extra car. This distinction is also made because the focus groups think that a hub is more likely to dissuade the purchase of cars then promote the selling of cars. The experts and focus groups also expect that sold cars would be mainly a second or third car. This is supported by the data, as no first cars were sold.

Changing nothing can be split up in not selling a car or having no cars and not buying one. This distinction is made to avoid households without cars falling in the 'did not sell' category, while they have no cars to sell.

Tables 8.13 and 8.14 show actual changes and potential change respectively. The respondents who actual changed their car ownership are excluded from the 'Potential for change' table, as they already changed their car ownership. It is possible that respondents are in doubt about car ownership changes, i.e. they're not yet seriously considering car ownership change but they are thinking about the effect of the hub on their car ownership. These respondents are categorised in the 'In doubt' category.

Table 8.13: Changes in car ownership

	N	Sold a car	Did not purchase a car	Did not sell a car	Did not have a car and still does not have a car
Users	9	22%	11%	33%	33%
Non-users	36	3%	3%	86%	8%
Total	45	7%	4%	76%	13%

Table 8.14: Potential for change in car ownership

	N	Thinking about selling a car	Thinking about not purchasing a car	Did not think about selling a car	Did not have a car and still does not have a car	In doubt
Users	6	17%	17%	0%	50%	17%
Non-users	34	3%	3%	74%	9%	12%
Total	40	5%	5%	65%	13%	13%

The hub has an effect on the car ownership of the neighbourhood, both on the users and the non-users. The most interesting may be the fact that 6% of the non-users are selling or not purchasing extra cars due to the hub. While the motivation is not known, it may be because they have they have the hub to fall back on if the need arises. The hub can be accessed quite fast by non-users, making it quite a reliable back-up.

Users also changed their car ownership, in total 33% of the users sold or did not purchase a car. In total 11% of the respondents sold or did not purchase a car. This means, in absolute numbers, that the hub reduced the number of cars in the neighbourhood by five. If they all used public parking spaces with standard dimensions (2x6 metres), a total of 60m^2 is freed up by the hub. However, many of the households in this study have a private parking space, on private land. The actual freed up space is therefore lower.

The potential for car ownership changes is quite large, of the remaining hub users none are not thinking about selling a car. This means that the hub is really motivating users to decrease the number of owned cars. In total 10% of the respondents, that did not change their car ownership, are thinking about decreasing their car ownership.

Overall 20% of the respondents have changed, or are thinking about changing, their car ownership. The hub is thus leading to a decrease in car ownership. It is also good to note that the hub does not lead to an increase of car ownership, as some of the experts were worried about.

8.7. Conclusions

The goal of the analyses of the survey data is to answer sub-questions 2, 3 and 4. This goal is partly achieved, as limited data made it impossible to test all causal relations from the conceptual model. The results are further compared with the theoretical answers found in literature and during the interviews and the focus groups results.

The survey resulted in 44 fully completed data sets, 9 user sets and 35 non-user sets. Because of the limited number of respondents and the skewed distribution between users and non-users, not all

test prerequisites are met. This decreases the power of the tests, which can result in tests incorrectly showing no significance relation within the population. This may lead to the conclusion that a relation found in the sample can not be generalised to the population, while this relation in fact does exist in the population. If statistical differences are found the differences are large and the connections are strong.

The low number of respondents is partly due to the limited knowledge of the residents about the existence of the hub in their neighbourhoods. On average only 63% of the residents knew that the hub was located in their neighbourhood. There are however large differences between locations, ranging from 18% to 76%.

A binary logistic regression model is estimated for the socio-demographic variables, the model variables were not statistically significant. The model finds that living alone compared to living with a partner or with partner and children drastically reduces the chance of hub use. Having a high level of education and access to a car reduces the chance of hub use even further. Increasing income and the number of owned cars also reduces the chance of hub use. Having used shared mobility outside the hub increases the chance of hub use. Age, gender and having a car license have limited influence on hub use.

From the perspective of the municipality car access, car ownership and shared mobility use are the most important variables. These variables can be influenced by the municipality and have a relatively large effect on the chance of hub use. Restricting car access or ownership with policy measures can greatly increase the chance of hub use. The same is true for former shared mobility use, introducing persons to shared mobility increases their chance of using the hub.

Users in the sample have on average a more positive perception of the hub attributes compared to the non-users. Eleven of the perceptions are significantly different between the user and non-user groups, this means that hub users have a better perception of the attributes. The data does not indicate if the hub use improves the perception, or that a better perception improves the hub use.

Another important conclusion is that the neighbourhoods in which the hubs are located have no problems with parking space. Both users and non-users, on average, do not experience parking pressure. Hub users experience a slightly higher parking pressure, however this is not significantly different with non-users. Parking pressure is not the main reason of using the hub.

When considering travel behaviour changes the most important conclusion is that the hub decreases car ownership but increases the number of car trips. The hub led 33% of the users, and surprisingly 6% of the non-users, to sell or not buy an (extra) car. In total 11% of the respondents indicated that they had actually decreased their car ownership.

When looking at the potential for car ownership change, the most important conclusion is that almost all hub-users at least think about decreasing their car ownership. Not surprisingly, the percentage of non-users who are thinking about changing their car ownership is smaller. In total 20% of the respondents have decreased, or are thinking about decreasing, their car ownership. It is important to note that none of the respondents think about increasing their car ownership.

The hub leads to more car trips because the hub substitutes bike and train trips with car trips. The number of car trips made by users increased from 25% before the hub opened, to 75% now. The non-users who thought about using the hub also increase their number of car trips, from 41% to 56%.

This increase in trips leads to higher emissions due to car traffic, as most car trips via the hub are made with the gas powered cars (80%). The number of trips made with e-cars does not compensate the increase in the total number of car trips. The non-users see themselves using the e-cars more often, only 12% of their total trips would be made by gas powered car, compared to 41% without the hub. If the non-users would actually use the hub as they think they would, local emissions due to the car would be decreased

Finally, the hub is mostly used for incidental trips like visits and doing groceries. 89% of the users use the hub for visits, and 67% for groceries. The hub is least used for commuter trips, with 33% of the users. Non-users think about using the hub in the same pattern, with the emphasis on visits. However, the majority of the non-users (67%) do not think about using the hub at all.

9

Conclusions

This chapter concludes the study. Section 9.1 provides the main conclusions, followed by the implications in section 9.2. The limitations of the study are discussed in section 9.3 and finally suggestions for further research are provided in section 9.4.

9.1. Conclusions

The objective of this research was to describe the potential neighbourhood mobility hub user, explore their perceptions of the hub and find how the hub influences their travel behaviour. This objective is expressed by the main research question this study answers:

How do potential users perceive a neighbourhood mobility hub and what effect does the hub have on their travel behaviour?

To answer the main research question four sub-questions are answered. What defines a neighbourhood mobility hub, who are the potential hub users, how do they perceive the hub and how is their travel behaviour influenced by the hub? Four successive approaches are used to answer these questions: literature research, expert interviews, focus groups and a survey with statistical data analysis.

The literature research and experts interviews are used to define the hub and describe the theoretical potential hub user and travel behaviour changes. Two focus groups consisting of the theoretical hub users are held to confirm if they are indeed the potential users. They further shine light on which of the theoretical travel behaviour effects are likely to occur. They will also give a indication of how the hub is perceived.

The preliminary results from the literature research, expert interviews and focus groups are use to design a survey measuring actual perceptions, travel behaviour effects and perceptions. The resulting data set, comprised of answers of 44 respondents, is statistically analysed to find definitive answers to the sub-questions.

9.1.1. Definition of a neighbourhood mobility hub

A neighbourhood mobility hub is defined by its attributes and goals. This means that there is no fixed definition of the neighbourhood mobility hub. A hub should be tailored to the neighbourhood, taking into account the wishes and demands of the residents and the goal it aims to achieve.

All neighbourhood mobility hubs have two universal aspects. They are a central point in the neighbourhood and offer shared mobility. This base can be expanded upon by defining the following fourteen important design attributes: Diversity, availability, ease of use, visibility, safety of the hub and vehicles, state of the hub and vehicles, distance to the hub, costs of the hub and vehicle, sustainability of the hub and vehicles and if the hub is part of a network. Which and how these attributes should be implemented depends on the neighbourhood, its residents and the goal of the hub.

The goal of the hub depends on the actor. There are five important actors when discussing hubs: Municipalities, hub owners, shared mobility owners, neighbourhood residents and housing developers. Each of the actors has a different goal for the hub. Municipalities want to decrease local emissions, congestion and car ownership. Hub owners and shared mobility owners have a similar goal: a profitable hub. Neighbourhood residents want easy and accessible transportation, with or without the hub. Finally, housing developers main goal for the hub is decreasing car ownership, increasing the available building space.

This study is performed with the municipality goals in mind. This led to the following definition used in this study: A neighbourhood mobility hub is a central point in the neighbourhood where shared mobility is offered, with the goal of decreasing local emissions, congestion and car ownership.

9.1.2. The potential hub user

The theoretical hub user is mainly motivated by parking pressure in their neighbourhood, as this makes the use of a private car cumbersome. They live therefore in cities with high parking pressure. Socio-demographic factors are less important, in general the early adopters will be young people with a sustainable mindset and experience with shared mobility. They also have to have a certain disposable income to be able to afford the hub.

The focus groups contested the theoretical picture painted by the experts. The participants of the focus groups did not fully recognise themselves as potential hub users. Their main argument is that hubs in cities have no added value as services offered by the hub are already located in the city. They see the hub more as an extension of the public transport network. Their hub user lives at the edge of the (cities) public transport network.

The focus groups do agree that parking pressure would motivate people to use the hub. They also agree with the experts that young people are more likely to use the hub, adding that the hub could provide car access to persons without a car.

The survey among residents of neighbourhoods with a hub revealed that on average only 63% of the neighbourhood knew about the hubs existence, with large differences between neighbourhoods. From the persons that knew about the hub, 20% used the hub. The user and non-user groups are compared to find the variables influencing hub use.

An important first conclusion is that both users and non-users who filled in the survey did not experience parking pressure in their neighbourhood. Parking pressure has therefore no influence on hub use in the surveyed neighbourhoods.

A binary logistic regression model is estimated to find how socio-demographic variables influence the chance of hub use. All socio-demographics are taken into account, giving the effect of the variable in relation to all the other variables. The model finds that living with a family, with or without children, could drastically increase the chance of hub use, compared to living alone. This contradicts the results of the focus groups and additional information gathered while distributing the surveys. The focus groups and some of the survey respondents indicated that they were less likely to use because they had small children. The reason being that they have to carry all accessories in and out of the shared car.

Having a low level of education and limited access to a car could increase the chance of hub use even further, while a higher income reduces the chance of hub use. Having used shared mobility outside the hub could also increase the chance of hub use. Age, gender and having a car license could have limited influence on hub use. With increasing age, people are slightly less likely to use the hub. Females and people who have a drivers license could also be less likely to use the hub.

The most likely hub user found by the model can be described as a young male with a low education and income, living with partner and children. He has used shared mobility before and does not own, or have access to, a car.

While the data analysis does not point directly at parking pressure as a motivation for hub use, indirectly it could be of influence. Parking pressure could influence the number of owned cars and car access, which have a large influence on the chance of hub use. Increasing parking pressure could decrease the number of owned cars or the ease of car access, which leads to an increased chance of hub use.

In conclusion, the result of the regression model reflects the theoretical hub user found during the expert interviews and focus groups. There is no fixed type of hub user. However, relatively young households with restricted car access and experience with shared mobility are more likely to use the hub. While the data analysis did not find a direct influence of car parking pressure on the chance of hub use, it could play an indirect role.

9.1.3. Perceptions of the hub

The search for a definition of the neighbourhood mobility hub resulted in a list of fourteen important neighbourhood mobility hub attributes. These were confirmed as being the most important attributes during the focus groups. The survey measured for each of these attributes the perception of the neighbourhood residents.

The analysis of the perception data led to an ordered list of best perceived attributes. In order from highest perceived attribute to lowest: Distance to the hub, diversity in vehicles, sustainability of vehicles, availability of vehicles, sustainability of the vehicles, visibility of the hub, state of the hub, hub costs, ease of use, safety of the hub, safety of the vehicles, state of the vehicles, vehicle costs and finally round-trip nature of the hub.

The hub is perceived, on average, positive among the the average neighbourhood resident, with hub users having a more positive perception compared to non-users. Users are positive to very positive about the hub, while non-users are more neutral to positive. The literature research into travel behaviour effects found that perceptions could influence the interaction with the service (Ma & Cao, 2019). The largest differences in perception are found in those attributes of which non-users have limited knowledge (e.g. state of the hub, safety of the hub). This could indicate that the perception of these attributes became more positive due to hub use. However, based on the data found in this study does not definitively show if a more positive perception leads to an increased chance of hub use, or that hub use leads to a more positive perception. It does show that they are related.

None of the attributes are perceived negatively, both by users and non-users, with the lowest score being a neutral perception for the round-trip nature of the hub. The fact that the round-trip nature is perceived the most negative indicates that a point-to-point hub network would be an improvement. This matches the focus groups, who also prefer a point-to-point hub network.

Another attribute that stand out is the distance to the hub. Experts used a range of 300 to 500 metres for the catchment area of the hub. Distance to the hub is the highest scoring perception, which all user perceive very positive. The exact location of the respondents house to the hub is not known, therefore no ideal distance can be calculated. All respondents do live in a range of maximum 400 metres from the hub. This confirms the range of 300 to 500 metres as named by the experts.

The focus groups indicated that the maximum distance to the hub dependent on the total trip distance and the hub mode used. This could not be confirmed by the data, as all users scored distance the same, making the comparison between modes or trip motive not possible.

Besides the fourteen hub attributes, four context variables were identified: The addition of other services, the creating of free space in the neighbourhood due to a lower number of owned cars, car parking pressure and parking pressure with other vehicles. The perception of these four context variables is not different between users and non-users in the sample. Both think that adding other services is a good idea, while they do not perceive the creation of free space or parking pressure in their neighbourhood.

This means that adding other services to the hub is a good strategy. Especially because the experts and focus groups note that it will probably attract non-users to the hub. The experts believe that this increases the chance that a resident will try the hub.

The low parking pressure perception was already discussed in section 9.1.2. The low perception of free space created due to a decrease in car ownership is not that strange. The small size of the hub and the limited number of users limits the number effect on car ownership. Another reason is the fact that a large part of the surveyed households have private parking spaces.

In conclusion, the hubs are perceived relatively positive, there is however room for improvement. Hubs should be designed to improve the perceptions that are not scoring to high. Increasing perceptions of non-users will be hard, however starting with adding external services is a good first step.

9.1.4. Travel behaviour changes due to the hub

The hub aims to change two types of travel behaviour, the number of car trips and the number of privately owned cars. These changes should lead to the municipalities' goals of decreasing local emissions and congestion, and freeing up public space.

The most important conclusion from the data analysis is that the hub decreases car ownership but increases the number of car trips. This is comparable with the effects of shared mobility found in the literature study. This also means that the hub meets only one of the two goals.

Because of the hub, 33% of the users sold or did not buy an (extra) car. More surprisingly, 6% of the non-users sold their car or did not buy an (extra) car as well. In total 11% of the respondents indicated that they had actually decreased their car ownership. When looking at the potential for car ownership change, the most important conclusion is that almost all hub-users at least think about decreasing their car ownership. Not surprisingly, the percentage of non-users who are thinking about changing their car ownership is smaller. In total 20% of the respondents have decreased, or are thinking about decreasing, their car ownership.

The effect of the hub on car ownership is in line with the expectations of the experts. The hub replaces second or third cars, as expected by the experts, none of the car changes concerned first cars. The focus groups indicated that it would be hard to get people to sell their car, they suggested that prevention of car ownership would be more successful. This is supported by literature on the endowment effect (Marzilli Ericson & Fuster, 2014). The data analysis shows however that this is not the case in the sample, as the decrease in car ownership came mainly from people selling their car (60%). However, because of the small sample this is only a difference of one person, so no conclusive conclusions can be made.

The hub leads to more car trips because the hub substitutes bike and train trips with car trips. 75% of the trips users undertake via the hub is a car trip. Before the hub opened only 25% of these trips were made by car. The non-users thought about using the hub mainly for car trips as well. Increasing their number of car trips from 41% to 56%. This confirms the results of the focus groups. They indicated that the hub could be used as a more flexible alternative for public transport. Making it easier for people with limited car access to use the car instead of the bike or public transport.

The experts expected more positive results. They expected that the hub could motivate users to switch from car to bike, as both are offered at the same hub. The data does not show this effect, the e-bikes offered by the hub mainly replace the private bike. They especially had high hopes for the e-cargo bike as a replacement of grocery trips by car. The data shows this to be not the case. These results match the findings from Knippenberg (2019), who also finds that car is the most used mode and concludes that multimodality is not the motive to use the hub.

Experts and the focus groups think that a hub with e-cars could motivate users to try the e-car, decreasing local emissions. This assumption is partly confirmed, 20% of the car trips are replaced by e-car trips. However, the total number of gas powered car trips is increased due to the replacement of bike and train trips. There is a potential for a shift to e-cars, non-users mainly think about using the e-cars. It is however uncertain if they, when push comes to shove, really will use the (relative expensive) e-car.

At the moment, the hub does not decrease local emissions. The number of trips made with e-cars does not compensate the increase in the total number of car trips. The non-users will potentially decrease their emissions. Only 12% of their trips would be made by a gas powered car, compared to 41% without the hub. If the non-users would actually use the hub as they think they would, local emissions would decrease.

Finally, the hub is mostly used for incidental trips like visits and doing groceries. 89% of the users use the hub for visits, and 67% for groceries. The hub is least used for commuter trips, with 33% of the users. Non-users think about using the hub in the same pattern, with the emphasis on visits. However, the majority of the non-users (67%) do not think about using the hub at all. These results match the expectation of the experts that the hub would mainly replace incidental trips.

In conclusion, the hub is likely to decrease car ownership and increase the number of car trips. There is a potential for a decrease in car ownership, this is however dependent on the use of other modes

than car. Increasing the use of these other modes is probably difficult, as people are used to the car. Changing these habits takes time, a longer time than the year the hubs are in operation.

9.2. Policy implications

The conclusions of the study shine some light on possible policy implications. Municipalities have the three goals mentioned before: decreasing local emissions, congestion and private car ownership. To meet these goals they have a few policy options to steer the implementation and effectiveness of the neighbourhood hub.

Most important is that the hubs increase the number of car trips and decrease the number of owned car. Introducing hubs as is done now is therefore not the ideal situation. The hub should promote alternative modes to car to decrease the number of car trips. A good example is the use of the e-cargo bike, it is seen as a good alternative for the car for doing groceries and sport/hobby trips with the kids. The focus groups did see use for the e-cargo bike for these trips, while this was not the case in the surveyed neighbourhoods. By pointing users on the options and possible uses of the alternative modes they may switch mode.

From the perspective of the municipality car access, car ownership and shared mobility use are the most important socio-demographic variables. These variables can be influenced by the municipality and could have a relatively large effect on the chance of hub use. Restricting car access or ownership with policy measures could greatly increase the chance that someone uses the hub. The same is true for former shared mobility use. Introducing residents with shared mobility (e.g. by offering a free trial period to the hub), could increase the chance of them keeping using the hub after the trial period.

Equally important but not as easily influenced by municipalities are the household type, education and income of neighbourhoods. If hub use is the goal it is important that the hub is placed strategically. It is probably not a good idea to place a hub in a neighbourhood where the majority of residents is highly educated, have a high income or live alone. While these factors do not exclude someone from using the hub, they do decrease the chance of hub use quite severe.

The focus groups and survey data both showed that basic knowledge about neighbourhood hubs is not widely spread. Increasing the awareness of the hub is a good first step to increase hub use. This could be combined with the promoting of non-car modes, with the goal of preventing that car trips are replaces with car trips via the hub.

The hub increases the number of car trips. Most of these trips are made with gas powered cars, increasing local emissions. To combat this municipalities should demand hubs to offer only e-cars. However, this could have a negative effect on hub use, as e-cars are more expensive to use at this time.

Experts, focus groups and the data analysis all indicate that the hub will probably never replace the first car. It is important to understand that the hub is no golden ticket. To really reduce car ownership and especially car trips, neighbourhood mobility hubs should be part of a greater mobility plan. If implemented well neighbourhood mobility hubs could certainly play their part.

A combination of the above listed policy measures is needed for the municipalities to reach both goals. While car ownership is decreasing without any extra policy measures, reducing the number of car trips requires extra measures. Depending on the focus of the municipality, different combinations are possible.

9.3. Limitations

This study contains multiple limitations, both related to the methods used as in the results found during the study. All methods have their limitations, as noted in their respective chapters. The biggest limitation of this study is however the limited number of respondents who filled in the survey.

Only nine users and 36 non-users filled in the survey. This leads to problems with the statistical tests, reducing their power. This could lead the test to incorrectly showing no significant relation within the

population. This leads to the wrong conclusion that the relation does not exist in the population. Specifically, for the logistic regression analysis the coefficients could be biased.

The low number of respondents leads to problems with complete and quasi-completed separated data. This leads to the inability to find a maximum likelihood estimate. Because of this location could not be taken into account with the logistic regression. This also resulted in the need to combine certain variable categories, losing information in the process.

The limited number of respondents also made it impossible to test all the relations hypothesised in the conceptual model. Only the relation between the socio-demographic variables and hub use could be tested.

Another limitation of the survey was the limited knowledge about the hub. Most non-users never thought about the hub, and had limited knowledge about its workings and attributes. They did not have a clear picture of the hub attributes, leading relatively often to a neutral perception. The difference between truly perceiving the attribute as neutral or not knowing anything about the attribute is lost.

Another limitation of the research is the limited number of focus groups. The number of willing participants was low, this resulted in only one focus group with non-students. This group also did not include the most interesting participants, as most did not own a car. This could have been a limiting factor on the possible effects, however most relevant effects were probably still found.

Another limitation of the focus groups were the participants. They were chosen because the expert groups saw them as the potential hub users, while they did not see themselves as potential hub users. Focus groups among residents in a neighbourhood with a hub could have given more insight in what drives hub users.

Only residents with knowledge about the hub were surveyed, while all residents of a neighbourhood with a hub can be seen as potential users. This was a deliberate choice as residents without knowledge about the hub are less likely to have an opinion on the hub. This does however exclude a part of the potential user group.

How non-users think about using the hub is used to say something about the potential effects of the hub. This is not the most reliable way to find the potential effects. Potential travel behaviour changes are better measured with a stated preference experiment. However, knowledge among the non-users may not be enough to make the decisions needed in a stated preference experiment.

9.4. Suggestions for further research

This study is the first step in understanding neighbourhood mobility hubs, their users and their effects. The results give an insight into the possible user characteristics, and effects of the hub. However, the limited number of respondents in the survey limit the results. Reaching generalised conclusions is not possible.

It is therefore important to repeat the survey and data analysis part of this study. A wider distributed survey with more respondents should be used to find if the results found in this study hold. It takes time for a new service, like the hub, to attract users. Finding enough users by going door-to-door is therefore a time consuming process. To increase the number of users among the respondents, contacting them via the hub owner should be considered.

Increasing the number of respondents also makes it possible to test all relations hypothesised in the conceptual model determined in this study.

The current study does show that users are perceive the hub more positive compared to non-users. It does however not show how perceptions influence hub use. Research into the relation between perception and hub use is needed to find if increasing the perception could increase the chance of hub use.

To find how perceptions due to hub use, a study over a longer time period with multiple measuring points should be conducted. This will make it possible to see how perceptions change over time, and if they change because of hub use.

This study researched the differences between users and non-users in hub neighbourhoods, but did not ask about motivations for hub use. Research into the reasons why people use or not use the hub should be done to see why hubs are used. Making it possible to develop policy to more precisely steer hub use.

Finally, for the hub to have a lasting impact they should be situated as a long time solution. While this study did not address the financial side of the hubs, they should be financially viable to make an lasting impact. Further research into the financial viability of the hubs is needed.

9.5. Reflection on the process

Neighbourhood mobility hubs are relatively new and information about them scarce, making precisely scoping the problem difficult. This led to a continues changing research direction during the study. The result was that the research methods did not fully connect, e.g. during the expert interviews no specific travel behaviour effects were asked. Despite this slight mismatch of methods all relevant information was found.

The set up of this research may also have been too ambitious. Conducting expert interviews, focus groups and a survey with data analysis may have been to much as it led to problems with time. The time to gather data via the survey was limited leading to a small data set, which in turn led to limited results. However, all steps taken in this study were necessary, without the expert interviews and focus groups relevant information would have been lost.

The focus groups indicated that they did not see themselves as potential users. This put an end to the original plan to conduct a survey among this potential user group. This led to a gap between the qualitative and quantitative parts of the research. In hindsight, conducting focus groups among residents of neighbourhoods with a hub would have better connected the two parts.

Overall the process went largely as planned, and resulted in an overview of important relations concerning neighbourhood mobility hubs. The study shows that the neighbourhood mobility hub could certainly contribute to the problems faced by an ever more urbanising society.

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A

Semi-structured interview questions

Hello,
Thanks for taking the time for this interview. I am, as you know, conducting an exploratory study into neighbourhood mobility hubs. The first step in my research is determine which attributes and characteristics a neighbourhood mobility hub could have and who are the potential users. I will start the interview with a few questions about you and your background. These will be followed by multiple questions pertaining neighbourhood mobility hubs.

1. What is your name?
2. What is your occupation?
3. What is your relevant background?
4. How are you involved with shared mobility and/or hubs?

I see a neighbourhood mobility hub as a central point in the neighbourhood offering different shared mobilities, like bikes and cars, connected by a MaaS system. I imagine the physical hub as a parking lot for the shared mobilities.

5. How do you imagine a neighbourhood mobility hub?
6. What attributes could such a hub have?
7. Which attributes are, in your opinion, essential for a neighbourhood hub?
8. Where should a hub be placed, e.g. city centre, suburbs, etc.?
9. Who are, in your opinion, the potential users?
10. What do you think are their demands?
11. Who reap the advantages of a neighbourhood mobility hub?
12. When would you deem the neighbourhood mobility hub a success?
13. Do you think the neighbourhood mobility hub will be a success?

Thanks again for letting me interview you. This interview has given me valuable information for my research. Using the audio recording and my notes I will write down your answers to my question. These answers will be send to you so you can check if I written down your answers correctly. The answers to these questions will be used for this research only. Thanks again for taking the time to answer my questions.

B

Focus group participants

In this appendix the participants of the focus groups are listed with their current travel behaviour. table B.1 shows the participants of the student focus group and table B.2 shows the participants of the resident focus group.

Table B.1: Participants of the student focus group

Name:	Lives in a city centre:	Age:	Number of persons in the household:	Has access to a car	Prefers to travel to work with:	Prefers to do groceries:	Prefers to travel in his free time:	Has experienced parking problems with a mode:	Has used shared mobility before:
Eva	Yes	<25 years	3	No	Always PT/bike	On foot	Sometimes car, sometimes PT, sometimes on foot	No	Yes
Joost	No	<25 years	3	No	Always PT/bike	On foot	Sometimes car, sometimes PT, sometimes on foot	No	Yes
David	No	<25 years	4	Yes, one	Always car	By bike	Sometimes car, sometimes PT, sometimes on foot	No	No
Tessa	Yes	<25 years	3	No	Always PT/bike	On foot	By bike	Yes	Yes
Tim	Yes	25-35 years	7	Yes, more than one	Always PT/bike	By bike	By bike	No	Yes
Renate	Yes	25-35 years	3	No	Always PT/bike	On foot	By bike	Yes	No

Table B.2: Participants of the resident focus group

Name:	Lives in a city centre:	Age:	Number of persons in the household:	Has access to a car	Prefers to travel to work with:	Prefers to do groceries:	Prefers to travel in his free time:	Has experienced parking problems with a mode:	Has used shared mobility before:
Willem	Yes	>65 years	2	No	Always PT/bike	On foot	With PT	No	Yes
Henk	Yes	45-55 years	2	No	Always PT/bike	On foot	With PT	No	No
Mark	Yes	25-35 years	2	No	Always PT/bike	On foot	With PT	Yes	No
Piet	No	25-35 years	2	Yes, one	Always PT/bike	By car	Sometimes car, sometimes PT, sometimes on foot	Yes	Yes
Nick	No	55-65 years	3	Yes, more than one	Always car	By car	By bike	No	No
Maarten	Yes	25-35 years	2	No	Always PT/bike	On foot	With PT	No	Yes
John	Yes	35-45 years	1	No	Always PT/bike	By bike	By bike	No	No
Linda	Yes	45-55 years	2	No	Always PT/bike	On foot	With PT	Yes	Yes

C

Focus group categories and quotes

Contextual factors
Linda: ”I didn’t want a car anymore, I was going crazy from the parking.”

Linda: ”I prefer not to have a car in Delft city centre, as long as car-rental company Köhler is located in the centre. Because there are places you can’t reach without a car, we can walk five minutes and take the car at Köhler. Köhler is for me part of a hub or mobility thing, if Köhler would leave the centre I would buy a car immediately.”

Mark: ”I do have a bike but I use it once a week, max.”

Nick: ”Car traffic is getting more and more tedious, also on shorter distances.”

Henk: ”Köhler is easy, there is always personnel there to take cars in and fill them up”

John: ”All destinations I need to visit are within walking distance of a station. I think I would walk up to two kilometres.”

Piet: ”I had to be in Emmeloord for work, I took the car. If I could go to the nearest station and take a shared car there I would have done that.”

Willem: ”When I need a car I ask friends or family.”

Nick: ”It is location dependent. I have to travel 20 minutes by car before I reach a train station. If I drive 20 minutes towards work I’m halfway there.”

Karel: ”I think we have it easy in the city centre, I see the hub more for the suburbs.”
Linda: ”If I would live in the suburbs I would want a guarantee that there is always transport available. If this is not the case I would buy a car.”

John: ”I don’t see the added value of a hub in the city centre, as we already have all these separate functions. While not clustered together, but close enough for people to find them. I see more added value in Tanthof.”

Linda: ”It will be used when private cars are being banned.”
Nick: ”If you can’t enter the city with your own car, or can’t park anywhere, there is no choice.”

Linda: ”The car is intertwined with personal rituals.”
Henk: ”It is also a cultural questions, I think the next generation is less intertwined with the car. When I turned 18 I got my first driving lessons, like everybody around me. I see that less nowadays.”

Linda: ”I think that as long people are not forced out of their cars, the attractiveness of the car as a second living room is to much to overcome,”

Nick: ”It is also dependent on pricing. Owning a car isn’t that expensive, if you make ownership expensive the shared car will become more attractive.”
Linda: ”There should be a form of coercion.”

Nick: ”If you have trouble parking your car and, when you find a spot, you have to pay €50, it gets tiring real soon. Then this will be a good alternative.”

Eva: ”It is useful if your car or bike is broken down.”
Renate: ”You don’t need it for normal days, only for incidental activities.”
David: ”The car I use two or three times per week was broken, if I had a hub nearby I might have used it. I could’ve skip the repairs and decide later if I needed a full time car.”

Eva: ”For commuter trips it isn’t useful because you pay per hour.”
David: ”That changes when there is a hub close to your workplace, still, the travel time shouldn’t be to long to make it worth it.”

Tim: ”For destinations far away, more than 100 kilometres, a shared car would be useful.”
David: ”If point-to-point isn’t possible, the activity to where you travel shouldn’t take to long and shouldn’t be to far away.”

Tim: ”You shouldn’t be allowed to own a car, everybody should use shared mobility.”

Eva: ”It needs to be dry weather before you use a cargo bike.”

Eva: ”You really don’t need this where we live in The Hague, everything is close-by, or reachable by public transport. I see the hub in a place where this isn’t the case.”
Eva: ”I see this work more at my parents, that they sell the second car and use the hub for groceries.”

David: ”I see three important variables to make the hub a success, how far is the destination, what are the costs and is it point-to-point or round trip. Per activity there could be a different preference.”

Eva: ”I think it is harder in existing neighbourhoods as everybody has a car.”
Tessa: ”In new, yet to build, neighbourhoods you can coerce people to use the hub.”

Perceptions
John: ”I see my neighbours, who are students, making use of the Mobike. I do not understand this, it has to be cheaper to use your own bike.” Mark: ”I’m using my third bike at the moment because the others were being wrecked when parked, the OV-bike would have been a cheaper option.”

Willem: ”If I where to use a shared car I would always return to my starting hub.”

Henk: ”You risk the shared car to be gone if you need it. There should be a guaranteed availability.”
Nick: ”Yes, I think availability is key. I do not want to think about it, I do not want to wait for one to become available.”

Linda: ”I’ve had a Green Wheels account back in 2006. The vehicles weren’t easily accessible back then, and once I had opened the car it was dirty. With Köhler you can complain directly to the staff. I also had to reserve the time I wanted to use the car, I returned early but I still had to pay for the remaining time. These experiences led me to kick-off cold turkey, while the premise was so good.”

Linda: ”I only want to pay for the time I use the car.”

Nick: ”You’re looking for flexibility, you want to choose the easiest form of transport”
Karel: ”That’s why I use the OV-bike instead of the bus, flexibility.”

Linda: ”If the service doesn’t connect and is easy to use, we won’t use it”

Nick: ”I’m lazy, so the ease of stepping out of your home into your car is comfortable. The private car is form of convenience”

Linda: ”What are you going to do with car seats for children.”

Nick: ”It would be ideal if you could travel by car to a transferium at the edge of a city and use public transport to enter the city”

John: ”For daily use it is easier if cars are spread around an area, instead of a hub. You can use the app to find the nearest vehicle.”

Linda: ”If the app is up-to-date and I can reserve the car with a click on a button, you don’t need a central location.”

Piet: ”The advantage of a small hub is that you can place one in each neighbourhood”

Henk: ”You need to avoid that, if hub-to-hub travel is possible, all vehicles end at the same hub.”
Piet: ”Mobike redistributes their bikes over the area to avoid that problem.”

Linda: ”I do like the cargo-bikes, there are moments were I could use a cargo-bike for an hour or so.”
Karel: ”I would like the cargo-bikes and e-bikes to be at the station, swiping your OV-chipcard is easier than having to make a reservation.”

Nick: ”I think that offering multiple services in or near the hub is a good idea. A place to drink coffee and take shelter from the elements. A parcel pick-up point is also a good idea, as you are already passing the hub.”
Linda: ”I think a parcel delivery point would really add value.”

Henk: ”You need to think big. Create a large network which increases reliability and flexibility, starting big will create a flywheel effect.”

Henk: ”I would like to have a hub at a transferium, so I can take a bike or a bus or e-car if I need to travel further.”

Karel: ”I see two problems, the costs and the accessibility.”

Nick: ”It should be easy to use and cheap.”

Piet: ”I used a shared e-bike on vacation and I thought it was a fun way to explore the city. Especially for tourists.”

John: ”I don’t see when I would use a hub in Delft. I see the hub more as a point at the end of the bus line, where I could use it to travel further. The neighbourhood can then use it to pick up their packages as well.”

Karel: ”There should be different hubs for different locations, one for the suburbs, one for the edge of the city, one for hard to reach places.”

Linda: ”I’m missing a person at the hub, someone to talk to if something is wrong. Someone to help if you can’t get access or to clean the car when it is dirty, especially at night. This is more important for larger hubs, not so much for a small hub.”

Henk: ”It will make the hub more social, and provide security as well.”

Henk: ”If you need to bike to Köhler it takes away part of the ease of use.”
Linda: ”If I have to bike to Köhler and than drive back to my house in the centre it is to much of a hassle. Then I would apply for a parking permit and buy a car.”
Linda: ”It has to be within walking distance.”

Nick: ”I think it is quite expensive, especially with the car.”

John: ”I see the hub more at the end of public transport lines, if you need to travel further you take a car or bike.”
Linda: ”I would like to have hubs in places where public transport is failing. For example at Bergschenhoek if you exit the metro. However, this will not relieve city centres.”
Henk: ”To relieve city centres you need hubs near the highways, so you can leave the highway and enter the hub for the last mile.”
Linda: ”I also feel more comfortable to drop off someone at such a transferium, compared to a bus station in the middle of nowhere.”
Nick: ”I think the use of the hubs can be stimulated by placing them in easily accessible places, that it connects with your expectations.”
Linda: ”I see the hub for the last mile, from the station.”

Nick: ”With your own car you are less dependent on others, you accept that you have to sit in a traffic jam sometimes.”
Linda: ”Nothing can compare with the flexibility and comfort of your own car, once you are used to it. You need other incentives.”

Tessa: ”It is expensive but owing a car is also expensive. With bikes I don’t no but a shared could be less expensive than buying.”
David: ”Yes, it depends on the frequency of use.”
Tessa: ”True, if you don’t use the car that often. I think there are quite a lot of extra costs for owning a car.”

Renate: ”The OV-bike is also expensive.”
Tim: ”True, however that is mainly because if you use it for work, you’re paying for it sitting unused outside, while you are at work.”
Renate: ”It is cheaper to buy a used bike and place it a the station.”
Tessa: ”However, the Swapfiets is also more expensive and I still use it. There are more factors besides costs.”
Renate: ”It is all about convenience.”
All agree

Renate: ”You don’t always know if there are enough OV-bikes available. They also aren’t opened 24/7.”
Tessa: ”You need a hub where you know there is always shared mobility available.”

Eva: ”More then a 5 minute walk is quite far for a hub.”
Tim: ”It depends on which mode you want to use, I’m willing to walk further for a car.”
Renate: ”The total travel time is important, if I wanted a bike for 10 minutes, but first I had to walk 5 minutes to the bike, I would keep walking and save the money.”
Tim: ”For a car a longer distance is fine, you can always bike to the hub.”
Renate: ”Important is whether you pay per hour or kilometre, and if you can return to a hub at your final destination.”

Tim: ”The costs should be to high. If it is cheaper or somewhat more expensive but easier to use than the train I would use the hub.”

Joost: ”If you have a small hub close to your house, you can take the bike to a larger hub near an access road. I would be willing to rent a e-bike to travel 5 minutes to a larger hub for a car.”

David: ”The hub should fit in the environment, it would be a bit strange if a huge parking garage appeared in a neighbourhood to facilitate the hub.”
Eva: ”I wouldn’t want to have a view on a hub.”

David: ”I would offer expensive modes, e-bike and cars. If you can buy a bike for €100, then why would you use a bike from the hub.”
Renate: ”With bikes it is hard regardless, everyone has one or more bikes in the Netherlands.”
David: ”As long as you can buy a bike for €150 that is usable for 10 years no one will use the bikes from the hub.”

Renate: ”It has to be easy to use without any hassle, we are all lazy.”
Tim: ”We are all rather lazy than busy.”

Renate: ”You need to give insight into the costs, costs remain the biggest driver.”

Tessa: ”To avoid complaints about the hub you could make the hub socio-economic.”
Renate: ”The hub should be part of the neighbourhood.”
Tessa: ”It should become a meeting place for the neighbourhood.”
Tim: ”Add some plants.”
David: ”Add a PostNL pick-up point, making it also useful for other people.”

Tessa: ”The hub should be recognisable.”

Tim: ”The hub should be easy to use, no hassle with logins, just ’beep’ you can enter your car.”

Renate: ”Maybe someone at the hub to help you if the app doesn’t work or if people are struggling, like at the OV-bike. People want to be helped by a living breathing person, they crave interaction. If you are alone at a hub and it doesn’t work it feels worse.”

Renate: ”The hub should be open 24/7.”

Tim: ”I see drunk people using the shared cars more easily as their own private cars.”

Renate: ”Externalities should be available, like helmets and children seats.”

Renate: ”I think people will feel safer with camera supervision, I also think that the hub should provide cover from the elements.”

Possible travel behaviour effects
Linda: ”I think car users don’t want to leave their cars. I think they have their second live in their cars. They are used to have their water bottle and private calls in their car, they won’t give that up. Cars are extended living rooms”
Nick: ”My car is indeed like a second living room.”

Mark: ”I would use the cargo-bike for the weekly groceries. And the car for the few times I have a birthday somewhere in the province. Maybe I would use the e-bike for work, I think I would make use of the hub.”

Mark: ”I would use the car to get to places unreachable by public transport, those places are probably not viable for a hub.”

Nick: ”We have multiple cars because we use them. If we don’t use them they’re not standing in the way, you just pay a little tax, there is no motivation to get rid of them.”
Nick: ”Only with sporadic use the costs will counterbalance with a shared car, I can imagine this be more relevant in the city.”

Karel: ”If I would have a regular car I would think keep your hub and e-cars, why would I use it.”

Nick: ”If the aim is to get people out of their cars it could become hard, there is nothing as comfortable as sitting in your own car with your coffee. It may take some extra time but you are usually used to that.”
Piet: ”I think it is partly habit, I always use the train and I love it. I usually have a seat, I can read or watch a series.”
Nick: ”Yeah a lot of it is habit.”

Linda: ”You want exactly the same functionalities as a car.”

Mark: ”I have a drivers license, however I never really needed to use a car, these kind of hubs could prevent the car becoming a second living room for me.”
Linda: ”For the new generation who aren’t used to the ’living room’ effect, the hub could keep the private car out of the picture.”
Henk: ”It increases the number of alternatives and prevents people to use the car for the first time.”
Nick: ”If you haven’t developed a habit you can easily get used to an alternative.”
John: ”I have a friend from The Hague who uses Green Wheels, he doesn’t wants to own a private car”

Tim: ”If the shared car is cheaper than the train than it will become interesting to take the car. While the train is easy to reach here in Delft.”

Joost: ”I would us a round trip hub for doing groceries or a trip to IKEA.”
Tim: ”Or to spend an evening with my parents.”
Tessa: ”For one class it would also be useful, but not for the full day.”
Eva: ”Yeah, such a hub is for short distances like doing groceries.”
David: ”Going to sports, renting three or four cars with 12 or 16 people. One hour both ways and a two hour game, that could be a good idea.”

Tessa: ”The e-bike can replace cars in some cases. The Hague - Delft for example is a bit to far for the regular bike but doable with the e-bike.”

Tim: ”I think it will decrease the need for owned cars, especially if they aren’t needed for commuting. If commuting is possible with public transport than the hub is useful for car trips to for example IKEA.”

Eva: ”I think the hub will lead to me using more kind of modes, as I only own a bike.”
Tessa: ”But you wouldn’t buy a car.”

Tessa: ”I you own a car you use it for short trips because it is easy. With shared mobility you see the actual costs for those trips, and I think this will help to persuade people to use a bike. It will lead to people to think twice before using the car.”
Tim: ”If you’re able to see the actual costs of travel you think twice before travelling.”
Tessa: ”It has also an effect on the local economy, as bike riders shop local instead of at the super store at the edge of the city.”

Other relevant information
Linda: ”If you are used to use the hub and there is a person there to convince me to use a e-car for a change, than it could be a showcase to stimulate sustainable forms of transport.”

Piet: ”The most important for me is that I get from A to B. I have a budget, the way I travel doesn’t concern me much, I don’t car if I own the car, if the company can plan my trip more efficiently than me, I see that as an advantage.”
Piet: ”If I could go anywhere for a fixed price, more efficient than I can do it with the car for that price, that would be a turning point. I want an integrated model.”
Karel: ”The hub should be integrated with for example 9292.”
Piet: ”Or that I go to the hub and they tell me there is a traffic jam, and that I should take the bike to the station instead.”
Nick: ”That you can open the app in the morning and it tells you the easiest way to reach your destination.”

Linda: ”It is assumed that the second car isn’t used, however more and more households have both partners working.”

Karel: ”That one negative experience does linger.”

Nick: ”I think the hub might work, as a part of an integrated mobility system that offers the best alternatives.”
Karel: ”I would use it if I needed a car or if I needed to change from train to bus or tram when it is also possible by bike, to extent my range. To move large things I might use the cargo bike.”
Henk: ”I think the most important thing is a car rental place in the city centre, because other modalities are already available.”
Nick: ”The e-bike has added value because then you aren’t dependent on a bus line for the last 15-20 kilometres.”
John: ”I don’t think the hub concept is useful, I don’t see myself using it, especially not in Delft. I only see marginal improvements with public transport.”
Linda: ”As long as Köhler is located in the city centre, it isn’t interesting for me. I Köhler would move, I would like a manned hub which is easy to use, if not I will buy a car.”
Mark: ”I would use the hub for the cargo bike, the car perhaps for the few times I need to travel far away, and now I’m thinking about it the e-bike for travelling to work.”
Piet: ”I think is useful for the medium-long range with the bike or scooter, and a service to plan the most efficient way to get somewhere. As a supplement of the public transport and 9292.”

Tim: ”You should take the changing gender roles into consideration. Nowadays it is more and more so that both man and woman need a car for work.”

Tessa: ”You always pay for your parking privilege. If I had to choose between a parking place or an extra bedroom, I would choose the extra bedroom.”

Tim: ”The hub provides an easy first step to use something.”

D

Locations of Hely hubs

Table D shows all Hely hub locations at the moment of writing. The locations are sorted alphabetically by city. The locations are directly copied from the Hely site[1], on wich not all hubs have a number associated with the address. For each of the neighbourhoods the number of households is also noted, as the survey is held on the household level. The data is taken from the CBS[2], the data was updated last on October 23, 2019.

It should be noted that the numbers are outdated, especially for the Amsterdam and Delft locations as these areas were developed in the last few years. The numbers also indicate households in neighbourhoods determent by the CBS, and thus not the 400m radius around the hub on which the respondents are recruited. The number of households is merely an indication in what kind of neighbourhood the hub is located.

Finally the month in which the Hub was opened is noted. These dates were found in a combination of press releases, as the Hely website does not note the opening date of the hubs.

From these nine hubs only six are useful for this research. The Binckhorst and Caballero Fabriek hubs are located on a business park and not in a residential area, making them fall outside the scope of this study. The Hoogkwartier hub was opened very recently, making it unlikely that there are much persons knowledgable about the hub. The other six hub were surveyed.

City	Hub Name	Neighbourhood	Address	# Households	Open since:
Amsterdam	Buiksloterham	Buiksloterham	Klaprozenweg 27	70	12-2018
	De Werf*	NDSM terrein	TT Vasumweg 72	946	09-2019
Delft	Schoemaker Plantage	Bedrijventerrein Delftech	Van Embdenstraat	500	12-2018
Den Haag	Binckhorst**	Binckhorst	Maanweg	495	06-2019
	Caballero Fabriek**	Binckhorst	Saturnusstraat	495	04-2019
	Bezuidenhout	Bezuidenhout-midden	Carpentierstraat	2.140	06-2019
Haarlem	Scheepmakerswijk	Sportliedenbuurt	Harmenjansweg 4	625	04-2019
Rotterdam	Hoogkwartier	Stadsdriehoek	Hoogstraat 74	9.970	11-2019
Utrecht	Schildersbuurt	Schildersbuurt	Gabriël Metsusstraat	1.880	06-2019

Table D.1: Hely hub locations
*Only open for inhabitants of De Werf and Nautique Living, number of households is the combined number of households stated on their respective websites[3]
**Located within 200m of each other in the same neighbourhood, leading to the same neighbourhood data

[1] https://www.hely.com/
[2] https://www.cbs.nl/nl-nl/maatwerk/2019/31/kerncijfers-wijken-en-buurten-2019
[3] https://www.wonenopdewerf.nl & https://studentexperience.nl/locaties/nautique-living

E

Survey

On the following pages the user survey is displayed as it was presented to the respondents. The version displayed is the offline version aimed at hub users. The online version had the question about hub location added, and the non-user version has slightly different formulated questions.

MOBYCON TUDelft

Het gebruik van de Hely mobiliteitshub (Gebruikers)

Welkom bij deze enquête!

Als onderdeel voor mijn afstuderen aan de Technische Universiteit Delft en in samenwerking met adviesbureau Mobycon onderzoek ik kleinschalige hubs voor deelmobiliteit in woonwijken. Ik onderzoek het (mogelijke) gebruik van deze hubs door u, als bewoners.

Ik stel het op prijs dat u een bijdrage wilt leveren aan dit onderzoek door deze enquête in te vullen. U ontvangt deze enquête omdat u in een wijk woont waar een Hely deelmobiliteit hub is gevestigd.

Het invullen van deze enquête duurt ongeveer 10 minuten. De enquête is volledig anoniem.

Namens mijzelf, de TU Delft en Mobycon wil ik u hartelijk danken voor uw medewerking.

Daan van Rooij
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MOBYCON TUDelft

Het gebruik van de Hely mobiliteitshub (Gebruikers)

Omdat u gebruik hebt gemaakt van de Hely hub bent u waarschijnlijk bekend met deelmobiliteit en de werking van de hub. Om verwarring te voorkomen volgt hier een korte opfrisser over deelmobiliteit en de Hely hub.

Deelmobiliteit

Deelmobiliteit maakt het delen van vervoersmiddelen met andere, vaak onbekende, personen makkelijker. Er zijn vele verschillende vormen, maar de basis is dat je als gebruiker niet de eigenaar bent van het vervoersmiddel maar enkel betaalt naar gebruik van het vervoersmiddel.

De Hely hub

- **De Hely hub is een vaste plek in uw buurt waar deelmobiliteit wordt aangeboden.**
- **De aangeboden vervoersmiddelen verschillen per hub, maar er is altijd sprake van een keuze uit (elektrische) fietsen en (elektrische) auto's.**
- **De vervoersmiddelen zijn eenvoudig te open met de Hely app.**
- **U dient het voertuig terug te brengen bij dezelfde hub als waar u bent vertrokken.**
- **Gebruik van de Hely hub kost € 4,95 per maand, verder betaalt u per uur dat u een vervoersmiddel gebruikt. De kosten per uur verschillen per vervoersmiddel: Hoe duurder het vervoersmiddel is in aanschaf, hoe hoger de prijs per uur. Bijvoorbeeld: een e-fiets kost € 1,50 per uur en een stadsauto kost € 7,50 per uur.**

Voorbeeld Hely hubs in Utrecht (links) en Delft (rechts)

MOBYCON TUDelft

Het gebruik van de Hely mobiliteitshub (Gebruikers)

1. Zou u bij de volgende karakteristieken van de hub willen aangeven wat uw beeld erbij is:

	Heel negatief	Negatief	Neutraal	Positief	Heel positief	Weet ik niet
Kosten voor het gebruik van de hub	○	○	○	○	○	○
Kosten voor het gebruik van de vervoersmiddelen	○	○	○	○	○	○
Beschikbaarheid van vervoersmiddelen in de hub	○	○	○	○	○	○
Diversiteit in vervoersmiddelen in de hub	○	○	○	○	○	○
Gebruiksgemak van de hub	○	○	○	○	○	○
Zichtbaarheid van de hub	○	○	○	○	○	○
De afstand tot de hub	○	○	○	○	○	○
Duurzaamheid van de hub	○	○	○	○	○	○
Veiligheid van de hub	○	○	○	○	○	○
Staat van de hub (schoon, hygiënisch, geen technische mankementen, etc.)	○	○	○	○	○	○
Duurzaamheid van de vervoersmiddelen	○	○	○	○	○	○
Veiligheid van de vervoersmiddelen	○	○	○	○	○	○
Staat van de vervoersmiddelen (schoon, hygiënisch, geen technische mankementen, etc.)	○	○	○	○	○	○
Het feit dat je elke rit moet starten en eindigen bij dezelfde hub	○	○	○	○	○	○

2. Zou u aan kunnen geven in hoeverre u het eens bent met de volgende stellingen:

	Helemaal oneens	Oneens	Niet oneens/niet eens	Eens	Helemaal eens	Weet ik niet/NVT
Ik denk dat de hub zorgt voor meer vrije ruimte in mijn buurt omdat er minder auto's worden aangeschaft	○	○	○	○	○	○
Ik denk dat extra voorzieningen, bijvoorbeeld een PostNL pick-up punt, van toegevoegde waarde zijn voor de hub	○	○	○	○	○	○
Ik ervaar moeite bij het parkeren van mijn privé-auto in mijn buurt	○	○	○	○	○	○
Ik ervaar moeite bij het parkeren van mijn privé-fiets of ander privé-vervoersmiddel in mijn buurt	○	○	○	○	○	○

MOBYCON TUDelft

Het gebruik van de Hely mobiliteitshub (Gebruikers)

3. Om een beeld te krijgen van uw reisgedrag zonder de hub wil ik u eerst vragen hoe u zich verplaatste voordat de Hely hub geopend werd in uw buurt.
Zou u per reisdoel kunnen aankruisen welk vervoersmiddel u hier het meest voor gebruikt.

Als u meerdere vervoersmiddelen gebruikt tijdens één reis, kies dan het vervoersmiddel waarmee u de meeste kilometers maakt. Bijvoorbeeld: Als u voor uw werk met de fiets naar de trein fietst en met de trein naar een andere stad reist, vult u als vervoersmiddel de trein in.

	Te voet	Eigen fiets	e-Fiets	Scooter/ bromfiets /snorfiets	(e-) Bakfiets	Privé-auto	Huurauto	Tram/bus /metro	Trein	Taxi
Woon-werk of woon-educatie	○	○	○	○	○	○	○	○	○	○
Boodschappen	○	○	○	○	○	○	○	○	○	○
Sport/hobby	○	○	○	○	○	○	○	○	○	○
Visite	○	○	○	○	○	○	○	○	○	○

4a. Zou u in de onderstaande tabel voor elk reisdoel kunnen invullen hoe vaak u gebruik maakt van de hub.

	Dagelijks	Wekelijks	Maandelijks	Jaarlijks	Nooit
Woon-werk of woon-educatie	○	○	○	○	○
Boodschappen	○	○	○	○	○
Sport/hobby	○	○	○	○	○
Visite	○	○	○	○	○

4b. Dit is een vervolg op vraag 4a, zou u in de onderstaande tabel voor elk reisdoel kunnen invullen van welk vervoersmiddel u het meest gebruik heeft gemaakt.

Als u bij vraag 4a bij een reisdoel 'Nooit' heeft ingevuld, vul dan bij dat reisdoel in deze tabel NVT in.

	Auto	e-Auto	(e-)Fiets	e-Bakfiets	NVT
Woon-werk of woon-educatie	○	○	○	○	○
Boodschappen	○	○	○	○	○
Sport/hobby	○	○	○	○	○
Visite	○	○	○	○	○

MOBYCON TUDelft

Het gebruik van de Hely mobiliteitshub (Gebruikers)

5. Heeft de hub uw privé-auto bezit veranderd?

- ◯ Ja, ik heb mijn tweede (of derde) auto verkocht
- ◯ Ja, ik heb mijn eerste auto verkocht
- ◯ Ja, ik heb een tweede (of derde) auto niet aangeschaft
- ◯ Ja, ik heb een eerste auto niet aangeschaft
- ◯ Ja, ik heb een auto aangeschaft
- ◯ Nee, ik heb mijn tweede (of derde) auto niet verkocht
- ◯ Nee, ik heb mijn eerste auto niet verkocht
- ◯ Nee, ik had geen auto en heb er nog steeds geen
- ◯ Niet van toepassing

6, Heeft u het voornemen uw privé-auto bezit te veranderen dankzij de hub?

- ◯ Ja, ik denk erover mijn tweede (of derde) auto te verkopen
- ◯ Ja, ik denk erover mijn eerste auto te verkopen
- ◯ Ja, ik denk erover geen tweede (of derde) auto aan te schaffen
- ◯ Ja, ik denk erover geen eerste auto aan te schaffen
- ◯ Ja, ik denk erover een auto aan te schaffen
- ◯ Nee, ik denk er niet over mijn tweede (of derde) auto te verkopen
- ◯ Nee, ik denk er niet over mijn eerste auto te verkopen
- ◯ Nee, ik heb geen auto en ben niet van plan er een aan te schaffen
- ◯ Ik twijfel nog
- ◯ Niet van toepassing

MOBYCON TUDelft

Het gebruik van de Hely mobiliteitshub (Gebruikers)

Om een goed beeld te krijgen van de bewoners in de buurt van de Hely hub wordt hieronder een aantal vragen gesteld. Deze informatie wordt anoniem verwerkt en alleen gebruikt voor wetenschappelijke doeleinden.

7. Wat is uw geslacht?

◯ Man ◯ Vrouw ◯ Overig ◯ Ik zeg dit liever niet

8. Wat is uw geboortejaar?

9. Wat is uw hoogst afgeronde opleiding?

◯ Basis onderwijs
◯ VMBO, HAVO-, VWO-onderbouw, MBO1
◯ HAVO, VWO, MBO2-4
◯ HBO-bachelor, WO-bachelor
◯ HBO-master, WO-master, doctor

10. Wat is de samenstelling van uw huishouden?

◯ Alleenstaand
◯ Samenwonend/gehuwd
◯ Samenwonend/gehuwd met kinderen
◯ Alleenstaand met kinderen
◯ Met huisgenoten/studentenhuis

11. Wat is het jaarlijkse bruto inkomen van uw huishouden?

◯ Minder dan 10.000 euro
◯ Tussen de 10,000 en 19,999 euro
◯ Tussen de 20,000 en 29,999 euro
◯ Tussen de 30,000 en 39,999 euro
◯ Tussen de 40.000 en 49.999 euro
◯ Tussen de 50.000 en 59.999 euro
◯ Tussen de 60.000 en 69.999 euro
◯ Tussen de 70,000 en 79,999 euro
◯ Tussen de 80,000 en 89,999 euro
◯ Tussen de 90.000 en 99.999 euro
◯ Meer dan 99.000 euro
◯ Ik zeg dit liever niet

MOBYCON TUDelft

Het gebruik van de Hely mobiliteitshub (Gebruikers)

12. Bezit u een autorijbewijs?

- ◯ Ja
- ◯ Nee

13. Bezit uw huishouden één of meerdere auto's?

- ◯ Nee
- ◯ Ja, één
- ◯ Ja, twee
- ◯ Ja, meer dan twee

14. Kunt u altijd over een auto beschikken?

- ◯ Ja, wanneer ik maar wil
- ◯ Nee, dat gaat in overleg met mensen binnen mijn huishouden
- ◯ Nee, dat gaat in overleg met mensen buiten mijn huishouden
- ◯ Nee, ik kan nooit over een auto beschikken

15. Heeft u wel eens gebruik gemaakt van deelmobiliteit buiten de Hely hub om?

- ◯ Ja
- ◯ Nee

Nogmaals bedankt voor het invullen van deze enquête over het gebruik van de Hely mobiliteitshub!

F

Statistical tests

The data obtained by the surveys is used to find relations and differences between the variables. The theoretical relations in the conceptual model can be tested using statistical tests. These tests are run using SPSS, a statistical analysis software package (IBM Corp., 2017). This software makes it possible to easily perform the different test without the need for manual calculations.

This study uses different statistical tests, in this appendix the prerequisites for these tests are explained. However, to understand the tests the idea of the measurement scale needs to be explained.

Measurement scale

One of the important factors to decide which test should be used, is the measurement scale of the obtained data. There are four possible measurement scales:

- Nominal: Named variables
- Ordinal: Named and ordered variables
- Interval: Named and ordered with proportionate intervals
- Ratio: Interval but with an absolute Zero

When listed like this each step further on the scale provides extra information on the variable. The measurement scale is dependent on the question that is asked, Yes/No questions give nominal data while asking for an exact age leads to ratio data. The type of scale determines what kind of statistical test are possible with the data. As each step on the scale only adds information, higher scales can be analysed with the same test as the scales below them. In this study the tests in the following sections are used, the information is taken from a SPSS guide by Kent State University (2019).

Chi-square

For nominal and categorical data the Chi-square test is used to test if two categorical variables are independent from each other. The Chi-square test utilises a contingency table to analyse the data, one variable categories appear in the rows the other variable categories appear in the columns. Each cell contains the total count of cases of a pair of categories. There are a few prerequisites for using the Chi-square test:

- Two categorical variables
- Two or more categories for each variable
- Independence of observations
- Relatively large sample size

Independence of observations means that the subjects in each group have no relationship. The test expect at least 1 case per cell, and at least 5 cases for 80% of the cells, this leads to the relatively large sample size.

Independent samples t-test

The independent samples t-test is used to compare the means of two independent groups. The test can compare two, and only two, groups, for comparison between three or more groups the ANOVA test should be run. There are a few prerequisites for using the independent samples t-test:

- Dependent variable that is continuous (Interval or ratio scale)
- Independent variable that is categorical
- Cases that have values on both the dependent and independent variables
- Independent samples
- Random sample of data from the population
- Normal distribution of the dependent variable, or N>30 for each group. If the sample is not normally distributed and has a N<30 the power of the test is decreased
- Homogeneity of variances. This is tested by Levene's test for equality of variances, if the two groups are not homogeneous the Welch t-test is used instead of the independent samples t-test

For both tests a significant confidence interval of 95% is used, this means that differences found in tests are significant when the 'p value' is smaller than 0,05.

G

Data comparison with Knippenberg Data

In his thesis Knippenberg (2019) researched partly the same group. He did his research among users of the Hely hub. Parts of the results of this study overlap with his thesis, namely the socio-demographic variables and trip motive. The users in this study are compared with his. Matching data is more reliable, as his study was performed among 45 active users, decreasing measurement error. As the data set used by Knippenberg (2019) is not available no statistical tests are performed, the comparison is made by sight.

Socio-demographics

Not all socio-demographics measured in this study match the Knippenberg (2019) thesis. Table G.1 shows the values for the matching variables. Five of the in total ten socio-economic variables match, for each of these five the differences and similarities will be noted.

Gender in this and the Knippenberg (2019) study are comparable, with slightly more men then women. Age is also comparable, with the largest group being between 25 and 44 years old.

Household type in this study is skewed towards living with partner and children. Knippenberg (2019) found persons living with a partner being the largest user group, and also the 'living alone' group is larger in his sample. The sample in this study could be biased towards living with partner and children. A possible explanation is that the surveys in this study were mainly handed out among family houses. This increases the chance of the users belonging in 'living with partner' or 'partner with children' categories.

Household income is harder to compare as Knippenberg (2019) did not specify if it is gross or net income he is measuring. For this comparison it assumed that he measured gross income. The table clearly shows that the income of the Knippenberg (2019) is more evenly distributed among the categories. As the number of users found in this study is much lower, a even distribution is not possible. The data is also skewed towards the higher income categories. This can also be explained partly by the high number of family houses in the survey distribution area.

Car ownership is also different between the two data sets. This study found more users with no car while Knippenberg (2019) found that the majority of users owns at least one car. This can influence the power of the car ownership variable.

Table G.1: Socio-demographics users and (Knippenberg, 2019) data

Variable	**Value**	**Users**	:	**(Knippenberg, 2019)**
Gender	Male	66.7%	:	55.0%
	Female	33.3%	:	45.0%
Household type	Alone	11.1%	:	20%
	With partner	33.3%	:	40%

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Table G.1 – continued from previous page

Socio-demographic	Category	Users	:	(Knippenberg, 2019)
	With partner and children	55.6%	:	35%
	Living with roommates	0.0%	:	5%
Age	<24	11.1%	:	9%
	25-34	33.3%	:	33%
	35-44	33.3%	:	24%
	45-54	22.2%	:	24%
	55-64	0.0%	:	9%
	>64	0.0%	:	3%
Gross household income (€)	< 19,999	0.0%	:	20%
	20,000-39,999	22.2%	:	14%
	40,000-59,999	22.2%	:	25%
	60,000-79,999	0.0%	:	15%
	80,000-99,999	11.1%	:	11%
	> 99,999	33.3%	:	6%
	I rather not say	11.1%	:	9%
Household car ownership	0	55.6%	:	34%
	1	33.3%	:	41%
	2	0.0%	:	25%

Trip motive

Both studies measured for which kind of trips the hub was used. Table G.2 shows for each of the four trip motives how the Knippenberg (2019) respondents used the hub. His data and the data found in this study is comparable, the hub is mainly used for incidental trips. He found a higher number of users using the hub for commuter trips, but still most use the hub for visits and doing groceries.

Table G.2: Hub use per trip motive

	Commuter	Groceries	Sport/hobby	Visits
User	33%	67%	33%	89%
Knippenberg (2019)	40%	50%	22%	74%