Optimizing carsharing policies for a new generation

A quest on how to upscale carsharing as part of sustainable mobility systems in Dutch urban regions

Hannah Habekotté

July 2021

Version: MSc Thesis Environmental and Infrastructure Planning

Date: 9th of July 2021

Author: Hannah A. Habekotté

Student number: S3495701

University: University of Groningen, Faculty of Spatial Sciences.

MSc Environmental and Infrastructure Planning

Supervisor: prof. dr. E.J.M.M. (Jos) Arts, Professor Environmental and Infrastructure planning

2nd reader: Dr. F (Femke) Niekerk, Assistant Professor in Spatial Planning

Internship: Ministry of Infrastructure and Water management

Images title page: *bottom image: NOS (2018), top image: (Vanhoutte, 2019)*

Preface: “Huisje, boompje, beestje” en een auto?

EN: House, tree, animal and a car?

In the Netherlands, the saying ‘huisje, boompje, beestje’, in my opinion embodies the traditional idea of the Dutch household, a nice house, a garden and a pet. To this list, for the past decades, a car was also an essential part of this ‘idyllic’ Dutch household. My parents never owned a car; because they felt they did not need one and were environmentally conscious among other reasons. From a young age, this has made me aware of the other transport options available. On the other hand, I have also become aware of the high car dependence of others, which can astonish me at times.
With the lack of space in urban areas and in the new age of environmental activism, Greta Thunberg’s and climate marches, will car ownership still be a standard element of the traditional Dutch household? Is a question I often have. And, on one of my neighbourhood walks (corona times), I saw more shared vehicles available around me, as well as the parking pressures that exist in the neighbourhood I live. This sparked an interest in carsharing as alternative for car ownership.
This interest and motivation have created the extensive work about carsharing that lies before you. It discusses the concept of carsharing, carsharing users and carsharing policy recommendations. It has grown my knowledge about carsharing, sharing mobilities as well how difficult developing policies can be. Through this research I hope to shed light on what influences potential carsharing users, with a focus on young adults, and how carsharing policies can be developed to help the upscaling of carsharing as a means to transition to more sustainable mobility systems. It has been a true ride, although not one in a traditional B2C shared vehicle yet.
During this thesis period, I have had the wonderful opportunity to be guided by Jos Arts throughout the thesis process, and our frequent although always slightly chaotic meetings always gave me new inputs and suggestions. This also extends to the other teachers from the I&W annotation program. Additionally, I have had the opportunity to do an internship at the ministry of Infrastructure and Water management which has been an amazing experience thus far. My internship coordinator Liselotte Bingen, has been a great support throughout this digital internship period. Additionally, the whole team at the MaaS program has helped me through the process with their ideas, suggestions and questions. Their contacts have enabled me to meet and connect with very interesting people that have improved this thesis in my opinion. A key lesson I take with me is how their progressive out-of-the-box thinking has been super very refreshing in how mobility is approached. The team is a true embodiment of how future sustainable mobility systems can look when a car is a less dominant part of people’s daily transport. ‘Huisje, boompje, beestje’ but not necessarily a privately owned vehicle is both practiced and ‘preached’ in this team, and that has been a wonderful experience.
Whether I will own a car myself in the future, is of course a little uncertain. It all depends on which factors influence me, I would say, and how carsharing policies develop, which are essential for the upscaling of carsharing as this research has shown. This thesis has opened my eyes however to the variety of alternatives to vehicle ownership, and I hope it inspires you as reader as well to think about the other more sustainable transport modes out there like carsharing.

Enjoy reading this thesis,

Hannah Habekotté

Groningen, 9th of july 2021

Abstract

This research examined how carsharing policies can contribute to the upscaling of carsharing as a means towards sustainable mobility systems, with a focus on young adults as potential user group. Using a transition theory multi-level perspective, these dimensions have been examined. B2C carsharing has deemed to be most effective in reducing landscape pressures, through reducing CO_2 emissions, parking pressures etc. Important influencing factors for potential users, specifically young adults are the reliability/convenience of carsharing and cost attractiveness. Policy measures can play into this.

Groningen and Utrecht are case studies in this research. GIS analysis has shown that in both places carsharing vehicles are mainly located in densely populated, urban areas, where there is a positive inhabitant to car ownership balance. Survey results have shown that B2C carsharing users are highly economically and environmentally motivated but not socially motivated. These motivations do not/only weakly correlate with the user frequency. Through interviews with carsharing experts, young adults have been determined an attractive user group, with possibilities for the upscaling of carsharing. However, it has become clear that carsharing policies cannot be smoothly executed before governmental barriers are solved. The lack of capacity, knowledge and sometimes motivation at municipal levels, as well as the fragmented position of carsharing nationally make it difficult to develop effective carsharing policies for users and carsharing providers. There is a general desire for a more leading role for the national government in providing carsharing policies and sharing knowledge. Better collaboration in this process is important.

Key words: Carsharing, Young Adults, Sustainable mobility systems, Transition theory, Carsharing policies, Upscaling, Carsharing users

Overview

Overview of tables and figures

Figures

Tables

List of abbreviations

B2C – Business to consumer carsharing
EV – Electric Vehicles
GIS – Geographic Information Systems
I&W – Ministry of Infrastructure and Water management
KiM – Kennisinstituut voor Mobiliteitsbeleid
MaaS – Mobility as a Service
OW – One-way carsharing
PSS – Product Service System
P2P – Peer to Peer carsharing
PPP – Public Private Partnership
PT – Public Transport
RWS – Rijkswaterstaat
RT – Round trip carsharing
SQ – Sub-question

1. Introduction

1.1 Background: The change needed in Dutch mobility systems

In the Netherlands, the number of personal cars is still rising each year, with a total of 8.7 million personal cars at the beginning of 2020 (CBS, 2020b). Most privately owned vehicles are also not used the majority of the time. While overall, there are more personal kilometres driven, each individual car drives less kilometres (CBS, 2019). This demonstrates less efficient car usage as well as increasing pressures on urban space due to the high number of cars there (International Transport Forum, 2016). As part of the Dutch Climate Agreement, the Dutch government strives to reduce mobility emissions through sustainable energy carriers, stimulating electric (personal) travel, improving sustainable (heavy) transport, and increasing sustainable personal mobilities (Rijksoverheid, n.d.). New sharing concepts like (electric) carsharing but also more integrated concepts such as 'Mobility as a Service' (MaaS) are seen as important components for reducing CO_2 emissions in both personal and business mobilities (Rijksoverheid, 2019).

In 2015, the first Dutch 'Greendeal Autodelen' was signed, a covenant between governmental organisations, private partners and knowledge institutes to promote and increase carsharing as alternative sustainable mobility (CROW, 2020). Carsharing concepts can foster a shift from vehicle ownership to usage-based systems and are therefore often described as a Product Service System (PSS), a service catering to the needs of users, and with that aiming to replace/reduce car ownership (Liu, et al., 2014). Through that, carsharing can stimulate a transition from ownership to user-based systems and contribute to the reduction of greenhouse gas emissions and the amount of public space needed for parking, which is especially relevant in urban areas. Carsharing can also serve as a means to achieve more sustainable mobility systems which are less dependent on car ownership (Greendeals, 2018). As a shared vehicle is expected to replace multiple private vehicles, there is potential for increased liveable public space due to lower parking space requirements as well as reduce greenhouse gas emissions (International Transport Forum, 2016).

In 2018, the Greendeal Autodelen was renewed, aiming to reach 700.000 carsharing users and 100.000 shareable cars by 2021. The first goal has been reached in November 2020, but the second is still to be aimed for (CROW, 2020). Reaching the Greendeal goals shows the increasing number of carsharing vehicles and users as well as the general potential carsharing has to grow and expand throughout the Netherlands.

Young adults: potential user group for car sharing?

Münzel et al. (2019) have described carsharing as an innovation in the transition from traditional ownership to usage-based systems. In this innovation, young adults are often mentioned as an important potential user group and a general early adopter group of innovations (Münzel et al., 2019). Positive personal traits of young adults that contribute to them adopting carsharing are higher educational attainments, pro-environmental attitudes (Hopkins, 2016) and pro-technology attitudes (Faber et al., 2020; Acheampong & Siiba, 2020). Additionally, car ownership among 18-30-year-olds is decreasing (Klein & Smart, 2016). In the Netherlands, there is a small decrease in car ownership among young adults between 2015 and 2020 (CBS, 2020). Especially Dutch urban young adults own significantly less cars than their rural counterparts (Kampert et al., 2018). Young adults also have lower financial resources to own and sustain a car (CBS, 2018; Münzel et al., 2020) making them an interesting potential user group for carsharing.

Stating that car ownership is decreasing among young adults is too simple, as it also often concerns the delay of car ownership rather than a permanent mobility shift as people study longer and buy houses later in life. (Kampert et al., 2018). Such life changes can have a significant impact of car ownership (Oakil et al., 2016). By being already familiar with carsharing and using it, buying a (additional) car can be prevented despite the life events. If one has never owned a car, it is perceived as less of a loss and therefore makes the use of a carsharing service easier (Liu et al., 2014).

Overall, encouraging carsharing amongst young adults could be really fruitful as the age group generally has a lot of positive potential user group characteristics, like a high frequency of living in more urban areas and lower car ownership. Furthermore, young adults are often familiar with using a multitude of transport modes which makes them more likely to try and integrate new modes of transport in their daily life (Münzel et al., 2019). Tech-savvy mindsets also make them more open towards carsharing (Münzel et al., 2019) and MaaS services (Zijlstra et al., 2020).
Groth (2019) described young adults as the 'new generation' in a transition towards smart and sustainable mobility as this group moves away from private car ownership. In the transition from ownership-based mobility systems to sustainable user-user based systems, the next generations of car owners and car users – Gen Y, millennials etc.- can play in an important role in enabling a sustainable mobility shift. Therefore, there is clear importance of in-depth research into how to make carsharing attractive to groups that could really benefit, including lower income groups (Münzel et al., 2019).

Focus on carsharing networks in the Dutch Urban regions

Illgen & Höck (2020) stressed the importance of stimulating carsharing supply to potential user groups in order to expand the carsharing network. This requires selecting business cases where carsharing has the potential to attract a lot of users. As highlighted by Dias et al. (2017), the large groups of young adults living in high density (urban) regions are important target group for carsharing networks. Figure 1 illustrates the inward movement of young adults (purple lines) into Dutch urban areas which has exceeded outward-migration (blue lines) since 1996 (Husby, et al., 2019).
Additionally, urban regions are often able to sustain multiple transport modalities such as trams and busses due to high (potential) user numbers. Having this multi-modal transport system makes it easier to live without a car as there are more supplementary transport options for potential carsharing users (Münzel et al., 2020). Lastly, at this moment in time, rural regions are not as attractive business cases for carsharing companies, neither is there a high interest in carsharing among rural populations (Rotaris & Danielis, 2018).
There is a logical focus on carsharing in urban regions. To successfully expand carsharing, there is an urgency to regulate and also steer the developments of carsharing to enable upscaling and switch from the early adopter phase to the early majority user phase as a means to create more sustainable mobility systems.

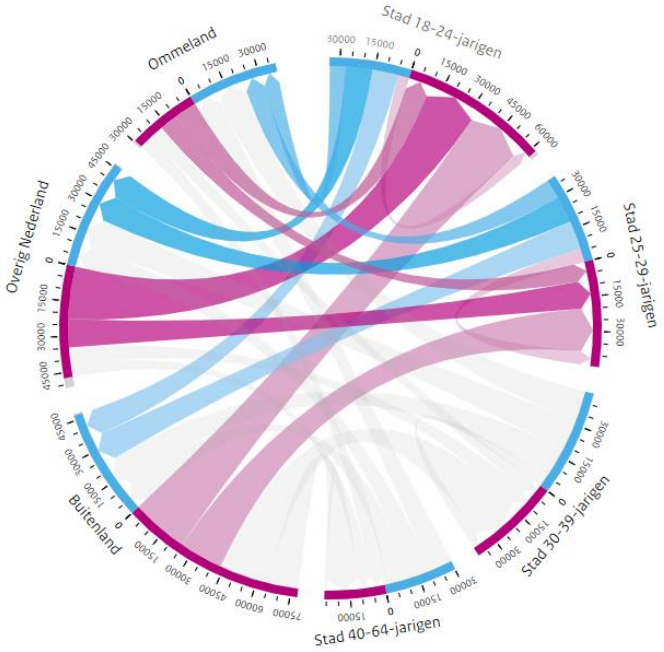


Figure 1: Overview of urban migration among Dutch young adults (Husby, et al., 2019)

1.2 Carsharing as innovation for a sustainable mobility transition

Environmental problems are often complex and often require more than incremental changes; it requires a substantive transition (Geels, 2010). Systems such as mobility systems are often embedded into institutional arrangements, investments and behavioural patterns; 'path dependency', making it difficult to change them (Geels, 2010). However, if climate mitigation is desired, a transition in mobility systems is necessary (Geels, 2018). This transition requires a change from current mobility policies and institutions focussed on private car ownership as regime, to sustainable mobility policies on a regime level (Münzel et al., 2020b). Sustainable mobility according to Banister (2008, p. 73) *"(…) provides an alternative paradigm within which to investigate the complexity of cities, and to strengthen the links between land use and transport".* Spatially, this entails that sustainable mobility systems would offer innovative services (e.g., carsharing) and public transport as highest priority, through accessible corridors. Additionally, mixed developments would encourage active forms of transport more, where *"the intention is to design cities of such quality and at a suitable scale that people would not need to have a car" (*Banister, 2008, p. 74).

Figure 2 presents a multi-level perspective on socio-technological transitions and how they can be achieved. It can provide a schematic overview of the dynamics at play when striving for a change in established systems (Geels, 2018). Considering carsharing as an innovation in this multi-level perspective is according to Meelen et al. (2019) a suitable case as it can transform the mobility system as well as change the existing regime.

The *landscape* or *macro* level represents the large societal trends and changes, such as political changes, macro-economic changes, or cultural shifts (Brugge et al., 2005). Such changes create pressures on the existing *regimes*, creating windows of opportunities for innovations from a micro-level to create change (Geels, 2010). Current mobility systems (fossil fuel ownership-based systems) have resulted in different landscape pressures such as transport poverty (Wappelhorst et al., 2014) climate change, air pollution and over-use of resources (Burghard & Dütschke, 2019). These pressures are strengthened by the need for more sustainable mobility systems as defined by the climate agreement (Rijksoverheid, n.d.).

The *regime level* or *meso-level* consists of different institutions, rules and regulations. It provides the structure for the social system (Brugge et al., 2005). The regime level is often quite rigid, due to the formally embedded rules and regulations that make change more difficult (Smith et al., 2005). On one hand, the regime level consists of informal institutions such as the car as status symbol and commuter patterns (Meelen et al., 2019). Private vehicle ownership has become the regime mode of transport around which the mobility system is designed. With regards to formal institutions, in the Netherlands, carsharing is regulated on municipal level, however, with each municipality defining their own rules and regulations for carsharing, parking policies and private vehicle ownership. Besides municipal regulations, there have been attempts for implementing sustainable mobility policies on the regime level (see Explainer, p. 81), although it has not led to a substantial sustainable mobility transition or change.

On a *micro* or *niche* level, niche innovations can form the foundation of for a transition (Geels, 2010). They are small networks that experiment and develop innovatory concepts and ideas, that can grow and align to become an idea that will disrupt the existing regime (Brugge et al., 2005). Looking at a transition in mobility systems from ownership to more user-based systems, carsharing is deemed a promising innovation that can help with this shift (Kimbrell, 2021).

With over 700.000 users in 2020, (CROW, 2020) of carsharing platforms, one could argue that the early adopter group of carsharing has been established, although carsharing is still a niche. To move from early adopters to early majority however, the CROW (n.d., a) argues that there must be a full-fledged consumer product, or PSS (Liu et al., 2014). Especially, social norms and societal influences play an important role for later adoption groups (Burghard & Dütschke, 2019). A challenge in every transition is connecting niche innovations to regime-based institutions, and actually realising a transition. Geels (2010) has mentioned the struggles between niches and regimes, as the innovation actively replaces an existing concept.

To understand how a niche such as carsharing can actually influence regime changes, it is important to consider who the early adopters are, and which later adoption groups can be considered in the transition. As young adults are considered to be an attractive potential user group and traditional 'early adaptor', targeting them can help upscale and expand carsharing networks towards an early majority phase (Münzel et al., 2019).
Considering the landscape pressures created by the current ownership-based mobility system, and innovations from the micro level, such as carsharing, it is relevant to look at the role of policy instruments in developing and stimulating connections between niche carsharing innovations and regime-based institutions.

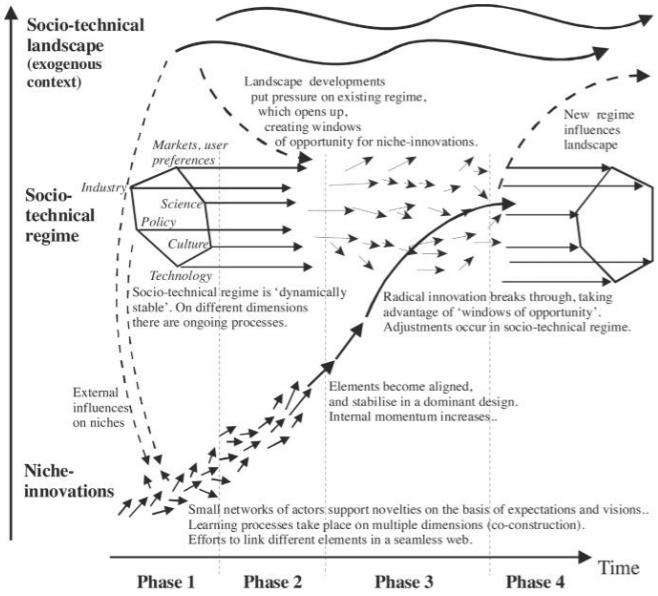


Figure 2: multi-level perspective on socio-technical transitions (Geels, 2018)

1.3 Academic and societal relevance

Societal relevance

In 2013, 50% of young adults between 25-29 did not know carsharing existed (61% of young adults between 17-24 years) (Jorritsma & Berveling, 2014). Since then, carsharing vehicles have increased significantly (CROW, 2020). Greenwheels experienced an increase in carsharing users under 32 making up 33% of Greenwheels' clientele in 2018, highlighting that there is a real interest among young adults (Goudappel Coffeng, 2018). Although young adults are seen as an important potential user group to cater to, there is no recent data available on how to cater to such user groups (KiM, 2015). This knowledge gap can make carsharing policies less effective ad carsharing generally less attractive for the general public.
Secondly, well-placed shareable cars can offer a valid alternative to car ownership and therefore prevent individuals or households from buying a (second) car and improve transport accessibility (CROW, 2020b). There is however limited knowledge about where shared vehicles are placed in urban regions as this knowledge is currently only per provider available. Therefore, to know where shared vehicles are located in an urban network, can contribute to better policy making and also help upscaling of carsharing networks and a knowledge gap that should be targeted.
Thirdly, there is a real challenge in how to develop carsharing policies for governments. There is often a desire for harmonisation of carsharing policies and knowledge sharing between governments, however a lot of policy differentiation remains (CROW, n.d.). Where the CROW (n.d.) has made an effort to make policy standards accessible for a broad public, the relationships between the national government, municipalities and also carsharing providers and how they are affected by policy making remain largely unexplored which could contribute to better understandings on why policy harmonisation has proven difficult.

Scientific relevance

This research aims to discuss the possibilities of upscaling carsharing through focussing on young adults as early adopter and potential user group. This is desirable as carsharing is deemed to be able to contribute to more sustainable mobility systems. Where there has been research into carsharing user groups and how they use carsharing such as Münzel et al. (2019) and Zhou et al. (2020), this is often to a limited extent translated to policy measures. Carsharing research has mostly focussed on the empirical aspects such as why people adopt carsharing and the impact of carsharing on the environment (Tuominen et al. 2019), but has not considered the potential policy measures that can be implemented to improve and stimulate carsharing (Münzel et al., 2020b). This research aims to reduce the knowledge gap between user groups and policy measures by looking at the user group young adults, their motivations for carsharing, and how this translates in current and potential policy measures.

As Tuominen (2019, p.2) have stated *"Car sharing is still a marginal issue and very little information, approaches or tools exist on how to expand locations of car sharing areas and user base in a sustainable manner, and integrate the sharing mode into transport and urban planning and local decision-making in practice".* Where Tuominen (2019) have taken a specific focus on the urban form in exploring how to upscale and expand carsharing in a sustainable manner, this research will aim to contribute insights to this knowledge gap from a transition theory perspective focused on how policy measures can contribute to better niche stimulating carsharing policies including how to make carsharing more attractive for young adults, as well as looking at regime disturbing policy measures.

Spatially, Meelen et al. (2019) described that the presence of B2C vehicles is influenced by certain landscape and regime factors being present. Better carsharing policies could contribute to creating more favourable conditions for carsharing on the regime/landscape level which can help the upscaling of carsharing. By looking at the location of shared vehicles, and demographic characteristics, this research aims to contribute insights in the location of shared vehicles linked to demographic characteristics to define favourable spatial conditions for carsharing.

Upscaling carsharing networks from a niche product to a generally accessible service is expected to help reach the goals in the Dutch Climate Agreement (Ministerie van Infrastructuur en Waterstaat, 2019) as well as relieve pressures on urban areas. However, policy makers do not know which policy objectives and measures can be implemented to aid and support this upscaling process. As the Explainer (p. 81) has illustrated, despite attempts by the current 'mobility regime' to introduce sustainable mobility policies, these have yet to lead to concrete changes. By interviewing experts, this research aims to explore the barriers and opportunities for the upscaling of carsharing.

1.4 Research questions

The increasing pressures on urban regions as well as the established sustainability goals of the Dutch government (Climate Agreement) illustrate the need for a transition in the current regime of mobility usage and mobility policies. Establishing carsharing networks (niche innovations) embedded in sustainable mobility governance policies could facilitate this shift, especially with catering towards young adults, a traditional 'early adopter group'. This research therefore aims to answer the following question: **How can carsharing policies focussed on young adults, support upscaling of carsharing as part of a sustainable mobility system in Dutch urban regions?**

To structure the research, a few theoretical sub-questions are addressed that will guide and frame the conceptual model and therefore the data collection design. The empirical sub-questions will be guiding the research design, data collection, and data analysis. Appendix 1 elaborates per sub question which research method has been used.

Theoretical research questions

1. What is carsharing and what is its potential for sustainable mobility policies?

2. Which factors influence the adoption of (sustainable) carsharing by young adults?
3. What are barriers and opportunities in carsharing policy making discussed in international literature?

Empirical research questions

4. What are the current B2C carsharing networks and the spatial distribution in the urban regions of Utrecht and Groningen?
5. What are differences between young adults and other user age groups in how they use carsharing services?
6. What motivations stimulate young adults to adopt B2C carsharing?
7. What are the current (urban) carsharing and sustainable mobility policy frameworks in the Netherlands and how are these perceived by carsharing practitioners?
8. What are the barriers, success factors and conditions needed for the planning of successful carsharing networks in Dutch urban regions?

1.5 Structure of this study

The following Chapter (Ch.2), will start with a dive into what carsharing is and what impacts carsharing can have on the different landscape pressures that exist in current urban mobility systems. In the second leg of the theoretical framework, the factors that influence potential carsharing users to adopt carsharing will be discussed, as these users are needed to further upscale carsharing. In this section, personal, economic and spatial influencing factors have been determined. In the third leg of the theoretical framework, different policy recommendations from literature will be discussed (user group, economic and spatial policy suggestions) as well as what sustainable mobility systems entail.
Chapter 3 explains the methodological steps taken in this research. First a general introduction into the research framework will be given, after which, the three research methods (GIS, secondary data analysis, interviews) will be explained, where the section ends with ethical considerations. In the results, Chapter 4, a similar structure is followed, where for each research methods the results have been discussed, as well as a concluding section where findings from theory have been compared to the findings from the results. Chapter 5 concludes the research and includes the discussion including recommendations for further research. Chapter 6 offers a reflection on the research process.

2. A theoretical framework on carsharing

In this chapter, different aspects of carsharing will be discussed as part of developing a theoretical framework. The first section will explore different forms of carsharing, whereas the second section considers the impact of carsharing on the environment. At the end of these two sections, a conclusion will be made on which carsharing format is the most attractive to stimulate through policy making.
The third section discusses three factors that can influence the adoption of carsharing. The section will go into personal, economic and spatial factors. In the last section describes carsharing in the context of sustainable mobility policy frameworks and gathers policy recommendations from literature, categorized similarly to the influencing factors in user group, economic and spatial policies. Eventually, the chapter's theoretical findings will be gathered in the conceptual model.

2.1 Exploring carsharing, a niche innovation

Carsharing as the practice in which an individual can use a locally available car at any moment and for a self-determined duration (Münzel et al., 2019). It is a form of car rental which enables users to rent cars for a short time period. Car renting is not new, companies such as Hertz and Europcar have been in business for years. However, there are some significant differences between carsharing and car renting (Liu et al., 2014). Car renting is often in time slots of days, whereas carsharing can be for any duration desired by the user, simulating more of a car ownership feeling. Furthermore, carsharing is often organized through memberships whereas car renting does not require this. Lastly, insurance and fuel costs are often covered in carsharing through the membership and hourly rates, but with car renting, these costs are frequently excluded or charged additionally (Liu, et al., 2014).
These differences, make carsharing networks Product Service Systems (PSS) which actively aim to provide equal or improved accessibility and functionality to products without having to own these products.
Most carsharing forms can be categorized as either business-to-consumer (B2C) or peer-to-peer carsharing (P2P) (Münzel, et al., 2019). Figure 3 provides a schematic overview of the different carsharing forms under B2C and P2P. B2C carsharing consists of companies providing a fleet of cars to consumers through digital platforms, with key boxes for 24/7 access and general contactless services (e.g., Greenwheels or MyWheels). B2C is frequently permitted and regulated through municipal permits. Traditional B2C round-trip carsharing also includes reserved parking spots(Münzel, et al., 2020). One-way carsharing is a newer form, where cars can be left somewhere around the city or at specific stations (Münzel, et al., 2019). The possibility to return the car to a different carsharing hub parking spot is seen as attractive characteristic (KiM, 2015).

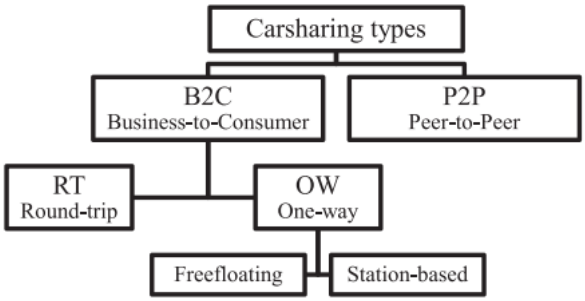


Figure 3: Overview of carsharing types by Münzel et al. (2020)

P2P carsharing concepts centre around individuals being able to rent out their car to peers. This often happens via online platforms such as Getaround or Snappcar and can take place wherever (Münzel et al., 2020). Although platforms provide general rules, each individual vehicle provider has different regulations for their vehicle. Additionally, their motives are often aimed at renting out to friends and family, rather than developing a widespread network of shared vehicles (Rotaris & Danielis, 2018). An

importance difference between P2P and B2C is that P2P platforms have a lower user frequency compared to B2C options as owners/advertisers on P2P platforms do not experience financial liabilities if the car is not rented out (Münzel, et al., 2020). Contrary to P2P providers, B2C providers need enough demand in order for the operator to justify the investment of shareable cars and run a profitable business.

Two different forms of carsharing not included by Münzel et al. (2020), but discussed by CROW (n.d., b), are business to business (B2B) carsharing and local communities. Local communities are often neighbourhood initiatives that share a (second) car (CROW, n.d., b). 'Business carsharing' provides carsharing opportunities via an employer and is perceived to have great potential (CROW, n.d., b). Work is specifically for young adults often a reason to buy a car (Hopkins, 2016). Clark et al. (2015) described that B2B can contribute to creating more sustainable work-related travel for both employers and employees as well as be complementary to regular carsharing, as it concerns different hours of the day.

In order to upscale carsharing as niche innovation and contribute to a sustainable mobility transition, it is important that the format is as accessible to every user group as possible As B2B and local community carsharing are not generally accessible to everyone (it depends on your neighbourhood or employer), either P2P or B2C carsharing could be considered more suitable. However, as Münzel et al. (2020) premised, P2P shared vehicles might not be used as optimally, as B2C shared vehicles are, due to different business objectives. To consider which business model is more suitable for the upscaling of carsharing through policies, the next section will discuss the impacts carsharing can have on urban environments.

2.2 Solving landscape pressures: the impacts of carsharing on (urban) environments

Carsharing is a means to create a more sustainable mobility system and through that reduce landscape pressures. This section will discuss the potential impacts of carsharing on the environment will be discussed in the context of the impact on the climate (sustainability), the social environment (social inclusivity) and the urban environment (liveability). To what extent there is a positive contribution depends on the different carsharing business models (Smolnicki & Soltys, 2016). Often the potential impacts of carsharing are translated into policy motivations to stimulate carsharing. One must consider that these are three separate policy reasoning as the impacts on these environments. This entails that carsharing can contribute to lower CO_2 emissions (sustainability) but might increase transport poverty (social inclusivity). The three impact spheres should be seen as separate entities. At the end, a selection in the earlier presented business models will be made, based on how positively these business models can influence the environment to elaborate on further.

Potential impacts on the climate

Climate change is a significant issue that has humankind has to face, and for which, after many years, policy steps are being taken (Rijksoverheid, n.d.). CO_2 emissions and air pollution are issues that put pressure on the landscape level. Nijland et al. (2015) researched the impact of carsharing on climate pressures and found that car sharing users' car ownership decreased from 1.08 cars to 0.72 cars in 2014. Shaheen et al. (2020) also found that in their research, 25% sold their private vehicle, and 25% postponed vehicle purpose after starting using round-trip carsharing. The mileage also decreased after starting carsharing from 9.100 to 7.500 kilometres averagely (Nijland et al., 2015), something Münzel et al. (2020) attributes to the use of multiple travel modes. When it comes to CO_2 emissions, car sharers emit 175 to 265 fewer kilograms of CO_2, an 8-13% decrease in vehicle-related emissions (Nijland, et al., 2015). Especially electric carsharing vehicles could reduce CO_2 emissions even more. Using electric shared vehicles contributes to lower greenhouse gasses, as well as better air quality and lower congestion levels in urban areas (Wappelhorst et al., 2014). These numbers are based on B2C roundtrip carsharing business models. There is an active effort by B2C companies to optimize the use of shared vehicles and their emissions (Münzel et al., 2019), whereas with P2P carsharing, there is less financial

incentive to optimally replace private car ownership, as the car is still in 'private ownership'. Generally, there is also less information about the impact of P2P on greenhouse gasses because of the ownership structure.

Potential impacts on the social environment

Besides environmental benefits that are associated with climate pressures on the existing mobility system, there are also social environmental benefits to carsharing. Wappelhorst et al. (2014) highlighted the potential positive aspects of carsharing on the social environment. Carsharing grants access to a car for households without one, or households that do not have the funds to buy and sustain a car full time, reducing transport poverty. Münzel et al. (2019) similarly described that people with a lower income in their study showed extra interest in carsharing due to the cost-effective mobility opportunity it provides.

In international literature, the concept of 'transport poverty' is often used to describe *"(…) the social exclusions of mainly the marginalized persons (such as often those with low income, low education or precarious employment), which can be attributed to a lack of mode options (driving license, own car, PT access, own bicycle, etc.)"* (Groth, 2019, p. 57). Where Wappelhorst et al. (2014) has seen carsharing as solution for transport poverty, Groth (2019) shares concerns about how new forms of smart/sustainable mobilities will actually increase transport poverty. Marginalized groups and neighborhoods most likely have limited access new sustainable modes of transport such as carsharing as it would not be available in their area (Groth, 2019).

Although new sustainable mobilities have a real chance of reducing CO_2 emissions as discussed above, corrections in multi-modality supplies might also be valuable to prevent transport poverty in western countries, and can also support broader sustainable mobility within urban regions or rural areas to resolve transport poverties (Groth, 2019).

Potential spatial impacts on the urban environment

In the spatial environment, carsharing can reduce the need for (urban) parking spaces (Carrone et al., 2020; Münzel et al., 2020). Especially in urban areas can carsharing be a great solution for spatial pressures according to Schreier et al. (2018). Private vehicles are not in use for the majority of the time, which illustrates the ineffective use. Shaheen et al. (2020) stated that on average, 1 round trip carsharing vehicle can replace 9 to 13 private vehicles, which would create new free urban space. Jochem et al (2020) researched the potential of free-floating carsharing and the impact on car ownership and found that throughout European cities, 1 free-floating B2C vehicle could replace 11.4 private vehicles. This reduced need for parking allows for other uses, such as greenery, recreation or clean mobility modalities (Münzel et al., 2020b). In P2P carsharing, this reduction in car ownership is not present (Meelen et al., 2019).

Secondly, Faber et al. (2020) and Carrone et al. (2020) see that carsharing would take away from public transport. Especially, in a futuristic MaaS system, people would start using traditional PT a lot less according to Faber et al. (2020). However, in correlation with the existing mobility systems, Shaheen et al. (2020) found that carsharing users actually increase their PT usage or non-motorized modal uses. Schreier et al. (2018) have also found that carsharing users do not decrease their PT use, but actually increase their trips made through PT, cycling and walking. This reduces traffic and benefits urban traffic flows and potential congestions. The KiM (2015) has described the integration of PT and carsharing as a success factor that helps carsharing establish itself as a more sustainable mode of transport for users. Having access to multi-modal transport system as carsharing user is considered to be quite important (Münzel et al., 2019).

Lastly, Schreier et al. (2018) described that carsharing users shop more in their local neighbourhood, rather than large shopping centres, contributing to the local neighbourhood's economy. The local services are more important to individuals that do not own a vehicle.

Even more sustainable: Electric and Hydrogen carsharing

Generally, carsharing is perceived as a more sustainable form of (urban) mobility, as research has shown that carsharing users utilise cars less, and therefore emit less CO_2 (Nijland et al., 2015) as well as reduce the pressure on the urban environment (Münzel et al., 2020). However, carsharing could potentially be more sustainable for instance using electric or hydrogen cars.

Electric vehicles (EVs) can contribute to a more sustainable, climate and environmentally friendly mobility system (Wappelhorst, et al., 2014). Even if EV batteries are not charged with renewable energy, the ecological impact of owning a private (fuel-based) car is much larger, due to the non-renewable resources that are used for production and operation of the vehicle (Wappelhorst, et al., 2014).

In recent years, more EVs have been added to fleet of carsharing organisations such as the Nissan Leaf and Renault Zoe by B2C provider MyWheels (MyWheels, n.d.). However, charging infrastructure (and the lack of this) as well as the long charging time can be a challenge (Brandstätter et al., 2017). The operational aspects of EV carsharing are of higher significance than traditional fuel-based carsharing (Turón et al., 2019). For electric carsharing, monitoring is important for carsharing providers to create a functional and reliable sustainable mobility system, otherwise users might have unexpected uncharged vehicles (Turón et al., 2019).

Another innovation could be hydrogen powered carsharing. Similarly, to electric cars, it would provide a sustainable locally emission-free mobility systems which contrary to EVs can be re-fuelled quickly (Klöppel et al., 2019). The energy density of hydrogen batteries is compacter, and therefore, hydrogen cars could theoretically drive similar distances as traditional fuel cars. Due to the lack of hydrogen infrastructure, the price and lifetime of the fuel cells and lack of regulations, rolling out a hydrogen carsharing system is still a challenge (Kriston et al., 2010). Kriston et al. (2010) predicted that after 3 years of operating, a hydrogen based carsharing system should be profitable in 2010. In Munich, a hydrogen carsharing provider is already active (Klöppel et al., 2019).

Conclusions

As was already concluded, P2P and B2C carsharing models are most accessible. As private sharing model, P2P providers are difficult to regulate with national or municipal policies, whereas B2C can be regulated through permits and policies.

In the second section, the impacts of carsharing on the urban environment have been discussed to examine the potential of carsharing in sustainable mobility policies. It has been made clear that B2C carsharing has the most well-researched positive impacts on sustainability (CO_2 reductions, decrease in air pollution), social inclusivity (reducing transport poverty provided that there is proper regulation) and the liveability (fewer parking spaces needed, less congestion). For P2P carsharing, such results cannot be found. As B2C carsharing business models are often regulated through municipal and national policies, this form of carsharing is deemed to be the most sustainable. Therefore, B2C is deemed the most suitable form of carsharing to integrate into sustainable mobility policies to contribute to a more sustainable mobility transition.

2.3 What grows a niche? Influencing factors of carsharing adoption

In the introduction, young adults that live in urban areas, who are frequent public transport users, generally higher educated, male and have environmental concerns are a good potential ***user group*** for both carsharing (Münzel et al., 2019; Carrone et al., 2020). In order to grow a niche, in the case of carsharing, the number of carsharing users must grow, and move from early adopters to early majority (Münzel et al., 2019). To build onto this knowledge, the following section will explore the different factors that can influence the adoption of carsharing by young adults. Throughout, a distinction will be made between personal, economic and spatial influencing factors. Although this distinction is not explicitly described in literature, scientific articles tend to focus on specific perspectives of carsharing. The distinction between these three influence groups illustrates the different points of view from which carsharing influences can be considered. The first sub-section on personal influencing factors

directly influences the potential user group of young adults, a topic Münzel et al. (2019) and Kent & Dowling (2018) have written about. The second section discusses economic influencing factors which relate to the costs associated with carsharing as well as external costs. Carrone et al. (2020) and Zhou et al. (2020) have looked at the influence of such factors. The last segment centres around spatial influencing factors. Hu et al. (2018) and Meelen et al. (2019) are among the authors that have looked at spatial characteristics and how they can increase carsharing adoption among user groups.

Personal factors influencing carsharing usage

Personal factors that can influence carsharing usage are discussed based on literature from Liu et al. (2014), Kent & Dowling (2018) and Zhou et al. (2020). Importantly, a driver's licence is a must-possess factor in order to participate in carsharing but not something that automatically leads to carsharing (Kampert et al., 2018). The following personal influencing factors have been found that do help contribute to carsharing: environmental awareness, low car ownership, the probability of needing a car, awareness and reliability & convenience.

Environmental awareness

Both Meelen et al. (2019) and Münzel et al. (2019) discuss environmental awareness as personal characteristic and important motivation for carsharing. Where Meelen et al. (2019) have found that individuals that are part of an environmental organisation, are a lot more likely to live in areas with more shared vehicles, Münzel et al. (2019) argued that environmental motivations have decreased, with economic and convenience factors becoming more important to carsharing users. Having sustainable mindsets is a user characteristic that is generally perceived to be positive for adopting carsharing (Acheampong & Siiba, 2020).

Low car ownership

Young adults between 18 and 30 have different motivations for car ownership and the lack there of. For working young adults, living in an urban area is one of the most preventing influencing factors on car ownership, whereas for students, this is income (Kampert el., 2018). This means that working young adults living in an urban area are less likely to own a car. Generally, not owning a car is perceived as a positive personal factor that can contribute to a higher likelihood of being a carsharing adopter (Münzel, et al., 2019).

The likelihood of needing a car: Certainty and probability effects

Liu et al. (2014) discussed carsharing as a PSS concept. Explained through prospect theory, individuals tend to overweigh the value of certain events (certainty effect) and overweigh the significance of events with a low probability (Liu et al., 2014).

Depending on the individual and how often they need a car, Liu et al. (2014) argued that they will choose different owning or service alternatives. Carsharing comes with higher risks (e.g., the car might not always be there) for those that desire high certainty of a car as can be seen in table 1. Although owning a vehicle might be more expensive, people that desire the certainty of being able to use a car on a daily basis due to fear of surprise and risk adverseness will accept those costs (Liu et al., 2014). Individuals with a high probability of frequent car use, are therefore less likely to choose a carsharing service rather than owning a car.

Table 1: Decision-making table by Liu et al. (2014) showing the difference between product owning and service using in carsharing context

	Low Cost	High Cost
Certainty Effect (High Certainty)	Highly certain will need a car on a daily basis, fear of disappointment, risk averse → choose product (i.e., car owning)	Highly certain will NOT need a car on a daily basis, desire to avoid high cost, risk seeking → choose service (i.e., car rental or car sharing)
Probability Effect (Low Certainty)	Lowly certain will need a car on a daily basis, desire of reduce cost, risk seeking → choose service (i.e., car rental or car sharing)	Lowly certainty will NOT need a car on a daily basis, fear of surprise, risk averse → choose product (i.e., car owning)

Awareness

Being aware is essential for adopting carsharing as has been researched by Jain et al. (2021) and Zhou et al. (2020). If carsharing is just 'available', individuals will not just 'give up their car' (Zhou et al., 2020). Not knowing about carsharing is the first initial barrier of adopting an innovation such as carsharing. As carsharing is not the default transport option or the social norm, therefore, people need to be informed (Jain et al., 2021). By normalizing carsharing new user groups can be encouraged to give it a try. If individuals were better educated and informed about carsharing; they are more open and likely to select a different preference including carsharing (Zhou et al., 2020).

Additionally, Münzel et al. (2020) described that if individuals are familiar and aware of different sharing systems (such as bicycle share of shared scooters) it has the possibility to create spill over effects. In the Netherlands, the shareable moped (NL: 'Deelscooter') is a new mode of transport that is rapidly becoming very popular, especially among young adults (Het Parool, 2020). This can be a catalyser for carsharing as new mobility modes and thus move young adults towards carsharing. As carsharing and shared mopeds are each unique modalities, being aware and having the option of multiple shared mobilities allows individuals to rely on multiple transport modalities, which is needed to make giving up a car attractive (Münzel et al., 2020).

Reliability of carsharing

Reliability of a carsharing service is very important for user groups to experience benefits. Having a shared car nearby positively influences carsharing adoption (KiM, 2015) and can be linked to the desire of certainty discussed by Liu et al. (2014). Schreier et al. (2018) have shared similar views and expressed the importance of a reliable carsharing system and a straight-forward book process.

Common complaints about carsharing are that a car is not always available or technology is not working perfectly (e.g., not unlocking) (Kent & Dowling, 2018). KiM (2015) also found user difficulties with time slots and technical challenges with using the shared cars (e.g., app is not working, car does not work).

Despite these complaints, users adapted a more flexible approach and booked additional time slots before and after to cope with the time uncertainty of their appointments and the to that extent less flexible carsharing (Kent & Dowling, 2018). If a desired shared car is not available, users will often select another one, or wait (Faber et al., 2020). Only 2% of the respondents selected another mode of transport. This illustrates the loyalty of users to the carsharing platforms. Where in an ideal situation, a car would always be available or nearby, user groups seem to still stick with carsharing despite this higher uncertainty compared to ownership.

Convenience of carsharing

The convenience of a carsharing service matters (Münzel et al., 2019). Increased usage of carsharing platforms makes individuals better aware of what they can expect and therefore increase convenience (Kent & Dowling, 2018). However, there needs to be a good convenience level to attract new users created by carsharing providers (Jain et al., 2021). Important barriers in convenience are carsharing with children and having to put effort into planning a trip which can be reduced through an easy-to-use app with quick reservation system (Kent & Dowling, 2018). However, mainly non-carsharing users saw carsharing as less convenient. Carsharing users mainly saw the benefits in convenience, such as having a clean new car always present, as well as reduced ownership responsibilities (Jain et al., 2021). Generally, convenience is perceived to be intertwined with the reliability/accessibility of carsharing (Jain et al., 2021). A carsharing provider that offers an easy-to-use service with reliable accessibility is an essential personal influencing factor that can attract user groups to a carsharing platform and have them continue using it and holds therefore an important position when it comes to reliability and convenience.

Economic factors influencing carsharing usage

Looking at the economic factors influencing carsharing usage, costs next to convenience are seen as two important influencing factors by Münzel et al. (2019) and Jain et al. (2021). 40% of the respondents in Münzel et al.'s (2019) questionnaire mentioned cost-saving as a reason to adopt carsharing. Bardhi & Eckhardt (2012) concluded similarly that carsharers are mainly motivated by self-interest and utilitarianism. In this section, a further look into different financial influencing aspects of the cost attractiveness of carsharing, the carsharing providers (Zhou et al., 2020), the cost comparison with car ownership (Liu et al, 2014) and other transport modalities (Carrone et al., 2020; Münzel et al., 2020).

Carsharing providers: the one who determines the pricing

KiM research (2015) has described that one of the preferred characteristics of a carsharing service are low costs, with a driving price of €0,30 per kilometre driven. Carsharing providers play an important role in setting the prices for carsharing and the secondary conditions. Ideally, the price setting by providers matches to general public willingness to pay. Compared to the KiM (2015)'s findings, the two largest B2C carsharing providers of the Netherlands, Greenwheels and MyWheels, are both under this target price for certain car options. However, the hourly rates as can be seen in table 2 are not included in this preferred characteristic, and thus makes it more difficult to compare.

Transparency about what to expect around carsharing including pricing is an important element of providing a reliable service (Kent & Dowling, 2018), in which carsharing providers have a main role. The one-time deposit that is often asked for, such as 225 euros for Greenwheels (Greenwheels, n.d.) can make carsharing less accessible and attractive for users. For frequent users, the subscription options can make carsharing more attractive such as My Wheels' Plus 10 euros p/m (MyWheels, n.d.). Another option it to offer discounts on longer-term renting which both providers already offer as long-term renting discounts.

Additionally, integrating carsharing in a MaaS system (multiple transport modes in 1 app) with one monthly fee for all transport modes could increase cost attractiveness with a set similar price to vehicle ownership as a way to create traction and create a clear picture of the costs (Zhou et al., 2020). However, this does take away the current principle that often attract users now; you only pay for what you use.

Cost attractiveness for users, car ownership vs carsharing

The cost of carsharing vs car ownership

Compared to car ownership is carsharing is the more cost attractive option if an individual drives less than 10.000 km on a yearly basis (Nibud, n.d.). Table 2 differentiates different costs between carsharing and car ownership. Owning a car is generally associated with having fixed monthly costs, whereas carsharing offers flexible pricing, often based on the usage (Münzel et al., 2019). Liu et al. (2014) mentioned that there is less awareness of the costs they pay while owning a car compared to using a carsharing service. Traditionally, services or renting have been as an inferior consumption mode compared to ownership, where people who rented, have been considered to be of lower financial status (Bardhi & Eckhardt, 2012). In recent decades, this perspective has changed, especially young adults have become more mindful about their spending habits and lifestyle, something which sharing economies contribute to. Young adults have less desire to own but want to be close to work and local businesses (Bardhi & Eckhardt, 2012).

Cost attractiveness could be emphasized more in targeting young adults as potential user group. Often individuals are not aware of the cost of vehicle ownership, and if, adapted to their life, carsharing could be a more cost attractive option.

The transaction costs of carsharing: framing effects

To get individuals to sell their car, and adopt carsharing, carsharing costs must be ideally be lower than car ownership rates to compensate for the framing effects and higher transaction costs (Liu, et al., 2014). Often, people 'frame' a loss (e.g., loss of car ownership) as more 'painful' than the happiness of

a similar gain (carsharing) called framing effects. Together with the inconvenience of sharing a car (e.g., finding the car, reserving the car), there are higher transaction costs for carsharing users compared to having a car constantly in the driveway ready for use.
Framing costs are not only negative, carsharing businesses can also take advantage of it. Framing included fuel costs and insurance as additional free no-risk gains to (potential) customers it makes it more attractive, especially for young adults, of whom many have not owned a car yet, and therefore do not experience negative framing effects.
Where the framing and endowment effects are for existing car owners' negative factors influencing their perception of carsharing, for potential carsharing users (the non-car owners among young adults), it can also be used as a positive factor, using the framing effect to highlight the gains of carsharing.

Table 2: Overview of the costs expected in owning a car versus using a carsharing service
Based on Dutch knowledge institutes and carsharing providers in In March 2021. Sources: (Nibud, n.d.), (Oostvogels, 2017), (MyWheels, n.d.) (Greenwheels, n.d.)

Owning a car			**Carsharing**		
Car size	***Fixed costs****	***Flexible costs*** **	***Car provider – size***	***Fixed costs per month****	***Flexible costs***
Mini (Citroën C1, VW up)	€144	€133	MyWheels mini (Citroen C1, Skoda CITIGoe)	€0 -25	€2,95 pcph*** €0,24-0,27 p/km
			Greenwheels (VW up)	€0 -25	€3-6 pcph €0,24-0,34 p/km
Compact (VW polo, Opel Corsa)	€187,50	€163,5	MyWheels electric (Renault ZOE, Nissan E-leaf)	€0 -25	€3,25 pcph, €0,24 p/km
Small middle class (VW Golf, Ford Focus)	€260	€201,50	MyWheels (Citroen C3)	€0 -25	€3,25 pcph €0,29 p/km
			Greenwheels (VW E-Golf)	€0-25	€8-11 pcph €0,12-0,20 p/km
Middle class (Peugeot 508)	€410	€258,50	Greenwheels (VW Golf Variant/VW Caddy)	€0 -25	€4,50-7,50 pcph €0,29-0,39 p/km

*Include: depreciation, insurance, vehicle ownership tax and maintenance. ** Include depreciation (unexpected), maintenance and repairs, and fuel. *** per car, per hour. + Greenwheels requires a one-time €225 deposit

Relationship between carsharing costs and other transportation modalities
Being a multi-modal transport user is a positive attribute of potential carsharing users and is often found in carsharing users (Münzel et al., 2019). However, carsharing can also take away from public transport depending on the costs of different transportation modes. Carsharing cost attractiveness is influenced by the price elasticities of other transport forms such as PT or the price of new vehicles (Carrone et al., 2020). Zhou et al. (2020) described that a 10% increase in PT fares, increases both car ownership and carsharing. On the other hand, if vehicle ownership costs rise, this leads to a higher carsharing percentages (although this increase is minor). Where certain authors are weary of carsharing and how it takes away from PT (KiM, 2015), Münzel et al. (2019, 2020) are firm believers in the combination of PT and carsharing in a multi-modal transport system that makes carsharing attractive.
Additionally, young adults could be positively influenced by integrating carsharing into the Student Travel Product (Studenten-OV), which Dutch students can use often free of charge, or at a 40% discount rate (depending on the subscription type). The 'Studenten-OV' provides cheap transport for studying young adults and is therefore of influence when considering the potential of carsharing amongst young adults as user group. Generally, students are frequent PT users as the CBS (2021) calculated that 41% of students with a week subscription use PT daily. Among individuals between the ages 18 to 25, 24% uses the PT daily, a sharp contrast to 8,6% average among the Dutch population. For students PT is a lot more attractive than carsharing due to this discount card. If the desire to create

a more sustainable mobility system, with lower car ownership rates, introducing carsharing through an integrated Studenten-OV multi-modality mobility system (such as MaaS) could positively influence young adults to try out carsharing.
A last economic factor that could positively increase carsharing usage are increasing the additional costs associated with owning and parking a car, described by Münzel et al (2020b) as regime-disturbing measures in the form of additional costs. Higher parking fares or congestion fees for cities can be additional steps to make car ownership less attractive (Zhou et al., 2020). These factors could be regulated through municipal and national policies and promote carsharing and other forms of sustainable mobility and make carsharing more cost-attractive.

Spatial factors influencing carsharing usage

From a transition theory perspective, carsharing as innovation in a sustainable mobility transition has the potential to reduce spatial pressures like parking pressures and pollution (Kimbrell, 2021). In general, as De Luca & Di Pace (2015) discussed, it is both about spatial characteristics of the PT system and the walkability in a neighbourhood as well as the design of the car sharing system that can be influence carsharing attractiveness.
This section will discuss the influencing role of neighbourhood characteristics including parking spaces (Hu et al., 2018; Münzel et al., 2020b), the spatiality of carsharing (Celsor & Millard-Ball, 2005) as well as the role the urban mobility system (Steeneken, 2019).

Neighbourhood characteristics

Meelen et al. (2019) have researched the potential of carsharing in the Netherlands. The current regime focused on private car ownership is strongest in more rural parts of the country. In these areas, carsharing is generally perceived to have lower potential. The higher the car ownership in neighbourhoods, the lower the chance of shared vehicles becomes. Additionally, neighbourhoods with above average households (such as big families) are less likely to have shared vehicles. Neighbourhoods with higher educated and higher income residents are more likely to have shared vehicles, as do neighbourhoods with a higher density and close-by facilities (Meelen et al., 2019). Neighbourhoods with a higher inhabitant density are often urban and have a larger potential user pool which makes placing carsharing vehicles more feasible and also allows multiple transport modes within one neighbourhood (Münzel et al., 2019). Living in an area with multiple transport modalities creates better spatial conditions for carsharing.

Neighbourhood characteristics: Parking places

An essential element of neighbourhood characteristics that influence carsharing adoption are the parking spaces. Without parking pressures, there is not enough motivation for carsharing and inconvenience in owning a car (Celsor & Millard-Ball, 2005). Hu et al. (2018) find a negative relationship between the number of parking spaces and carsharing as a continuous availability of parking spots encourages driving and private car ownership. A low availability of parking spots is therefore needed to provide the necessary parking pressures and irritations individual is expected to experience in urban areas and would stimulate carsharing. The difficult accessibility of parking places is a direct reason for individuals to shift transport modes. (Hu et al., 2018). In areas where parking spaces are limitedly available, carsharing initiatives could benefit from reserved parking places (Kent & Dowling, 2018) or premium access spots (Carrone et al., 2020).

The spatiality of carsharing: accessibility and density

In order to create a convenient service, it is important that shared vehicles are available in close proximity to users (Münzel et al., 2020). A ‘good’ service area for a shared vehicle according to Celsor & Millard-Ball (2007) is a buffer of 0.8 km. In the Netherlands, the KpVV Dashboard (2016) described service areas for different services with as a rule of thumb, a distance of 350m for a local bus stop and 450m for a more regional stop is used. A share vehicle should be available within a similar distance,

especially in urban areas where most daily needs are within 500m (KpVV Dashboard,2016). Whether this desired service density is met depends in large part of carsharing providers and on which locations they decide to request a carsharing permit.
Where carsharing providers decide to place their vehicles, and with what distance from each other can influence the network coverage and therefore the accessibility of carsharing. Looking at the spatiality of carsharing, having carsharing cars available within 400 to 800m is seen as a positive spatial feature.

Carsharing as part of urban mobility systems
As Münzel et al. (2019; 2020) have described, carsharing users also often rely on other transport modes. If there is a strong PT network, living a multi-modal transport mobility life is easier. As carsharing is part of an urban mobility system with its users using multiple modalities, considering the spatial relationships is relevant for a good carsharing network. In this network, different carsharing locations or stations should not be too close to each other, as it decreases their effectiveness (Hu et al., 2018). Additionally, Hu et al. (2018) found that for free-floating carsharing stations near transit hubs attracted more users, but also created inefficiencies (too many cars in one location). Hu et al. (2018) found that both shared vehicles near transit hubs as well as in areas with less transport modalities (maybe even with transport poverty), were used quite effectively.
To work towards a sustainable mobility system, Hu et al. (2018) argued that it is important that transport modes complement each other. It is therefore important to create complementing transport systems rather than competing transport systems. In areas where there is a dense PT network, PT should be given a priority to relieve the traffic burden and therefore carsharing should not be oversupplied as this also does not seem to increase turnover (Hu et al., 2018). Currently, carsharing is used unimodally in the Netherlands (Faber et al., 2020) due to the Round-trip business models. Next to carsharing locations in areas without PT and close by potential user groups, mobility hubs are one way to complement different transport modalities. A hub can have many different definitions, but in a mobility perspective if often a place where different types of transportation come together. It is also a place where new mobility concepts such as MaaS and carsharing can be integrated (Steeneken, 2019).
Carsharing locations should be spatially spread, and not too close together. Carsharing locations should both include locations in neighbourhoods, potentially further away from other PT modalities, as well as locations near transit locations to create a complementary mobility system.

Conclusion

Table 3 provides an overview of the factors identified in literature that can influence carsharing adoption amongst young adults. This overview summarizes the different perspectives from literature in the three factor categories. General positive personal traits that have already been discussed in the introduction are being a ‘Multi-modal transport user’, having an ‘environmental mindset’, being ‘technologically aware’ and ‘higher educated’ (Münzel et al., 2019).
Personal factors are for the most part directly related to the young adult user group themselves, and their own behaviour. There are however correlations between personal factors of behaviour, such as how often someone needs and uses a car, and the financial attractiveness of carsharing for that individual. Secondly, for some of the influencing factors, there is a prominent role for the carsharing provider, shown in table 3. Reliability and convenience are determined by the format provided. The cost attractiveness also depends on the price providers ask for their service. The three main influencing factors described in literature are cost attractiveness (Münzel et al., 2019.; Bardhi & Eckhardt, 2012; Liu et al., 2014), convenience/reliability (Münzel et al., 2019; Jain et al., 2021; Kent & Dowling, 2018) and neighbourhood characteristics such as parking pressures (Hu et al., 2018) and accessible multi-modal transport systems (Münzel et al., 2019).

Table 3: Overview of different influencing factors on carsharing based on previously discussed literature.

Personal factors	***Factor***	***Remarks***
	Driver's licence possession and car ownership	A driver's license is a required condition for carsharing, additionally income and urbanity influence car ownership (Kampert, et al., 2018).
	The likelihood of needing/using a car	The more an individual needs a car on daily basis, the less attractive carsharing becomes (Liu et al., 2014).
	Awareness	The foundation for attracting new users. Can be improved through educational campaigns (Zhou, et al., 2020).
Role carsharing provider	Reliability and convenience	A reliable carsharing platform that is easy to access and book attracts and keeps users (Kent & Dowling, 2018).
Economic factors	***Factor***	***Remarks***
Role carsharing provider	General cost attractiveness	Determined largely by the carsharing provider. Depends on the frequency of car usage (personal factor) and potential for discounts.
	Costs of car ownership compared to carsharing	General mindset towards the status of ownership (Bardhi & Eckhardt, 2012). Transaction costs for carsharing are often experienced to be higher compared to owning a car. Framing of costs influences attractiveness (Carrone et al., 2020; Liu et al., 2014).
	Price elasticities other transport modalities	Influenced to an extent by market mechanisms (e.g., the cost of a car) (Carrone et al., 2020). Regime disturbing measures (congestion fees, parking fares etc.) can make carsharing more attractive (Zhou, et al., 2020). OV-card amongst students makes PT very attractive, potential to include carsharing.
Spatial factors	***Factor***	***Remarks***
	Neighbourhood characteristics	Higher density neighbourhoods, with facilities close and lower ownership rates are higher potential carsharing places (Meelen et al., 2019)
	Parking spaces	Limited parking availability makes carsharing attractive, especially if shared cars have reserved parking spots (Hu et al., 2018).
Role carsharing provider	Density and accessibility of carsharing	A shared car should be available within 400/800m, more attractive in urban areas where there is a multitude of mobility modes available (e.g., trains, busses, shared cars) as well as in more urban areas (Celsor & Millard-Ball, 2007).
	Urban Mobility systems	PT and carsharing should complement each other to create sustainable mobility systems, hubs can be a central point where multiple transport modalities meet (Steeneken, 2019).

Looking ahead to the following section which will discuss policy recommendations, the strong role of the provider in these factors does not take away the assisting and contributing roles policies can have in upscaling the carsharing network. Especially the spatial influencing factors are mostly indirectly influencing carsharing attractiveness, through neighbourhood characteristics of parking space availability

In order to stimulate a transition to sustainable mobility, PT and carsharing should not compete with each other, but rather with existing private car ownership prices. Young adults and other potential user groups can be positively influenced to adopt carsharing If there are more attractive price options for both carsharing as PT compared to vehicle ownership.

2.4 Regime dynamics: Carsharing & sustainable mobility policies

In this section, a closer look will be taken at the current carsharing policy recommendations from literature to contribute to the knowledge how carsharing policies can be optimized. Beforehand, it is important to look in which context these policy recommendations should be applied.

Regime dynamics in sustainable mobility systems

As described in the introduction, in a sustainable mobility system according to Banister 2008), innovative services and public transport should be central features. Urban areas should also be shaped to include these features to create accessible corridors throughout urban regions. Relating to the transition theory described in the introduction by Geels (2010), there needs to be a shift from micro-level innovations, to embedding these innovations into institutional contexts (e.g., policy frameworks) on the regime level. This also requires a change in the current regime level contexts. Innovations and policy developments are influenced by broader macro-level developments (landscape pressures) and existing institutions (Geels, 2010). Therefore, this research aims to look at carsharing not just as a separate policy topic, but also as a part of broader sustainable mobility governance contexts.

In the urban spatial context, carsharing can reduce car ownership and replace around ten private vehicles and through that contribute to the reduction of landscape pressures (Shaheen et al., 2020). As Münzel et al. (2020b) stated, carsharing policies are currently aimed at supporting the small niche product of carsharing. In order to achieve Climate Agreement goals however, there is a shift needed from looking at carsharing as an isolated niche to carsharing as part of a broader sustainable mobility system. Currently, carsharing policies are quite reserved, and focussed on supporting carsharing as a niche innovation, rather than as part of a broader sustainable mobility transition. These are called niche supporting policy measures. On the other hand, there are regime-disturbing policy measures aimed at changing the existing regime of private car ownership. Such policy measures are only applied limitedly at this point (Münzel et al., 2020b).

Governance dynamics on a regime level

Governance concerns the role of the governments as a facilitator of cooperation between different social, political and administrative actors (Jordan, 2008). Different actors or stakeholders can influence the 'transition arena'. The role municipalities and the national government play in the regulating of carsharing matters, as it can influence the transition towards more sustainable mobility systems.

The explainer on page 81 has sketched the current governance and policy framework on national level, with the national government mainly organizing voluntary agreements. A lot of the regulations happen at local governmental levels, which greatly differs per municipalities. Existing carsharing policies do not align nationally, but are municipally differentiated making it difficult to actively change an existing regime. To stimulate policy standardisation, the CROW (n.d., f) Five main policy steps for municipal policy makers according to the CROW (n.d., f) are to *1) develop the right conditions (e.g. equal playing field for providers, sharing data, keep privacy as priority), 2) develop a permit system (e.g. first a pilot or not, which zones or parking spots, integration with other regions, costs for parking spots), 3) integrate carsharing in the mobility system of the municipality/region, 4) develop a route to zero-emission (time framework), 5) allow for experimentation, while also learn and regulate these (pilot) developments* (CROW, n.d., f).

On one hand, there is a growing desire for standardisation and uniformity in policy developments around carsharing (CROW, n.d.), which can help upscale carsharing. On the other hand, the conflicting principles on how to regulate carsharing and target user groups between municipalities remain (Münzel et al., 2020b). Governmental actors have the opportunity to influence carsharing providers and (potential) users through governance structures and help stimulate the upscaling of carsharing (Münzel et al., 2020b). However, these barriers make optimizing carsharing and stimulating carsharing as innovation in a sustainable mobility transition challenging. It also illustrates the change needed in the development of policies and thus far, policy makers often do not know how to achieve this (Münzel et al., 2020b).

Carsharing policy recommendations from literature

To shift from the segregated policy measures, and move towards more concrete harmonized policy recommendations on how to develop carsharing policies for young adults, policy suggestions from literature will be discussed. Recently, Münzel et al. (2020b) published a report based on a policy workshop among Dutch carsharing policymakers and experts. A distinction between 'niche-supporting' and 'regime-disturbing policy measures were made, which again finds its foundation in transition theory. The first category focus on supporting carsharing as niche, to protect and develop carsharing models, but not move forward to a transition. The latter, as mentioned before, aims to disrupt the established regime of owning a private car, which is needed in order to make space for new innovations to embed themselves institutionally and stimulate a broader sustainable mobility transition (Münzel et al., 2020b).

In the following section, the three established influencing factors (personal, economic and spatial) will be used as foundation for looking into common policy mobility policy fields. The first group of policies focusses on carsharing users, and how policy recommendations related to personal influencing factors can be integrated into user group based carsharing mobility policies. The second policy group, includes policy recommendations based on economic influencing factors, which does not only influence the user group, but the carsharing provider as well. The last policy group includes recommendations based on spatial influencing factors and mainly impact the spatial environment in which users live. Within these policy groups, the differentiation between niche-supporting and regime-disturbing measures will be made based on Münzel et al. (2020b). This distinction between niche-supporting and regime-disturbing is relevant as it can illustrate the contribution of the policy recommendation to the transition from a traditional car ownership-based mobility system, to more sustainable usage-based systems and take away the subordination that Münzel et al. (2020b) described carsharing has in the current mobility system.

User group policies

Zhou et al. (2020) have expressed the importance of education and awareness campaigns about carsharing to improve potential use. Education and increased awareness are necessary to increase carsharing usage according to Zhou et al. (2020) because people more familiar with carsharing are more likely to use it. Policy initiatives should emphasize educational aspects or include a general incentivising campaign (Münzel, et al., 2019).

Another element of user group policy is the reliability and convenience for users. An app that works consistently and good customer service can influence and enhance carsharing usage as well as a good service when things do not work (Münzel et al., 2019; Schreier et al., 2018). Where the service and app layout are mostly in hands of the carsharing provider, and what is convenient for users can differ per person, policies can stimulate different pilots and providers in order to offer more variety to citizens. The CROW (n.d., c) emphasized therefore to not commit too early as a policy maker to one direction of carsharing, but should allow for different carsharing schemes to be developed which are monitored to learn and create optimized carsharing schemes. This can eventually help enhance carsharing adoption (Zhou, et al., 2020). Research into carsharing users and their preferences could create more specific recommendations on how to cater to user convenience and reliability of a carsharing service Additionally, communication is key. When there are pilots or testing programs or changes of temporary nature, this should be communicated clearly to uses as taking away a shared car would mean that carsharing users lose a part of their mobility freedom (CROW, n.d., d).

Economic policies

Influencing economic factors to adopt carsharing are often based on cost attractiveness, the transactions costs and other costs associated with car ownership such as parking. The cost attractiveness is for a large part determined by carsharing providers, and they play an important role in the pricing of carsharing. Potential users can be stimulated to adopt carsharing by offering financial

incentives such as vouchers or discounts for specific user groups organised through policies (Münzel et al., 2020b). This can reduce transaction costs for those starting to use carsharing by making it more attractive to 'try it once'. For students, carsharing could be integrated into the PT-card that students receive that allows them to use PT for free. Carsharing does not have to be offered for free on this card, but could be offered at a discounted rate to let students get to know carsharing. It can stimulate carsharing and can increase awareness of carsharing among users and generally make carsharing more cost attractive.
Another niche stimulating measure could be to offer start-up subsidies to new carsharing companies which could indirectly stimulating a differentiation of carsharing companies and therefore enhance the chance of reliability and convenience for consumers as they can use different carsharing providers.
Furthermore, where for commercial parties, placing cars in rural areas of less dense areas is financially not attractive, municipalities do often desire good transport accessibility throughout their neighbourhoods. Subsidized parking spots in specific areas can be provided to carsharing companies to make an investment in particular area more attractive as it reduces external transportation costs.
Lastly, offering financial benefits and integrate carsharing with other mobility concepts was suggested by Zhou et al. (2020) whom proposed to offer a monthly (MaaS) subscription fee to use all kinds of mobility services. This both increases cost attractiveness for users while also integrating different sustainable mobility options.
Looking at economic regime-disturbing policy measures, financial disincentives could include raising car parking costs for private vehicle owners, or environmental zone taxes in urban areas (Zhou et al., 2020). Münzel et al. (2020b) also mention increasing general taxes on car possession as well as financial incentives for company (shared) cars to reduce private car ownership.

Spatial policies

Regarding spatial policies, awareness can be increased through uniform marketing and traffic signs highlighting carsharing locations (Münzel et al., 2020b). Secondly, to improve convenience for users, governments should offer reserved parking spaces for carsharing vehicles as searching for a parking space significantly increases transaction costs for users and makes carsharing less attractive (Carrone et al., 2020). These parking spaces should be easily accessible and safe (CROW, n.d., e). Thirdly, although carsharing providers usually determine where they want to place their shared vehicles (if permitted), local governments can steer the permits. Local governments can enhance the spatial distribution by offering financially attractive discounts (financial measure) as well as offering spatially optimal locations to carsharing providers on the condition of them providing a shared car in less (financially) attractive areas; a spatial trade-off policy through which municipalities can regulate the market and provide carsharing to a wider geographic audience. Especially with new forms of free-floating and one-way carsharing, Hu et al. (2018) argued it is important for municipalities to support the spatial distribution by managing the accessibility and density of the carsharing network by providing a location-based and geographically differentiated quota to manage carsharing program. This can prevent oversupply in areas, and can help create a transport network that enables each other, rather than compete with each other over different transport modes.
The latter disputed point in literature is the integration of carsharing with other mobility modes such as PT. As Tuominen et al. (2019) stressed, spatial carsharing policies should complement PT systems and active transport systems (e.g., walking), rather than taking away from PT and other more sustainable modes of transport. Integration of carsharing with other mobility concepts however, is needed to attract new carsharing users and should therefore by supported by developing parking spaces near PT facilities or hubs, as Münzel et al. (2020b) proposes. The CROW (n.d., e) provided another spatial perspective. Of the two spatial policy directions the CROW (n.d., d) proposed, the first is to develop carsharing parking spots in locations where a lot of car sharers live, or there is growth potential, a demand driven spatial policy. On the other hand, the CROW (n.d., d) proposes spatial distribution of carsharing through either hubs or a grid pattern (e.g., focussing on areas with transport poverty), developing a more supply driven policy.

Finally looking at regime-disturbing spatial policies, Münzel et al. (2020b) discuss the potential in parking policies, by changing parking norms or reducing the number of parking spots for private vehicles. Additionally, spatial policies and visions in the future could integrate carsharing measures more explicitly, highlighting a transition in the way individuals travel. Furthermore, carsharing measures should be integrated in future neighbourhood developments and the developmental policy plans so carsharing is already adapted into the local infrastructure.

Conclusion

Governmental parties play an important role in integrating national, regional and local visions, as well as regulating/enabling market desires (Schreier et al., 2018). Governmental parties can take a pioneering role into the provision of vision and policy documents that integrate carsharing in corporate mobility management as well as into broader sustainable mobility objectives. Table 4 (next page) provides an overview of the above-described policy recommendations, separated in two groups, niche-supporting and regime-disturbing policy recommendations.

There are no user group policy recommendations that are considered regime-disturbing. As Münzel et al. (2020b) have discussed, personally targeting car owners is for many policy makers a step too far and politically challenging, which could be an explanation as to why user group policies mainly focus on niche-supporting measures. Additionally, policy recommendations based on spatial and economic influencing factors often go together. For example, the spatial distribution of shared vehicles could be improved through economic solutions (offering subsidized parking) or a spatial trade off. In these categories, more regime disturbing measures are proposed, willing to challenge car ownership.

Table 4: Overview of niche-supporting and regime-disturbing measures as established by Münzel et al. (2020b) grouped in three policy groups (user group, financial and spatial) which relate to earlier discussed influencing factors

Niche-supporting	User group policies	Economic policies	Spatial policies
Increasing awareness	Awareness campaigns for young adults (Zhou et al., 2020; Münzel et al., 2020b)	Vouchers or discounts (e.g. Studenten OV) for specific user groups e.g., new users or students (Münzel et al., 2020b)	Traffic signs and national marketing that highlights carsharing (Münzel et al., 2020b)
Reliability and convenience	Research into carsharing user preferences to improve knowledge about policy boundaries (Zhou et al., 2020)		Reserved and easily accessible parking spaces (Carrone et al., 2020; KiM, 2015)
Carsharing businesses		Start-up subsidies (Münzel et al., 2020b)	
Spatial distribution		Subsidized parking spots for carsharing (Münzel et al., 2020b)	Trade-off between optimal and sub-optimal parking spots. Geographically differentiated quota (Hu et al., 2018) or grid patterns
Integration with other (sustainable) mobility concepts		Offer one payment subscription e.g., MaaS concepts or OV-kaart. (Zhou et al., 2020)	Create hubs and carsharing parking places at PT spots.
Regime-disturbing	**User group policies**	**Economic policies**	**Spatial policies**
Parking spaces		Increase parking fares for private vehicle owners (Zhou et al., 2020)	Remove parking spaces for private vehicles Change parking norms (Münzel et al., 2020b)
Taxes		Increase taxes for car possession or urban congestion taxes (Münzel et al., 2020b)	
Carsharing in new development and mobility policies			Integrate carsharing in future policy visions, transport and (urban) spatial planning (Münzel et al., 2020b)

2.5 Conceptual model

Carsharing can be considered a niche innovation that could contribute to a transition from traditional ownership-based mobility systems, to sustainable mobility systems, where car ownership is no longer the 'regime' (Banister, 2008). Therefore, carsharing and the potential for upscaling will be considered from a transition theory perspective (Geels, 2010; 2018). Carsharing also comes in many shapes and sizes. This research has therefore first explored in section 2.1 and 2.2 *'What is carsharing and what is its potential for sustainable mobility policies?'* B2C carsharing has been deemed the most accessible to the general public as well as most effective in achieving different policy aims and reduce landscape pressures.

Figure 4 presents the conceptual model, where the Multi-Level Perspective of transition theory forms the foundation of the theoretical findings. Due to these landscape pressures (orange arrows) such as climate change, air pollution and pressure on the urban landscape, the current regime is presented with significant challenges to maintain the current way of consuming. Due to new accords such as the Climate Agreement goals, maintaining the existing regime compromises sustainability goals. The Climate Agreement goals have embedded the need for institutional change on the regime level towards more sustainable mobility systems.

Landscape pressures also affect niche levels, as sustainability and environmental conscious thinking have become more important attributes of societal mindsets for potential users of carsharing (Faber et al., 2020, Münzel et al., 2019). Carsharing is still defined as a niche with a decent establishment of the early adopter group has been established in part due to the efforts of the Greendeal Autodelen I & II. However, as Münzel et al. (2019) have described, it is still unclear who the early majority group will be. Where eventually, the aim of upscaling is to provide carsharing to everyone, not just specific user groups, young adults have been identified as a user group with a lot of potential. Young adults often do not own a private vehicle yet, are used to multiple transport modalities, and environmentally conscious which can help stimulate the upscaling of carsharing. On the niche level, young adults are a potential successful user group of the niche innovation carsharing. What influences young adults to adopt carsharing has been discussed in section 2.3 and has answered the question *'Which factors influence the adoption of (sustainable) carsharing by young adults?'*

A challenge described by Geels (2010) in any transition, is moving from niche innovations to actual changes in the existing regime, which is often robust and inflexible. From a policy perspective, there is a growing desire to better regulate carsharing, as well as stimulate the innovation from a policy perspective. As the CROW (n.d.) had described in their toolkit, harmonizing carsharing policies can help stimulate the upscaling of carsharing networks. Carsharing now often is regulated in a local municipal context, but there is also a need for national governance policies that harmonize carsharing policies with a broader sustainable mobility context which also exceeds local policy developments. As Münzel et al. (2020b) have emphasized, in order to grow carsharing networks, there is a need for national direction and associated policy developments. Therefore, in the conceptual model, there is an important role for municipal and national governments and the interactions between them. As formal institutions, the policy measures these organisations develop can either directly influence the regime of car ownership, as well as stimulate the niche carsharing, as Münzel et al. (2020b) have described. Section 2.4 has therefore examined the question *'What are barriers and opportunities in carsharing policy making discussed in international literature?'* and discussed different policy recommendations from literature that these governmental organisations can apply to stimulate and regulate carsharing. These governmental parties can influence both the attractiveness of carsharing for (potential) users as well influence carsharing providers through the policy measures they uphold. Carsharing providers are an important stakeholder in upscaling carsharing as they directly have influence over the influencing factors as table 3 illustrates.

If the influencing factors are attractive enough for young adults to adopt carsharing (section 2.3), which is influenced by carsharing providers as well as the policy measures at play, carsharing can grow within that population and through that, lead to an increase in shared vehicles and potential decrease of

privately owned vehicles. This can contribute to a change in the regime of car ownership and through that contribute to a reduction of the different landscape pressures.

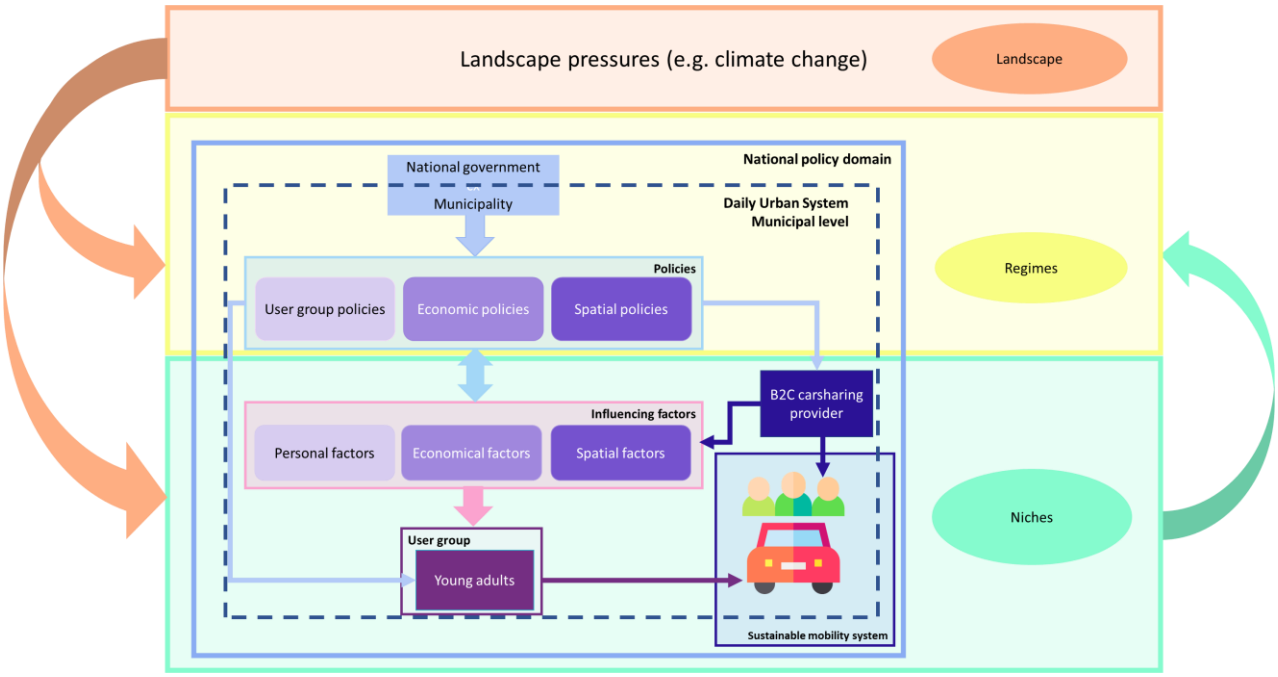


Figure 4: Overview of the conceptual model based on the theoretical framework (developed by author)

3. Methodology

This chapter will first elaborate on the general research approach, which will focus on the foundation for the data collection. After this overview, the different elements of the research approach will be elaborated, starting with the literature research used to establish the theoretical framework. Next, an explanation of the GIS analysis, secondary data analysis and the qualitative data approach including semi-structured interviews will be explained. Lastly, the ethical aspects of this research will be discussed.

3.1 Research approach

This research has been a mixed-method case-study research including both qualitative and quantitative research methods. Taylor (2016) described case study methodology as a good method for small-scale in-depth research which suits this research as it aims to explore how carsharing can be optimized for young adults, as well as examine carsharing policy contexts. Trying to move from carsharing as niche product to integrated element of a (sustainable) mobility system is often influenced by local policy actors and existing policy documents (Münzel et al., 2020b), and thus is best examined in a case study setting as a case study research method is expected to catch the complexity of the case (Tight, 2017). This allows to explore how carsharing is established within the case (spatially) as well as why this has developed through policy making and case specific elements. Mills et al. (2010) have discussed that case study research in public policy is a method frequently used to improve the understanding of the policy-making process and includes the complexity of policy developments.

This research does not include hypothesis as there have been limited theoretical foundations for carsharing and how to upscale carsharing through policy making. Especially for specific user groups, there is limited theoretical knowledge, in which case, one should not develop a hypothesis (Punch, 2014).

Furthermore, findings of case studies are difficult to generalize for the whole population (Taylor, 2016). In this study the results from the case studies cannot be generalized for the entire carsharing dynamics in the Netherlands. However, analytical generalisations are possible (Yin, 1994), whereby the results of the case studies are compared to theories discussed in literature to see if there is theoretical support of these outcomes (Taylor, 2016). In this study, the conclusion and discussion will elaborate on this. The main aim of this research is to explore how carsharing policies can be optimally developed cater to young adults as a potential user group and through that stimulate a shift from carsharing as niche, to carsharing as part of a broader sustainable mobility system.

Cases studied: Groningen and Utrecht

Taylor (2016) has discussed different types of case studies and the importance of defining well-determined boundaries of cases. A case can be selected because it is unusual or common among other reasons (Taylor, 2016). This research will focus on two urban regions in the Netherlands. Utrecht has been selected as the first urban region as it is both part of the 'Greendeal Autodelen' and the 'City deal Elektrische deelmobiliteit in stedelijke gebiedsontwikkeling' (Agenda Stad, n.d.; Greendeals, n.d.). The city has actively developed carsharing and other shared mobility policies and pilots. In addition, Utrecht is currently the municipality with the highest number of shared vehicles per 100.000 inhabitants and therefore an 'unusual case' (CROW, 2020). Utrecht as municipality and urban region are therefore the Dutch frontrunner and an interesting case to examine as the municipality actively has promoted carsharing.

Yin (1994) argued that using multiple cases allows researchers to explore similarities and differences between cases, creating a more robust research compared to single-case study research. Rather than looking for similarities, this research aims to explore differences in policy contexts and approaches and how this affects the integration of carsharing into a broader sustainable mobility system. Therefore, the other urban region that has been selected is Groningen. This region is not part of any of the national policy programs with regards to carsharing but the service is available in the urban region. Where the

two cases have a different policy context, there are many social similarities. Similar to Utrecht, Groningen is one of the 'student cities' of the Netherlands, which influences car ownership rates (Kampert, et al., 2018). Although it is a smaller urban region, with over 200.000 inhabitants, similar to Utrecht, the region is expected to grow in the upcoming years (Riele, et al., 2019). It also one of the Dutch cities with the highest household numbers next to the four largest cities in the Netherlands (Amsterdam, Rotterdam, Den Haag, Utrecht) which can be explained by the many one to two person households in the city (Riele, et al., 2019). Due to its northern location, it lies outside the 'Randstad' influence sphere', which creates clear boundaries for the urban region as well as having a distinct city-rural division (Stad & Ommeland), whereas Utrecht is already more embedded in the multi-city landscape of the Randstad.

Research framework

To ensure rigour and quality in case study research, triangulation can be a useful tool in any research, which is often achieved through using multiple research methods. It is a way to achieve a more accurate representation of case study research (Taylor, 2016). To answer the main research question "*How can carsharing policies focussed on young adults support upscaling of carsharing as part of a sustainable mobility system in Dutch urban regions?*" multiple research methods have been used to come to conclusions. On the main research level, the multiple methods triangulate to form one conclusion and recommendation on how to improve carsharing policies to support the upscaling of carsharing. However, on a sub-question research level, the three research methods used each bring their own insights, which do not directly triangulate. Appendix 1 contains the methodological approach which elaborates on how each sub-question has been answered, what data is collected and how this has been analysed. The first three theoretical sub-questions have been used to guide the literature study and have aimed to define carsharing, its influence on the environment, and what moves young adults to adopt carsharing, as well as how policies can influence carsharing adoption. Secondly, the GIS analysis has helped gain better insights in the spatial carsharing networks in the two case studies to look at the density of the current carsharing networks (SQ4). A secondary analysis over survey data has aimed to include young adult perspectives on carsharing, and what motivates them to use carsharing (SQ5 & SQ6). Semi-structured interviews have been held to contribute to an answer for sub-questions 7 and 8, which aimed to gain insights into the current carsharing policy frameworks. Through three empirical methods, the research has shed light on three different perspectives on carsharing; a spatial perspective, a user-oriented perspective and a policy-based perspective. A more elaborate description on each research method will be given in the following sections.

3.2 Theoretical literature review

The main aim of this literature review has been to establish relevant concepts, theories, issues and debates around carsharing and young adults as user group specifically. The literature has been described in the theoretical framework and formed the foundation of the conceptual model presented in figure 4, which will be used as a foundation for the semi-structured interviews.

Punch's (2014b) five steps for literature research have been followed; searching, screening, summarising /documenting, organising /analysing /synthesising and writing. In the searching; multiple online journal libraries have been used, as well as a general web-search on Google. The libraries consulted have been Scopus, Elsevier's Science Direct, Taylor & Francis Journals as well as SAGE Journals online and SAGE Research methods. The search terms used for these libraries can be found in table 5. Articles with these terms selected on relevance (did they include the search terms), citation scores, as well as up-to-datedness as carsharing has developed and grown very rapidly in the past 10 to 15 years (Li et al., 2021) resulting in 73 articles. After this initial selection, the articles were screened based on the abstract and conclusion and grouped under specific concept tags (Carsharing forms, rural vs urban, carsharing + age group, Transition theory etc.). If articles were found deemed irrelevant (e.g., not enough linkages with policy, unsuitable user groups), the references were scanned through to look for potential other relevant literature. This can be described as manual snowballing which is

traditionally used in empirical research, when sampling is executed through referrals (Frey, 2018). Based on this screening, the third step concerns summarising of the articles, which in this research has consisted of writing some key notes about the different articles and their main aim. Fourthly, for each 'concept' group, the articles were analysed a (looking at the different theoretical elements) and synthesized (making connections between different literature) within one session to create a completer and more focused overview of a theoretical concept (Punch, 2014b). Throughout these steps, snowballing has still been applied to find relevant concepts and theoretical discussions. For the last step, the writing, the separation in concept groups has been used as the start of the theoretical framework, leading to the current theoretical framework which first discusses the types of carsharing, the impact of carsharing, the influencing factors and the policy recommendations.

Table 5: Overview of key words researched in the multiple library search engines.

Carsharing +		Separate concepts
Young adults	Ownership	Young adults + license
Rural / Urban	Electric	Greendeal Autodelen / Autodeelbeleid
System/network	B2B	Case study research
Hydrogen	Sustainable	MaaS
Business models	Policies	transition theory
Innovation (theory)	Early adaptor	Multi-level perspective

3.3 GIS research

The GIS analysis has aimed to explore the spatial dimensions of carsharing. For the GIS analysis, the spatial boundary of each case is defined by the border of each municipality in this case study. As input, carsharing data, online available data for B2C carsharing has been gathered for both urban regions. The data of the carsharing vehicles has been collected through B2C provider's websites or apps, whom share the location and other details about their vehicles. Initially this has been written down in Excel, and then transformed to GIS based on the coordinates. For both Groningen and Utrecht, each B2C carsharing provider and their cars has been mapped in a separate shapefile. An Isochrone analysis has been run based on the walking distances provided in literature. Where Celsor & Millard-Ball (2007) consider an 800m buffer to be the attractive distance to a shared vehicle, the KpVV Dashboard (2016) discussed that for a local bus stop, individuals are most likely to walk 350m and 450m for a more regional bus stop. An average of 400m has been taken in this instance. Especially in urban areas, 50% of inhabitants have their daily needs within 500m (KpVV Dashboard, 2016), and a shared vehicle should be included in this.

The density pattern created by the isochrones can help find potential under-utilized and overutilized areas and be overlayed with existing data from the CBS. The CBS provided data about income, population density and also car ownership, which can help analyse where spatially carsharing is more attractive. The aim of this GIS analysis has been to gain insights into current carsharing networks, the current network coverage and density, as well as explore the correlation between demographics within the two-case study and answer the sub-question: *'What are the current B2C carsharing networks and the spatial distribution in the urban regions of Utrecht and Groningen?'*. These insights can contribute to policy recommendations on better spatial carsharing policies. A detailed step-by-step overview can be found in Appendix 2.

3.4 Secondary survey analysis

Survey research has proven to be very useful for researching people's attitudes and opinion on social issues (McLafferty, 2016). For this research, a secondary analysis has been executed on a dataset acquired by Nicole Stofberg, PhD researcher at the UvA. The aim of this analysis has been to explore the user-group based perspectives on carsharing to examine what motivates young adults to adopt carsharing.

The dataset has been collected in 2018 through questionnaire data collection. Through newsletter invites amongst multiple carsharing providers, respondents have been reached. In agreement with Nicole Stofberg, the actual dataset has been shared by the Kennis Instituut voor Mobiliteitsbeleid (KiM), whom also used the dataset for their shared mobility report (KiM, 2021, concept). The survey is included in Appendix 3.
The dataset includes both P2P and B2C users from providers Greenwheels, MyWheels, Buurtauto and Snappcar. As verified in Nicole Stofberg, MyWheels was at the time a combined provider, offering both P2P and B2C carsharing. Where there is a question asking respondents which vehicle option they used most (from people, MyWheels themselves, garages, combination or don't know), it introduces an uncertainty about which type of carsharing MyWheels users actually use. In the dataset, the only certain B2C user experience in provided by carsharing provider Greenwheels. As MyWheels held a very different position in 2018 than in 2021, it has been decided to exclude MyWheels users.
In this research, as mentioned earlier, young adults have been defined as people between 18 and 30, as also used by Kampert et al. (2018) and CBS (2020). For Greenwheels, Goudappel Coffeng (2019) published a report about how carsharing users use Greenwheels. This report has described that the frequency of Greenwheels members is equally distributed when looking at the age groups 18-32, 32-52 and 52+ in the year 2017/2018. This gives us insights into the distribution of the population compared to the dataset. The age group 18-32 aligns closely with the through literature defined age bracket. More information on the representation of the population can be found in Appendix 4. However, as this research aims to research young adults and to an extent how they compare to the two other age groups, there is less concern about how they represent the entire population, but more if this specific group of young adults can present young adults. The newsletter design, combined with the fact that young adults are perceived to be less responsive to survey invites could explain a lower response ratio.
To differentiate between user frequencies, the distribution of the KiM (2021, concept) will be used, low (less than 5 times per year), medium (5 to 30 times per year) and high frequencies (30+ times a year), as someone that carshares less frequently might have different motivations than someone who carshares a lot more frequently.

Data analysis

Through the secondary analysis, the following sub-questions aimed to be answered: *'What are differences between young adults and other user age groups in how they use carsharing services?'* and *'What motivations stimulate young adults to adopt B2C carsharing?*'. In the dataset, the flowchart described in appendix 5 has been executed for the data analysis. Firstly, descriptive results have been generated to compare young adults to other age groups. Secondly, correlations between the different motivations have been examined using a Spearman's Rho test specifically for young adults. This test has examined whether there are correlations/relationships between 2 variables, in this case the motivations for carsharing, as well as the strength and direction of that relationship. This test is suitable as the motivations are ordinally scaled.
After the Spearman's rho test, the Cronbach's Alpha test has been run. Based on the results and determined correlations between the motivations, it was determined that similar motivations seemed to have similar motivations. The Cronbach's Alpha test has examined the reliability and consistency between the different motivational categories. As certain motivational statements examine the same motivation, it is to be assumed that they have a good internal consistency (Cronbach's alpha 0.8) (Allen, 2017) which can be formulated as similar intervals on the 7-point Likert Scale as used in this dataset. After this test, the motivations have been grouped and divided by the number of statements creating a new variable per motivation category consisting of arithmetic means.
Lastly, the Spearman's Rho tests have been rerun to determine potential correlations between the different grouped motivations, as well as the correlation between the grouped motivations and the frequency of carsharing.

3.5 Semi-structured interviews

To form a better understanding of the current policies and the aimed direction of carsharing and sustainable mobility policies, with young adults as user group in mind, semi-structured interviews have been held. The following sub-questions guided this process: *'What are the current (urban) carsharing and sustainable mobility policy frameworks in the Netherlands and how are these perceived by carsharing practitioners?'* and *'What are the barriers, success factors and conditions needed for the planning of successful carsharing networks in Dutch urban regions?'*. This has aimed to explore the policy perspective on carsharing. These interviews have been with policy makers on national and municipal levels, carsharing providers, and mobility experts. The first aim of the interviews has been to understand a practitioner's perspective on the current policy frameworks in place for carsharing and sustainable mobilities as well the future direction of sustainable mobility developments. By questioning about this topic, the aim has been to identify policy barriers, success factors and conditions for implementing carsharing. The second aim has been to understand the interviewee's perspective on young adults as a user group, and how they would target this user group through policies measures. The interviews were held in semi-structured interview styles in which the interviewee is given the possibility for open response as well as the flexibility to develop the conversation into potentially unpredicted directions (Lunghurst, 2010) and allow additional unexpected insights to be brought into the conversation. On the other hand, semi-structured interviews have provided enough structure to explore the concepts and findings from the theoretical framework through pre-defined questions. Before the interviews, an interview guide had been developed. The interview guide that has been created can be found in Appendix 6.

In the interviews with the municipalities, the preliminary findings of the GIS analysis have been presented to discuss the spatiality of carsharing in their municipality and how this correlates with their spatial carsharing policy measures.

Selection of interviewees

The conceptual model has defined multiple stakeholders that play a role in the transition and upscaling of carsharing. These actors can contribute to the shift from carsharing as niche innovation, to established transport modality on a regime level. In order to achieve a holistic view, multiple stakeholders in the carsharing field have been interviewed. Four interview groups have been established; Carsharing policy makers from the national government, Carsharing policy makers from municipal governments of the two case studies, Carsharing providers, and Knowledge experts. By interviewing the different groups, the relationships between different stakeholders can be made clearer and barriers and opportunities for future policy directions can be identified. Policy makers play an important role in developing policy frameworks, which influence carsharing providers. Both parties influence carsharing as a concept and user groups. The last group of knowledge experts can contribute by giving either specific inputs or a holistic overview of the carsharing developments over the past year, and the role of young adults in this. In table 6, an overview of all the respondents, their organisation, function and date of the interview can be found. In total 8 interviews have been held with 9 interviewees, as respondent 4 and 5 were interviewed together.

Table 6: Overview of interviewed respondents

Code	Organisations	Date interview	Interviewee group	Transcribed
Respondent 1	Rijkswaterstaat	12-5-2021	National policy maker	Yes
Respondent 2	University of Twente	17-5-2021	Knowledge expert	Yes
Respondent 3	Gemeente Groningen	18-5-2021	Local policy makers	Yes
Respondents 4+5	KIM	20-5-2021	Knowledge experts	Yes
Respondent 6	Ministry of Infrastructure & Water management	20-5-2021	National policy maker	Yes
Respondent 7	Ministry of Infrastructure management	25-5-2021	National policy maker	Yes
Respondent 8	Gemeente Utrecht	26-5-2021	Local policy maker	Yes
Respondent 9	Greenwheels	31-5-2021	Carsharing provider	Yes

As the majority of the interviewee selection will be working in Dutch policy fields, the interviews have been held in Dutch. Additionally, the interviews have been held online because of the Corona virus. For the video service Webex was used.

interview analysis: Coding

When given permission to record the interview, the interview has been recorded with the Dictaphone app from Apple, which is password protected. Here the interviews will be stored as well. Afterwards, the interview will be listened to, and transcribed in word. Atlas.ti, will be used to analyse qualitative data, in this case to apply coding to the interviews (Lewins & Silver, 2007).
A combination of deductive and inductive codes has been used. Defining deductive codes beforehand (a priori) can embody a clear set of objectives, which can help inform and steer thinking from the beginning as well as look for theoretical relationships (Lewins & Silver, 2007). The deductive codes based on the theoretical framework and conceptual model have been expressed in italics in Appendix 7. These deductive codes have been used as a foundation for the interviews.
In vivo/inductive coding aims to develop codes that lie as close as possible to the interviewee's own words and are developed on the interview transcripts (Given, 2008). In an open coding process, the transcripts have been read, looking for similar terminology or reasonings that can form codes. Deductive and inductive codes have been applied within the same coding process. The second step taken in the coding process, is selective coding, where the inductive findings are combined with deductive categories based on theoretical findings from the theoretical framework to establish code categories (Given, 2008)
Of the 99 codes originally applied (combined inductive/deductive), 41 codes have formed the final code tree and codebook (app. 7). These codes have been divided over five code categories (landscape level, regime level, niche level, transitions, stakeholders and other). Next to the codebook, a code tree has been developed to illustrates the connections between code groups.

3.6 Ethical considerations

Throughout this thesis, I have been interning at the Ministry of Infrastructure and Water management. During the internship, there has guidance from the internship coordinator at the Ministry as well as other colleagues such as discussions about the theoretical directions of the thesis as well as the general process. The colleagues have shared their expertise on topics such as behavioural policy making and

data analysis as well as gave me access to their contacts in the carsharing field. These connections have made it possible to hold interviews with experts and gave me access to a dataset with information about carsharing users I might not have otherwise. This positionality might put me in a different position compared to regular MSc thesis students. While this research is relevant for the ministry, their aid and support has been unconditional, and they have not been given access to the raw data from the interviews or dataset as it contains personal identifiers.

Ethical processing of the interviews

As can be seen in the interview guide in appendix 6, each interview has started with a short introduction and a set of disclaimers about the interviews. Before each interview, the interviewee has been asked permission in order to record the interviews. Furthermore, the interviewees have been made aware that the interviews are anonymous, only their organisation will be included in the research. Additionally, interviewees were made aware that they could stop participating at any moment without explanation, which is considered ethical practice according to Lunghurst (2010). Until two weeks after the interview, interviewees have the possibility to retract any statements made during their interview. Each interviewee has also been asked whether they were interested in a summary of the research results, which will be provided at the end of the research. The interview recordings will be stored on the recording device

Ethical processing of the survey data

Before receiving the dataset, it was discussed with the owner of the dataset for what the data would be used. Based on these conditions, the dataset has been shared for this research. After receiving the dataset, the dataset has been checked for unnecessary information such as personal identifiers. Additionally, as agreed upon, the conceptual results have been shared with the owner of the data to check if the data has been interpreted correctly. The dataset will be removed after this master's programme has been finalised and the thesis has been graded.

4. Results

In this chapter the results of the three different data strands will be discussed. As described in Chapter 3, five different empirical sub-questions have been formulated, to be answered by three different data strands. Before examining the three data strands, a short introduction into the policy contexts of both case studies will be given. Afterwards, the GIS analysis is discussed, which has been used to gain insights into carsharing networks. These spatial insights have also been used as input for the interviews. Following this, the survey results are presented, which concerns findings about young adults and their motivations for carsharing, as well as how they use carsharing. Lastly, the interview results will be reviewed, separated in code categories. Within the interviews, elements of the spatiality of carsharing networks (researched by GIS analysis) as well as the users of carsharing and their motivations have been discussed (researched through secondary analysis) in the broader context of carsharing policy making and the upscaling of carsharing. At the end of each section, a conclusive interpretation will be discussed.

4.1 Policy contexts

This section will shortly discuss the existing policy contexts in the two case studies. In Groningen, the city policy makers are at this moment developing an execution program for carsharing, which should be finished in 2021. Additionally, the municipality offers an information page about carsharing (Gemeente Groningen, n.d.) for both users and carsharing providers. A carsharing permit costs €83,76 per year, which is a low price compared to other cities in the city.

In Utrecht, similar to Groningen, the municipality offers an information page about carsharing on their website, which includes information about how one can carshare and the benefits (Gemeente Utrecht, n.d.). Furthermore, the municipality has done research into the topic, such as the 'Voordelen, onderzoek naar het gebruik van deelauto's in Utrecht' (Gemeente Utrecht, 2019). The municipality has also developed an internal 'shared mobility direction' as was discussed by respondent 8. In 2021, Utrecht revised and adapted their mobility vision to include a vision until 2040, this will be decided on by the municipal council in July 2021. This also includes the intention of an upcoming revision of the parking regulations (Utrecht, 2021).

On a national policy level, the 'Greendeal Autodelen' and 'Citydeal Elektrische Deelmobiliteit' are the two main agreements at this moment, consisting of voluntary cooperation agreements with a general goal or aim to be achieved within a set time period (Agenda Stad, n.d.). The Greendeal Autodelen II is already the second Greendeal for carsharing. These deals will both be terminated at the end of 2021. Therefore, follow-up possibilities are being considered at this moment (R7).

4.2 GIS Analysis: Exploring the spatiality of carsharing

In this section, the number of shared vehicles, types of vehicles, spatial distribution and correlation with demographic statistics will be presented for both Utrecht and Groningen. With regards to the network coverage analysis, the network coverage has been calculated for both 400m and 800m. In the interview with respondent 9, carsharing provider Greenwheels, the interviewee confirmed that Greenwheels manages a 400-500m service area for their vehicles, which is why the results section will only include the 400m network coverage but the 800m network coverage can be found in Appendix 8.

Utrecht

Carsharing fleets

Utrecht is the city with the most shared vehicles per inhabitant (CROW, 2020), which according to Trouw can be explained by the high share of young adults that are used to sharing, critical of car ownership as well as a general 'autoluwe' policy mindset (Claus, 2020). In numbers, this translates to 533 B2C shared vehicles across four providers. Greenwheels is the largest with 269 shared vehicles in Utrecht and Juuve the smallest with 43. Figure 5 shows the geographical placement of the different carsharing providers in Utrecht.

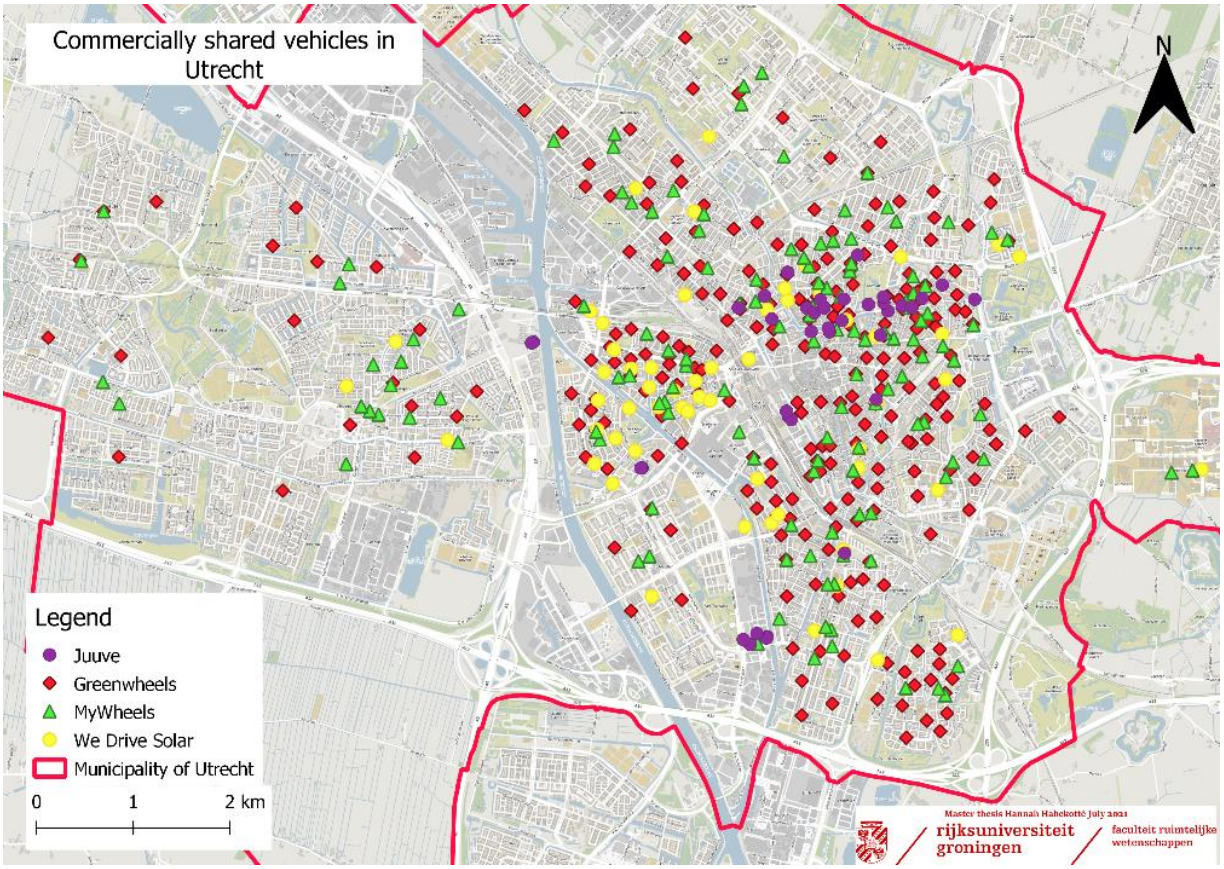


Figure 5: Geographical location of the number of shared vehicles in Utrecht
Shared vehicle per provider: Greenwheels= 269, MyWheels=141, We drive Solar =80, Juuve =43

Diversity in carsharing fleets

With regards to the models of vehicles offered, We Drive solar and Greenwheels offer the least variety. We drive Solar provides Renault ZOE's and 27 Tesla Model 3's. Greenwheels has three vehicle options, mainly Volkswagen UP's (239), and two larger vehicle options; Volkswagen Golf 7 Variant (24) and five Volkswagen Caddy's. On the other hand, providers MyWheels and Juuve have a lot more vehicle options, with MyWheels offering seven different vehicle models and Juuve offering sixteen different vehicle models and brands. This illustrates that carsharing providers offer different fleets and different degrees of variety within their fleet.

The electric share of the shared vehicle fleet is presented in figure 6. In Utrecht, 63,8% of the fleet is gasoline-based with 35,8% of the fleet being electric vehicles. Greenwheels does not offer electric vehicles currently in Utrecht. In the Netherlands, the market share of privately owned electric vehicles is 2,0% in 2020 according to the RVO (2021). The share of electric shared vehicles in Utrecht is a lot higher, which contributes to sustainability goals, as electric shared vehicles are deemed more sustainable especially in urban areas as they do not produce exhaust gasses (Chapter 2, section: 'Even more sustainable: Electric and Hydrogen carsharing').

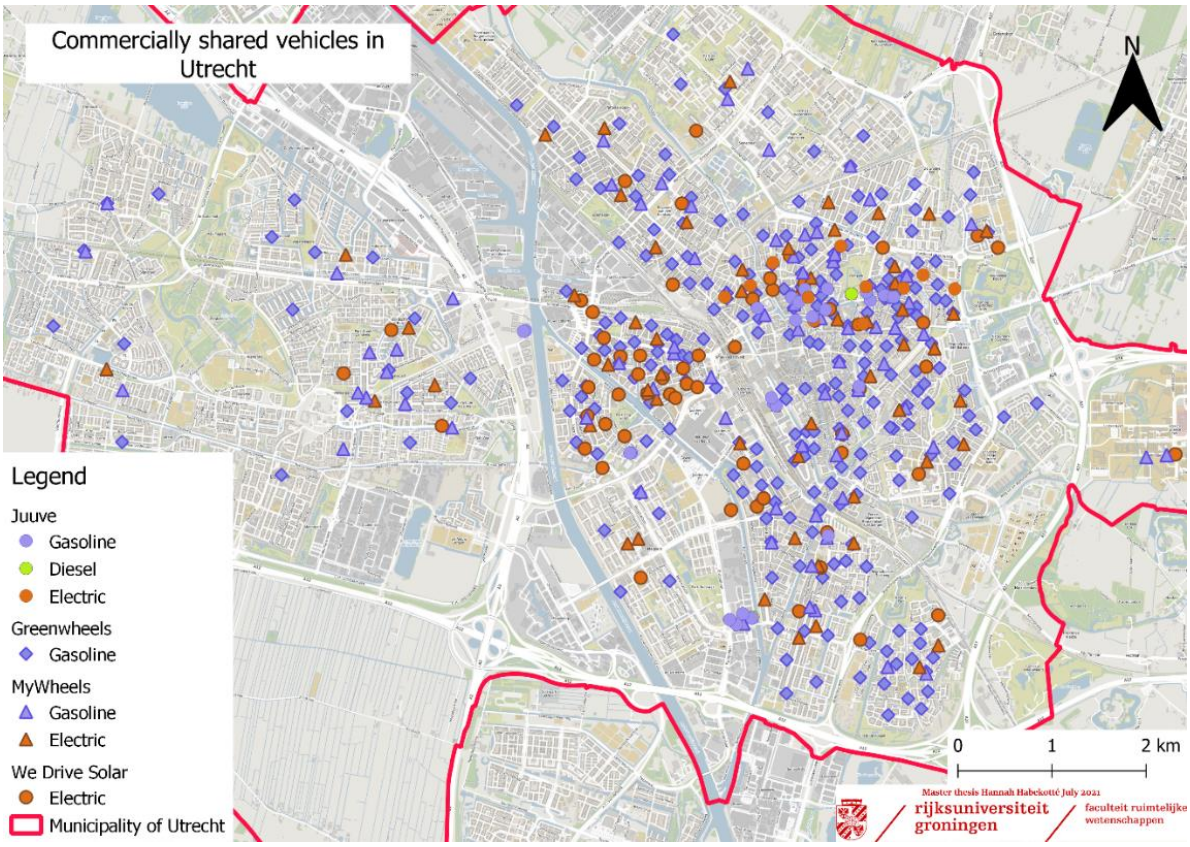


Figure 6: Shared vehicles in Utrecht differentiated by their fuel type.

Carsharing in relation to public transport

Compared to other transport modalities, the Greenwheels offers multiple 'station' vehicles (six in Utrecht), which are shared vehicles located near NS stations. As Greenwheels and NS have a partnership, they are also promoted on the NS website (NS, n.d.). Not every station in Utrecht has a Greenwheels vehicle. The locations that do, are 'Utrecht Vleuten', 'Utrecht Centraal', 'Utrecht Vaartse Rijn', 'Utrecht Overvecht' and 'Utrecht Maliebaan'. MyWheels also offers two Station locations, at 'Utrecht Leidsche Rijn' and 'Utrecht Vleuten'. Looking at the P+R facilities, only Greenwheels offers two shared vehicles on P+R Overvecht combined with the station Overvecht. Other P+R are not serviced with a shared vehicle.

Network density

Having shared vehicles available close to where (potential) users live, makes carsharing more attractive (Münzel et al., 2020). Figure 7 shows the number of shared vehicles per neighbourhood, highlighting the large differences per neighbourhood. In the neighbourhood Wittevrouwen, the most shared vehicles can be found, a total of 33. Out of the 111 neighbourhoods, 71 neighbourhoods have less than five shared vehicles available in their neighbourhood. To ensure reliability and convenience of the service, ideally multiple vehicles would be available in each neighbourhood.

Figure 8 illustrates the network coverage of each shared vehicle in Utrecht when an individual would walk a maximum of 400m. The overlay between the different carsharing providers shows that there virtually always are multiple providers active in the same service area. In the neighbourhoods Vleuten en de Meern (West), there is relatively little network coverage.

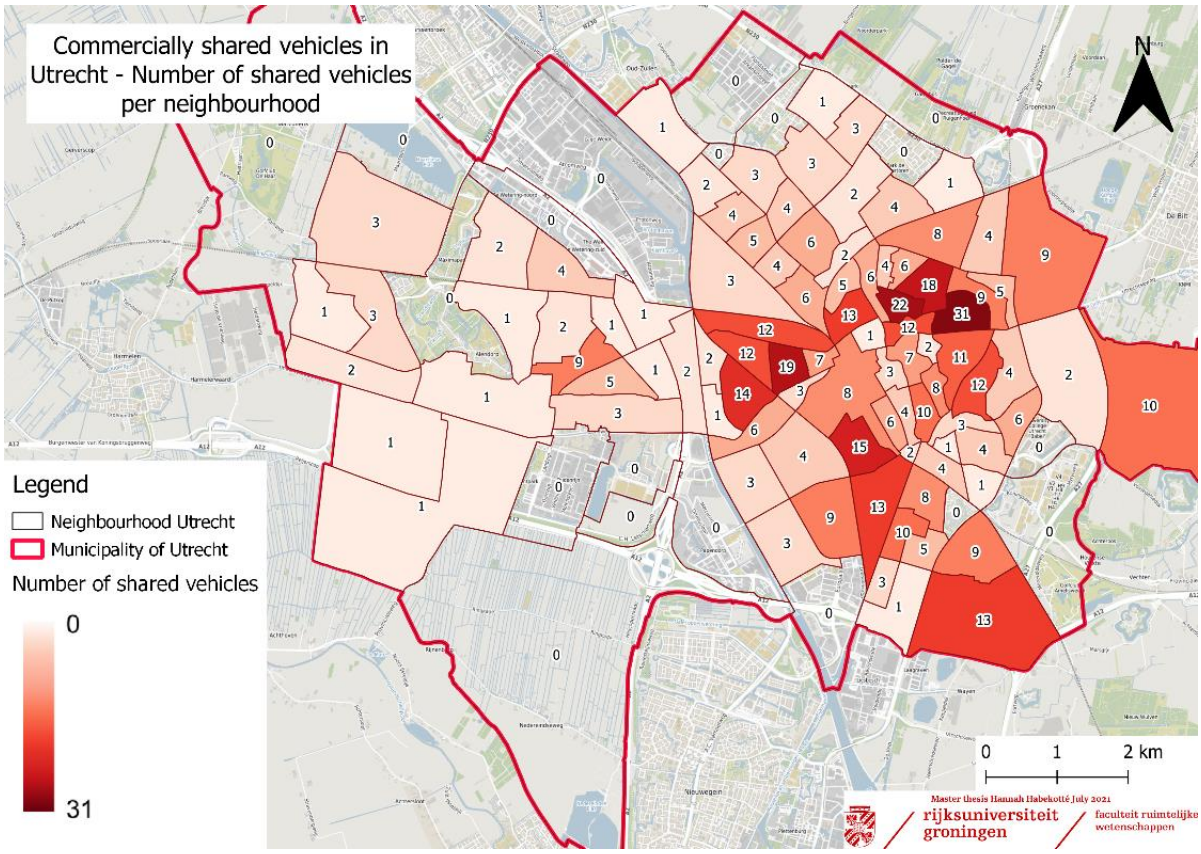


Figure 7: Number of shared vehicles per neighbourhood in Utrecht

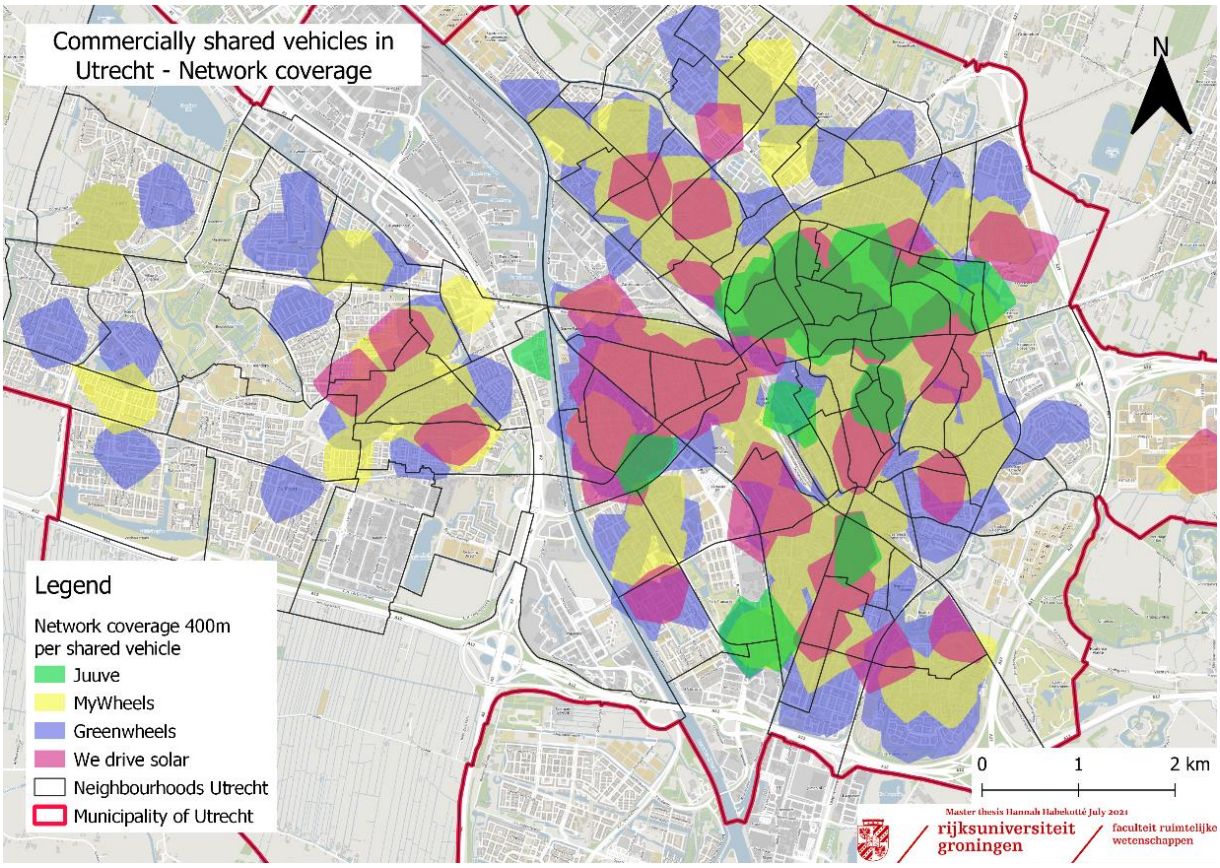


Figure 8: Overview of the network coverage per shared vehicle, differentiated per carsharing provider

Demographic comparison

Taking demographics into account, it becomes clear that it makes sense shared vehicles are not available everywhere. As figure 9 shows, the majority of cars are located in areas with high population densities, with 1500-2000+ inhabitants per 500x500m.These squares contain 447 out of 553 shared vehicles (83,9%). Looking at the degree of urbanity (App. 8) 506 of 533 shared vehicles in Utrecht are located within highly to strongly urban locations, which make up 52% of Utrecht.

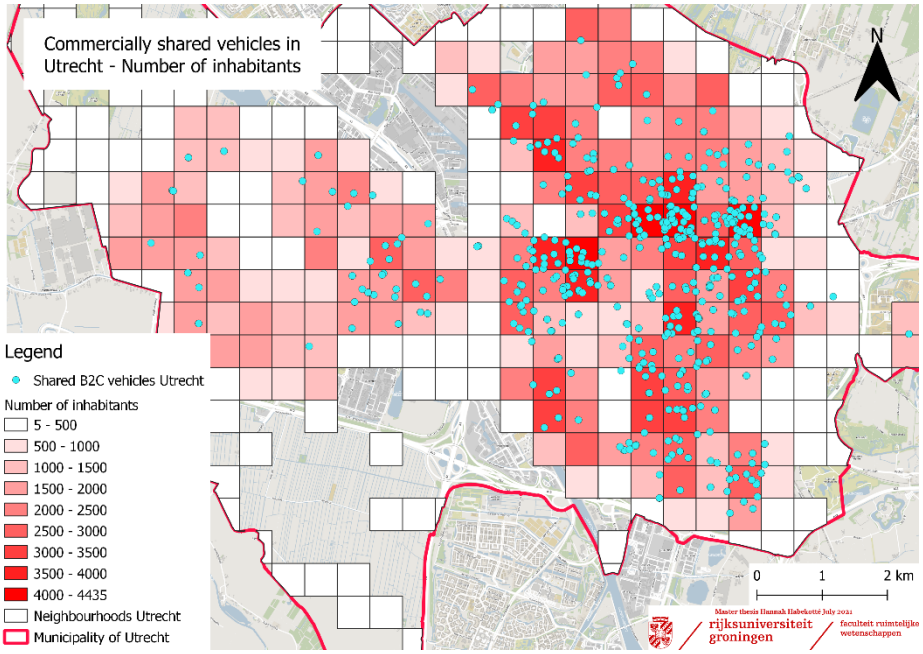


Figure 9: Number of inhabitants per 500x500m overlayed with the locations of shared vehicles.

The CBS provides age groups in 15-year brackets. This means that the selected age group in this research 18-30 cannot be determined in the GIS datasets. However, looking at the age group from 15-25, figure 10 highlights that the majority of youth live in the eastern part of the city. Squares with more than 485 youth inhabitants make up 5% of Utrecht's geographical boundaries. In these squares, 30,7% of the carsharing fleet is located.

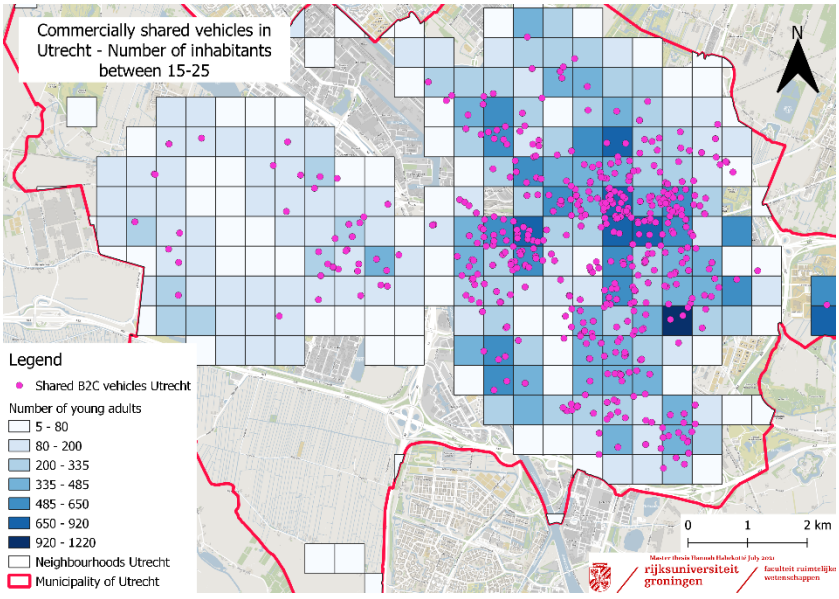


Figure 10: Number of youth inhabitants between the ages 15-25 in 500x500m squares.

Figure 11 overlays car ownership per neighbourhood with the number of shared vehicles per neighbourhood. Compared to car ownership, the neighbourhoods with more than 11 shared vehicles are neighbourhoods with 500 to 2500 privately owned vehicles, so neighbourhoods with 'lower' car ownership. In the seven neighbourhoods with 2500+ privately owned vehicles there are 32 shared vehicles available.

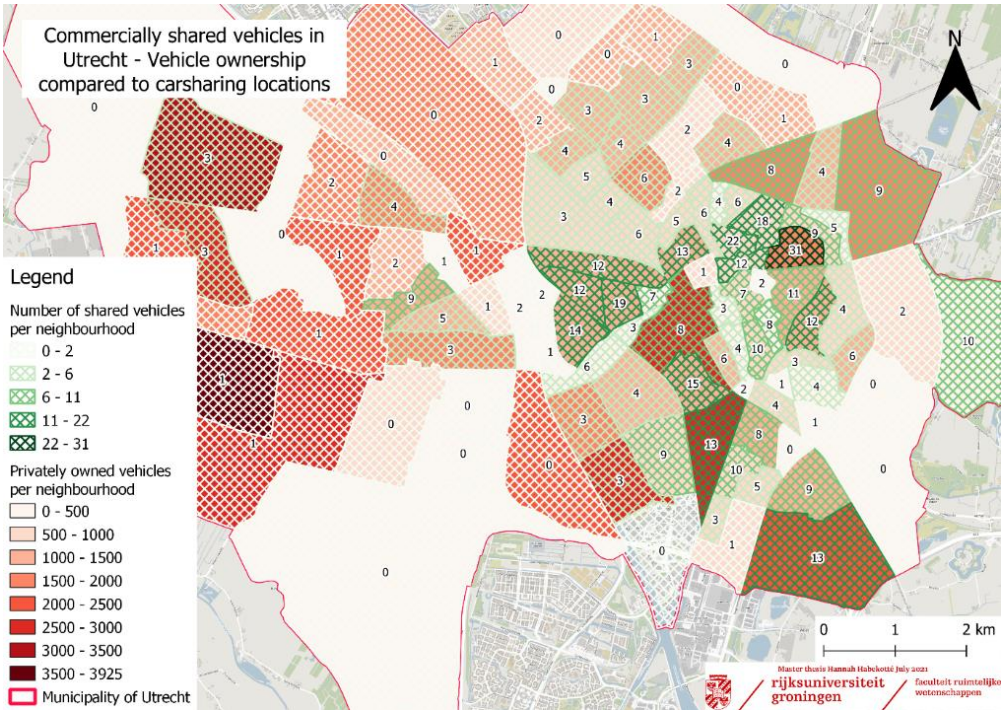


Figure 11: Car ownership overlayed with the shared vehicles per neighbourhood.

When comparing the number of inhabitants to the number of private vehicles registered per neighbourhood, 101 out of 110 neighbourhoods have more inhabitants than vehicles as can be seen in figure 12. Children under the age of 15 have been excluded. Two other outliers can be identified, the neighbourhoods Bedrijventerrein Lageweide and Bedrijventerrein Papendorp. These industrial areas also most likely have lease car companies that who's fleet counts as personal car ownership.
Looking at the number of shared cars, 397 shared vehicles (74,5%) are located within neighbourhoods that have 2000+ inhabitants more than privately owned vehicles.

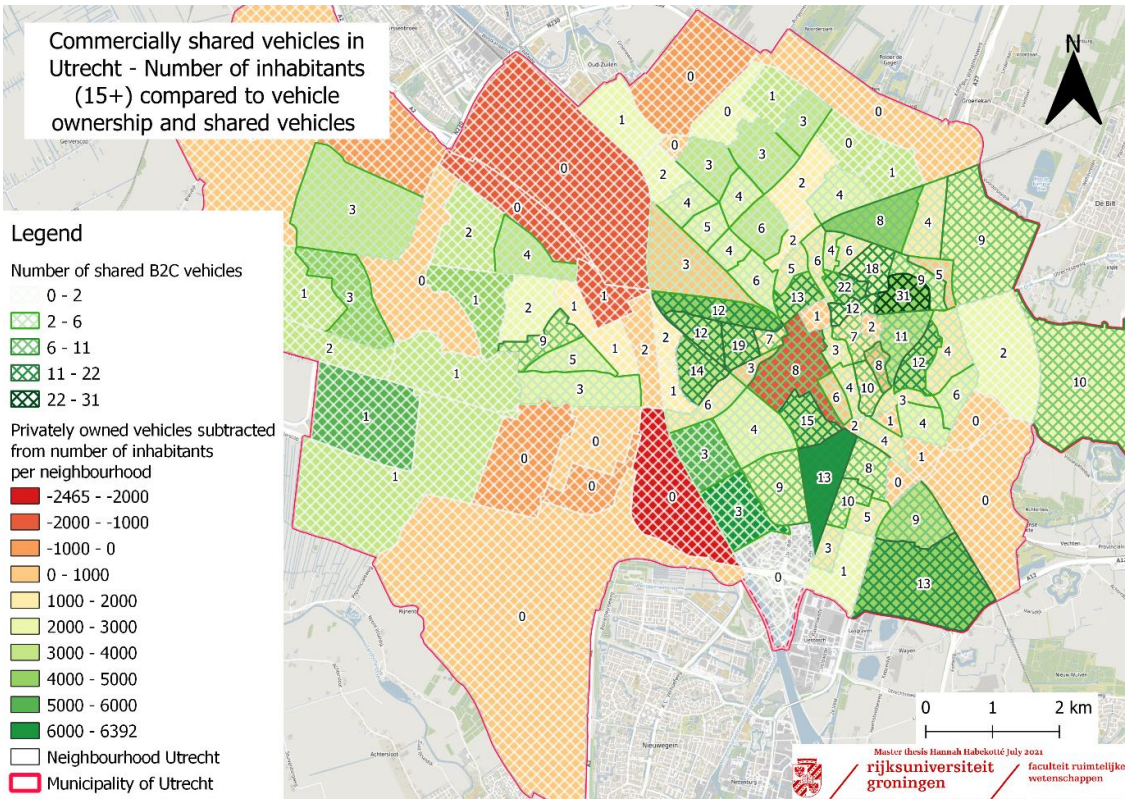
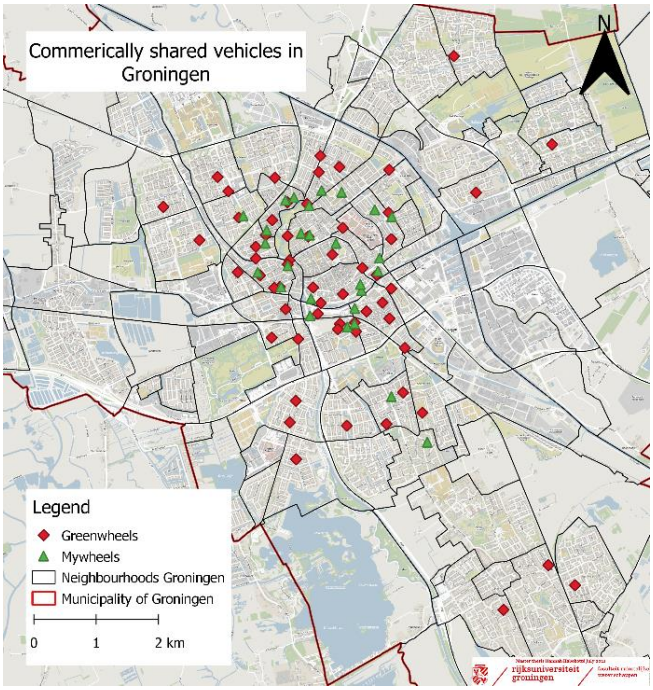


Figure 12: Number of private cars withdrawn from the number of inhabitants. Orange to red illustrates neighbourhoods where there are more cars than inhabitants, green illustrates the other way around. Overlayed with the number of shared vehicles per neighbourhood.

Groningen

Carsharing fleets

In Groningen, the number of shared vehicles is compared to Utrecht a lot smaller. In the city, there are two carsharing providers, Greenwheels and MyWheels with 59 and 27 shared vehicles each. In total there are 86 shared vehicles in the city available as can be seen in figure 13. Looking at the distribution between fuel and electric run vehicles, only eleven vehicles are electric, offered by provider MyWheels. This is 12,8% of the total fleet, and are mainly offered around the city centre, as can be seen in figure 14.



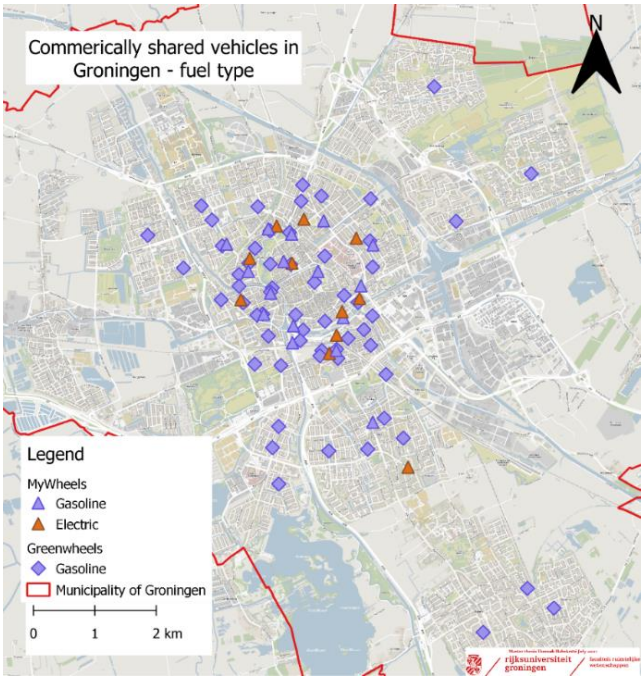


Figure 13 (L): Overview of shared vehicles in Groningen
Figure 14 (R): Shared vehicles in Groningen differentiated by their fuel type

Diversity in the shared vehicles

In Groningen, there are less providers compared to Utrecht, which automatically translate to less variety in the diversity of the types of shared vehicles offered. In Groningen, Greenwheels offers the three same vehicle options as they do across the country. MyWheels offers six vehicle options in Groningen, from smaller Citroen C1's to Nissan Leaf's.

Carsharing in relation to public transport

In Groningen, Greenwheels offers four 'station' vehicles, which are parked in proximity of train stations. The company has two vehicles at Groningen Hoofdstation, one at 'Groningen Europapark' and one at 'Station Haren'. MyWheels also offers a 'station'/P+R vehicle at the main station.

Network density

Figure 15 shows the number of shared vehicles per neighbourhood, highlighting the many neighbourhoods where a shared vehicle is not available. Out of the 150 neighbourhoods in the municipality, 111 neighbourhoods do not have carsharing as a service. Here it must be noted that the municipality of Groningen also includes many rural neighbourhoods (around 50). Looking at the 100 other neighbourhoods that lie within the urban region of the town, 39 neighbourhoods include one or more shared vehicles whereas 61 other neighbourhoods do not. The neighbourhood with the most shared vehicles is the Schildersbuurt, seven in total.

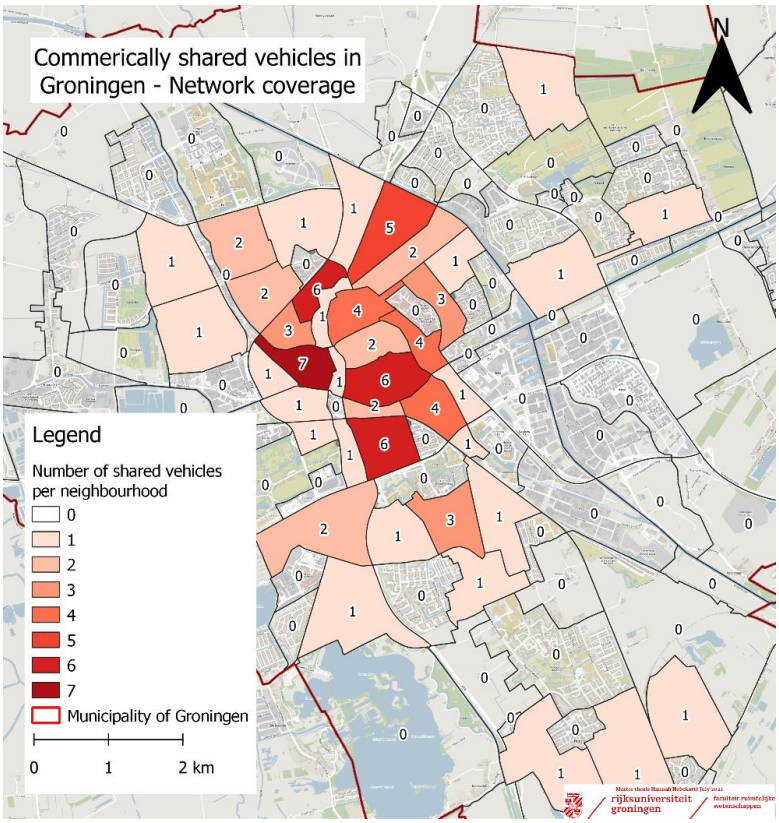


Figure 15: The number of shared vehicles in Groningen per neighbourhood

Figure 16 shows the network coverage of each shared vehicle in Groningen when an individual would walk a maximum of 400m towards the vehicle. The network coverage is mainly focussed around the city centre, with more suburban neighbourhoods being mostly uncovered. The network coverage between Greenwheels and MyWheels overlap mostly, with their cars sharing service areas, especially around the city centre.

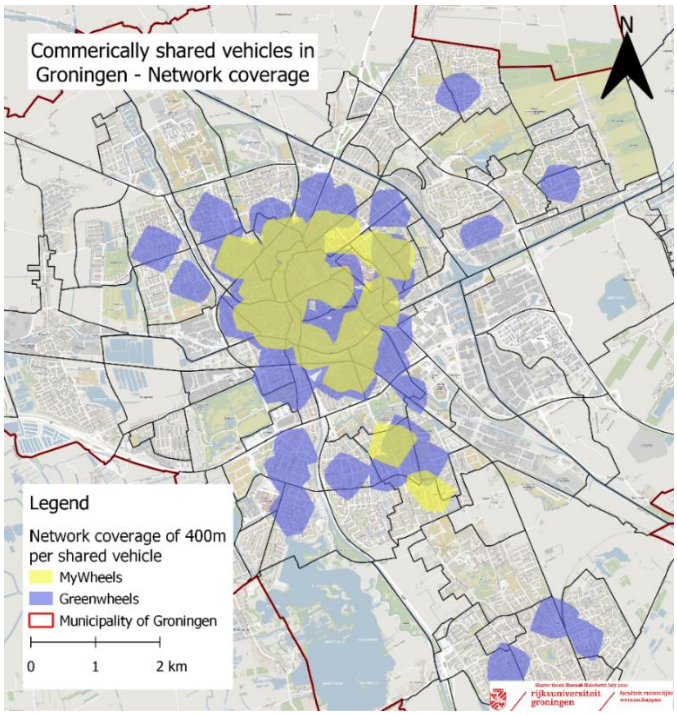
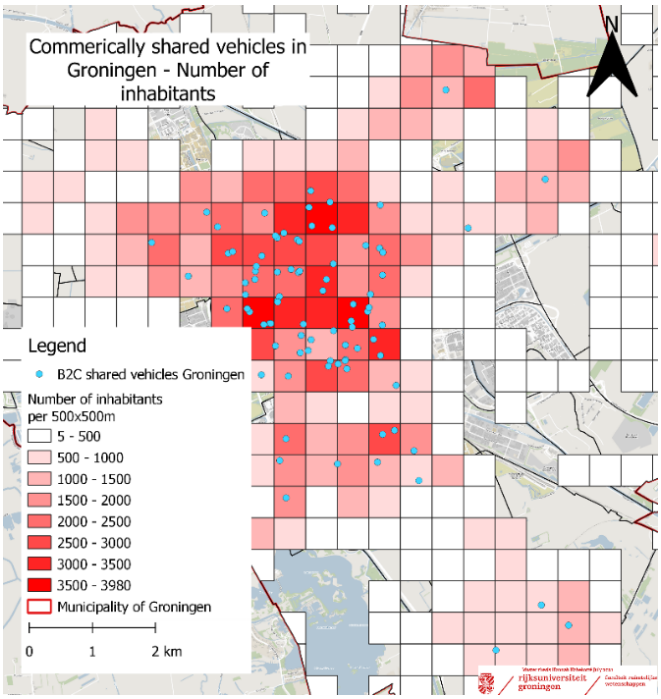


Figure 16: Overview of the network coverage per shared vehicle, differentiated per provider

Demographic comparison

Similar to Utrecht, when comparing the placement of shared vehicles to the locations where inhabitants live, it makes sense that there are not shared vehicles everywhere. Looking at the placement of shared vehicles, 72 out of 86 vehicles (83,7%) are located within squares with 1500 inhabitants or more as can be seen in figure 17. Looking at the urbanity of the city of Groningen (App. 8), 82 of 86 shared vehicles is located in (very) strongly urban areas. Specifically looking at the distribution of for youth between 15-25 (figure 18), 29 out of 910 squares (again many rural parts) have more than 480 young adults living in them, which also contain 51 of the 86 shared vehicles of the city (59,3%)



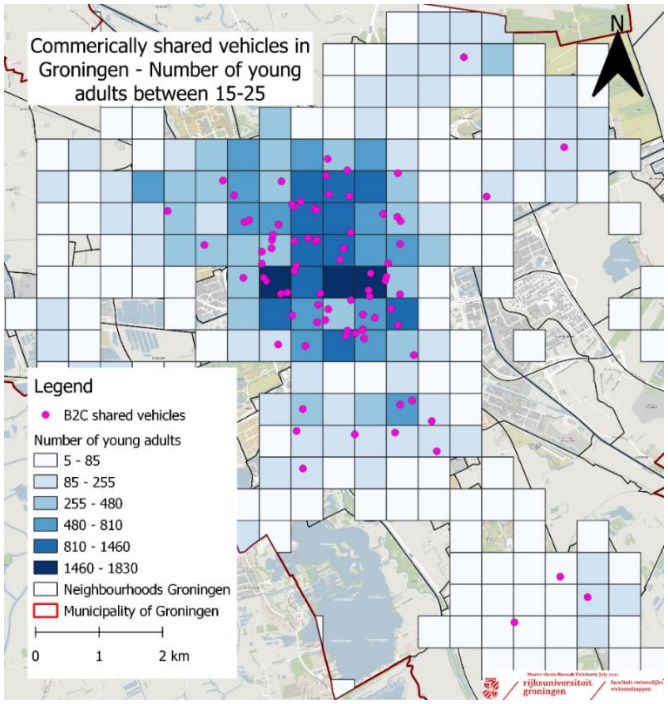


Figure 17 (L): Number of inhabitants per 500x500m compared to carsharing locations.
Figure 18 (R): The number of young adult inhabitants (15-25) compared to carsharing locations

Figure 19 shows the combination of inhabitants, vehicle ownership and shared vehicles in neighbourhoods. Different than Utrecht, the locations of shared vehicles are not for the majority in neighbourhoods with low car ownership. Even in neighbourhoods with high number of private vehicles such as the Indische buurt and Groningen-Zuid, also have high numbers of shared vehicles, 6 each. There are 22 neighbourhoods out of 139 neighbourhoods in the city which have more cars than inhabitants, which might be explained through lease company constructions. The neighbourhood 'Indische Buurt' has a very positive inhabitants-vehicle ownership balance, with 6511 more inhabitants than cars. 81,4% of the carsharing fleet is located within neighbourhoods that have a 2000+ positive balance towards inhabitants (more inhabitants than cars). The other shared vehicles have been placed in locations with more prominent car ownership.

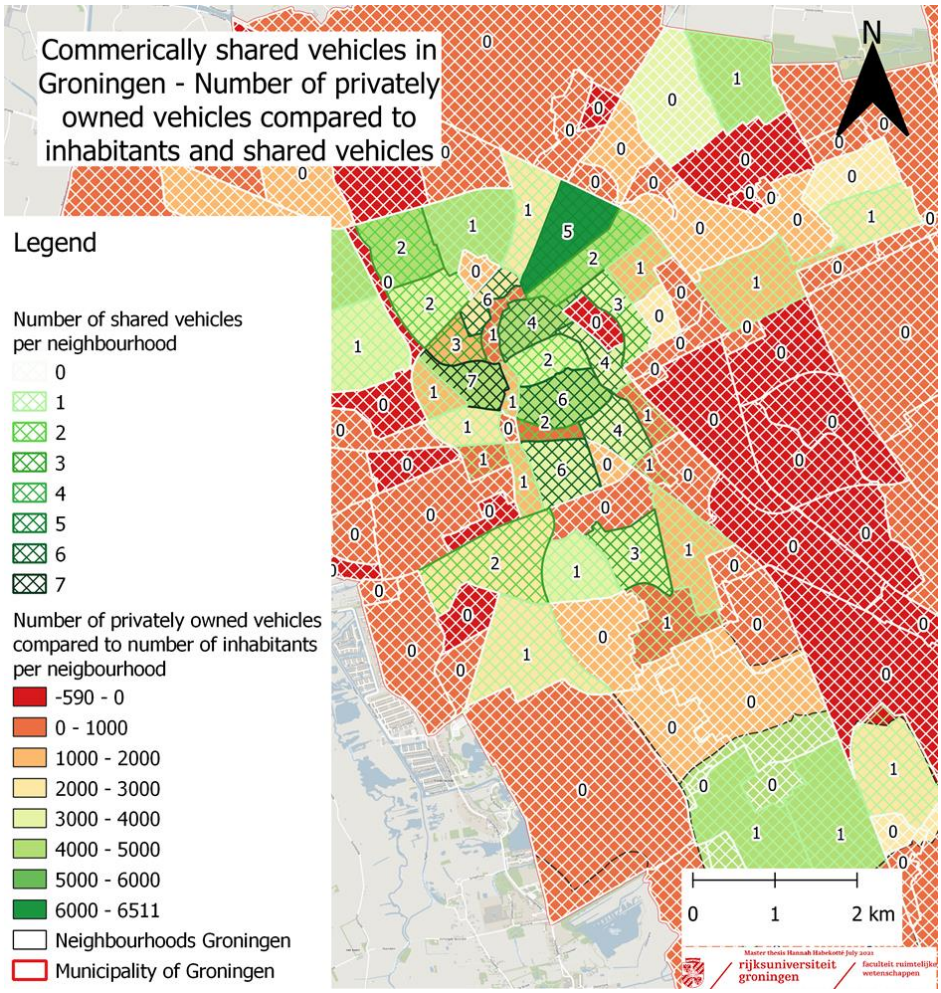


Figure 19: Number of private cars withdrawn from the number of inhabitants.
Red illustrates neighbourhoods where there are more cars than inhabitants, green illustrates the neighbourhoods where there are more inhabitants than cars. This is overlayed with the number of shared vehicles in Groningen.

Interpreting GIS findings

The GIS analysis has aimed to give insights to the question: *'What are the current B2C carsharing networks and the spatial distribution in the urban regions of Utrecht and Groningen?'* Between the two cases, Utrecht has six-fold the number of shared vehicles Groningen has. In both cities, the network coverages are mostly centred around the inner-city neighbourhoods. In Utrecht, Leidsche Rijn and Vleuten are two neighbourhoods where there is limited carsharing access, in Groningen many more suburban neighbourhoods no not have access to a B2C carsharing service. As figures 8 and 16 have illustrated, the network coverages between providers largely overlap especially in Utrecht, meaning that within walking distances, there are always multiple shared vehicles from different providers available.

Looking at the density of the cities, most shared vehicles are located within 1500 inhabitants or more per 500x500m, 83,9% in Utrecht, and 83,7% in Groningen. Furthermore, in these two cities, carsharing is definitely a service provided in highly urban areas with 94,9% of shared vehicles in Utrecht and 95,3% in Groningen being located in those areas. This aligns with findings from Rotaris & Danielis (2018) and Schreier et al. (218) who emphasized carsharing as a more urban service at this point in time.

Specifically looking at young adults (15-25), in Utrecht, only 30% of shared vehicles are located in areas with higher numbers of young adults, whereas in Groningen, this is around 60%. As Utrecht's carsharing fleet is larger and more widespread throughout the city, it is difficult to compare these findings between the two cases.

With regards to the distribution of shared vehicles compared to the distribution of vehicle ownership and inhabitant numbers, neighbourhoods in Utrecht with a high number of shared vehicles tend to

have lower car ownership rates. In Groningen, similar results have been found. This does account for the number of inhabitants. In both Groningen (81,4%) and Utrecht (74,5%), the majority of shared vehicles is located in neighbourhoods where there is a positive inhabitant to private vehicle balance, which means there are more inhabitants than vehicles. This correlates with the findings of Meelen et al. (2019) who described that carsharing is more likely in neighbourhoods with lower car ownership and higher population densities, which can be found in both GIS analysis of the case studies
The findings of the GIS analysis suggest that carsharing is a highly urban phenomenon, mainly in areas of cities with higher population densities and lower car ownership rates compared to inhabitant numbers.

4.3 Secondary data analysis: Researching carsharing users

This section will discuss the results from the secondary data analysis as discussed in Chapter 3.4. The analysed dataset consists of 2652 respondents (Stofberg, 2019), with 365 young adults between the ages of 18-30. However, selecting the Greenwheels users, leaves 1770 respondents, of whom 229 between the ages of 18 and 32. In appendix 9, all descriptive statistics and other analyses can be found. Compared to the age group representation described by Goudappel Coffeng (2019) (equal percentages across the three groups), the percentage of the 18-32 age group is lower in this sample.

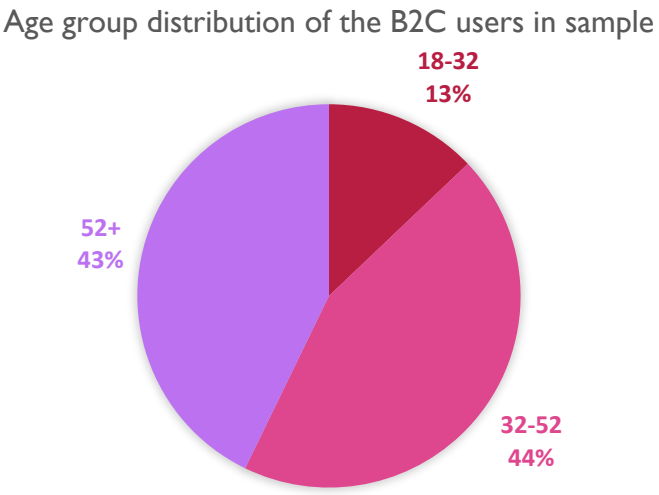


Figure 20: Overview of the age group distribution in the sample using the same categorisation as Goudappel Coffeng (2019) for Greenwheels.

Descriptive statistics: User characteristics, car ownership, and other transport modes.

For the secondary analysis, one of the aims has been to examine how young adults use carsharing compared to other age groups. Looking at the descriptive statistics in figure 21, the majority of carsharing users are medium users, which is defined as someone who uses a shared vehicle between 5 to 30 times a year. Among young adults, 67,2% are medium users. In the other two groups, this is 70,2% and 70,6%. Regarding the intention to keep using carsharing, 80% of young adult respondents agreed with the statement that it was their intention to keep using Greenwheels in the future. Although high, this is lower than the other two age groups of which 86% of the 32-52 age group agreed and 90% of the 52+ age group agreed.
Where carsharing is sometimes described to be a more male dominated mode of transport, in this dataset, the gender distribution is quite balanced for young adults: 46,3% is female, and 50,7% is male. This is similar for the age group 32-52 with a 49,4% and 49,9% female-male distribution. Only for the oldest age group, an imbalanced gender distribution can be found, there is a higher percentage of men (59,3%) to women (40,2%).

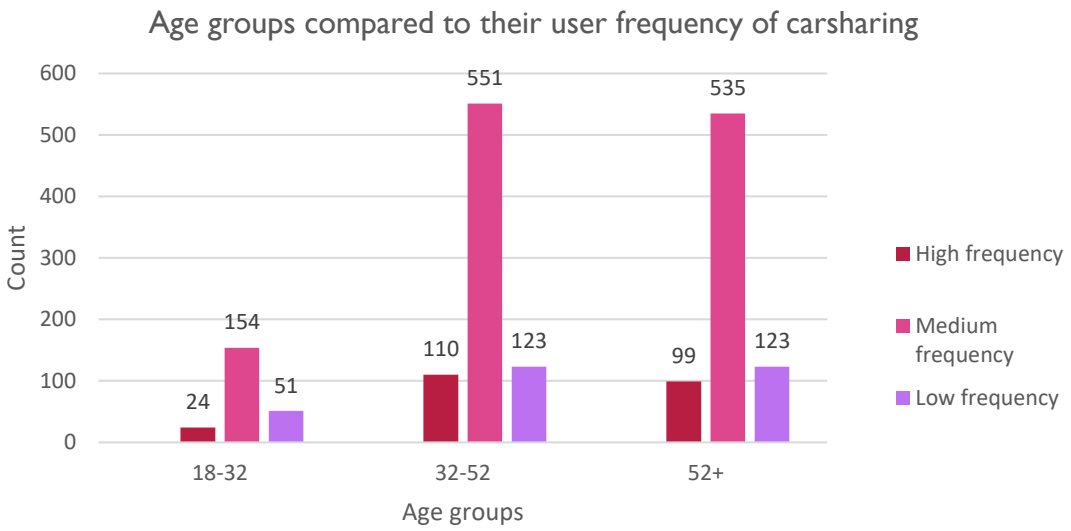


Figure 21: Overview of the number of carsharing users determined by age brackets, compared to their user frequency. High frequency= >30 times a year, middle frequency= 5-30 times a year, low frequency = <5 times a year

Figure 22 illustrates the highest achieved education level of carsharing users. Carsharing users are highly educated across all age categories with 87+% of respondents having a higher professional education or university degree.

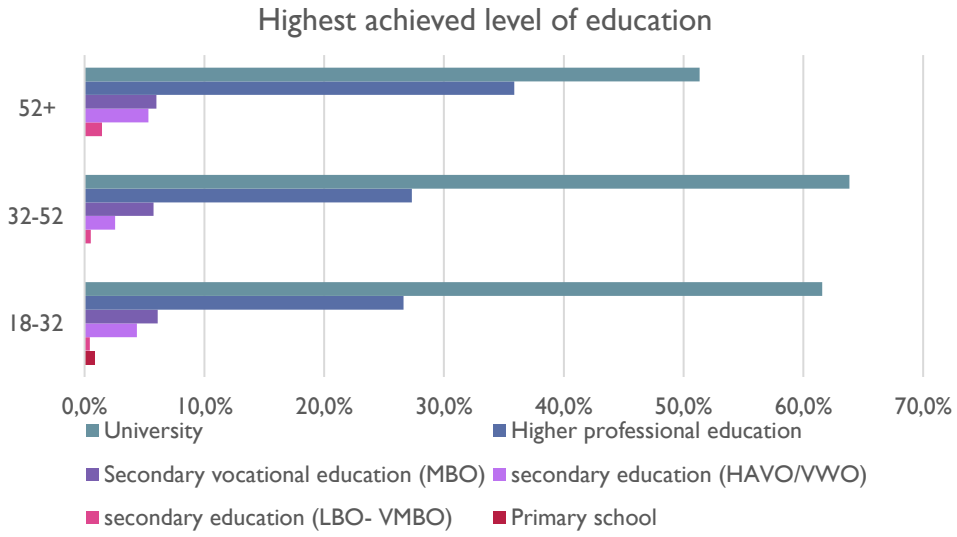


Figure 22: Highest achieved levels of education amongst carsharing users

When looking at income in figure 23, young adults that carshare earn less compared to the two other age groups. The mean income of young adult Greenwheels users is between 1500 and 2500 euros, whereas for the other two age groups this is between 3500-4500 and 2500-3500 euros gross monthly income. This illustrates that carsharing is used by people with a variety of income levels.

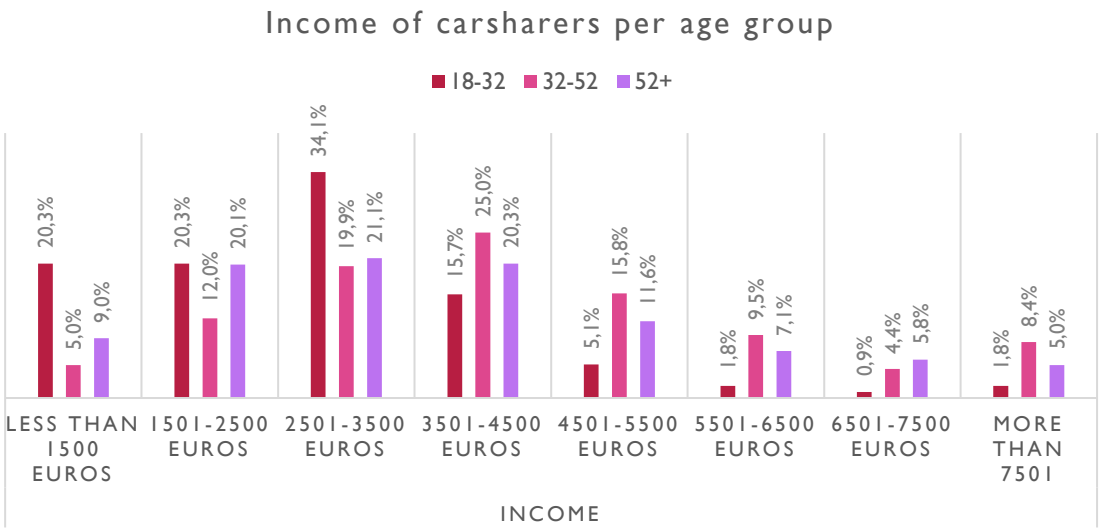


Figure 23: The gross income of carsharers compared to their age group

Looking at the duration of membership amongst the three different age groups, there again is a clear difference between young adults and the other two age groups. Where for young adults, the mean membership is 1 year, for users between 32-52 this is 5 years and for the 52+ age group, this is more than 6,5 years, which can be logically explained by age. For the latter two age groups, there is a significant group that has been carsharing for over 10 years (20,6% and 34,7%), which skews the mean. When looking at the frequency groups and how long they have been using Greenwheels, the membership average for medium and high frequency users is around 5 years. For low frequency users this is 4,5 years which shows that there is only a small difference in the membership duration between the different user frequency groups.

The impact of carsharing on car ownership

With regards to the impact of carsharing on car ownership, respondents were questioned about their car ownership before being a carsharing member and 'now', at the time of filling out the survey as member of B2C carsharing. Looking at figure 24, young adults own strikingly less vehicles in percentages when set against the other age groups, with 84.3% not owning a vehicle before adopting carsharing. After adopting carsharing, only 10% of young adult carsharers own a car. For older age groups, where car ownership before is higher, the decrease in vehicle ownership is more noticeable, with the 52+ age group experiencing a car ownership decrease from 0,72 vehicles to 0,16 vehicles on average.

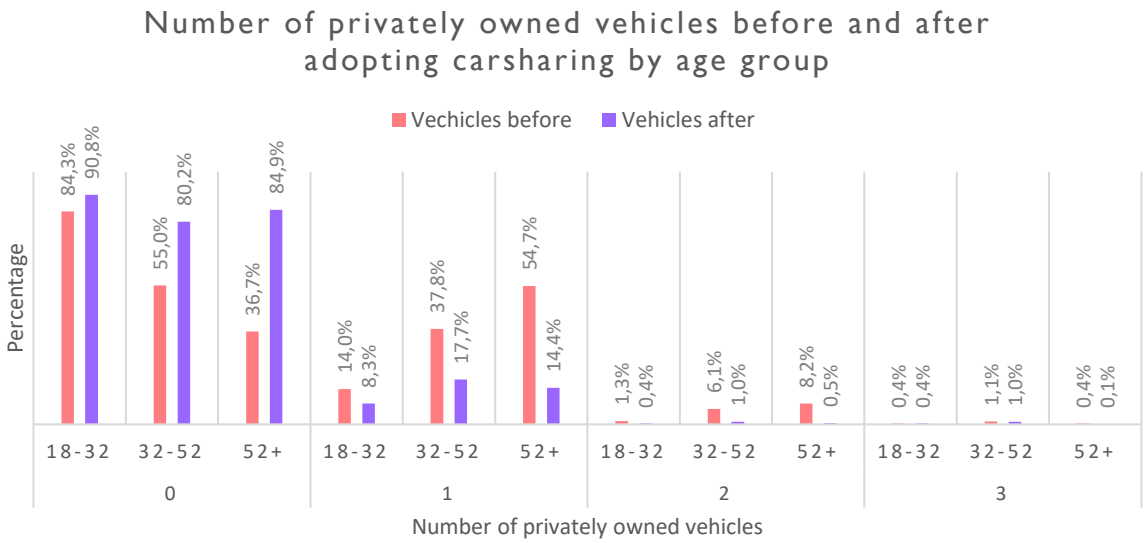


Figure 24: The number of privately owned vehicles by respondents before and after they adopted carsharing by age

Figure 25 displays the impact of carsharing on car ownership per user frequency. Highly frequent and moderately frequent carsharing users see the largest decrease in car ownership, with 38,2% and 34,7%. After adopting carsharing, more than 80% of the users in both categories do not own a private vehicle. Even in the category of low frequency carsharing users (less than 5 times a year), there is a decrease in car ownership. There is a 13,1% decrease in low frequency carsharing users owning a vehicle as well as a 20% increase in number of low frequency users without a car after adopting carsharing. Both figure 24 and 25 illustrate that carsharing memberships can contribute to a reduction in vehicle ownership.

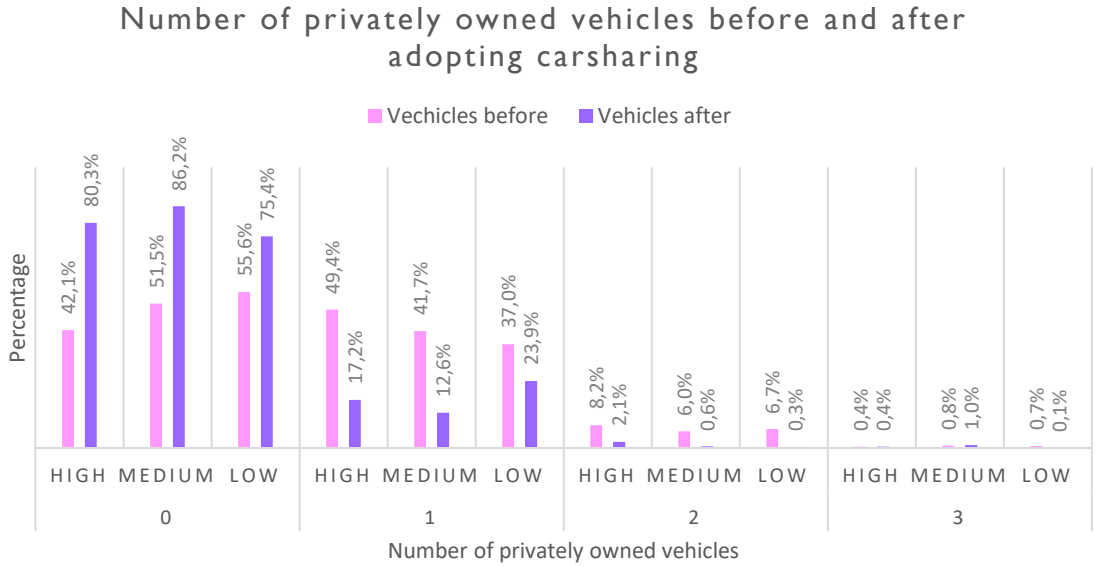


Figure 25: The number of privately owned vehicles by respondents before and after they adopted carsharing categorized by user frequency

Spatiality of carsharing

Respondents have been asked how many shared vehicles were available in their neighbourhood (figure 26). Across user frequencies and age groups, the majority of respondents has access to 6 shared vehicles or less, with on average, 4,7 vehicles available within walking distance. People that are higher frequency carsharing users also tend to have more shared vehicles within walking distance, 5,04 to be exact, compared to low frequency users, who have 4,85 shared cars within walking distance.

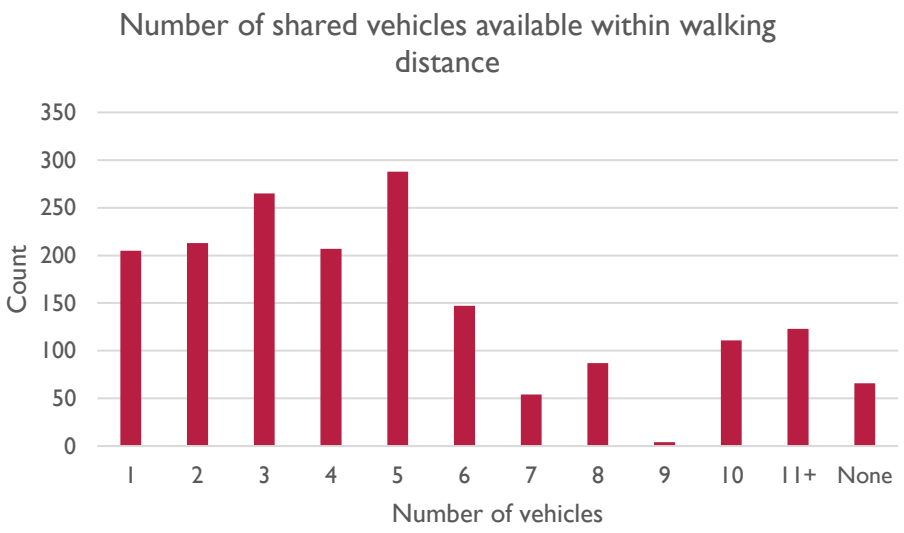


Figure 26: The number of shared vehicles available to respondents within walking distance

For what and why do respondents use carsharing?

With regards to with what purpose carsharing users use a shared vehicle, the survey offered a few response categories, including an "other…" There was the possibility to select multiple options. For young adults, using the shared vehicle for 'day trips' was selected the most (26,3%), combined with visiting family or friends as a second (24,2%) (Figure 27). In the other age groups, visiting family or friends was selected often as a motive. As 'other' purposes of carsharing listed, many wrote down going to the trash disposal site (Millieustraat), bringing or picking up of large boxes or other big luggage. Furthermore, construction markets, informal care, going to places inaccessible with PT and bringing people from and to the airport were listed multiple times.

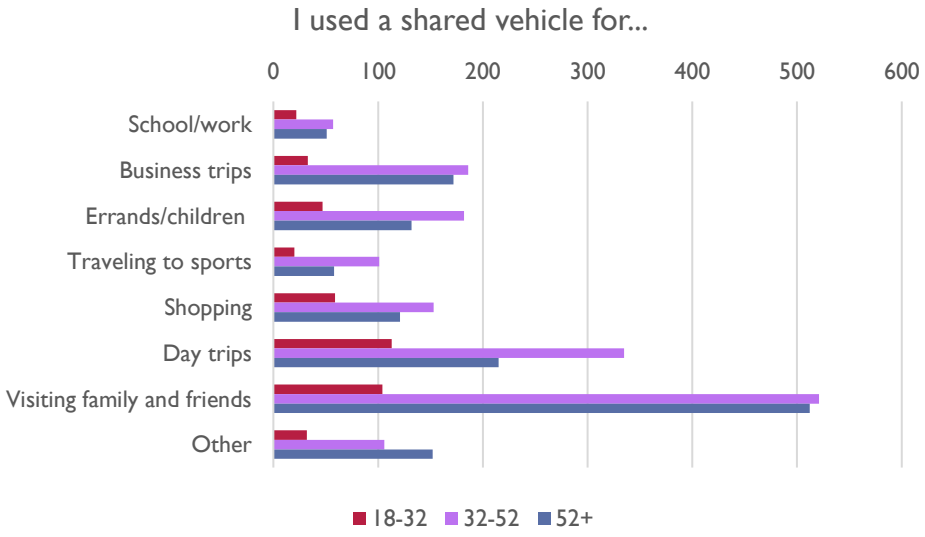


Figure 27: Reasons for carsharing according to users, differentiated by age.

Concerning which mode of transport users would take otherwise, PT was the most selected option, especially among young adults, together with walking and cycling as figure 28 illustrates. Among older age groups, the private vehicle was selected 30% of the time, whereas with young adults this is only 7%. This correlates with the findings in figure 24 that young adults often do not own a car and therefore most likely rely on other transport options.

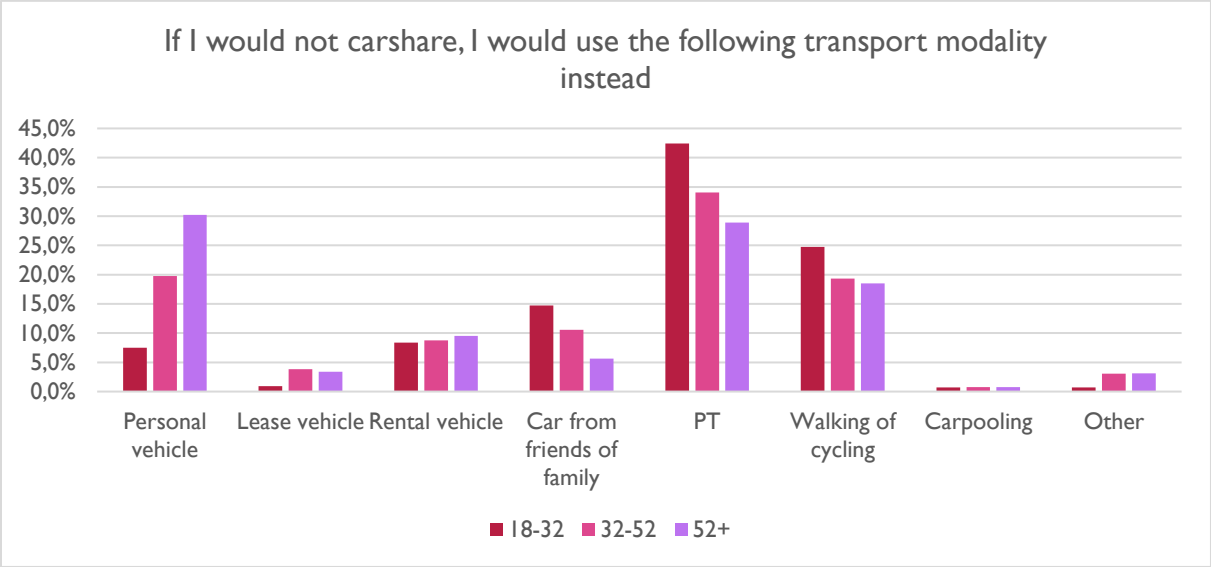


Figure 28: Which mode of transport carsharing users would use otherwise if they did not do carsharing

Interpreting the descriptive analysis of user characteristics

The results discussed above have aimed to answer the question '*What are the differences between young adults and other user age groups in how they use carsharing services?*' Compared to other age groups, young adults are often newer carsharing users and have lower incomes than older age groups. The variation in income illustrates that carsharing is not only for average income households but shows that young adults with 'lower' incomes (below 2500 euros per month) are also interested. This aligns with the findings of Münzel et al. (2019) who described an interest in carsharing among lower income groups. Across all ages, carshares are highly educated.

Figures 24 and 25 illustrate that becoming a carsharing member/using carsharing reduces car ownership amongst all age groups and user frequencies. Reflecting on the effects of carsharing on car ownership, it is noticeable that young adults often do not own a vehicle before carsharing, which is different for other age groups. Car ownership is still reduced after becoming a carsharing member as a young adult. Becoming a carsharing member as young adult more likely prevents car ownership in contrast to reducing vehicle.

Furthermore, the findings in figure 28 suggest that carsharing especially among young adults takes away from PT and walking/cycling, which is something Carrone et al. (2020) also have described as a potential pitfall of carsharing. Considering the user frequencies of carsharing users (many being medium users, figure 21) it seems unlikely that carsharing is the only transport mode of users. Although carsharing replaces some PT and active transport movements, the survey does not examine how many transport trips have been replaced by carsharing, which makes it difficult to interpret how significant the replacement of carsharing is.

Additionally, to get people to carshare, awareness is an important policy measure as described by Zhou et al. (2020). Playing into the different activities for which carsharing are used, can be helpful. For young adults, day trips and visiting family were two important activities for which they use carsharing. These are two activities where carsharing awareness campaigns could target.

More general findings have been that GIS results have shown that the accessibility to shared vehicles can be quite varied, and in a city like Groningen (figure 15) there are often only a few (1 or 2) shared vehicles within walking distance. As figure 26 has shown, this is experienced differently by carsharing users. Although 'walking distance' is not specified in the survey, the average 4,7 shared vehicles available seems to align more closely to the network density of a city as Utrecht, where the carsharing fleet is a lot larger than the smaller carsharing fleet of Groningen.

Where there are similarities across age groups, young adults specifically, earn less compared to the older age groups, often do not own a vehicle yet, and because of this often replace active transport modalities or PT with carsharing. Additionally, they use carsharing for slightly different activities than older age groups. This can help create a better understanding of current and possibly also potential carsharing users.

Motivations for carsharing among young adults

The second section of the secondary analysis will focus on the motivations for carsharing among young adults. The statements respondents have been asked to identify their motivations, can be grouped into functional/economic, social and environmental motivations. These will be discussed separately, starting with economic motivations.

Economic motivations

Figure 29 shows the descriptive results for different functional motivations. The majority of young adults, a cumulative 62 percent 'agree' that they carshare because it saves money (agree includes 'agree a little', 'agree', 'completely agree', idem for each of the following statements). However, only a third of young adults agrees that they are motivated to carshare as it improves their economic situation. On the other hand, young adults are motivated to carshare as it saves them time (75,9%). Young adults that carshare with a medium and high frequency are more motivated by saving money (around 2/3rd of respondents) compared to young adults with a low user frequency (51% of respondents). The high frequency young adult group is very small, with 24 respondents which should be considered as a too small number to be normally distributed and most likely not representative for the broader population of high frequency young adult carsharing users.
On the other hand, low user frequency groups (74,5% agree) are more often 'time saving' motivated to carshare. Medium frequency young adult users are the most time savings motivated, with 78,6% agreeing with that motivation being a reason they carshare.

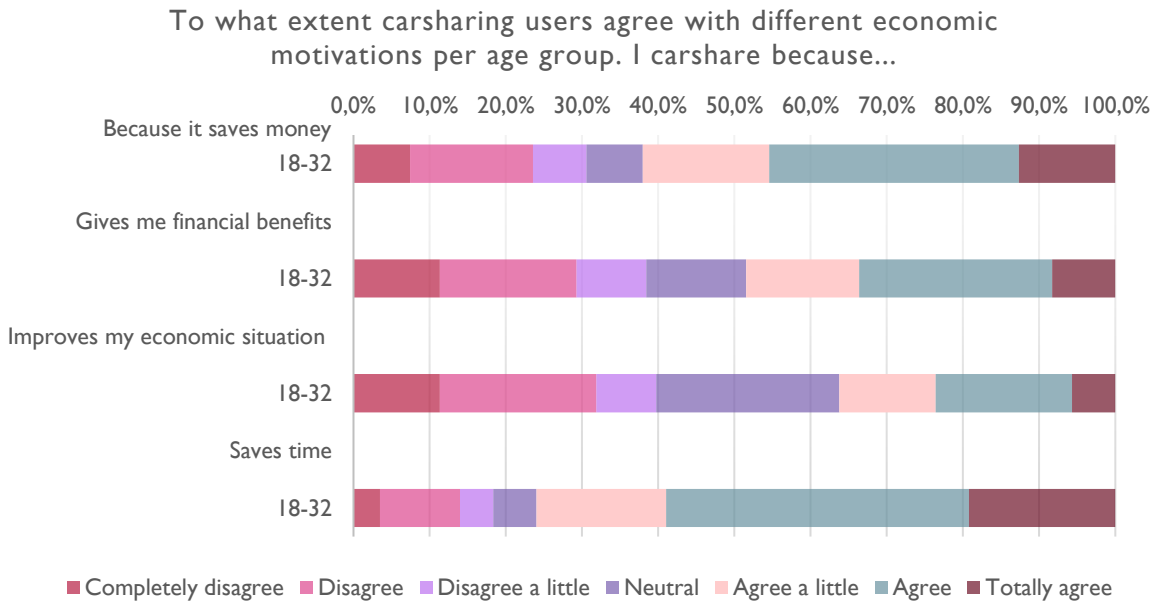


Figure 29: Descriptive results for statements about functional/economic motivations.

For the relationships between the different economic motivational statements (money saving, financial benefits, and improvement of economics situation), significant ($p<0,01$) positive strong correlations have been found (Appendix 9, p. xliii). The results have shown that if young adults are motivated to carshare because of money saving motivations, this also increases their 'financial benefits' motivations and 'improving my financial situation' motivations. These correlations can be

found regardless of user frequency, meaning that there is no difference in a young adult that carshares frequently, or someone that only carshares a few times a year.
On the other hand, the relationship between the three economic motivational statements and 'time saving motivations' is not significant, which means that if someone is highly motivated to carshare because it saves them money, this does not affect their motivation to carshare from a time savings perspective. As the correlations between the three economic motivational statements are quite strong, this illustrates that time saving motivations do not belong to similar motivation categories as the three economic statements.

Social motivations
With regards to social motivations, results show that Greenwheels users do not carshare because of social motivations. As figure 30 illustrates, for the first three statements, less than 10% of young adults agree with the statements being one of their motivations for carsharing. With regards to the last statement 'I carshare because It helps me live in a blossoming local community', 21,8 percent agree with statement as being a motivation of them, although the majority of young adults does not see it as a motivation for them to adopt carsharing.
When categorized by user frequency groups, young adults across the three frequency groups are for the majority not socially motivated to adopt carsharing. Low frequency users disagreed most with being socially motivated to adopt carsharing, excluding the last statement 'I carshare because it helps me live in a blossoming local community

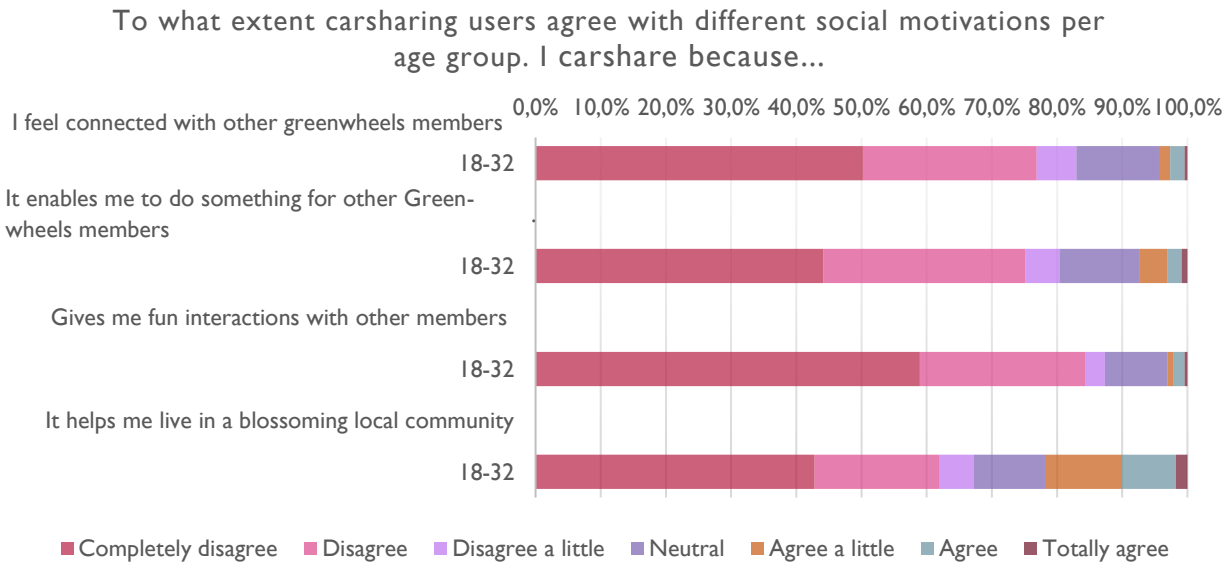


Figure 30: Descriptive results for statements about social motivations.

With regards to the correlations between social motivations, there are significant and (very) strong correlations between the four social motivations at $p < 0,01$ (Appendix 9, p. xliii). Similar to the correlations between different economic motivations, there are not large differences between the correlations for different user groups. This means that for both a highly frequent young adult carsharers as well as medium to low frequency users, there are strong relationships between the different social motivations. For example, being motivated to adopt carsharing because it makes members feel connected and enabling them to do something for other members are correlated.

Environmental motivations

The last category of motivational statements concerns environmental statements. With regards to environmental reasonings for carsharing, a large majority of carsharing users agree that they do have environmental motivations for carsharing as figure 31 illustrates. For each statement, more than 80% of young adults argued to be environmentally motivated. With regards to the distribution across different user frequency groups, high frequency users seem to have slightly less environmental motivations for carsharing than medium or low frequency users.

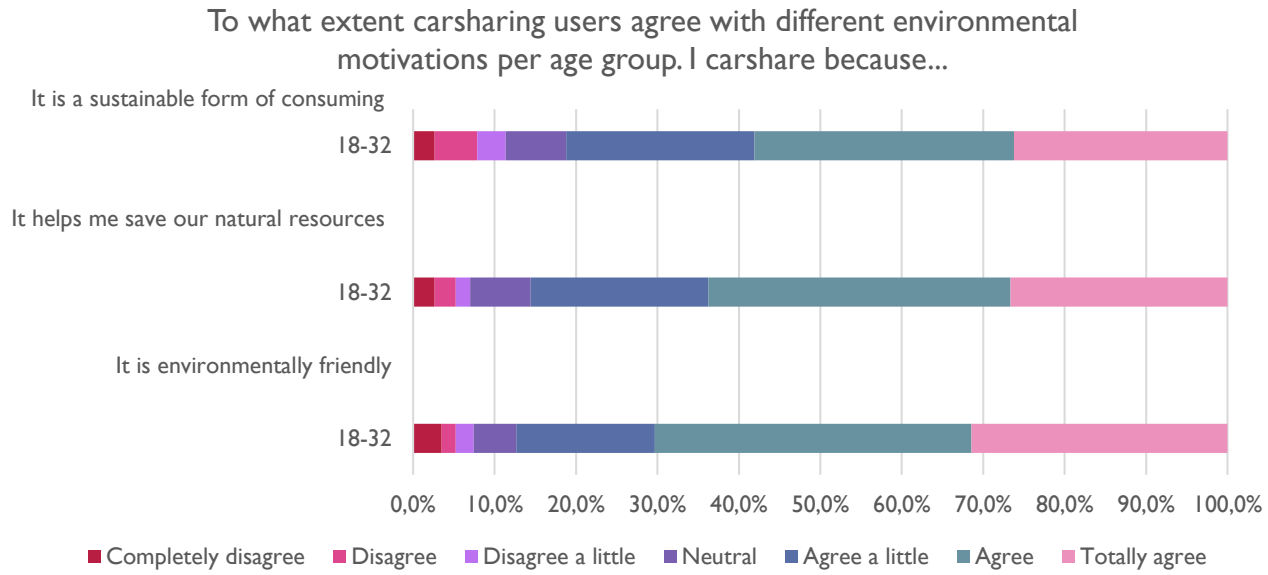


Figure 31: Descriptive results for statements about environmental motivations.

Similar to the other motivational categories, there are (very) strong positive correlations between the environmentally motivational statements (Appendix 9, p. xliii). Someone that is motivated to carshare as they feel it is a sustainable form of carsharing is also highly likely to be motivated to carshare as it saves our natural resources. Especially the relationship between statements 'Because it is environmentally friendly' and 'because it helps me save our natural resources' is very strong (correlation coefficient of 0,898 for medium user frequencies). Similar to the previous motivational categories, there again is not a large difference in the correlation coefficients (strength-wise) between the different young adult user frequency groups.

Reliability analysis

The three motivational categories have been found to strong significant positive correlations within each category (except for time saving motivations). This could be explained by the similar topics the statements questioned. Therefore, a reliability analysis has been done to determine the degree of consistency between the motivations in each motivational category. For each motivational category, the Cronbach's Alpha coefficient is above 0,8 which demonstrates a good internal consistency (Appendix 9, p. xliv). This can be found for each user frequency group in the young adult age group. These findings give validation that the motivation categories can be grouped into economic, social and environmental motivations.

Do different carsharing motivations affect carsharing usage?

Based on the three motivational groups established above, Spearman's Rho tests have been rerun based on the three newly established motivational categories (economic, social, environmental and time). Between the different motivations for carsharing, significant positive correlations have been found between financial motivations and social/environmental motivations. As table 7 shows, there is variety in the strength of these significant correlations that have been found. Where for low and high

frequency users, there are moderate relationships between economic and social motivations whereas for medium frequency young adult carsharing users, this is only a weak relationship.

*Table 7: Significant correlation coefficients for the three motivation categories and 'time saving' as motivation. Separated by age group and frequency (high = H, medium = M, Low = L). * Significant at p<0.05, ** Significant at p<0.01.*

	Economic	Social	Environmental	Time
18-32		H: 0,474* M: 0,169* L: 0,504**	H: 0,519** M: 0,338**	X

Lastly looking at the correlation between user frequency (App. VI, p. xlvii) and the different motivation categories, a significant negative although weak relationship can be found between economic motivations and carsharing frequencies among young adults. This entails that if the user frequency increases, young adult carsharing users are a little less economically motivated, or vice vera. There are no correlations between social or environmental motivations and user frequency.

Interpreting the analysis of young adult's carsharing motivations

The second section of the data analysis has focused on young adults as carsharing users, and what motivates them to answer: *'What motivations stimulate young adults to adopt B2C carsharing?'.*
As the results have shown, Greenwheels carsharing users are often economically and environmentally motivated to carshare. Environmental reasons for carsharing were discussed in the literature by Münzel et al. (2019) and Meelen et al. (2019) but were not considered to be the main reason why people start using carsharing in their research The high percentage of users that have environmental motivations (across age groups and user frequencies) show a new perspective.
Convenience, reliability and cost attractiveness as well as spatial characteristics were discussed in literature to be the main influencing factors and motivations for (potential) carsharing users to adopt carsharing (see Ch 2.3 'What grows a niche? Influencing factors of carsharing adoption'). Cost attractiveness correlates with economic motivations, of which the results in figure 29 have shown that carsharers are often economically motivated. This aligns with findings from Münzel et al. (2019), Bardhi & Eckhardt (2012) and Liu et al. (2014).
That Greenwheels carsharers are not socially motivated to carshare, can be contributed for a large part to how the service is designed, to optimally replace your own car, without having to meet, call or discuss with people as was discussed in Chapter 2.1. This is different for P2P carsharing services, which were also included in the survey but not in this secondary data analysis.
Where there is a weak correlation between financial motivations and carsharing frequencies (illustrating that someone carshares more, they are less economically motivated), it cannot be interpreted that certain motivations enhance or strongly decrease carsharing user frequencies. Knowing what motivates young adults to carshare increases the knowledge about current and potential carsharing users, and how they can be accounted for in the upscaling of carsharing.

4.4 Interview analysis: Experts perspectives on carsharing

In this section, the interview results will be discussed. The section is structured according to code categories which have been mainly pre-defined based on the conceptual model. The five categories are carsharing on a landscape level, regime level, niche level, stakeholders; which examines the interrelations between niche and regime level, and transitions; which zooms into the upscaling of carsharing. The category stakeholders have been defined inductively but encompasses stakeholders that have been discussed in the conceptual model such as the national government, municipalities and carsharing providers as well as how to cooperate. The codebook and code tree form the foundation for this result section can be found in appendix 7.

Carsharing on a landscape level

Experienced landscape pressures and policy motivations

Similar to in the theoretical framework (Ch 2.2), the interviewed experts have not explicitly mentioned landscape pressures, but have phrased them more as policy motivations. Carsharing is seen as a tool to reduce car ownership/usage and contribute to policy motivations as respondent 6 discussed. The four categories of policy motivations that have been mentioned throughout the interviews are sustainability, political motivations, spatial planning, social inclusivity. Both the municipality of Groningen (R3) and Utrecht (R8) expressed their main policy motivation was spatial planning based. The lack of space and pressures of the current mobility system is for both municipalities and important motivation for them to stimulate carsharing. On a national policy level, the interviewed experts expressed their motivation to stimulate carsharing is embedded politically in the Climate Agreement, as carsharing has been labelled as an option to reduce CO_2 emissions in mobility systems (R1). Social inclusivity is been deemed a more recent 'buzzword' policy motivation. As Respondent 7 phrased: *"(…), then, it is all of a sudden included in the discussion that shared mobilities contribute to the inclusivity of transport. Well great, then a buzzword is thrown in, as everything should be inclusive. That's a fine goal, but if you need to include it in the upscaling of shared mobilities, you shoot your own foot."*

Carsharing as part of sustainable mobility systems

Respondents perceived the direction of urban mobility systems to move towards more active transport modes such as cycling and PT use, with a decrease in car usage (R5). This is also strengthened by mobility visions of municipalities, something both Groningen and Utrecht are working on. Those visions focus on active modalities first, then PT, shared mobilities and lastly car usage (R3, R8). Within the mobility system, carsharing is often used unimodally (R4), however, when looking at the broader mobility patrons of users, carsharing is not deemed to be a 1-on-1 replacement of car ownership (R6). This requires the mobility system to offer a variety of transport modalities to create the trust and convenience for carsharing users to give up their car (R4). As Respondent 6 stated: *"It is definitely true that if you do not travel with your own car, you will not replace it one-on-one with carsharing, that doesn't work, it doesn't make sense. It is too expensive and does not make sense. So, when is carsharing interesting? When you as user can use a mix of possibilities, and that means that every day, every trip, you can make a different choice"*.

A last factor that influenced the mobility system was spatial planning. How neighbourhoods are designed, the parking norms, access to PT, it can influence the mobility patterns of (potential) users. Respondent 7 expressed their interest in the carsharing potential of cauliflower neighbourhoods and respondent 8 verified that in Utrecht's VINEX neighbourhoods, only this year carsharing became available whereas in other locations, carsharing has long been available. Respondent 6 also argued that if your private vehicle is able to be parked free or cheaply right in front of your home, there is no motivation to adopt carsharing.

Carsharing on a regime level

On the regime level, two main sub-categories were discussed, the regime dynamics and the policy developments. Furthermore, as separate code, the need for a mobility visions was discussed.

Mobility visions (NL: Mobiliteitsvisie)

On the regime level, what respondent 2 felt strongly about was the need for a vision, a 'mobiliteitsvisie' in Dutch. This often describes longer-term aims for the entire mobility system and mobility landscape. As Respondent 2 stated: *"(..) there should be a clear vision, a clear plan, in which carsharing is a building block."* In Groningen and Utrecht, mobility visions are being developed at this moment, which indeed include carsharing as well as general ideas about the direction of the mobility.

Current carsharing policy approaches, from reactive to regime-disturbing measures (regime dynamics)

Regime dynamics concern the different approaches to formalizing carsharing policy institutions. At this moment, current carsharing policies mostly include municipally defined ***reactive policies***. This entails that carsharing providers come to municipalities with a set of preferred locations for shared vehicles, and this is accepted. As Respondent 3 explained: *"Now it is indeed the case that we have left a lot up to the carsharing provider, we say; okay we will assess your permit request. We are forming a reactive policy, and assess where they request [the vehicle], assuming that they know best where their shared vehicle will do well."*

On national policy levels**,** there is no official carsharing policy (R6) besides the voluntary Greendeals. Respondent 6 and 7 both see that this can possibly be explained by the niche status of carsharing, compared to the big themes of the Ministry of Infrastructure and Water management such as Public Transport and Road infrastructure. The sectoral organisation of the ministry strengthens the importance of these sectors (R7) and makes it difficult to place a multiplex topic such as carsharing. On the other hand, respondent 6 has stated*: "The ministry of I&W is not the only one within the national government that should concern itself with this topic, or already concerns itself with it now. So, housing deals and future parking norms, and environmental laws (omgevingswetten), that all also naturally has to do with it".*

Besides reactive policies, most experts were familiar with the distinction between ***niche-supporting and regime-disturbing policies***. With regards to niche-supporting policies, the general mindset among interviewees was that such policies should strive for making carsharing a good experience, as similar as possible to vehicle ownership. Respondent 1 described*: "You want to see if for a group of car sharers or the physical shared vehicle, the things are organised as well as for a private char. At least as good, but preferably even a little better".* On the other hand, regime-disturbing policies concern policy measures that actively try to disturb the current regime of car ownership. However, as respondent 2 expressed: *"What became very clear [in their research], that most stakeholders found it very difficult to actually change the regime, to bring forth big changes, especially big changes on the national level".* On the other hand, respondent 7 generally argued that: *"So, I see the most in positive stimulating policies, that you ensure that shared mobilities are a good experience for the users, and then the private cars will disappear by itself".* Therefore, this respondent does not believe as much in regime-disturbing policies.

Municipalities as barrier for carsharing

What came forward in every interview ***is the barrier municipalities form on the regime level in the upscaling of carsharing.*** As carsharing permits are arranged at municipal level, there lies a lot of power with municipal organisations. The different regulations/permits municipalities uphold make it difficult for carsharing providers to quickly place new cars or even get permits (R7). For municipalities themselves, there is often a lack of knowledge (R1, R5) capacity (R7, R9) and motivation (R6, R9) to take up carsharing policy making. As carsharing provider Greenwheels (R9) expresses; *"It would help us a lot if we would know what to expect in a certain way, as it is now so different per municipality, and it costs us a lot of time to do it differently and have different conversations".* Even in municipalities like Utrecht, who have shown the motivation and knowledge, have difficulties with capacity and the bureaucratic processes that concern for example changing parking spots (R8).

This has also stimulated the desire among respondents to standardise carsharing policies or upscale carsharing policies to a national policy level.

Policy desires: Upscaling and standardisation

The policy desires expressed by respondents are ***policy upscaling to the national policy level*** and ***policy standardisation***. The first is deemed desirable according to respondents 3, 5 6 7, 8, and 9 as this would relieve pressure on municipal policy making levels, with a more leading role at the national level. As Respondent 7 stated that in working on the Greendeal Autodelen II it became clear that: *"The lesson we draw from that is that there is a desire to have coordination from I&W and that I&W should take*

that role upon themselves and not hide behind; they are local policy domains, if we decide something it's too top-down." A variety of respondents suggested that the national government could be a leader in standardising policy formats, stimulate cooperation at more regional levels, as well as provide a knowledge platform with more force than the CROW does at this moment.
On the other hand, there is also the desire for policy standardisation. Currently most municipalities develop their own regulations. As respondent 6 describes*: "(…) Because, with 300+ municipalities in the Netherlands, it's a hell of a job for all these carsharing providers to make different agreements with municipalities and explain how it works. And the other way around, a lot of policy makers in small municipalities have little personnel available to concern themselves with these themes. They hope on something ready-to-use that they can join".* This sentiment is resonated by respondent 9. On the other hand, standardisation can remain challenging, as Respondent 8 described when the municipality aimed to standardise policies with surrounding regions. The different policy motivations have made it difficult to create standardised carsharing policies regionally. Additionally, the different knowledge levels of municipalities about carsharing, shared mobilities etc. can make it more difficult to latch onto regional policy developments.

Developing good policies: a challenge in and of itself
Developing carsharing policies can be a challenge, that is something these interviews have made clear. When asked about clear don't in developing carsharing policies, respondent 3, 6 and 7 expressed their concerns about too demanding policies. Specifically with regards to electrification of the carsharing fleet, respondent 1 expressed concerns. Important do's in carsharing policy making according to the interviewees are good cooperation with stakeholders (R2, R7), knowledge exchange between governments and providers (R2), clear rules (R3) and parking permits and capacities within municipality (R9). Core policy conditions that need to be present according to the interviewees are integrated mobility policies (R2, R4, R8), good communication (R2, R7), clear municipal policies (R3, R5) including parking policies (R6, R9) and good cooperation with providers (R2, R8).

Policy barriers
Policy barriers are barriers that experts experience when developing carsharing policies and therefore upscaling of carsharing more difficult. A general lack of policies on local and national policy levels is considered a barrier especially for smaller municipalities that do not have the capacity to develop their own policies (R6, R9). Additionally, some municipalities take on a reserved position towards carsharing as it is a commercial product (R4, R6, R9). At a municipal level, Groningen and Utrecht expressed the challenge of designing a solid permit system that is durable as well as future oriented. Municipalities also run into ***practical barriers*** such as bureaucratic measures that need to be taken when wanting to change public space (R8). Two other important barriers are the at times negative image of sharing mobilities because of 'deelscooter' nuisance experiences (R4), or that municipalities do not want to be known as 'car bully'. As respondent 7 stated: *"Eventually it is also is, because of the resistance amongst municipalities to develop policies, as they do not want to be known as 'car bully".* Respondent 8 (Utrecht) also expressed that the different policy motivations make it difficult to get standardise policy approaches among municipalities or regions.
Potentially the most significant policy barrier is ***the lack of knowledge*** amid municipalities, which was discussed by all respondents (except R2). Certain municipalities do not know a lot about carsharing, permit structures or additional policies. Generally, the levels of knowledge differ greatly between municipalities according to respondent 7. Regarding the spatial location of shared vehicles, both Groningen and Utrecht seemed to have limited knowledge about the locations of shared vehicles and how well they perform, which makes developing spatial policies more challenging.
Another barrier is the ***policy fragmentation***. As Respondent 7 expressed, within municipalities carsharing is often a niche and not well integrated with other policy departments. Other times, such as in Utrecht, carsharing has been positioned within different departments and thus also fuelled by different policy aims (R8). At a national policy level, embedding carsharing as a policy field has also been challenging (R6/R7). As respondent 6 discussed: *"And the reason why there is still not a national*

carsharing policy is also not always clear to me. In part I think, is because it is such a small phenomenon, it is not rail or roads. Those are the real big themes within I&W and water of course, but that's another part, where almost all of the attention goes to. That concerns a lot of passengers and a lot of money, and this [carsharing] is a more difficult to grasp topic where there is not one logical owner. I&W is organised in policy domains, one is sustainable mobility, another road traffic, and another OV and rail, you know, where does it belong?" Unless the policy fragmentation barriers are solved, it can be challenging to realise a stable national carsharing policy framework as is desired by many interviewed respondents.

Policy recommendations

Table 8 shows an overview of the policy recommendations given by interviews (following page). Key findings are the importance of communication as well as spatial policies. The municipality of Utrecht, while having mainly a reactive policy attitude, has started looking at the spatial distribution of their fleet and if they can also provide carsharing is less attractive neighbourhoods with for example high car ownership (R8). Currently the CROW is an important knowledge provider for example mentioned by respondent 4, however, many respondents feel there can be more knowledge sharing between municipalities and the national government (R2, R3, R4, R6). This is a key measure that needs to be taken in order to make policy developing go more smoothly. Regarding regime-disturbing policy measures, there is a desire, as both the interviewees from Groningen and Utrecht and national policy makers have expressed, however, little is happening at this moment. As respondent 1 and 8 mentioned, parking policies are already challenging. Respondent 5 discussed, regime-disturbing policies are needed for carsharing upscaling*: "yes, it would be a step. (…) If you look at policy measures aimed at vehicle reduction, in combination with supporting carsharing, that is offers solace, at least for the long term".*

Lastly, with regards to successful policy examples, Amsterdam, Gent and Utrecht were mentioned by multiple respondents. Some respondents also did not feel they knew a successful example (R4/R5).

Table 8: Overview of policy recommendations given by the interviewees. Per category, the policy measures are sorted from most to least mentioned.

Policy recommendation	Short explanation	Policy group established in TF
Niche-supporting		
Communication and information provision	Communication to potential users to create awareness about carsharing and how to use this. Also specifically oriented at young adults and communicated through the platforms they use (all except R1 and R7)	User group policies
Spatial distribution	Distributing the placement of vehicles through more active municipal policies, for example. A top tier location is given on the condition with the placement of a car on a less popular location (all except R2 and R6)	Spatial policies
Knowledge exchange between policy makers	An important policy barrier is the lack of knowledge and capacity at the municipal level. Through knowledge exchange between municipalities and governments this barrier can be reduced. (R1, R2, R3, R4, R5, R6, R7)	
Financial compensation carsharing providers	Another method to stimulate upscaling and carsharing in less attractive neighbourhoods (R3, 4, 5 and 8)	Economic policies
National carsharing policies	The City/Greendeals are ending, there is a desire for a follow up, potentially with a more concrete national direction (R3, R7, R9)	
User group oriented policies	Not used a lot yet, focus on specific characteristics of user groups and target carsharing towards that (R1, R3, R4, R8)	User group policies
Electrification of the fleet	To increase the sustainability of carsharing and make it easier for carsharing providers to roll out electric carsharing.	
Hubs	Increases the change of having a car available, Utrecht's success story of Grifthoek parking garage.	Spatial policies
Play into life changes	Having communication at specific life changing moments, such as communication at the time of driver's license possession.	User group policies
P2P carsharing	Only mentioned by respondent 3, in Groningen they are starting a pilot with P2P	
Financial compensation users	In Utrecht, they wanted to offer carsharing credit after their graduation → practical limitations	Economic policies
B2B carsharing	Respondent 3 felt that needing a car for work was an important contributor to vehicle use, by stimulating B2B carsharing this could reduce car ownership.	
Regime-disturbing policies		
Additional (flankerend) beleid	Integrating carsharing into other policies. Going further than only rolling out carsharing but also actively integrating it into existing policies	
Behavioural changes	Both the interviewees from Groningen, Utrecht and interviewees from the national government highlighted their interest and the importance of developing policies aimed at changing mobility patterns and steering mobility patterns	User group policies
Combined niche supporting and regime disturbing policies		
Parking policies	Having good parking permitting systems for carsharing providers on one hand can stimulate upscaling of carsharing. On the other hand, stricter parking norms are almost needed to make a shared vehicle more attractive than a privately owned one. Can also be related to the costs of parking	Economic and spatial policies
Spatial planning	Include carsharing in the restructuring of existing streets, and with that, removing parking spots or other measures. As well as include carsharing in the development of new neighbourhoods and how streets are designed.	Spatial policies

Carsharing on a niche level

On a niche level, an important theme were the characteristics of carsharing. That carsharing is still a niche, was generally agreed upon by the interviewees. With regards to whether or not carsharing is a supply-led or demand-led market, most interviewees found that carsharing initially is a supply-led market. People are only prepared to give up their own vehicle if they have enough alternatives, as respondent 7 argued. Provider Greenwheels also saw the supply-led side of their market, but also saw that after carsharing is rolled out, often demand increases. Respondents 4 and 5 aligned with this reasoning. Different carsharing types and effects were also discussed with a general weariness of free-floating carsharing (R2, R4, R9).

Electrification of the carsharing fleet

Currently there is quite some focus on electrifying shared vehicles, something respondent 9 felt was a shame, as rolling out electric carsharing takes a lot longer and thus prevents upscaling. With regards to the position of carsharing and other modalities, as was touched upon in the landscape section, carsharing is often used in a broader mobility pattern. To make carsharing attractive one needs other modalities such as PT. Most respondents felt that a combination of modalities was needed to make carsharing really attractive and possible (R1, 2, 4, 5, 6, 7, 8, 9). As respondent 1 stated: "*When you have more opportunities as traveller, you have more trust or you get affirmation that traveling without a car ownership is possible. How higher the number, the better, and this also includes Public Transport".*

Carsharing user groups

With regards to the different user groups discussed during the interviews, respondents 1, 2, and 7 discussed the change between early adopters and early majority. At this point, many experts argue that the early adopter pool has been satisfied and a move towards early majority is needed. Whom the early majority group will form is not clear at this time for the interviewed experts. Generally, neither policy makers or the interviewed carsharing provider Greenwheels focus on different user groups. Young adults were considered by many interviewees as an attractive user group, where often their 'carlessness' (R7) and less determined travel habits (R8) were among the reasons why young adults could be a good user group to target. In Utrecht, there have been an attempt to offer carsharing credit to young adults who just graduated, however, this failed due to practical privacy limitations. Additionally, the city also offered shared vehicle locations to carsharing providers near student and young adult neighbourhoods or housing to stimulate the upscaling of carsharing and make carsharing accessible for young adult users.

Influencing factors of carsharing Adoption

The two most important influencing factors according to the interviewees where reliability/ convenience (R2, 3, 4, 7, 8, 9) and cost attractiveness (R2, 3, 7, 8). As respondent 3 described: "*If you ensure that the cost differences grow, then you motivate people and make it clear to them that a different form of car usership is desirable".* With regards to convenience, carsharing should be as close to actually owning a vehicle in order to make it really attractive. Other factors that were mentioned was environmental awareness, diversity of the carsharing fleet, living in 'autoluwe' neighbourhoods, the ambassador's effect and life changes. The ambassador's effect explains that young adults are inspired by other 'leading' young adults to adopt carsharing as it becomes a more normalized lifestyle.

Exchanges between the regime and niche level: the role of stakeholders

An inductively found category were the stakeholders. Stakeholders are parties that influence the exchanges between the niche and regime levels. A few key stakeholders that have been discussed during the interviews are the national government, municipalities, carsharing providers and others. These are similar to the stakeholders in the conceptual model. Governmental stakeholders influence the regime level through formal and informal institutions whereas carsharing providers are located on

the niche level, shaping the innovation that is carsharing. The national government executes voluntary agreements about carsharing motivated by sustainability aims.
As discussed in the regime section, there is a desire for a more leading role for the ***national government***. As respondent 5 suggested: *"I think the goal of the national government can be to stimulate municipalities to develop standards as to make it more manageable for providers, so they do not run into different procedures at every municipality".* Respondent 2 and 8 also saw a more leading role for the government.
Municipalities are often motivated by spatial pressures. According to the respondent 3 from Groningen, important tasks are to define clear rules and standards for carsharing as well as work together with carsharing providers. Creating a level playing field is also deemed important by respondents 1 and 3.
Carsharing providers are often limited in their upscaling capacities due to governmental barriers as respondent 9 (Greenwheels) made clear. Carsharing providers often want more than is possible at this time due to municipal barriers. Additionally, carsharing providers often have a lot of experience and knowledge about their users, which should not be underestimated and welcomed more by governments (R8).
Looking at the different accords between carsharing providers and governments, governments sometimes have their reservations about B2C carsharing. As respondent 6 describes: *"(…) I sometimes talk with municipalities that have the idea that they, yes, they don't want to work together with market parties because they are all commercial parties and there are also municipalities that say; we won't we don't even want to put something on our website because they are all commercial parties".* Respondent 3 (Groningen) also expressed that they preferred P2P over B2C as it is not a commercial product in the public space but something shared among residents. There are relational challenges between municipalities and providers, such as getting a hold of the right person for the carsharing permit.
Between the national government and municipalities there are different policy motivations for carsharing (R1) as well as the desire for a more active national role where the national government coordinates and leads more (R7). Fragmentation within the governmental bodies can make effective cooperation more challenging.
Respondents express a ***desire to cooperate*** (more). Between municipalities and providers (R2, R6, R8) as well as between carsharing providers. This would create a better integrated supply of carsharing options and could improve the knowledge exchange between different stakeholders (R2). Increased cooperation can reduce transaction costs, increase knowledge sharing between different parties and potentially make policy standardisation easier.
Regarding knowledge exchange, the ***CROW*** already plays an important role according to respondents 4 and 5, however it does not achieve the desires aim of policy standardisation yet. Another stakeholder that can pose as a barrier are local ***citizens***, that might not like the removal of parking places, but they are also a stakeholder that can encourage carsharing (R8).

Upscaling carsharing as part of a sustainable mobility system: transitions

Upscaling expectations

Many respondents discussed the transition from the current mobility system with a dominance of car ownership, to a more multi-modal mobility system with less ownership. This requires the upscaling from carsharing as niche, integration into regime dynamics and the mobility system. In Groningen and Utrecht, this change has also been articulated in their upcoming mobility plans/visions. Interviewees 1, 2, 3, 6, 8 and 9 do believe in the system change and the upscaling of carsharing as part of this new mobility system. There is a general upscaling expectation in urban regions as respondent 3, 6 and 9 mentioned. On the other hand, respondents 4 and 5 did not expect to see the upscaling of carsharing in the future. As respondent 5 stated: "*It has been a niche for 25 years, and it does not come up in the curve [S-curve], that is the problem. And if you look at international studies, and the different countries where carsharing has been introduced, than you see that, also in the US, also in Asia, that it stays a niche. It does not go further than the early adopters".* Although growth might not be expected

according to respondent 5, stimulating the diversity in modalities is important and a system change in itself as a few years ago, there were very little options if you did not own a car.

Upscaling barriers and opportunities

With regards to upscaling barriers, the lack of regime-disturbing measures is considered to be an upscaling barrier by multiple respondents (R1, R6). There is a general difficulty to change the regime and also get a political movement behind this (R1, R2, R6). Respondents questioned whether without these policies, carsharing could upscale, of which many were doubtful.

Secondly, the lack of knowledge (R2, R6), slow bureaucratic processes (R1, R8) and lack of capacity (R3, R9) all contribute to municipalities forming barriers for upscaling and developing regime disturbing measures. As respondent 9 from Greenwheels stated: "*It costs us a lot of time at the moment as a lot of requests are on hold because municipalities say; hey, we do not have policies, so we do nothing. That is a shame in my opinion. It hinders the growth of parties tremendously, despite the demand. What you get is that there is demand, but our cars are so occupied that not all users can use them, and that does not stimulate people to get rid of their vehicle, which is the goal of shared mobility".*

Other barriers are the non-fixed policy position of carsharing, on both municipal and national levels. This creates uncertainties for carsharing providers and their investments. Furthermore, the back-end sector such as financing and insurances as well as subsidies can be challenging to arrange (R1). Another challenge are electrification requirements, which makes it for providers difficult to place more vehicles. As respondent 9 stated: "*There are a 100 coming in September [electric vehicles], but I have been working on that since January and it costs a lot of time. And I think it is a shame that this goes at the expense of the growth that you can do in two months [with gasoline vehicles] by accepting permit requests".*

With regards to upscaling opportunities, and active municipal role in developing policies, external expertise (R1, R2), expanding to smaller municipalities (R1, R9), standardising policy frameworks (R2, R3, R6, R7) as well as a good multi-modal transport system (R2) among the opportunities to scale up carsharing.

Interpreting interview results

Through holding interviews, answers to the questions *"What are the current (urban) carsharing and sustainable mobility policy frameworks in the Netherlands and how are these perceived by carsharing practitioners?"* and *"What are the barriers, success factors and conditions needed for the planning of successful carsharing networks in Dutch urban regions?"* have been explored.

Throughout the interviews, many theoretical findings from Chapter 2 were discussed. For example, respondents discussed similar policy motivations as were found in Chapter 2.2. Additionally, the suggested policy recommendations in table 3, correlate to an extend with scientific policy recommendations in table 4. Generally, respondents saw carsharing was still a niche, but also a tool that could be implemented/upscaled to contribute to sustainable mobility systems. Young adults were considered a good potential user group by interviewees as well. In the following two sections, the interview results will be interpreted more extensively.

Carsharing policy frameworks

With regards to the current carsharing policy frameworks and how carsharing experts perceive them, many interviewed experts were familiar with the distinction between niche-supporting and regime-disturbing measures described by Münzel et al. (2020b). Current carsharing frameworks include mostly reactive carsharing policies, which were not explicitly described in literature. The barriers that municipalities form in the developing of policies and general upscaling of carsharing is an important finding in this research. Where the differentiation of carsharing policies across municipalities (Münzel et al., 2020b) was mentioned in literature, the illustrations of the interviewed experts about lack of knowledge, capacity and motivation highlight the more extensive barrier municipalities form in the upscaling of carsharing. This has also stimulated the desire among respondents to standardise

carsharing policies or upscale policies to a national policy level, something Münzel et al. (2020b) and CROW (n.d., f) also described as desirable. Current carsharing policy frameworks, if there are any policies to begin with, are perceived as very complex due to the many municipal differentiations. Additionally, policies are perceived as not stimulating enough, as the policy barriers make the upscaling of carsharing very difficult.
In the theoretical framework, the main policy-oriented focus was on potential policy measures that could be applied. The difficulties associated with developing policies have been discussed very limitedly. The policy barriers found in the interviews highlight a theoretical gap in knowledge that this research has not included.

Upscaling carsharing as part of sustainable mobility systems
When looking at upscaling of carsharing and developing successful carsharing networks, current barriers need to be taken away. Better cooperation between governments (e.g., ministries, municipalities, carsharing providers) is therefore desired. Additionally, integrating knowledge sharing between stakeholders is an important step to enable upscaling and developing successful policies in the future. These steps could be considered important conditions for creating better agreements and manage expectations between parties which would make the upscaling and developing of carsharing policies an easier process.
Looking at the main barriers, many respondents were positive about a more leading role for a ministry such as I&W, to stimulate and guide municipalities. This could take away policy barriers on municipal levels. Embedding carsharing on a national policy level however, it not without its own challenges. The segmented nature of the national organisations, the niche status of carsharing and the different policy goals carsharing can be associated with create upscaling barriers on a national policy level (R1, R6, R7). This also explains the lack of national carsharing policies described in the explainer (p. 81)
With regards to the upscaling of carsharing, from a transition perspective, carsharing is deemed to be a tool that can be used to reduce car ownership and through that contribute to different policy aims based on landscape pressures. There are multiple upscaling barriers, with the main one being the lack of focus on the actual changing of the regime and the associated steps with that process. As already described in the theoretical framework, often little regime-disturbing measures taken, which is also reiterated by the respondents. Potential policy measures that could help the upscaling of carsharing are illustrated in table 8. Where there are new policy suggestions, quite a few policy recommendations align with the findings from table 4.

5. Discussion and conclusions

In this chapter, the conclusion and discussion will be discussed. The discussion will reflect on the found results and provide recommendations for further research. The conclusion will provide four recommendations to answer the main research question. As the empirical sub-questions have been discussed at the end of each paragraph in the result section, the conclusion will focus on the triangulation between the different methodological approaches and answering the main research question.

5.1 Conclusions

In answering the main research question '**How can carsharing policies focussed on young adults, support upscaling of carsharing as part of a sustainable mobility system in Dutch urban regions?**', this research has illustrated that carsharing is a tremendously broad topic. To conclude how carsharing policies focussed on young adults can support the upscaling of carsharing, four concluding recommendations are proposed. Firstly, governmental barriers need to be solved, which prohibit the current upscaling of carsharing. Furthermore, integrating spatial perspectives into carsharing policy could develop more accessible carsharing networks which can help the upscaling process. With regards to young adults as users, developing user group policies based on their motivations for carsharing can make carsharing more attractive to other potential users. Lastly, in order to transition towards sustainable mobility systems, regime-disturbing measures will be needed, something that has been difficult to achieve thus far. These four concluding recommendations will be elaborated on, starting with solving policy and upscaling barriers.

Solving policy and upscaling barriers: a first step in developing carsharing policies

Six out of nine interview respondents agreed that carsharing has upscaling potential. In order to realise this upscaling potential however, the interviewees made clear that policy and upscaling barriers must be reduced, which mainly concern governmental barriers. Although in literature (Münzel et al., 2020b), policy barriers mainly concerned the municipal policy differentiation, the interview results have shown that this municipal barrier is more extensive in terms of capacity, knowledge and policy fragmentation barriers. Without solving the barriers that prohibit smooth policy making and smooth permit processes, the upscaling of carsharing will remain a complex and slow process.

Interview respondents discussed two main solutions to these governmental barriers. The first solution is to standardise policies amongst municipalities for example by working together regionally and build in knowledge sharing between municipalities, which could take away capacity and knowledge barriers. The second suggestion has been to upscale certain elements of carsharing policy making to a national policy level which could provide an external push and potential instruments for knowledge sharing and standardisations as well. This does require a stable governmental position for carsharing to develop policy frameworks. In both these processes, good cooperation between stakeholders has been signalled to be important by multiple interview respondents.

Concluding, the success of the upscaling of carsharing is highly dependent on governmental parties, their policies and permit schemes, presenting the policy dimension to carsharing. As the interview results have made clear, solving these barriers is the first step in being able to support the upscaling of carsharing.

Developing carsharing networks: Integrating spatial perspectives

The GIS results have shown that carsharing is a highly urban service, located mainly in areas with higher population densities and lower car ownership rates when compared to inhabitant figures. This correlates with theoretical findings on spatial influencing factors. Meelen et al. (2019) described that carsharing is more likely in neighbourhoods with higher inhabitant densities and lower car ownership rates. Results from the interviews have displayed that carsharing is a supply-led market in the early phases of upscaling. Therefore, accessibility to shared vehicles is important to upscale carsharing. Interview respondents reiterated this and discussed the spatial distribution of shared vehicles. For

policy recommendations, multiple respondents discussed spatial distribution measures to contribute to the upscaling of carsharing and make carsharing broadly accessible, including locations near young adult housing facilities.

Upscaling carsharing: Stimulating the potential user group of young adults

Through literature research, important influencing factors were found that affect (potential) carsharing users. These influencing factors are cost attractiveness, the reliability/convenience of a carsharing service, and spatial neighbourhood characteristics. Interviewees brought forward similar influencing factors, with an emphasis on cost attractiveness. Survey results illustrated the motivations of young adults to adopt carsharing, with high economic motivations. This triangulates with literary and interview-based findings. On the other hand, survey results show high environmental motivations to adopt carsharing, which were limitedly discussed during the interviews and literature research.

Generally, interviewees agreed that young adults would be an interesting potential user group for carsharing to target. On the other hand, interview results also made clear that different user groups were not considered in carsharing policies or by market parties. Survey results show that young adults do have different user characteristics than older age groups, which is strengthened by multiple interview respondents who agreed that specific user group policy measures should be developed. Generally, interview results discussed that carsharing should be made as attractive as possible, which include playing into the motivations of carsharing users.

Building carsharing policies: combining niche-stimulating and regime-disturbing policy recommendations

Lastly, looking at which policy measures should be developed, Münzel et al. (2020b) found a reserved attitude towards regime-disturbing policy measures. Interview results showed similar findings. The majority of policy measures focused on niche-stimulating policy measures, rather than taking steps to dismantling or changing the existing regime. There are desires for developing regime-disturbing policies but policy measures are not implemented yet as there often are political barriers. Without regime disturbing policy measures, four respondents questioned whether carsharing would actually be able to upscale. Interview results show that there is still a regime change to be had, in order to roll out regime-disturbing policies, and actively move towards sustainable mobility systems, as without regime-changing policies, sustainable mobility systems will most likely not be created.

Conclusion

As survey results have shown, being a carsharing member, actively reduces car ownership across ages and user frequencies. This has illustrated that carsharing can reduce the landscape pressures described in the theoretical framework, as well as contribute to the different policy aims discussed the interviews. However, as the interview results have shown, there are significant barriers that challenge the development of carsharing policies as well as the possibility to upscale. As long as policy measures remain niche-supporting, it is doubtful whether a transition to sustainable mobility systems will actually happen. It requires a regime change which policy makers and political actors are not willing to make at this moment in time. With the above-described recommendations, steps can still be taken to enable the upscaling of carsharing. This can make carsharing more accessible to user groups like young adults and can further reduce car ownership in Dutch urban regions which contributes to the different policy aims Dutch governments try to achieve. Eventually, the upscaling of carsharing can serve as a means to sustainable mobility systems.

5.2 Discussion

This research has looked a carsharing through transition theory lenses. In the discussion, the found conclusions and results will be to the conceptual model and of the results, limitations of the research and the impact of planning practice will be reflected upon.

Conceptual expectations compared to empirical findings

Compared to the conceptual model proposed, the empirical findings align for a large part with the theoretical findings. Similar policy measures and influencing factors have been found in literature and in the three empirical research methods. An unexpected finding was the high environmental motivations for carsharing as found in the survey. As the survey included only functional, social and environmental motivation statements, there might be other motivations to adopt carsharing, such as neighbourhood characteristics as described in the theoretical framework. As these have not been questioned in the survey, in this research, it cannot be stated with certainty that these are the only motivations for young adult carsharers. Furthermore, looking at the interactions between stakeholders described in the conceptual model, there seems to be minimal interactions between carsharing providers and governments. Carsharing providers were mainly deemed to be influenced by carsharing policies Interview results have shown this is a two-way street of cooperation between governments and carsharing providers, or ideally it should be.

Where the conceptual model and found results align, the two new insights deserve further research. Which motivations stimulate young adults to adopt carsharing is highly important as it influences whether they as user group will adopt carsharing. Additionally, as the interview results have shown, improved cooperation between stakeholders is desired to create smooth policy making processes, which should take away upscaling barriers. Where this research has identified the desire to cooperate more and the importance of interactions between stakeholders, it has not included concrete steps on how to improve and structure cooperation between different stakeholders. This could be included in further research.

Research limitations

Looking at the limitations of this research, the findings of this research specifically apply to Dutch urban regions. The research has included two cases, which are both larger urban regions in the Netherlands. Although national policy makers and knowledge experts have been interviewed to provide a more holistic view of carsharing policy frameworks, policy developments are always highly embedded into local contexts. The scope of the research therefore is only applicable to urban contexts and has left out the challenge of providing carsharing in rural regions. Upscaling carsharing is a different challenge in smaller urban and rural areas. There are often less viable business cases, higher car dependencies, and different potential user groups. Further research could focus on more rural carsharing business cases to examine who this differs in user groups as well as policy contexts, which are highly case dependent. Other research could also explore other urban policy contexts and zoom into how policy standardisation across different municipalities can be realised, something that was mentioned to be desirable in the interviews.

Conclusion

Despite these limitations and suggestions for further research, the variety of methods is the strength of this study as each method has allowed to look at a different aspect of the upscaling of carsharing. Often, literature focusses on one aspect of carsharing, such as Meelen et al.'s (2019) spatial perspectives and Münzel et al.'s (2020b) policy perspective. This research has combined spatial, user-based and policy-based perspectives to create a more holistic view on how to upscale carsharing through policies oriented at young adults. This research therefore serves as a guidance for contemporary carsharing practices and can have a direct impact on planning practice and the accessibility of shared vehicles if the recommendations are followed.

6. Reflecting on research methods

In this last section, a reflection on the research process will be given. Before diving into the reflection per research method. Where the discussion has reflected on the results, this section will reflect on the research methods. This research has included three empirical research methods. Where the different methods bring breadth to the research, the wide variety of research methods also limit the depth of the research. Selecting less research methods would have allowed for potentially more interviews or a more extensive secondary data analysis.

Literature research

In the theoretical framework, Münzel et al. (2019, 2020, 2020b) has delivered the majority of the knowledge around policy development with regards to Dutch carsharing and carsharing policies. Where in the interviews, many of the respondents seem to have similar ideas as Münzel et al. (2019, 2020, 2020b), ideally a broader foundation of scientific literature would have been used to describe carsharing policies in the Netherlands.

GIS analysis

The GIS data of the shared vehicles has been collected through primary data collection, however, there is the possibility for collection error, where a shared vehicle might have been missed. The open data used like the CBS Buurten 2019 maps and CBS 500x500m maps have limitations. Where this research has defined young adults to be 18-30 based on research from CBS (2018) and others, demographic statistics from the same organisation are categorized in age categories of 15 years, which does not allow to select the age group between 18-30. For further research, one would prefer to isolate the age group of 18 to 30 years old, to provide more accurate GIS analysis.

Secondary survey analysis

As it concerns a secondary data analysis, it is to be expected that the research aims do not perfectly align. Therefore, parts of the dataset are therefore irrelevant for this research.

A limitation to the data is the age of the dataset. Since 2018, there already have been significant developments and growth. MyWheels used to be combined P2P/B2C and is now fully B2C in 2021, and growing quickly with 1000 vehicles placed Winter 2021 (MyWheels, 2021). Another limitation is that this dataset only contains respondents that already carshare, and therefore are most likely part of this early adopter group described by Münzel et al. (2019) along with others, as carsharing was an even smaller niche in 2018. This makes it more difficult to make statement about what potential user groups might attract to carsharing. Despite this limitation, insights into the motivations of current carsharing users, and their car ownership before have been very relevant as this does inform about the effects of carsharing.

Stofberg et al. (2019) has published a paper about the dataset, where similar data analyses have been executed. This was not known by the researcher nor internship organisation until the analysis had been finalized. Despite this, Stofberg et al. (2019) have focused on peer-to-peer carsharing, whereas this research has focused on B2C carsharing with a differentiation in user age groups, to look at the differences between young adults and older age groups. This shows clearly two different selection approaches in the dataset which illustrates that this analysis is still relevant and useful.

Lastly, although postal codes could be differentiated in the dataset, the choice has been made to not select the two case studies in the data, but keep the focus on young adult carsharing users in the Netherlands. The sample numbers would decrease significantly when selecting on those specific locations, which would decrease the strength of the analysis. Additionally, as Greenwheels is the only provider selected in the case study, the business model is similar throughout the country, with similar prices as well.

Interviews

With regards to the interviews, 9 respondents in 8 interviews have been interviewed. Very relevant where also the insights from the three researchers (R2, R4, R5), who especially with regards to transition theory as well as niche and regime disturbing measures brought in relevant points. Despite multiple attempts to reach different carsharing providers (MyWheels, Greenwheels, Juuve) through emails, calls and contacts, eventually only one carsharing provider was willing to partake in an interview. Holding interviews with multiple carsharing providers might have created a better understanding of the perspective of carsharing providers. Further research could examine the differences between carsharing providers and how they for example deal with the governmental barriers their practice faces. This could create better insights in how to solve barriers between carsharing providers and governments and provide more concrete recommendations.

7. References

Allen, M. 2017, *The sage encyclopaedia of communication research methods*, vol. 4, SAGE Publications, Inc: Thousand Oaks, CA.

Acheampong, R. & Siiba, A. (2020). Modelling the determinants of car-sharing adoption intentions among young adults: the role of attitude, perceived benefts, travel expectations and socio-demographic factors. *Transportation,* Volume 47, pp. 2557-2580

Agenda Stad, (2018) *Elektrische deelmobiliteit in stedelijke gebiedsontwikkeling*. Retrieved on November 25th 2020 from https://agendastad.nl/citydeal/elektrische-deelmobiliteit-in-stedelijke-gebiedsontwikkeling/

Agenda Stad (n.d.). *City deals.* Retrieved on June 15th 2021 from https://agendastad.nl/city-deals/

Banister, D. (2008). The sustainable mobility paradigm. *Transport policy.* Volume 15, pp. 73-80

Bardhi, F. & Eckhardt, G. (2012). Access-based consumption; the case of Car Sharing. *Journal of Consumer Research,* Volume 39, pp. 881-898.

Brandstätter, G., Kahr, M. & Leitner, M. (2017). Determiing optimal locations for charging stations of electric car-sharing systems under stochastic demand. *Transportation Research Part B,* Volume 104, pp. 17-35.

Brugge, R. van der, Rotmans, J. & Loorbach, D. (2005). The transition in Dutch water management. *Regional Environmental Chang*e, 5(4), 164-176.

Burghard, U. & Dütschke, E., (2019). Who wants shared mobility? Lessons from early adopters and mainstream drivers on electric carsharing in Germany. *Transportation Research Part D: Transport and Environment,* Volume 71. Pp. 96-109

Carrone, A.P., Hoening, V.M., Jensen, A.F., Eriksen Mabit, S., Richt, J.et al. (2020). Understanding car sharing preferences and mode substitution patterns: A stated preference experiment. *Transport policy,* Volume 98, pp. 139-147.

CBS, (2018). *Autobezit jongeren in stad helft van dat op platteland*. Retrieved on November 16th 2020 from https://www.cbs.nl/nl-nl/nieuws/2018/03/autobezit-jongeren-in-stad-helft-van-dat-op-platteland

CBS, (2019). *Hoeveel rijden personenauto's?* Retrieved on November 16th 2020 from https://www.cbs.nl/nl-nl/visualisaties/verkeer-en-vervoer/verkeer/verkeersprestaties-personenautos

CBS, (2020). *Autopark groeit sterker dan bevolking*. Retrieved on November 19th 2020 from https://www.cbs.nl/nl-nl/nieuws/2020/10/autopark-groeit-sterker-dan-bevolking

CBS, (2020b). *Hoeveel personenauto's zijn er in Nederland?* Retrieved on November 16th 2020 from https://www.cbs.nl/nl-nl/visualisaties/verkeer-en-vervoer/vervoermiddelen-en-infrastructuur/personenautos

CBS, (2021). *Verkeersdeelname en deelname openbaar vervoer; persoonskenmerken*. Retrieved on March 2nd from https://www.cbs.nl/nl-nl/cijfers/detail/84707NED#Verkeersdeelname_1

Celsor, C. & Millard-Ball, A. (2007). Where does carsharing work? *Transportation Research Record: Journal of the Transportation Research* Board, Volume 1992, pp. 61-69.

Clark, M., Gifford, K., Anable, J. & Le Vine, S. (2015). Business-to-business carsharing: evidence from Britain of factors associated with employer-based carsharing membership and its impacts. *Transportation*, Volume 42, pp. 471-495.

Claus, S. (2020). Auto's zijn zonde van de ruimte en dus zijn ze in Utrecht kampioen autodelen. *De Trouw.* February 12th 2020. Retrieved on June 15th 2021 from https://www.trouw.nl/nieuws/auto-s-zijn-zonde-van-de-ruimte-en-dus-zijn-ze-in-utrecht-kampioen-autodelen~baa93a0a/

CROW, (2020). *Met 730.000 deelautogebruikers is het doel overtroffen*. Retrieved on November 15th 2020 from
https://www.crow.nl/over-crow/nieuws/2020/oktober/met-730-000-deelautogebruikers-is-het-doel-overtro

CROW, (2020b). *Waarom Autodelen*. Retrieved on November 16th 2020 from
https://www.crow.nl/dashboard-autodelen/home/wat-is-autodelen/waarom-autodelen

CROW, (n.d.). *Uniformering autodeelbeleid.* Retrieved on November 18th 2020 from
https://www.crow.nl/dashboard-autodelen/home/aan-de-slag/uniformering-autodeelbeleid

CROW, (n.d. a). *Factsheet 3: Wie is de autodeler?* Retrieved on April 19th 2021 from
https://www.crow.nl/downloads/pdf/verkeer-en-vervoer/crow-kpvv/factsheet-autodelen-3-wie-is-de-autodeler.aspx

CROW, (n.d., b) *Autodeelvormen*. Retrieved on November 18th 2020 from
https://www.crow.nl/dashboard-autodelen/home/wat-is-autodelen/autodeelvormen

CROW, (n.d., c) *Faciliteren vs. Stimuleren*. Retrieved on January 18th 2021 from
https://toolkitautodelen.crow.nl/home/content?contentId=9&roleId=1&vsId=6

CROW, (n.d., d) *Handhaven rondom deelauto's*. Retrieved on January 18th 2021 from
https://toolkitautodelen.crow.nl/home/vraagstuk/13

CROW, (n.d., e) *Inrichten van een vaste standplaats*. Retrieved on January 18th 2021 from
https://toolkitautodelen.crow.nl/home/Vraagstuk/12

CROW, (n.d., f) *Toolkit Autodelen - Vijf handvatten voor gemeenten.* Retrieved on January 18th 2021 from https://toolkitautodelen.crow.nl/home/handvattengemeenten

Dias, F.F., Lavieri, P.S., Garikapati, V.M., Astroza, S., Pendyala, R.M. & Bhat, C.R. (2017). A behavioural choice model of the use of car-sharing and ride-sourcing services. *Transportation*, Volume 44, pp. 1307-1323.

Faber, R., Durand, A. & Zijlstra, T. (2020). *Kansrijke verplaatsingen met Mobility-as-a-Service.* Retrieved on December 28th 2020 from
https://www.kimnet.nl/publicaties/rapporten/2020/12/17/kansrijke-verplaatsingen-met-mobility-as-a-service

Frey, B., (2018). *Snowball Sampling*. Retrieved on March 9th 2021 from http://methods.sagepub.com.proxy-ub.rug.nl/reference/the-sage-encyclopedia-of-educational-research-measurement-and-evaluation/i19094.xml?fromsearch=true

Geels, F.W., (2010). Ontologies, socio-technical transitions (to sustainability), and the multi-level perspective. *Research Policy.* Vol. 39 pp. 495-510.

Geels, F.W., (2018). Disruption and low-carbon system transformation: Progress and new challenges in socio-technical transitions research and the Multi-Level Perspective. *Energy Research & Social Science.* Vol. 37, pp. 224-231.

Greendeals, (n.d.) *Green Deal Autodelen II.* Retrieved on November 25th 2020 from https://www.greendeals.nl/green-deals/green-deal-autodelen-ii

Greendeals (2018). *GD 225 Deal tekst Green Deal Autodelen II*. Retrieved on 27th of May 2021 from https://www.greendeals.nl/sites/default/files/2019-03/GD%20225%20Deal%20tekst%20Green%20Deal%20Autodelen%20II.pdf

Greenwheels, (n.d.) *Tarieven.* Retrieved on January 7th 2021 from https://www.greenwheels.nl/tarieven

Gemeente Groningen, (n.d.). *Deelauto*. Retrieved on June 10th 2021 from https://gemeente.groningen.nl/deelauto

Gemeente Utrecht (n.d.). *Deelauto.* Retrieved on June 15th 2021 from https://www.utrecht.nl/wonen-en-leven/verkeer/deelvervoer/deelauto/

Gemeente Utrecht (2019). *Onderzoek naar het gebruik van deelauto's in Utrecht.* Retrieved on June 15th 2021 from https://www.utrecht.nl/fileadmin/uploads/documenten/wonen-en-leven/verkeer/deelvervoer/2019-10-onderzoek-naar-het-gebruik-van-deelautos-in-utrecht.pdf

Gemeente Utrecht (2021). *Mobiliteitsplan 2040.* Retrieved on June 15th 2021 from https://omgevingsvisie.utrecht.nl/thematisch-beleid/verkeer-en-mobiliteit/mobiliteitsplan-2040/

Given, L. M. 2008, The sage encyclopedia of qualitative research methods, vol. 0*, SAGE Publications*, Inc., Thousand Oaks, CA,

Goudappel Coffeng, 2018. *GREENWHEELS PUBLICEERT UITKOMSTEN REPRESENTATIEF ONDERZOEK ONDER GEBRUIKERS.* Retrieved on November 19th 2020 from https://autodelen.info/publicaties/2019/1/21/greenwheels-publiceert-uitkomsten-representatief-onderzoek-onder-gebruikers#:~:text=30%25%20van%20de%20Greenwheels%20gebruikers,18.700%20auto's%20minder%20op%20straat%3B&text=84%25%20is%20tevreden%20over%20het,

Groth, S., (2019). Multimodal divide: Reproduction of transport poverty in smart mobility trends. *Transportation Research Part A.* Volume 125, pp 56-71.

Het Parool, (2020). Meer deelscooters in Amsterdam: aanbieder Check zet 350 scooters in. *Het Parool,* September 10th 2020.

Hopkins, D. (2016). Can environmental awareness explain declining preference for car-based mobility amongst generation Y? A qualitative examination of learn to drive behaviours. *Transportation research part A*, Volume 94, pp. 149-163.

Hu, S., Chen, P., Lin, H., Xie, C., Chen, X. (2018) Promoting carsharing attractiveness and efficiency: An exploratory analysis. *Transportation Research Part D.* Volume 65, pp. 229-243

Husby, T., Weterings, A. & Groot, J. (2019). *Trek van en naar stad - Veranderingen in verhuispatronen*, *1996-2018*, Den Haag: Uitgeverij PBL.

Illgen, S. & Höck, M (2020). Establishing car sharing services in rural areas: a simulation-based fleet operations analysis. *Transportation*, Volume 47, pp. 811-826.

International Transport Forum, (2016). *Cijfers en Onderzoek.* Retrieved on November 15th 2020 from https://www.itf-oecd.org/sites/default/files/docs/shared-mobility-liveable-cities.pdf

Jain, T., Rose, G., Johnson, M., (2021). ‘‘Don’t you want the dream?”: Psycho-social determinants of car share adoption. *Transportation Research Part F.* Vol. 78, pp. 226-245

Jochem, P., Frankenauser, D., Ewald, L., Ensslen, A. & Fromm, H. (2020). Does free-floating carsharing reduce private vehicle ownership? The case of SHARE NOW in European cities. *Transportation Research Part A: Policy and Practice,* Volume 141, pp. 373-395.

Jordan, A., (2008). The governance of sustainable development: taking stock and looking forwards. *Environment and Planning C: Government and Policy*. Volume 26, pp. 17-33

Jorritsma, P. & Berveling, J. (2014). *Niet autoloos, maar auto later*. Den Haag: Ministerie van Infrastructuur en Millieu.

Kampert, A., Molnár-in 't Veld, H., Nijenhuis, J. & van der Spoel, M. (2018). Rijbewijs en daarna direct een auto? Autobezit werkende en studerende jongeren onderzocht. *Tijdschrift Vervoerswetenschap*, Volume 54, pp. 1-22.

Kennisinstituut voor Mobiliteitsbeleid, (2015). *Mijn auto, jouw auto, onze auto.* Den Haag: Kennisinstituut voor Mobiliteitsbeleid

Kennisinstituut voor Mobiliteitsbeleid (2021). *Deelmobiliteit in Nederland: Ontwikkelingen, effecten en potentie (Concept).* Den Haag: Kennisinstituut voor Mobiliteitsbeleid.

Kent, J. & Dowling, R. (2018). Commercial Car Sharing, Complaints and Coping: Does Sharing Need Willingness? *Urban Policy and Research,* 36(4), pp. 464-475.

Kimbrell, C.M., (2021). Electric carsharing and the sustainable mobility transition: Conflict and contestation in a Czech actor-network. *Energy Research & Social Science.* Vol. 74, pp. 101971

Klöppel, M., Schmid, W. & Lienkamp, M. (2019). *Agent-based Simulation of a Car-sharing System with Hydrogen-powered Vehicles.* Monte-Carlo, Monaco, Fourteenth International Conference on Ecological Vehicles and Renewable Energies (EVER).

KpVV Dashboard, (2016). 30% tot 75% woont op loopafstand van dagelijkse voorzieningen. Retrieved on April 16th 2021 from https://kpvvdashboard-13.blogspot.com/2016/06/dummy-41-van-de-

loopverplaatsingen.html#:~:text=Als%20we%20willen%20dat%20mensen,1000%20meter%20voor%20een%20intercitystation.

Kriston, A., Szabó, T. & Inzelt, G., (2010). The marriage of car sharing and hydrogen economy: A possible solution to the main problems of urban living. *International Journal of Hydrogen energy,* Volume 35, pp. 12697-12708.

Lewins, A. and Silver, C. 2007. Coding Schemes, Coding Frames. In: Using Software in Qualitative Research, London: SAGE Publications, Ltd pp. 92-117

Li, M.; Zeng, Z.; Wang, Y., (2021). An innovative car sharing technological paradigm towards sustainable mobility. *Journal of Cleaner Production.* Volume 288, pp. 125626

Liu, A., Wuest, T., Wei, W. & Lu, S. (2014). Application of prospect theory on Car Sharing Product Service System. *Procedia CIRP,* Volume 15, pp. 350-355.

Luca, S. de & Di Pace, R. (2015). Modelling users' behaviour in inter-urban carsharing program: A stated preference approach. *Transportation Research Part A,* Volume 71, pp. 59-76.

Lunghurst, R. (2016). Semi-structured interviews and focus groups. In: N. Clifford, M. Cope, T. Gillespie & S. French, (ed.). *Key Methods in Geography* (pp.143-157). London: SAGE Publications Ltd.

McLafferty, S. (2016). Conducting Questionnaire Surveys. In: N. Clifford, M. Cope, T. Gillespie & S. French (ed.). *Key methods in Geography* (pp. 129-143). London: SAGE Publications.

Meelen, T., Frenken, K., Hobrink, S. (2019). Weak spots for car-sharing in The Netherlands? The geography of sociotechnical regimes and the adoption of niche innovations. *Energy Research and Social Science.* Volume 52, pp. 132-143

Mills, A. J., Durepos, G., and Wiebe, E. (2010). *Encyclopedia of case study research*, vol. 0, SAGE Publications, Inc., Thousand Oaks, CA.

Ministerie van Infrastructuur en Waterstaat (2020). *Visie.* Retrieved on January 18th 2021 from https://rwsduurzamemobiliteit.nl/beleid/duurzame-energiedragers-mobiliteit/visie

Ministerie van Infrastructuur en Waterstaat (2019). *Schets Mobiliteit naar 2040: veilig, robuust, duurzaam,* Den Haag: Ministerie van Infrastructuur en Waterstaat.

Ministerie van Infrastructuur en Waterstaat (2019b). *Mobility as a Service (MaaS): Multimodaal reisadvies op maat.* Retrieved on January 18th 2021 from https://www.rijksoverheid.nl/onderwerpen/mobiliteit-nu-en-in-de-toekomst/mobility-as-a-service-maas

Münzel, K., Boon, W., Frenken, K., Blomme, J., van der Linden, D. (2020). Explaining carsharing supply across Western European cities. *International journal of sustainable transportation*, 14(4), pp. 243-254.

Münzel, K., Arenthorst, M., Boon, W. & Frenken, K., (2020b). *Beleid voor opschaling van autodelen – een beoordeling door belanghebbenden*. TNO: Den Haag.

Münzel, K., Piscicelli, L., Boon, W. & Frenken, K. (2019). Different business models – different users? Uncovering the motives and characteristics of business-to-consumer and peer-to-peer carsharing adopters in The Netherlands. *Transportation Research Part D*, Volume 73, pp. 276-306.

Oakil, A., Manting, D. & Nijland, H. (2016). Dynamics in car ownership: the role of entry into parenthood. *European Journal of Transport and Infrastructure Research*, 16(4), pp. 1567-1741.

MyWheels, (n.d.). *Betalen en Tarieven.* Retrieved on January 6th 2021 from https://mywheels.nl/help/betalen-en-tarieven/abonnement/uit-welke-abonnementen-kan-ik-kiezen

MyWheels, (2021). *MyWheels plaatste 1000e deelauto.* Retrieved on June 27th 2021 from https://mywheels.nl/blog/2021/02/mywheels-plaatst-duizendste-deelauto

Nibud, (n.d.) *Wat kost een auto?* Retrieved on January 6th 2021 from https://www.nibud.nl/consumenten/wat-kost-een-auto/

Nijland, H., van Meerkerk, J. & Hoen, A. (2015). *Impact of car sharing on mobility and* CO_2 *emissions,* Den Haag: PBL.

NOS, (2018). *Nieuwe poging om autodelen te stimuleren*. Retrieved on June 28th 2021 from https://nos.nl/artikel/2253297-nieuwe-poging-om-autodelen-te-stimuleren

NS (n.d.) *Greenwheels*. Retrieved on June 26th 2021 from https://www.ns.nl/deur-tot-deur/consumenten/greenwheels.html

Oostvogels, B. (2017). *Duidelijkheid over Autosegmenten.* Retrieved on January 6th 2021 https://autorai.nl/duidelijkheid-over-autosegmenten/

Punch, K. (2014). Qualitative research design. In: K. Metzler (ed.). *Introduction to Social Research: quantitative and qualitative approaches* (pp. 113-142). London: SAGE publications Ltd.

Punch, K., (2014b). Literature searching and reviewing. In: K. Metzler (ed.). *Introduction to Social Research: quantitative and qualitative approaches* (pp. 301-327). London: SAGE Publications Ltd.

Riele, S. te, Huisman, C., Stoeldraijer, L., de Jong, A., van Duin, C., Husby, T., 2019. *Regionale bevolkings-en huishoudensprognose 2019-2050*, Den Haag: Centraal Bureau voor de Statistiek.

Rijksoverheid, (2019). *Afspraken voor Mobiliteit.* Retrieved on November 16th 2020 from https://www.klimaatakkoord.nl/mobiliteit

Rijksoverheid, (n.d). *Klimaatakkoord*. Retrieved on November 16th 2020 from https://www.rijksoverheid.nl/onderwerpen/klimaatverandering/klimaatakkoord

Rijkswaterstaat, (n.d.). *Toolbox Slimme mobiliteit.* Retrieved on January 18th 2021 from https://rwsduurzamemobiliteit.nl/kennis-instrumenten/toolbox-slimme-mobiliteit/

Rotaris, L. & Danielis, R. (2018). The role for carsharing in medium to small-sized towns and in less-densely populated rural areas. *Transportation Research Part A*, Volume 115, pp. 49-62.

RVO (2021). Elektrisch Rijden op (de) weg – voertuigen en laadpunten. Rijksdienst voor Ondernemend Nederland – Den Haag. Retrieved from

https://www.rvo.nl/sites/default/files/2021/03/Elektrisch%20Rijden%20op%20-%20de%20-%20weg%20-%20voertuigen%20en%20laadpunten%20-%20jaaroverzicht%202020.pdf

Schreier, H. Grimm, C., Kurz, U., Schwieger, B., Kebler, S., Möser, G. (2018). *Analysis of the impacts of car-sharing in Bremen, Germany.* Bremen, Germany: Team Red.

Shaheen, S., Cohen, A., Chan, N. & Bansal, A. (2020). Sharing strategies: carsharing, shared micromobility (bikesharing and scooter sharing), transportation network companies, micro transit, and other innovative mobility modes. In: E. Deakin (ed.). *In Transportation, Land Use, and Environmental Planning* (pp. 237-262). Amsterdam: Elsevier.

Smith, A., Stirling, A., Berkhout, F (2005). The governance of sustainable socio-technical transitions. *Research Policy.* 34:10, pp. 1491-1510

Smolnicki, P. & Soltys, J. (2016). *Car-sharing: the impact on metropolitan spatial structures.* Prague, CBU INTERNATIONAL CONFERENCE ON INNOVATIONS IN SCIENCE AND EDUCATION.

Steeneken, P., (2019). *Van knooppunten naar mobiliteitshubs*. Retrieved on February 16th 2021 from https://www.crow.nl/blog/augustus-2019/van-knooppunten-naar-mobiliteitshubs

Stofberg, N., Bridoux, F., Ciulli, F., Pisani, N., Kolk, A. and Vock, M. (2019), A *Relational-Models View to Explain Peer-to-Peer Sharing*. J. Manage. Stud., 58: 1033-1069.

Taylor, L., 2016. Case Study Methodology. In: N. Clifford, M. Cope, T. Gillespie & S. French (eds.). *Key Methods in Geography* (pp. 581-596). London: SAGE Publications Ltd.

Tight, M. 2017. Origins and Applications of Case Study. In: Understanding Case Study Research: Small-scale Research with Meaning, 55 City Road, London: SAGE Publications Ltd pp. 5-17.

Tuominen, A., Rehunen, A., Peltomaa, J. & Mäkinen, K. (2019). Facilitating practices for sustainable car sharing policies - An integrated approach utilizing user data, urban form variables and mobility patterns. *Transportation Research Interdisciplinary Perspectives,* Volume 2, pp. 1-11.

Turón, K., Kubik, A. & Chen, F. (2019). Operational Aspects of Electric Vehicles from Car-Sharing Systems. *Energies,* 12(4614), pp. 1-18.

Vanhoutte, I. (2019). *Minder en efficiënter gebruik van de wagen kan uitstoot met 35 procent doen dalen tegen 2030*. Retrieved on June 28th 2021 from https://www.mo.be/analyse/autodelen-om-klimaatdoelen-te-halen

Wappelhorst, S., Sauer, M., Hinkeldein, D., Bocherding, A., Glab, T. (2014). Potential of electric carsharing in urban and rural areas. *Transportation Research Procedia,* Volume 4, pp. 374-386.

Yin, R. (1994). Discovering the Future of the Case Study. Method in Evaluation Research. *Evaluation Practice, 15(3), pp. 283-290.*

Zhou, F., Zheng, Z., Whitehead, J., Perrons, R.K., Washinton, S., Page, L. (2020). Examining the impact of car-sharing on private vehicle ownership. *Transportation Research Part A,* Volume 138, pp. 322-341.

Zijlstra, T. D. A., Hoogendoorn-Lanser, S. & Harms, L. (2019). *Kansrijke groepen voor Mobility-as-a-Service.* Retrieved on Januar 2nd 2021 from

https://www.kimnet.nl/publicaties/rapporten/2019/04/14/kansrijke-groepen-voor-mobility-as-a-service

Explainer: Background on the Dutch sustainable mobility policies

The Dutch national mobility vision

In 2019, the Ministry of Infrastructure and Water management (2019) presented their mobility vision for 2040, which should be safer, more intelligent, cleaner and different. Creating more sustainable and more liveable mobility systems is one of the key achievements aims of the vision, highlighting the importance of sustainable mobility also experienced on national policy making levels. This achievement aim argues that more mobility results in more CO_2 emissions, as well as more noise and air pollution. Therefore, the government needs to make choices between which goals they want to serve and how to develop new sustainable mobility concept such as the development of zero-emission infrastructure and carsharing concepts. Here, the ministry of Infrastructure and Water management (2019) describes the increasing role of data in mobility policies. This vision also requires a change in mobility governance, where the ministry describes a needed shift from planning for different modalities, to one integrated mobility system, from economy focussed to making decisions on broader societal goals. In addition, the ministry emphasizes a shift from 'one-size-fits-all' project-based policies to more differentiated area-based approaches. A direction the vision wants to develop in, is creating accessible and liveable city and rural areas which include the development of sharing mobilities such as carsharing. In general, the vision focusses on providing and planning with an integral mobility perspective where one does not only consider mobility aspects but also broader spatial, environmental and societal aims which aligns with general sustainable development visions (Ministerie van Infrastructuur en Waterstaat, 2019).

Sustainable mobility policies in the Netherlands

One of the currently being executed sustainable mobility policies is the MaaS program of the ministry which consists of a national sustainable mobility pilot (Ministerie van Infrastructuur en Waterstaat, 2019b). The Ministry of Infrastructure and Water management does not only look at MaaS but also at other new mobility concepts which are part of MaaS such as carsharing and bicycle sharing. The MaaS program consists of 7 pilots throughout the Netherlands, whereby in each pilot, different consortia work on the development of a MaaS-app. The different pilots have different aims and different contexts in which they are developed but carsharing is an important mode of transport included (Ministerie van Infrastructuur en Waterstaat, 2019b).

Besides the Ministry of Infrastructure and Water management, the Dutch executing agency for roads and waterways, Rijkswaterstaat (RWS), also focusses on sustainable mobility based on the Climate Agreement goals. In the Toolkit Slimme Mobiliteit (Smart Mobility), RWS works out different "deemed-most-successful" policies for managing cars, which focus on rush-hour avoidance, parking policies and as well as carsharing (Rijkswaterstaat, n.d.). This focus on carsharing stems from the 'Greendeal Autodelen II', which as mentioned in the introduction, aims for 700.000 carsharing users and 100.000 shared cars available b 2021.

Specifically focussed on electric sharing mobilities is the City Deal 'Elektrische deelmobiliteit in stedelijke gebiedsontwikkeling'. This policy program combines the development of new neighbourhoods where electric carsharing vehicles will be charged through the solar energy of the new houses that are developed. Each of the parties involved (both public and private organisations) have developed learning goals and objectives that they want to achieve throughout the three year program (2018-2021) which will be combined in yearly progres reports to the CROW (Agenda Stad, 2018).

On national policy level, the vision 'Duurzame Energiedragers in Mobiliteit' similarly to the regional City Deal aims to create a national vision to shift to emission-free transport. For personal cars, the aim is to provide a solid electric charging system with 1.8 million charging points by 2030. Additionally, the ministry wants to invest in hydrogen cars and charging stations with 210 charging stations publicly available by 2030. This vision will be formalized through a hydrogen mobility policy and make new agreements with public and private parties with regards to electric transport and can potentially create more traction to electric carsharing alternatives. (Ministerie van Infrastructuur en Waterstaat , 2020).

To assist in developing a (national) policy framework for carsharing, the CROW has developed a Toolkit for carsharing. In the foundation, the CROW (n.d.) sees that a municipal or regional carsharing policy framework are legally integrated in parking permits, parking costs regulations, and regulations for the standardization of parking (the number of shared cars). Furthermore, the CROW describes the power municipalities have in negotiations with carsharing providers and can influence the type of vehicles provided, determine the costs for using the parking spot, how the shared car is made visible on the street and how much information should be provided to the municipality. Five main policy control aspects for municipal regulators are according to CROW (n.d., f) are to *1) develop the right conditions (e.g. equal playing field for providers, sharing data, keep privacy as priority), 2) develop a permit system (e.g. first a pilot or not, which zones or parking spots, integration with other regions, costs for parking spots), 3) integrate carsharing in the mobility system of the municipality/region, 4) develop a route to zero-emission (time framework), 5) allow for experimentation, while also learn and regulate these (pilot) developments* (CROW, n.d., f).

What all these policy documents share, is there lack of concrete policy steps to create a national carsharing policy that provides national guidelines for carsharing. There are voluntary policy aims such as reaching 100.000 shared carsharing vehicles or reaching 1.8 million charging points by 2030 however these are targets without consequences or national implications. These policy documents are more visions and ideas rather than solid plans. In order to create more publicity, to harmonize sustainable mobility governance between regions as well as to grow the availability and volume of carsharing vehicles, there is a shift needed from policy ideas and suggestions to more concrete guidelines.