CAR-SHARING AS A CONTRIBUTOR TO MOBILITY, CLIMATE, AND SPATIAL PLANNING POLICY TARGETS.

A COMPARISON OF CAR-SHARING IN THE MUNICIPALITY OF GRONINGEN AND SURROUNDING MUNICIPALITIES.

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Abstract:

The aim of this research is to investigate the contribution that (station-based) car-sharing can have on mobility, spatial and environmental policy plans of municipalities. In order to do this the current situation of car-sharing and potential contribution to spatial, environmental, and mobility challenges currently present have been assessed. Car-sharing is still a niche market in the mobility sector but is steadily gaining ground. Due to characteristics of urban areas, such as high population density, car-sharing is seen as a predominantly urban endeavour. This does not mean however that car-sharing is not present in rural areas. Because of this, a case study has been performed including the municipality of Groningen, as an urban area, and the surrounding rural municipalities of Westerkwartier, Het Hogeland, and Eemsdelta.
To answer the research questions, secondary data in the form of a literature review has been gathered combined with primary data in the form of semi-structured interviews. This research has shown that car-sharing has the potential to positively influence policy ambitions concerning accessibility, liveability, social inclusion, climate, and spatial planning. There is, however, a difference in potential and approach between urban and rural regions. The urban municipality is commercially more attractive due to a higher population density, relatively less private cars and a better complementary public transport system. Car-sharing contributes in these areas by reducing cars, freeing up public space and reducing emissions. In the rural areas car-sharing with a community-based approach seems more feasible, contributing to the improvement of social cohesion, reduction of cars and accompanied emissions. Future research on the differences in mobility needs regarding shared cars for urban and rural regions is recommended.

Key words: (Station-based) car-sharing, Mobility, Policy plans, Rural & Urban

1. Introduction

1.1 Background

1.1.1 Current situation of car-sharing in the Netherlands and Groningen

Liao, Molin, Timmermans, & van Wee (2020), refer to car-sharing as a concept that "grants people access to cars without the responsibilities and hassles related to car ownership such as regular maintenance and high parking costs''. The first car-sharing initiative in the Netherlands emerged in 1974, with the introduction of the Witkar project in Amsterdam. Later on, in the early 1990s, the former Dutch Ministry of Transport, Public Works, and Water Management started stimulating car-sharing programs, with the aim that car-sharing would contribute to the policy goals of reducing both car use and the emission of pollutants (Ministerie van Verkeer en Waterstaat, 1988).
In June 2015, 29 Dutch organizations, including national and local authorities, lease companies, insurance companies, and nature and environment organizations, entered into a Green Deal on car-sharing (Nijland & van Meerkerk, 2017). The aim of this deal was to support Dutch climate goals and reduce some of the urban mobility problems. A target of 100.000 shared vehicles in 2018 was set, but this proved to be too ambitious (Greendeals, 2019). In 2018 a green deal car-sharing II was initiated, connected to the Paris climate agreement. Similar goals were set, including 100.000 shared cars in order to reduce emissions and car occupancy of the spatial environment (Greendeals, 2019).

According to estimates of knowledge platform CROW, in 2021 the Netherlands had approximately 970.000 car sharers with 87.825 shared cars, of which 13% was electric (CROW, 2021). This is an increase in cars of over 13.000 relative to 2020. In research from MPN, mentioned in KiM (2021), they estimate the number of people that actually participated in car-sharing over the last 3 years, either commercial or private, to be around 2% of the Dutch population over 18 years old, which is somewhere around 200.000 inhabitants.

Car-sharing as a concept encompasses different forms of sharing methods. There are overarching systems such as business-to-consumer (B2C), consumer-to-consumer (C2C) or Peer-to-Peer (P2P), and Business-to-Business (B2B) (KiM, 2021). They show the kind of provider that offers the cars. Within the forms (B2C) and (C2C) there are several concepts, which are depicted in figure 2.

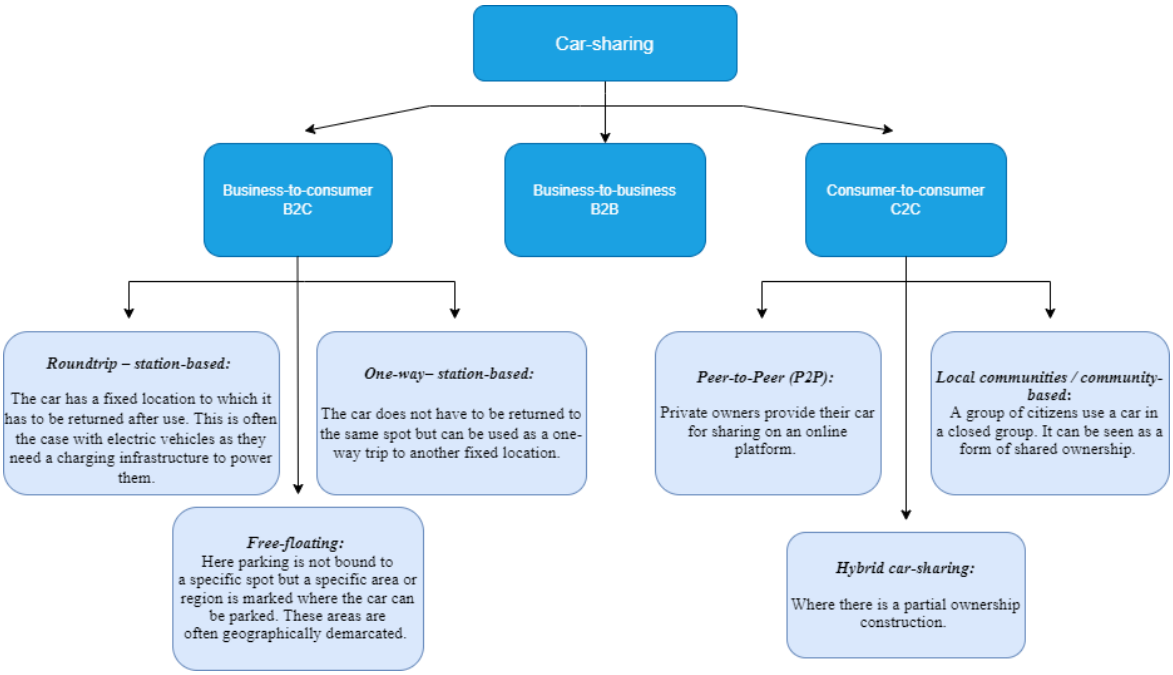

Figure 2: overview of the variety of car-sharing concepts (Shaheen et al. 2020. Adapted from: KiM, 2021)

As all the providers/facilitators of shared vehicles in the interviews of this research used roundtrip station-based car-sharing, in this research the focus will be on this type of car-sharing.

Until 2020 the number of users per shared car was gradually growing, but this changed in 2021 (CROW, 2021). This is mainly visible for the free-floating concept. This concept is also the car-sharing concept with the most users, with around 100 users per shared car. The community-based segment is also one that is growing relatively fast. The number of cars available under this type of sharing grew with 734 cars up to 3.300 cars between 2015 and 2020 (KiM, 2021).

According to KiM (2021), the roundtrip station-based type of car-sharing grows in absolute numbers. Nonetheless, relative to other types of car-sharing such as the above-mentioned local communities or other business types, they stay somewhat behind. The majority of the shared cars that are offered are concentrated in very high and highly urbanized areas, as can be seen in figure 3. These urban areas are also the locations where the highest increases in numbers are noticed (CROW, 2020).

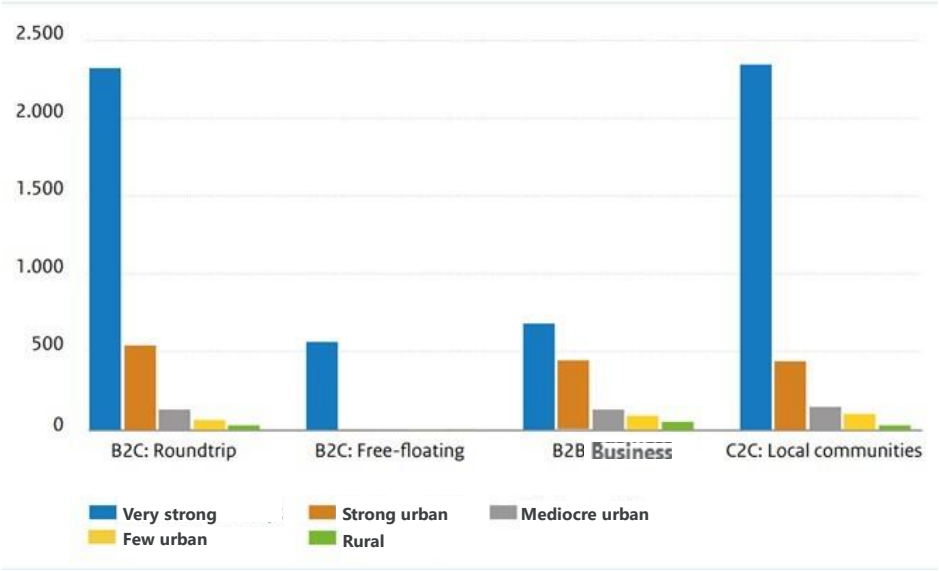

Figure 3: Number of shared cars per variety in different degrees of urbanity (CROW,2020. Adapted from: KiM,2021)

As a municipality, Groningen is the 8th biggest grower in absolute numbers of the Netherlands(Kennisplatform Crow, 2021). With 102,9 shared cars per 100.000 inhabitants in 2021. For the other municipalities addressed in this research this number was significantly less. In the municipality of Eemsdelta 6.5 cars per 100,000 inhabitants were present. In Westerkwartier 9,4 cars were provided and for the municipality of Het Hogeland 10,50 per 100.000 inhabitants were present in 2021. (Waarstaatjegemeente, 2021).

1.1.2 Introduction of the case study area

For this research, the municipality of Groningen, as an urban area, has been compared to the surrounding, rural, municipalities of Westerkwartier, Het Hogeland, and Eemsdelta. Therefore, when Groningen in mentioned, it refers to the municipality of Groningen. The municipalities of the case study are situated in the northeastern part of the Netherlands (figure 4).

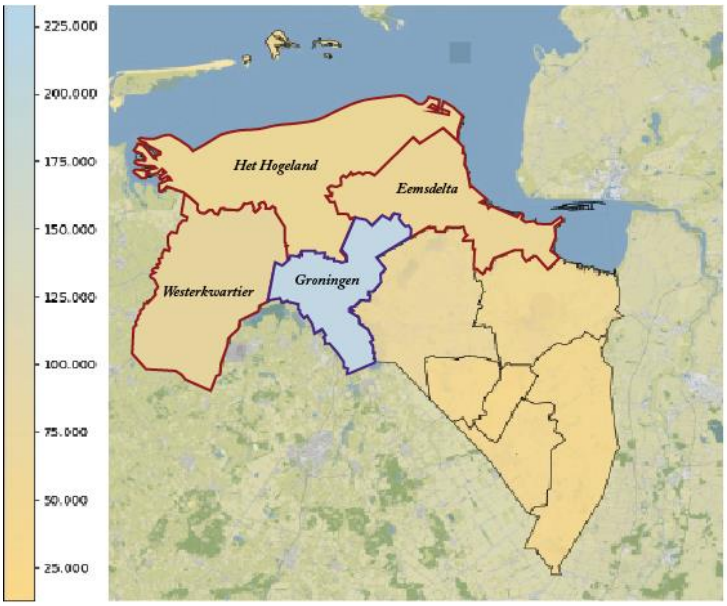

Figure 4: Number of inhabitants province of Groningen with the case study municipalities highlighted (Adapted from: Allecijfers.nl)

In table 1 the data on each municipality concerning inhabitants, number of cars, and households are portraited. What stands out is that Groningen has a lower number of cars per household than the other municipalities. In figure 5 the number of cars is displayed per 100 households. According to oisgroningen (2021), this is due to the characteristics of Groningen as a student city. They also mention large differences between neighborhoods in the municipality. In 2020 for example, in the inner city, 80 percent of the households did not have a car.

Municipalities	Number of inhabitants 2020	Number of cars 2020	Number of households 2020
Groningen	232 874	93.752	136 383
Loppersum	9.537	5.239	4.297
Het Hogeland	47 801	24.609	21 434
Westerkwartier	63 329	34.484	26 371

Table 1. obtained from: (CBS 2020 and CBS statline 2020a & b)

Data concerning the number of cars in the municipality of Eemsdelta for 2020 could not be found. Therefore the former municipality of Loppersum has been depicted for this table. This still gives relevant data, as the car-sharing cooperation that has been interviewed is operating in this former municipality. The municipality was independent up to and including 2020 and is now part of Eemsdelta (plaatsengids, 2021).

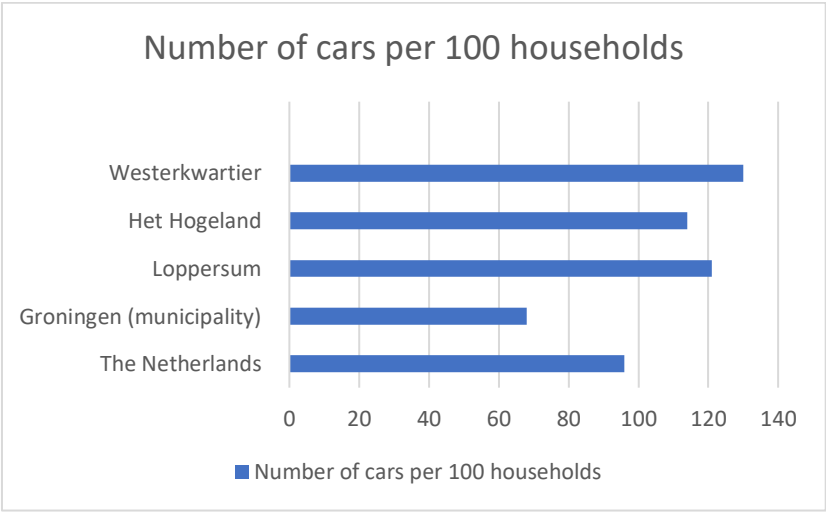

Figure 5: Number of cars per 100 households for the municipalities and the average of the Netherlands (Based on data table 1 & oisgroningen (2021))

1.2 Research problem

Research on car-sharing in an academic, as well as a non-academic manner, has increased in recent years, but the field is still far from saturated. This is why Hjorteset & Böcker (2020) urgently request researchers to conduct more empirical case studies. This research project aims to investigate the contribution that (station-based) car-sharing can have on mobility and environmental policy plans of municipalities. What are the policy goals of the municipalities and how can car-sharing contribute to these goals? What is the current situation of car-sharing and in which ways could spatial, environmental, and mobility challenges currently present benefit from car-sharing? To find this out a main question and sub-questions have been formed.

The main research question is defined as followed:

Does (station-based) car-sharing contribute to environmental, spatial and mobility policy plans of the municipalities of Groningen and surrounding areas? And in which aspects do they differ?

To answer the main questions, the following Sub-questions have been formed:

I: What is the current state of car-sharing in the area of Groningen?

II : What are beneficial features of (station-based) car-sharing?

III : Which environmental, spatial and mobility policy goals are affected or can be influenced by (station-based) car-sharing?

IV: What are the major issues concerning (station-based) car-sharing in the area of Groningen?

V: What is the potential of electrification in (station-based) car-sharing in contributing to municipal policy goals?

2 Theoretical Framework:

2.1 Characteristics of car-sharing

As mentioned before the majority of car-sharing services have been developed in high-density metropolitan areas, providing the accompanied transportation modes which complement the car-sharing business. This trend is beneficial for the car sharer as well as other road users, as it avoids too much congestion, parking, and pollution problems (De Luca and Di Pace, 2015). Another aspect of car-sharing is that it offers sharers the benefit of a car's flexibility without having to bear the full financial burden of a car (Huwer, 2004). Cohen and Shaheen (2018), came to similar conclusions, with the addition that land affordability, parking availability, and travel time hinder car-sharing.

At this moment car-sharing is still perceived as a niche market where novelties develop that might eventually challenge the status-quo or socio-technical regime (Schlüter & Weyer, 2019).
With complementary options of transportation such as public transport, cycling routes, and walk lanes present in many urbanized areas, it seems that there is a large potential for car-sharing and that a lot of citizens currently owning a private car might have more financial benefit using a shared car.

Besides the individual financial benefits, there are also societal benefits that arise from car-sharing. Some articles suggest for example that each shared car replaces between four to 15 private ones. Which could reduce car ownership and subsequent embodied energy carbon emissions more or less 30% (Namazu & Dowlatabadi, 2018).

Socio-demographic variables play an important role in choices concerning car-sharing. These factors might influence individual choice behaviour regarding car-sharing services. Factors such as living in the city center, being male and, being highly educated according to Burkhardt and Millard-Ball (2006), significantly increase the probability of car-sharing. Other characteristics, such as a high degree of environmental consciousness and awareness are important contributors to car-sharing adoption according to Sovacool & Axsen (2018).

2.2 Hindrances for car-sharing

The increase and the present dominance of gasoline-powered vehicles, generally in the possession of private owners, is a major contributor to several societal problems, including climate change, air pollution, excessive traffic congestion, and negative land-use impacts (Sovacool & Axsen, 2018). Visualized in figure 6. The negative external effects of cars seem unnecessary considering that, according to Shoup (2017), the average privately owned car is unused more or less 95% of the time. The dominant focus on automobility has, as another side effect, led to the erosion of investments in the public transport and rail sector (Sovacool & Axsen, 2018). In all these facets the dominance of the privately-owned car has deeply influenced the urban environment as it exists today.

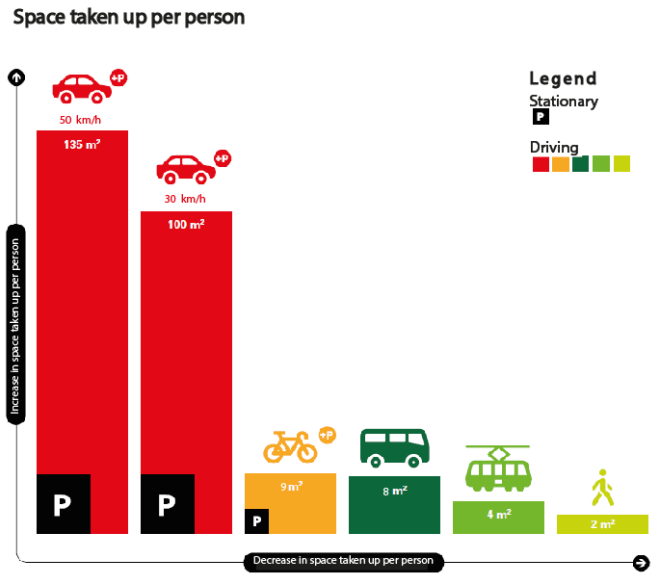

Figure 6: Space taken up per person(Adapted from: Mobility-vision Groningen, 2021)

Although privately owned vehicles are private goods in practice, due to effects that result from their production and usage they unwillingly also impact society more broadly. This is what economists describe as negative externalities. These are effects such as air pollution, greenhouse gas emissions, fossil fuel dependence, congestion, land-use impacts, and noise, among other things (Douglas et al., 2011; Calthrop and Proost, 1998; Hohmeyer et al., 1997).

According to Sovacool & Axsen (2018), in the past, several efforts have been made to support a transition towards alternative and more sustainable ways of transportation by policymakers as well as stakeholders. These were ideas such as more efficient vehicles, vehicles powered by low-carbon fuels, and promoting mode switching (walking, cycling, and transit) through improved urban density and infrastructure changes. But as of today, neither of the ideas mentioned above have made a significant change to the mobility sector.

There remains a persistent feature of privately owned cars that makes users reluctant to depart from their car as a possession. To better understand the potential switch away from the private car it is important to understand the full meaning of cars or automobiles for owners. According to Sheller and Urry's (2000), the automobile is defined as a complex, self-reinforcing socio-material system that is strongly intertwined with technology, culture, norms, and practices. Automobility is about far more than the car. It encompasses the broader system that supports car use, including industry and supply chains, users and non-users, social practices, and cultural expectations, as well as politics and policy. To comprehend the dominance of privately owned cars, it is necessary to look at the full system of automobility (Sovacool & Axsen, 2018). Therefore, to better understand what might influence a person's reasons for private purchase or car-sharing it is important to look deeper than merely rational economic reasoning.

For a Car-sharing network to become profitable a significant amount of regular users is necessary. Contradictingly, a broad user base can only be attracted by a widespread and well-situated car-sharing network (Efthymiou et al. 2013). These factors are mutually dependent, which significantly complicates the development of new car-sharing services. Especially in rural areas (Illgen & Höck, 2020).

Another angle explaining aloofness towards car-sharing has to do with possible discouragement by new technologies. Schlüter & Weyer, (2019) refer to this as the Technical Acceptance Model (TAM). This model assumes that the acceptance of, and the intention to use innovations is significantly influenced by two variables: perceived usefulness and perceived ease of use. In other words, do people understand the technologies sufficiently to work with, and is the system comfortable enough to use. This is an important aspect of the adoption of car-sharing due to an increase in online platforms for services such as car-sharing.

2.3 Conceptual model

In figure 7 the conceptual model is displayed. In this model, the mainline of the article is demonstrated.

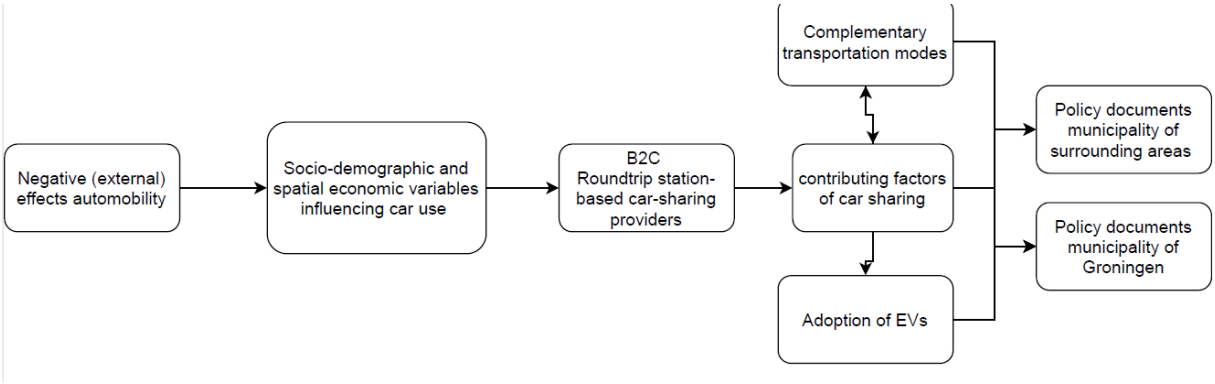

Figure 7: Conceptual model

2.4 Hypotheses / Expectations

The expectation is that shared cars can have a positive influence on the policy plans of municipalities concerning the spatial environment, climate, and mobility. However, this influence would differ for urban and rural areas.

3 Methodology:

3.1 Data collection

For this research qualitative research is used, which is focused on emotions, meanings, experiences of people and is subjective (Clifford, 2016). Furthermore, secondary data in the form of a literature review was gathered combined with primary data in the form of semi-structured interviews.

3.1.1 Secondary data: (Policy) documents, policy visions, reports and academic literature

The sub-questions III ***&*** *V* are similar in that they both focus on what the potential contribution can be to municipal policy plans. To answer these sub-questions and sub-question I, policy documents of the municipality of Groningen and the surrounding municipalities have been analysed. Another document used in answering these questions is a report of Kennisinstituut voor mobiliteitsbeleid: Deelauto- en deelfietsmobiliteit in Nederland. Ontwikkelingen, effecten en potentie (KiM, 2021). Aswell as other related academic literature or reports.
In the search for policy documents, this research mainly looked at documents relating to mobility and car-sharing, but where these were missing other documents related to the subject such as sustainability or spatial planning were also added. The documents used in this research are shown in table 2.

Policy documents municipality of Groningen	Municipality of Groningen (2021) Groningen goed op weg. Mobiliteitsvisie: naar een leefbare, schone en gezonde gemeente.	Municipality of Groningen (2018a). Ruimte voor de straat. Parkeren in een levende stad. Visie, uitgangspunten en beleid 2018 – 2025.	Municipality of Groningen (2018b). Omgevingsvisie 'the Next City'. De Groningse leefkwaliteit voorop.
Translation	Groningen well on its way. Mobility vision: towards a liveable, clean and healthy municipality.	Room for the street. Parking in a living city. Vision, principles and policy 2018-2025	Environmental vision 'the Next City'. The quality of life in Groningen is paramount.
Policy documents rural municipalities	Ambitiedocument verkeer, vervoer en mobiliteit (2018) (het Hogeland)	Duurzaamheidsbeleid 2020-2025 (2020) (Westerkwartier)	Programma begroting 2021 (2021) (Eemsdelta)
Translation	Ambition document traffic, transport and mobility	Sustainability policy 2020-2025	Program budget 2021
Provincial policy plan	Programma mobiliteit provincie Groningen (2021)		
Translation	Program mobility province of Groningen		

Table 2: policy documents related to the research

3.1.2 Primary data collection: Semi-structured interviews

To answer the sub-questions I, II and IV, semi-structured interviews have been used in combination with secondary data. Semi-structured interviews were preferred for this research because this form of interviewing has some degree of predetermined order but still ensures flexibility in the way issues are addressed (Dunn, 2005). The idea is that there is enough freedom to deviate from the question to make a broader point, but at the same time preserve an overall structure in the questions so that the main structure stays clear (Adams, 2015). For the interviews municipality officials involved with car-sharing and car-sharing providers or facilitators active in the municipality of Groningen or surrounding municipalities were contacted. Another participant was a consultant agency that has advised other municipalities on the subject of (shared)mobility. The respondents mentioned in table 2 were contacted via email or telephone. The interviews took place via Google meet meetings and lasted for around one hour. With verbal consent of the participants, the interviews were recorded. To analyze the interviews they have been transcribed manually. The entire interview guide used can be found in Appendix I.

Participants :	Relation to the subject:
MobiNederland	Facilitator and former provider
EasyDriving	Commercial provider
DeelSlee	Provider as a co-operation
OverMorgen	Consultancy firm
Municipality of Groningen	Policy Officer Urban Development
Municipality of Westerkwartier	Policy Officer Sustainability
Municipality Het Hogeland	Policy advisor sustainable business

Table 2: Respondents interviewed and their relation to the subject

3.2 Reflecting on validity and reliability

In reaching out to providers in the car-sharing sector the larger, national operating, commercial providers were not able to partake in this research. This, together with new findings in the earlier interviews, changed the original research framework's direction to more publicly oriented research in a specific area. Therefore it is important to mention that qualitative methods have their limits, mostly regarding external validity (Punch, 2014). The findings of this research may be very context-or area-specific and can thus not be generalized to other cases/areas (Longhurst, 2016). Due to a relatively small sample size of (N=7), a statistical analysis was not desirable. Nonetheless, qualitative methods on the data could reveal new insights that might also be true for other areas.

3.3 Data Analysis

The interviews were analyzed by qualitative coding with the program ATLAS.ti. Coding is a way of evaluating and organizing data in an effort to identify and understand meanings (Clifford, 2016). This program helps to get some structure in the data gathered in order to separate parts of the interviews into key concepts. This made it possible to better answer the sub-questions and with that the main question. Three approaches of coding are recommended by Strauss (1987). These approaches are open coding, axial coding, and selective coding. The purpose of the first approach is to open up the data to produce concepts that fit the data. These are often descriptive codes. Then axial coding focuses the attention along the axis, to a theme of particular interest. The last one is selective coding. This is a more systematic approach of coding that is done when a central or core category has been identified and followed (Clifford, 2016). With the first two steps mentioned above a coding scheme has been made that can be seen in figure 8. The third method was not used as it did not provide additional input for the codes.

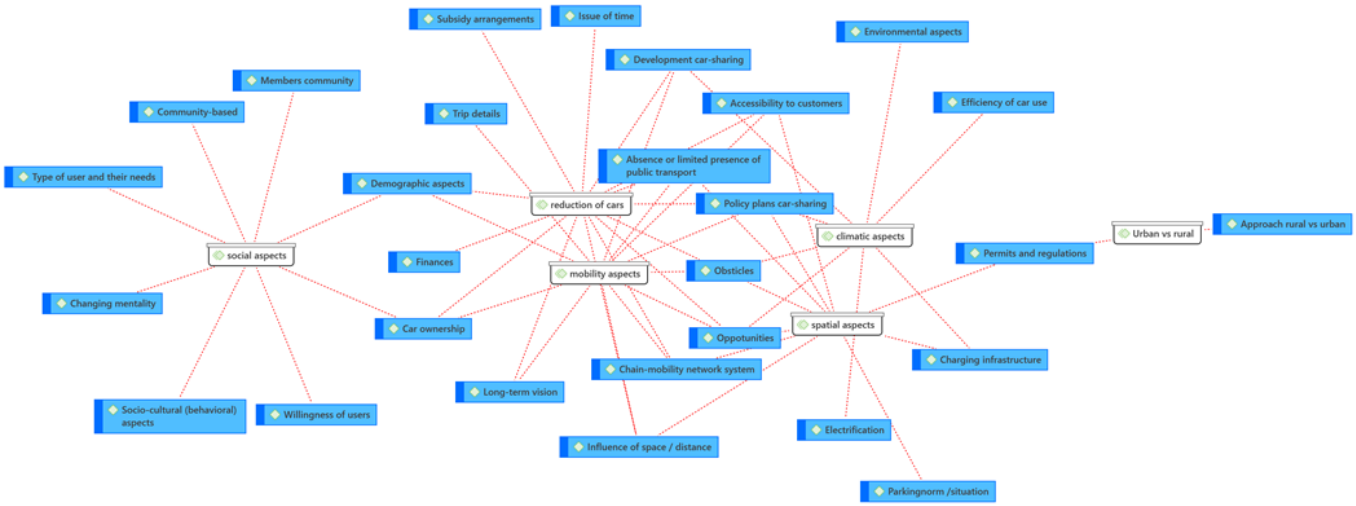

Figure 8: code scheme of code groups relating to codes used in the research.

3.4 Ethical considerations

Prior to the interviews, all the participants received a consent letter in which an explanation of the interview was given. It was also mentioned that the data is not redistributed to others except when necessary for academic purposes. The interviewees were also always allowed to ask for certain recordings to be deleted if for some reason they were no longer comfortable with it. The participants were also free to withdraw from the interview at any moment. To ensure anonymity mentioning the names of respondents in data files is avoided as much as possible.

4. Results

In the results section, the findings of the interviews are presented and discussed in relation to the policy documents and the literature.

4.1 Policy goals relevant to the subject

Municipality of Groningen :

As the municipality of Groningen expects an increase of inhabitants, from the current 233 273 (CBS, 2021) to 250.000 in 2035, agreements have been made to construct 20.000 homes in the next 10 years. This increase in inhabitants will, if not managed, lead to a surge in traffic congestion and reduced mobility as well. At this moment there are already 360.000 traffic movements each day. Therefore the municipality has, in its mobility vision (Municipality of Groningen, 2021), set a goal to limit traffic growth as much as possible. But at the same time change the way we transport and reduce the aspects of mobility where they conflict with other uses of public space. This is to create a municipality that is accessible, healthy, but most of all provides room to all users (liveability). Car-sharing is included in this policy with plans such as encouraging shared cars in chain transport, priority when applying for parking facilities and a mobility solution for new construction. Other policy documents of the municipality of Groningen concerning car-sharing are the parkeervisie 2018-2025 (parking vision) and omgevingsvisie 'the Next City'. Which focuses on the future development of the physical environment. Both policy documents have been incorporated in the Mobiliteitsvisie (mobility vision) as well.

Municipalities of Westerkwartier, Het Hogeland & Eemsdelta (Loppersum):

For the municipality of Het Hogeland, the Ambitiedocument verkeer, vervoer en mobiliteit (2018) portraits the mobility ambitions. The relevant goal for car-sharing in here is stimulating and facilitating sustainable mobility. For the other municipalities a specific document concerning mobility has not been found. Therefore related documents with some environmental, mobility, and spatial goals have been selected. For the municipality of Westerkwartier this was Duurzaamheidsbeleid 2020-2025. Electrification and reducing emissions are the most important goals in this document concerning car-sharing. For the municipality of Eemsdelta, Programma begroting 2021 is used in this research, with accessibility as the most important goal. Car-sharing is not specifically mentioned in these documents, however, is able to contribute to the aforementioned goals. On a provincial level there is the program: Programma mobiliteit provincie Groningen: wat Groningers beweegt. This is an overarching policy vision on mobility that applies to the entire province.

A potential explanation for the absence of spatial issues relating to mobility in the rural policy documents might be that a lack of space is not really an issue in these areas. The availability of land not being an issue in rural municipalities was something that was also mentioned in several interviews

4.2 Reducing car traffic with car-sharing through more efficient use

Throughout the years the car has occupied a large part of the public space. Due to a phenomenon that in the policy document (municipality of Groningen, 2021), is called 'autologica' (car-logic). In this logic, the car got relatively large amounts of space to enhance accessibility, and functions of transport, such as biking, were separated for safety reasons. In the new policy plans this dominance in public space is no longer without question. Cars take up a relatively large amount of space while driving, but also while parking, see figure 6. In order to change this, measures such as lowering speed limits in most of the 50km/h areas to 30km/h have been taken. But working towards less traffic in general might also be achieved through car-sharing.

According to Jorritsma et al. (2015), shared vehicles in 2014 were mainly used for the medium and long-range distances. Over half of the trips performed by shared cars were above 30 kilometers in range. For the shorter distances the shared car is therefore apparently not the preferred option. Within a broader mobility network, these short trips could be accommodated by, for example, public transport and therefore contribute to the goal of reducing car use.
In addition to that, research from Faber et al. (2020), concluded that in an international context, the average distance of a roundtrip station-based session is longer than that of a Free-Floating concept.

In the interviews was mentioned that people are more selective with their car use when using a shared one. This was due to a more direct link with the financial costs of driving. With a private car, much of the costs are shielded from daily use. This reduction is also seen in the data of Jorritsma et al. (2015). In this article, a comparison from before and after car sharers started using shared vehicles shows a reduction in traveled kilometers by car of 20 %. This number came about through contrasting the percentage of people that moved from a private car to a shared one, with a group that (partially) moved from public transport and a group that made trips with shared cars that would otherwise be avoided. All these aspects combined resulted in a decrease in kilometers traveled.

To maximize the efficient use of shared cars it might be beneficial to facilitate locations that provide businesses, residents, and visitors. This is something that was mentioned in the interviews and was supported by the data from(KiM, 2021). In the interview it was mentioned that for profitable and optimal use of shared cars you have to rely on residents and companies as regular users. The ideal location suggested was a place with a good mix of many homes and businesses. This coincides with the data of (KiM, 2021), in which is mentioned that car-sharing, when used privately, shows little action during the week and a surge in use over the weekend. Car-sharing in a business manner is, according to the same report, more similar to that of personal car use and happens during the week.

4.3 Climate, air quality, and electrification

Reduction in emissions due to (electric) car-sharing:

Car-sharing can have a positive influence on the sustainability goals of all the municipalities under the provincial aim to reduce emissions to zero in 2035 (Programma mobiliteit Provincie Groningen, 2021). According to Nijland & van Meerkerk (2017), car-sharing can lead to an annual C02 reduction of 110 kg, when looking at kilometers driven and the change of transport mode towards car-sharing. Other research by Jorritsma et al. (2015), with the same requirements, suggests this number to be 90 kg C02 reduction. The production and demolition of cars however also causes emissions. According to Gbeghaje-Das, (2013) and Samaras & Meisterling (2008), this amount is thought to be 10% to 20% of the C02 emitted during the car's lifespan, using a tank-to-wheel method calculating emissions. On top of this, car-sharing can have an additional positive contribution to sustainability goals as 13% of the car-sharing car park is powered by electricity (CROW, 2021b). The providers interviewed for this research all used a 100% electric car park, which besides the reduction in emissions can also have an educational aspect.

At this moment only 3.1 % of the cars in the Netherlands are powered by electricity (CROW, 2021b). To increase this number electrification of shared vehicles can be a first step for people to get more acquainted with electric vehicles. This is also something that was mentioned a couple of times in the interviews: '' You also give people the opportunity to get acquainted with electric driving.'' In the policy documents of the rural municipalities, climate mitigation and electrification is also an important aspect. The municipality of Het Hogeland has for example, in their Ambitiedocument verkeer, vervoer en mobiliteit (2018), the ambition to facilitate sustainable mobility, electrification, and a CO2 neutral future. Similar goals can be found in the other documents with the additional aim of having an emission-free car fleet in Duurzaamheidsbeleid 2020-2025 (2020).

According to RVO (2020), the electrification of cars results in fewer emissions, as fully electric cars do not emit nitrogen and particulate matter from the engine. Electric cars therefore have a positive influence on air quality. In the same article is mentioned that particulate matter emissions of electric vehicles are 25% less than for those with fuel engines. In the situation that an electric car would use grey produced electricity a 30% reduction of co2 emissions can be accomplished relative to a gasoline-powered car. For renewably generated electricity this reduction could be up to 70%.

Due to the necessary charging infrastructure for electric vehicles, roundtrip station-based car-sharing and electrification seem to go hand in hand, as the car needs to be returned to a charging station. These stations are requested through permits: " For shared cars, you simply need a permit, and then you have a spot that is reserved for you. So the car has a fixed parking space". Shared cars in this concept, therefore, seem bound to this particular station.
As mentioned above car-sharing with electric vehicles has a dual effect in reducing emission from car traffic with its sharing features and electrification. If, as Liao et al. (2018) suggested, car-sharing could increase the

electrification of the car fleet, this contribution could be even more beneficial. Nevertheless, this does depend on how the sector will develop.

Car-sharing as a stimulator for electrification:

In the interview conducted with the municipality of Groningen new plans to prohibit any fossil fuel-powered vehicles in 2025 for car-sharing providers was mentioned. This, in order to achieve another goal for 2050, to have only zero-emission traffic. However, in the interviews was mentioned several times that citizens do not always feel comfortable yet with the new electric cars. Car-sharing might serve as a stepping stone to achieve these long-term goals. This way people get acquainted with the new technologies an electric car has to offer in an accessible way. In the article of Schlüter & Weyer, (2019), they refer to this as the Technical acceptance model (TAM) mentioned in the theoretical framework. This model assumes that the acceptance of and the intention to use innovations is significantly influenced by two variables: perceived usefulness and perceived ease of use. Car-sharing could potentially contribute to the perceived usefulness of the day-to-day use and make people more at ease with the usage of electric vehicles.
Svennevik (2019) mentions in her research that car-sharing can trigger an even larger change in mobility mindset. In this article is mentioned that due to car-sharing people have the ability to change to a smaller, more efficient, or electric car. In her paper, she states that people often have a so-called 'omni purpose' car. That has the capabilities for the most diverse uses, often only needed very occasionally.

A similar view was also mentioned in one of the interviews. Here a provider suggested that people would possess a smaller electric car themselves that has the capabilities to meet the day-to-day needs. For more occasional situations a shared car would then be used, as these situations only occur once in a while. In the report of KiM (2021) a similar situation is described with a diverse car park containing long-range vehicles, a pick-up truck or van, camper, and some other more advanced cars to give people the ability to change their omni purpose car for a smaller (electric) one. This could potentially lead to the sustainability and rejuvenation of the car fleet. This increased rejuvenation was also mentioned in (Meijkamp, 1998). In this article is mentioned that shared vehicles are used more intensely than privately owned cars. Which makes them reach their maximum potential earlier. This results in a faster transition towards newer, more innovative cars. Which could accelerate the transition towards electrification in order to achieve the goals set by the municipalities. An example of such an omni-purpose vehicle is the SUV. These large cars have all sorts of extra options that are rarely used (Heubl, B, 2020). Yet sales of these vehicles increased by 35 million units in 2021 alone. Resulting in annual emissions of 120 million tons of CO2 (IEA, 2021).

4.4 Influence of car-sharing on the spatial environment through the reduction of parking

In the new mobility vision (Mobiliteitsvisie Groningen, 2021) the former mentality called 'car logic' is replaced with a more inclusive approach. In this approach parking of private cars in public places will be re-evaluated and might change in several situations. With the already announced closing of specific parking structures, the change from parking space to other public functions has direct effects for the public space.

At this moment however the majority of the 8,8 million passenger cars in the Netherlands (CBS, 2021) is still private property. Reducing the amount of space occupied by cars, while meeting the mobility needs of the citizens can be a challenge. With limited space, there is bound to be friction. Car-sharing can offer a potential solution in this regard. Because a car that doesn't drive much still has to park somewhere.

According to KiM (2021), car-sharing can lead to a decrease in cars in two ways. The first is that due to the use of a shared car people get rid of their personal car (observable effect). This effect is directly noticeable as the number of cars decreases. The second is that people who did not have a car of their own postpone or refrain from the purchase of one due to car-sharing (unobservable effect). According to CROW (2017), for each roundtrip station-based shared car there are 10 to 18 users in the Netherlands. Other studies show different results.

Data from Shaheen et al. (2019) for example, suggests that between 15% and 67% of the people making use of roundtrip station-based car-sharing get rid of their personal one (observable effect). At the same time, between 14% and 34% of the car purchases were prevented (unobservable effect). The decrease of 4 to 11 cars this would generate could reduce the number of necessary parking spaces with 3 to 10. The parking space a shared car would occupy included. In the interview with the municipality, it was mentioned that 1 shared car would at least replace 5 parking spots. As multiple factors are influencing this number per location, giving an exact number is complicated and will therefore always have to be viewed context-specifically.

The municipality of Groningen likes to hold on to a compact city. To do this the municipality prefers to build within the existing areas of the city. As space is more scarce in this area, complications can arise with friction over different interests. Parking is such an issue. In the municipal policy plans, the possibility of a reduction in the parking norm is allowed for housing development when implementing shared cars. This way the normally required space to facilitate housing can be reduced due to car-sharing. As mentioned above the norm for this would be 1 shared car replaces 5 normal cars, although no exact numbers could be found in the policy plans on this.

Providing sufficient charging infrastructure is in the policy plans (municipality of Groningen, 2021), as is, according to the same policy document, giving shared cars priority in parking spaces over private ones. Still, these issues are perceived as barriers for implementation. The providers interviewed for this research mentioned the availability and procedure for getting hold of charging infrastructure and permits as a hindering aspect in the car-sharing sector. Groningen does not seem to stand alone in this aspect. In (KiM, 2021) interviews were cited in which was mentioned that most municipalities are hesitant in providing the necessary permits for providers. An additional comment on this was that application procedures are often long, complex, and uncertain.

4.5 Sense of community and social cohesion:

As mentioned in the theoretical framework, car-sharing is mainly an urban phenomenon (Becker et al., 2017, Stillwater et al., 2009, Celsor and Millard-Ball, 2007) due to features of the urban such as walkability, cyclability, access to public transport, and larger availability of shared vehicles that stimulate car-sharing. This does not mean however that car-sharing is an exclusively urban endeavor, but it might require a different approach in more rural areas. Research conducted by Liao et al (2020) suggests that people from rural areas are as interested in car-sharing as people from urban areas. In one of the interviews, it was even mentioned that the absence of public transport can be an advantage. Due to this absence car-sharing can potentially fill this gap in mobility need and provide increased individual mobility at a cheaper cost than through private vehicle ownership. One of the initiatives interviewed for this research, working under a community-based concept, seems to be quite successful in the rural municipality of Eemsdelta. In the interview with this co-operation Deelslee, it was mentioned that the community plays an important role in the success of that initiative. While at the same time the co-operation enhances the sense of community and social cohesion in the villages.

This fits well with one of the policy-ambitions from the municipality of het Hogeland, in which they indicate the desire for a vital society with mobility initiatives from the village, in which citizen participation is proactively anticipated (Ambitiedocument verkeer, vervoer en mobiliteit, 2018). With community-based car-sharing these community and social cohesion goals might be achieved.

5. Conclusion / Discussion:

The aim of this research was to investigate the potential contribution of (station-based) car-sharing on mobility, spatial and environmental policy plans of municipalities. In particular, the municipality of Groningen and surrounding municipalities with a rural character were investigated for this purpose. In general, it can be concluded that car-sharing tends to be a more urban endeavor, with most of the commercial providers accumulating in these areas. This mainly has to do with a higher number of potential customers. Yet, there are also providers in the more rural municipalities. Car-sharing in general is still perceived as a niche market in the mobility sector but is gradually gaining ground.

The rural municipalities in this case study all have a higher number of private cars per 100,000 inhabitants than the urban municipality of Groningen. On the one hand, this shows potential for car-sharing in Groningen that, as part of a wider mobility network, can contribute to the mobility demand with private cars as less of an obstacle. On the other hand, it offers a greater potential for rural municipalities when it comes to reducing emissions per person. Nonetheless, due to a higher number of inhabitants in urban municipalities, the total reduction of emissions in these areas will be greater.

To assess the potential contribution of car-sharing for the selected municipalities, several policy documents have been analysed. The results show that there are various ambitions to which car-sharing can contribute. This study came to the conclusion that for the environmental ambitions, portraited in the policy documents, car-sharing can contribute in several manners. According to the research of (Jorritsma et al, 2015) and (Nijland & van Meerkerk, 2017), the use of a shared car could result in a reduction of between 90 and 110 kg of CO2. On top of that, CO2 reduction can be achieved on every car not produced. This potential reduction is between 10 and 20 % of the emissions emitted in the lifespan of a car.

Car-sharing can play a progressive role in the transition towards electric driving, has the potential to function as a catalyst for electrification and provides people the ability to get more acquainted with new technologies. Other additional benefits might be the replacement of private omni-purpose vehicles with smaller, more efficient, (electric) cars and a faster rejuvenation of the car park, realizing more efficient cars at a faster pace.

The direct link between use and the financial costs of driving, present with car-sharing, results in a reduction in kilometers driven of 20% (Jorritsma et al, 2015). This difference can be explained by the fact that with private car use much of the costs are shielded from daily use. This reduction in car use contributes to less congestion and space occupied. According to data from KiM (2021) and interviews, increasing the efficiency of 1 shared car could be stimulated even further, if it is deployed at locations that generate a good occupancy combination for business and private use.

For ambitions concerning the spatial environment, a reduction in cars through car-sharing can be accomplished in two ways. The observable effect of people getting rid of their cars and the unobservable effect of postponed or refrained purchases. This number differs but is somewhere between 4 to 11 cars. For the ambitions concerning the improvement of social cohesion, the concept of community-based car-sharing seemed most beneficial.

Overall car-sharing has the potential to contribute to several of the policy ambitions of the municipalities. This is the case for the urban areas, where car-sharing is commercially more attractive, as well as for the rural areas. For the rural areas, however, a different approach, such as the community-based concept, might be needed to make car-sharing a success. Focussing on a strong social cohesion to enthuse residents for the usage of car-sharing.

Policy recommendations & Recommendations for future research:

As mentioned in the results, car-sharing has the potential to contribute to several of the policy goals of municipalities. In an advisory role, municipalities could advise and inspire residents about the possible ways a shared car can be used. It is important to go beyond merely promoting car-sharing, but also communicate different ways car-sharing can be used. For example, as stated in 4.2, a more sustainable, smaller car can be purchased to provide for the daily mobility needs, reducing the growing number of SUV purchases and its accompanied emissions (IEA, 2021). A shared car can then be used for more exceptional situations, such as vacations, the move of larger items and other occasionally used options of a car. Mobility hubs might provide suitable locations for these omni-purpose vehicles to meet the occasional mobility needs of individuals.

Shared cars are also often used for medium and long distances. It is therefore important for the municipalities to respond with good complementary mobility facilities for the mobility needs concerning the short distances. This applies more to urban municipalities, but can also provide a basis for car-sharing in rural municipalities. A good alternative for short distances may reduce the demand for private cars. For rural municipalities, it is beneficial to develop car-sharing together with the local residents. Car-sharing can then gain more support through the sense of community, while at the same time strengthening this sense of community.

The findings of this research may be very context-or area-specific and can thus not be generalized to other cases or areas. Due to a relatively small sample size, firm conclusions about differences between rural and urban regions can not be made. More empirical research is necessary, concerning rural and urban car-sharing, in order to fully comprehend the differences between these areas. Research concerning the mobility needs and trip details for each area could provide a better understanding of the differences in car-sharing needs of both areas.

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Appendix

I: Interview guide

Introduction of the interview.

Main questions: current situation	**Sub-questions:**
How would you describe the current situation of car sharing in ……. ?	
Do you experience a change in willingness to use shared vehicles?	How do you perceive this change? What might be the cause of this change?
What is the current policy on shared cars within the municipality of …..?	
How is the current connection between shared cars and the P+R hubs that already exist?	
In what areas is the percentage of car sharers the highest?	
What kind of clientele does currently make use of car-sharing possibilities?	Does this differ from the situation in the past?
How are parking facilities for shared cars arranged in …….?	
How big is the role of electric vehicles or other sustainable power sources in the car-sharing sector?	
Main questions: hindrances in car sharing	**Sub-questions:**
What are the obstacles when it comes to the implementation of car sharing?	Did COVID-19 have an impact on the car-sharing sector?
Do you perceive land availability to play an important role in the car-sharing sector?	
What kind of permits are necessary from the municipality and how do these affect car-sharing?	
Main questions: Future situation and visions	**Sub-questions:**
How do you see the role of car sharing in the sustainable transition?	
What is the motivation to include shared cars in this transition?	
Is there a broader ambition for car-sharing and how would this look like?	Do you see possibilities for car sharing as part of an interconnected system of different transport modes? Called chain transport in the plans of the municipality.
Where do you want the car-sharing business to be in 2030?	What are the concrete goals for the near future?
Are there ambitions in creating a sustainable car park for car-sharing? Electric or otherwise.	

Is there something you would like to add or something else you want to mention concerning the interview?

Closing the interview.

II: Consent letter

Dear participant,

Thank you for participating in this research project regarding car sharing as a potential solution for congestion and greenhouse gas emissions. A case study of Groningen into the adoption of car sharing. The research is done in the name of the University of Groningen, as a bachelor project for the bachelor Spatial Planning & Design.

Research aim:

This research project aims to investigate the opportunities of car sharing in the city of Groningen and how land affordability influences this. What is the current situation of car-sharing and in what ways do spatial, environmental, and mobility challenges in the area influence characteristics of car sharing?

Interview information:

The interview can be held to a location that has a preference by the interviewee. If, due to certain circumstances, an in-person interview is not possible the interview can also be conducted through the phone.

The interview will be recorded, but you may always ask for it to be deleted for any reason. Furthermore, You have the right to change your answer or take it back, to stop the recording, or take back your consent at any time.

The recorded material will only be in possession by the researcher and will be deleted after transcriptions are made. Transcriptions of recorded material will only be in possession of the researchers and the bachelor coordinator dr.Farzaneh Bahrami. Transcriptions of the recordings will be made anonymous and are used for analysis, but only with your approval.

The interview will be held completely voluntarily and there are no rewards for specific outcomes to prevent biased or manipulated data. The research project is non-commercial.

If you are interested in the outcome of the research and want to receive the results, you are welcome to contact me to receive access to the report. Transcriptions and recordings of the interview are also available upon request.

Hopefully you agree to participate in this research,

Your preference can be sent to me by email: (*r.bloem.3@student.rug.nl*)

Kind regards,

Remco Bloem *(r.bloem.3@student.rug.nl)*