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Accelerate sustainable mobility

Aiming for decrease of car ownership in an outer urban area

T.A. van Dam



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Colophon

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Name	Titia van Dam
Student number	s1012770
E-mail	titiavdam@gmail.com

First supervisor	dr. D.F. Boezeman
University	Radboud University Nijmegen
E-mail	d.boezeman@fm.ru.nl

Second supervisor	J.F. Meekes
Organization	Gemeente Nijmegen
E-mail	j.meekes@nijmegen.nl

Radboud Universiteit 

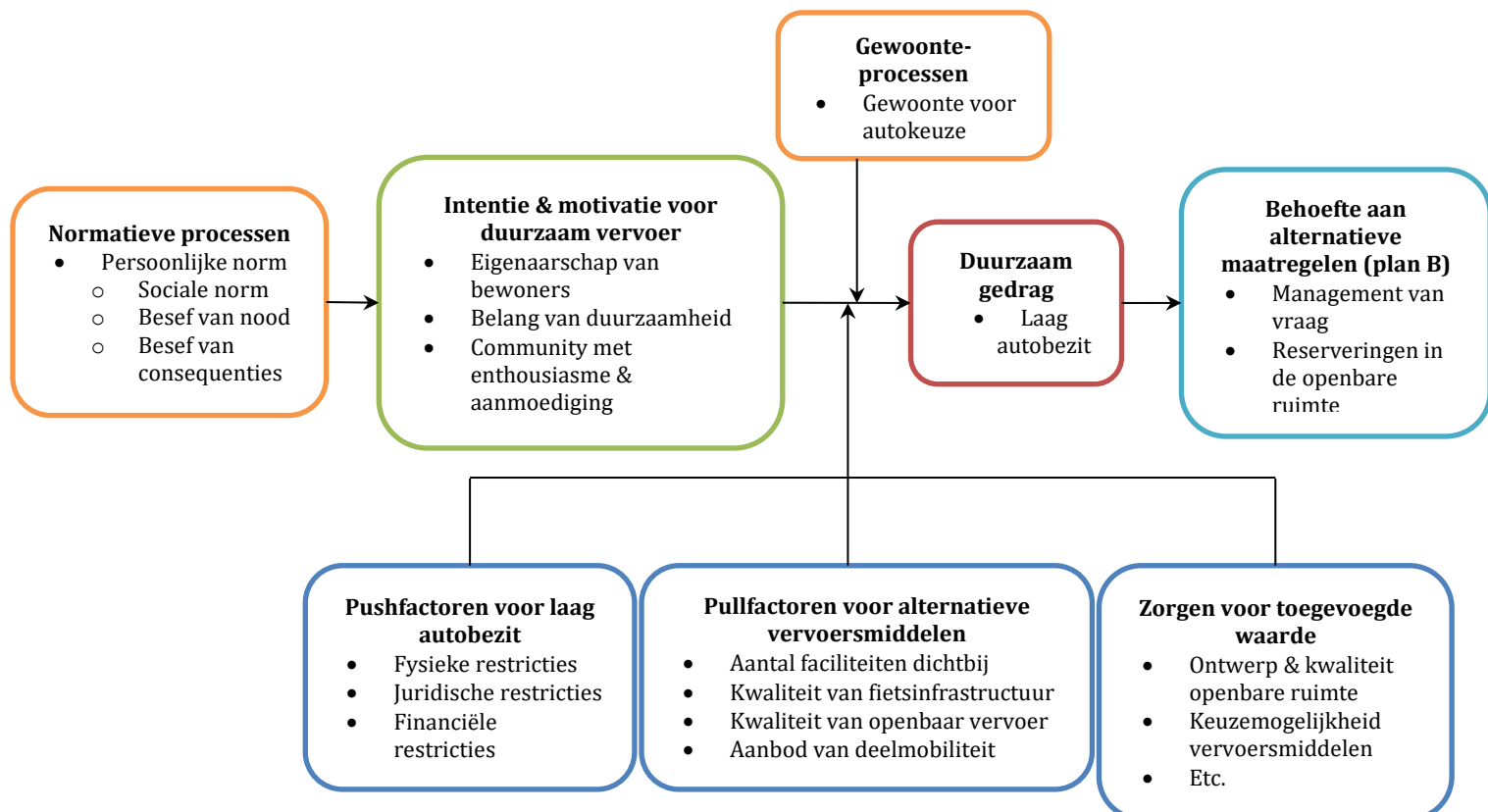
 *Nijmegen*

Dutch summary

Transport zorgt voor een aanzienlijk deel van de uitstoot van broeikasgassen en auto's nemen veel plaats in in steden op een inefficiënte manier. Grotere steden beginnen auto's te weren uit hun hoogstedelijke gebieden, maar het is onduidelijk of dit ook mogelijk is op minder stedelijke locaties, zoals de besproken casus Vossenpels-Noord in Nijmegen, omdat veel van deze ontwikkelingen onderliggende argumenten hebben zoals ontwikkelkosten, capaciteit van de infrastructuur, inefficiënt ruimtegebruik en leefbaarheid, terwijl de ontwikkeling in Vossenpels-Noord slechts op duurzaamheid is gericht.

Het doel van dit onderzoek is om bij te dragen aan het ontwikkelproces van Vossenpels-Noord, de kleine hoeveelheid beschikbare literatuur over dit onderwerp en de ontwikkelingen van andere gebieden met duurzame mobiliteitsconcepten. Om dit te doen, is de volgende onderzoeksvraag geformuleerd: *Hoe kunnen de voorwaarden voor Vossenpels-Noord worden ontworpen om een buitenwijk te creëren met weinig autobezit?* In het beantwoorden van deze vraag zijn drie vergelijkbare casussen, meningen van experts op het gebied van mobiliteit en duurzaamheid en de bereidbaarheid van inwoners van omliggende wijken onderzocht in interviews en zijn de geformuleerde voorwaarden geconcretiseerd en toegepast op de casus Vossenpels-Noord in een workshop.

In de resultaten kwam naar voren dat deze ontwikkeling grote risico's met zich mee brengt en dat dit concept van laag autobezit eerst in hoogstedelijkere gebieden toegepast zou moeten worden. Als de gemeente het concept in Vossenpels-Noord gaat gebruiken, speelt de motivatie van bewoners een grote rol (**Figuur A**, groen blok), die nodig is om andere instrumenten succesvol toe te passen, zoals te zien is in **Figuur A** (blauwe blokken). Alleen een combinatie van een aantal instrumenten kan leiden tot lager autobezit, als er enige intentie is. Op basis van de resultaten zijn twee aanbevolen scenario's mogelijk. De eerste optie is om de doelgroep en mate van duurzaamheid aan te passen, wat leidt tot een wijk die zeer gericht is op duurzaamheid. De tweede mogelijkheid is om de ambities wat betreft autobezit te verlagen, maar in plaats daarvan op autogebruik te focussen en de wijk alsnog innovatief in te richten.



Figuur A: Onderzoekresultaten

Summary

Transport accounts for a significant share of greenhouse gas emissions and cars occupy much space in cities in a very inefficient way. Larger cities start to ban cars from their highly urbanized areas, but it is unclear whether this is also applicable to an outer urban area, like the considered case of Vossenpels-Noord in Nijmegen, because many of these developments have underlying arguments such as development costs, capacity of infrastructure, inefficient use of space and livability, while the development of Vossenpels-Noord is only relating to sustainability.

The aim of this research is to contribute to the development process of Vossenpels-Noord, the low amount of available literature on this topic and developments of sustainable mobility concepts on other locations. To do this, the following research question has been formulated: *How can the conditions for Vossenpels-Noord be designed in order to create a neighborhood with low car ownership in an outer urban area?* In answering this question, three similar cases, opinions of experts in the field of mobility and sustainability and the willingness of inhabitants of surrounding neighborhoods have been investigated in interviews and the formulated conditions have been concretized and applied to the case of Vossenpels-Noord in a workshop.

In the results, it is emphasized that this development concerns large risks and this concept of low car ownership should first be implemented in more urbanized areas. If the municipality is going to implement the concept in Vossenpels-Noord, the motivation of future inhabitants plays a large role (Figure B, green box), which is necessary to have other instruments successfully implemented, as shown in Figure B (blue boxes). Only a combination of a number of instruments can lead to lower car ownership if some intention is present. Based on the results, two recommended scenarios should be considered. The first option is to adjust the target group and sustainability rate, leading to a largely sustainability oriented neighborhood. The second possibility is to lower the ambitions on car ownership, but focus on low car use and still design the neighborhood in an innovative way.

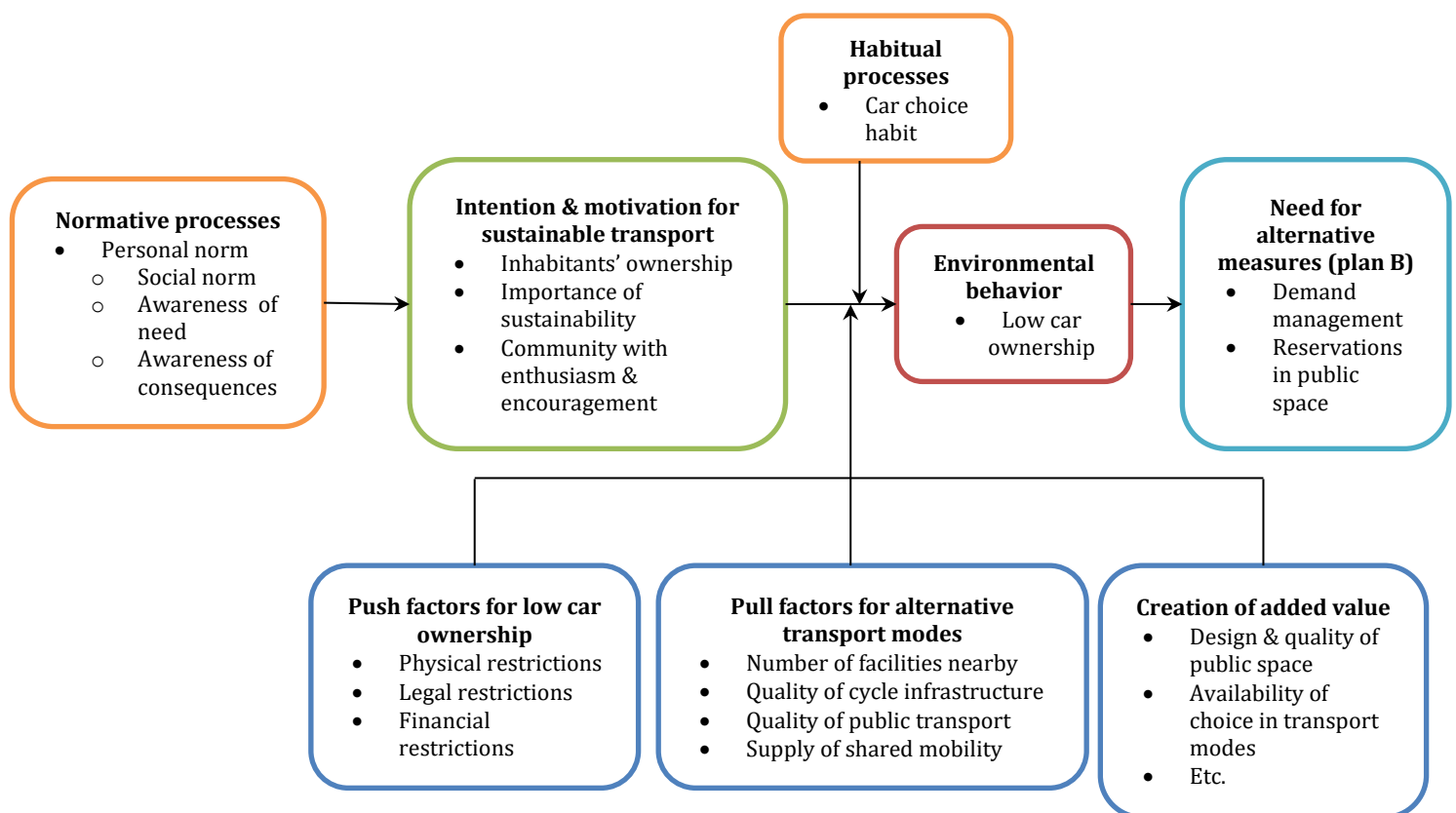


Figure B: Research findings

Foreword

In front of you lies the thesis *“Accelerate sustainable mobility: Aiming for decrease of car ownership in an outer urban area”*, the basis of an investigation among cases, experts, inhabitants and developers. It has been written to fulfill the requirement of the program of Environment & Society Studies at the Radboud University in Nijmegen. The research execution and writing process kept me busy from March until the beginning of September 2019.

My research was commissioned by the municipality of Nijmegen, where I executed an internship of five months, enjoying business experiences, acquiring knowledge and establishing warm connections. Jasper Meekes has been involved in the research process from day to day, always available to answer questions and to listen to my reasoning about every topic I had on my mind. The research became a large but satisfying process, in which my supervisors Daan Boezeman and Jasper Meekes helped to find the right directions and stay focused on my goal.

I would like to thank my supervisors for their excellent guidance and support during this process. Furthermore, I wish to thank all participants of the interviews and workshop for their time, effort and valuable knowledge and experience. Without them I would not have been able to conduct this research.

The support of my fiancé has been incredibly helpful and motivating, as well as the friends and family with whom I could discuss my research. Your motivation has made me putting even more effort in the result.

I hope you enjoy your reading.

Titia van Dam

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1. Introduction

The topic of this research will be introduced by addressing the need for cleaner mobility, briefly outlining the discussed case in Nijmegen, underlining the societal and scientific relevance and concluding with a formulated research aim and research question. The reading structure of the rest of the thesis will also be presented.

1.1 Need for cleaner mobility

The current developments in climate change are alarming and the consciousness that serious behavior changes have to occur increases (Olivier et al., 2017). The urgency to decrease the energy use and emission production of the transport sector rises. Road transport accounts for 17% of global fossil-fuel related CO₂-emissions, taking a second place in emission producing sectors (International Energy Agency [IEA], 2016). In 2010, fossil-fuel based transport took more than 53% of the global primary oil consumption (Sims et al., 2014). This accounted for 94% of the total energy demand of transport, because biofuels (2%), electricity (1%) and natural gas and other fuels (3%) completed the other only 6%. These significant shares in energy consumption and emission generation imply not only the importance to increase transport performance but also the potential for improvements. Also in terms of health and quality of public space it is preferable to have less pollution and less space reserved for motorized vehicles.

On the other hand, the statistics over the last years show an *increase* in car possession in the Netherlands, both in number of cars on behalf of company and in private possession (Centraal Bureau voor de Statistiek [CBS], 2018a). The distance traveled per Dutch car has decreased slightly, but because of the increase in number of cars, the total distance traveled by cars has increased (CBS, 2018c). The amount of electric and hybrid cars is rapidly increasing, but still represents only 3% of the total car fleet. The increase is mainly due to the growing segment of senior car owners, while the car possession by young adults remains stable or even decreases slightly (CBS, 2018b), but the argument is also raised that young adults only postpone their car purchase (CROW, 2018). Half of the Dutch citizens above the age of 18 own one or more cars (CBS, 2019a). A modal split of the Netherlands in 2017 shows that almost half of the trips is made by car (either driver or passenger), 27% by bicycle, 18% by foot and 6% by public transport, of which the car and public transport have a larger share in travel distance and travel time (CBS, 2019b).

The car is clearly considered as the most important transport mode in the Netherlands and this segment is still growing. Likewise, a worldwide study shows that vehicle ownership increases until a certain saturation level is achieved (Dargay, Gately & Sommer, 2007). Since many developing countries are far from saturation, the increasing rate of car ownership is expected to continue. Moreover, the share of rather sustainable cars (hybrid, plug-in hybrid and electric) is growing, but still has to come a long way. Also, replacement of all fossil fuel cars by electric cars does not solve the problems of for example limitations in infrastructure capacity and high building costs of parking spaces in more urbanized areas. The differences in car possession between different ages and locations (CBS, 2018b) are interesting and can be useful in attracting certain target groups for less car-oriented areas.

1.2 Problem statement

The municipality of Nijmegen would like to create a new neighborhood (Vossenpels-Noord, see Figure 1) with lower parking ratios than usual, sustainable

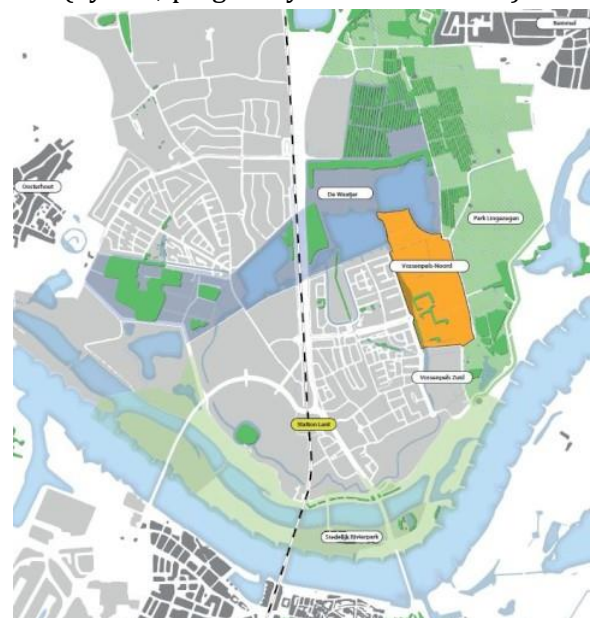


Figure 1: Location of Vossenpels-Noord (orange), with the center of Nijmegen below the river (Gemeente Nijmegen, 2018)

mobility as main transport modes and therefore less car ownership. In the ambition document, it is mentioned that lower parking ratios should be applied and the focus should be more on cycling, public transport and shared mobility than on private cars. This still to develop neighborhood should function as an example of a more sustainable, healthy and cultural area for other (future) neighborhoods (Gemeente Nijmegen, 2018).

However, this case study of Vossenpels-Noord does not have the natural characteristics of a low-car oriented neighborhood. Firstly, the neighborhood is not in or nearby the city center of Nijmegen (± 5 km) or other large business or shopping facilities, on moderate distance from a railway station (Nijmegen CS at ± 4 km for Inter-Cities and Nijmegen Lent ± 2 km for commuter trains) and belongs to the outskirts of Nijmegen with a well-developed car infrastructure nearby, while inhabitants living nearby many facilities, usually in city centers, often own less cars (van de Coevering et al., 2008). Furthermore, there is no lack of space or financial means to provide a sufficient amount of parking spaces or car infrastructure, which can also be a reason to focus on other transport modes, especially in areas with a high building density (Shoup, 1997). Thirdly, the housing plan concerns mostly owner-occupied houses to be built, attracting larger households with higher incomes and often a larger amount of cars (van de Coevering et al., 2008). Moreover, mentioned solutions like car sharing or self-driving cars are expected to result in less car ownership on the long term, but are not implementable yet or only on small scale, so do not provide a main solution for designing this neighborhood yet. In this case in Nijmegen, the motivation for sustainable transport is the only motivation instead of also a need for reshaping the mobility system and it is therefore difficult to determine how this neighborhood should be designed.

1.3 Stimulating neighborhoods with low car ownership: A challenge for policy

The layout of cities in the Netherlands has been oriented on stimulating car use since the sixties, when economic welfare increased after WWII and the government was encouraging car ownership among citizens (van de Coevering et al., 2008). The number of parking spaces increased as minimum parking ratios were established and these ratios mainly remained equal during the decentralization of these regulations. The research of PBL Netherlands Environmental Assessment Agency in 2008 recognized an increasing amount of car possession in the Netherlands, resulting in a higher need for more parking possibilities. It also addressed some experiments with lower parking ratios at various locations across the country, aiming at a higher livability by establishing more green or social facilities. However, all these experiments resulted in a failure. People would barely consider the parking facilities when buying a house, find it more important to have parking space than to have an attractive street view and would often use public instead of private parking spaces, because of stuffed garage boxes. The research concluded with the finding that lowering the parking ratio only brings problems instead of a change in behavior. This phenomenon of car orientation can also be recognized in an older document on parking norms of the municipality of Ede, where the focus is solely on providing sufficient parking facilities in newly built real estate in order to avoid a too heavy parking demand (Gemeente Ede, 2009). Also the Dutch national government aims to provide enough parking facilities on basis of the current parking demand instead of influencing mobility streams (MIWM, 2018).

In recent years, the vision on this topic slightly shifted towards decreasing parking norms because of the lack of available space, high realizations costs, limitations in car infrastructure capacity, low car ownership on central locations, etc., especially in larger Dutch cities (Gemeente Amsterdam, 2017; Provincie Zuid-Holland, 2017). Because the parking spaces in urban areas are expensive to establish and maintain, are far from fully occupied and often have to compete with other modes of transport, i.e. public transport, cycling and walking, these cities developed a stricter parking policy for certain central locations. This trend is also related to the higher demand for urban housing, which can be established easier, cheaper and with a higher density if the parking ratios are lower and therefore less restricting for building projects (Provincie Zuid-

Holland, 2017). Finally, a stimulation of more sustainable modes of transport is an argument for these cities, leading to avoiding polluting transport in the city center area (Gemeente Amsterdam, 2017; Gemeente Utrecht, 2018). To ensure a facilitating environment for an area with low parking ratios, the surrounding areas need to have paid parking and/or solely private parking, the possibility needs to exist to refuse parking permits for residents and either transport alternatives need to be available or business and facilities need to be nearby (Provincie Zuid-Holland, 2017). Also the municipality of Utrecht has defined ambitious plans to establish a new neighborhood without parking facilities in the neighborhood itself, but only on the edge of the area near the highway, creating room for a green and healthy environment while focusing on public transport, cycling and walking (Gemeente Utrecht, 2018).

As mentioned before, the case of Vossenpels-Noord in Nijmegen does not contain many of these circumstances. The municipality of Nijmegen has high ambitions in the field of sustainable transport compared to other cities, without the urgency as present in larger cities in the Netherlands with a similar approach, aimed at parking policies. To achieve the same intended results as those policies in terms of less parking in public space is already a large challenge, let alone the aim to reduce car ownership significantly in an area that is far from concerning ideal circumstances for such an approach.

To conclude, the trend of low-car oriented developments was until now only seen as failing projects or only possible in some high urbanized areas of larger cities, so it is not a widely spread phenomenon yet. While the awareness of the need to focus more on sustainable transport modes rises. Research and policy experience on this topic need to be extended in order to make implementation of neighborhoods focused on sustainable transport modes easier for municipalities. Furthermore, this topic of low-car orientation has become very concrete in Nijmegen, although the case of Vossenpels-Noord has many deviating characteristics compared to recent developments. Therefore, this research is important to find out how this neighborhood should be designed.

1.4 Stimulating neighborhoods with low car ownership: A knowledge gap

While there are clear problems associated with car dependent developments and cities demonstrate to have put the issue on spatial planning agendas, knowledge is still missing on establishing low car orientation. Firstly, the current available knowledge is discussed briefly.

Some examples exist of experiments with lower parking ratios, where the car use did not decrease, frustration grew because of the lack of parking spots and in the end more parking spots or permits had to be realized (van de Coevering et al., 2008; Gemeente Amsterdam, 2017). Even with a reliable public transport system, no actual change in car behavior could be recognized. The areas with lower car ownership, for example in a city center, do not have an explicit influence on the inhabitants' car behavior, but attract more people who already do not own a car instead (van de Coevering et al., 2008). On the other hand, there are many trends and opportunities recognized in the parking sector on which parking operators should adapt in future, e.g. sharing economy, integrated mobility, vehicle diversification, urban densification, autonomous mobility (Mingardo & Witte, 2018). How these developments will take form and which adaptations are necessary is still unknown of course.

When the scope is enlarged to more sustainable travel behavior, so the use of sustainable transport modes versus car use instead of less car ownership, more research can be found. For example the relation between travel behavior and certain identifications or lifestyles (Heinen, 2016; van Acker et al., 2016), suggesting that identification with a certain travel mode results in a lower likeliness to reduce the use of that respective transport mode. Furthermore, there are several studies about interventions to reduce car use. A study of Graham-Rowe et al. (2011) reviewing interventions aimed to reduce car use came across a large number of cases with low

quality methodologies, not achieving the preferred reduction in car use. However, some cases did establish a reduction and they recognized potential in, drivers who recently moved, employees that are being relocated and car drivers with a high motivation to reduce car use. In the last decade or so, the attention for focusing on sustainable transport modes has increased and this intention or motivation of people to travel in sustainable ways became more important, for example in a research of [Pooley et al. \(2011\)](#) where families were asked why they chose to walk or drive with their children and they found that many were willing to walk more often, but because of time, safety, cost and convenience issues the car was often more favorable. Also [Melia \(2010\)](#) found that people already living without a car or people currently owning a car, but willing to live without a car under at least some circumstances (improved public transport, changing circumstances of family/partner, moving to another place), are the two groups with significantly more interest in living in car-free housing areas than other groups. The demand for car free developments can increase if developed under preferable conditions, i.e. well-developed public transport, little amount of parking spaces and in some cases high density and parking regulation in surrounding areas. The interest of people already living without a car to live in a more spacious environment in comparison to the city center where they currently live, as long as the public transport is established well enough, is particularly interesting for this research. This mainly concerned moving within the same city/area instead of moving into a new town.

[Hayden, Tight & Burrow \(2017\)](#) did not look into the people that are willing to live without a car, the 'low hanging fruit', but to another large segment of travelers; the heavily car dependent people. They concluded that many individuals are willing to reduce their car use if their circumstances make them less car dependent, because they recognize the environmental impact of cars. This creates an opportunity for spatial planners to design urban areas in such a way that people can rely on other modes of transport instead of their car.

These research examples are possibilities for car use reductions, although the current developments are not reaching to their full potential. Furthermore, motivation for sustainable travel behavior is mentioned as important several times, but a certain combination of situational factors might also be able to establish sustainable travel behavior more naturally. This shows both the need and the opportunity for more knowledge and experience in this field. The lack of literature about discouraging car *ownership* (instead of only car use) also underlines the need for more research, especially under specific circumstances, like the outer urban area in the case of Vossenpels-Noord.

1.5 Research aim and research question

Wrapping up, the municipality of Nijmegen has ambitions in this new neighborhood Vossenpels-Noord to decrease the amount of car ownership by lowering the parking ratio, while other reports indicate the unwillingness of people to let spatial circumstances influence their car behavior. Because this movement towards more sustainable transport is rather new, it is a challenge for the municipality in what way this project can be designed successfully, especially in this outer urban area where car ownership is natural. This research will make a contribution to the available knowledge about how to stimulate people to use sustainable ways of transport, even when the situation does not naturally establish sustainable travel behavior.

The aim of this research is to investigate the conditions under which the amount of car ownership in this new neighborhood Vossenpels-Noord can be realized at a lower rate than comparable neighborhoods. These conditions should urge future inhabitants to own less cars and should be moldable by the municipality of Nijmegen. The recent developments with low parking ratios in the centers of larger cities are not well comparable to this neighborhood in the outskirts of Nijmegen, so more similar cases are searched for to investigate. The purpose of this research is therefore threefold:

- Provide the municipality of Nijmegen with an indication of how realistic its ambition is and knowledge on how its plans should be established.

- Contribute to the little amount of existing literature on this topic, especially in these less-urban circumstances.
- Provide other municipalities, provinces or districts with information about this relatively new phenomenon to encourage sustainable transport on a larger scale.

Because this topic is rather new in scientific research, the focus in this research will be on investigation of related cases with some similar aspects compared with Vossenpels-Noord and the opinions and experience of experts in the field.

The resulting research question can be formulated as follows: *‘How can the conditions for Vossenpels-Noord be designed in order to create a neighborhood with low car ownership in an outer urban area?’* with the following sub-questions:

1. Which conditions can be derived from similar cases in other cities?
2. Which conditions are proposed by experts?
3. Under which conditions are inhabitants of surrounding neighborhoods willing and able to change their car ownership?
4. How can the proposed conditions be applied to Vossenpels-Noord?

1.6 Further reading structure

The formulated research question and sub-questions are leading in the rest of the thesis. Some examples of relevant literature has already been discussed to address the scientific relevance of this research, on which the **Chapter 2** will elaborate by providing a larger literature review of the topic and establishing a theoretical framework as fundament for the research itself. The methodology of the research is outlined in **Chapter 3**, after which the results will be presented in **Chapter 4**, including descriptions of the investigated similar cases. Finally, **Chapter 5** contains an overall conclusion, together with some reflections in a discussion part.

2. Literature review and theoretical framework

Now that it has been discussed that Vossenspels-Noord is not a place where low car ownership would emerge naturally, additional instruments are necessary to change this and make inhabitants behave environmentally friendly by travelling with sustainable transport modes. To understand how this can be done, the antecedents of and influences on environmental (travel) behavior are discussed according to relevant scientific literature. Afterwards, the choice for sustainable transport modes will be discussed as a form of environmental *behavior*. The various aspects of the general behavior process will be applied to this specific behavior form and will briefly be related to the concerned situational factors in the case of Vossenspels-Noord, but the case is discussed more elaborately in previous and following chapters. This purpose of this literature review is to identify the most relevant contextual factors to achieve a pro-environmental behavior in terms of sustainable transport mode choice, which are also applicable to the case of Vossenspels-Noord, and position them in a theoretical framework, on which the further research is built.

2.1 Environmental behavior

The definition of positive environmental behavior, or also known as pro-environmental behavior, is “*behavior that harms the environment as little as possible, or even benefits the environment*” (Steg & Vlek, 2009, p1), where the environmental impact of behavior concerns changes in ecosystems or biospheres; supply of natural resources and the structures and dynamics of the systems themselves. To execute environmental behavior, one has to know about and be aware of the environmental consequences and intend to behave more environmentally friendly. However, knowledge, awareness and even intention do not automatically generate environmental behavior. To understand this behavior process, a few theories are discussed.

2.1.1 Theory of Planned Behavior (TPB)

Ajzen (1991) formulates the Theory of Planned Behavior as an extension of the Theory of Reasoned Action (Fishbein & Ajzen, 1975; Ajzen & Fishbein, 1980), which describes the influence of attitudes and subjective norms on behavioral intentions, leading to actual behavior. The TPB (see Figure 2) adds the direct influence of perceived behavioral control on all preceding variables of behavior and the indirect influence on behavior itself, considering the perceived ability to execute a certain behavior. This *perceived* control has a larger impact on behavior than *actual* control, because a person is more likely to accomplish a certain task if (s)he believes (s)he is able to do so.

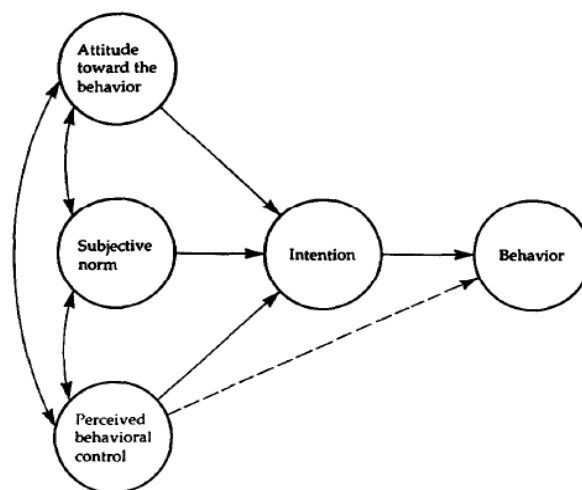


Figure 2: Theory of Planned Behavior (Ajzen, 1991)

This theory is heavily leaning on the motives and abilities of a person, suggesting that people often or always make a conscious choice in behavior on the basis of what reflects their

intentions in the best way. In practice, this might not always be the case, since it can take a lot of effort to make every choice in behavior in accordance with personal intentions, better suiting behavior might be more costly in terms of time, money and/or complexity, the choice might be made without an evaluation of all options after a certain repetition of behavior, etc. Because of these contradictions and a large unexplained variability in executed research based on the TPB, many others have tried to add other variables like habit and situational influences (see 2.1.3). The TPB has often been used – in original or extended form – to understand pro-environmental behavior and assess the level of influence of attitudes, subjective norms, perceived behavioral control and intention in various specific contexts (e.g. Bamberg, Ajzen & Schmidt, 2003).

2.1.2 Norm Activation Model (NAM)

In the Norm Activation Model, the predecessors of the personal norm of an individual, or labeled as subjective norm in the TPB, are determined, forming a feeling of moral obligation (Schwartz, 1977; Schwartz & Howard, 1981). This personal norm is the driving force of actual behavior. The influences on the personal norm concern awareness of need and awareness of consequences. In order to act, a person has to believe that an urgency exists to change a certain situation (awareness of need) and that (s)he is responsible for the consequences or that his/her actions can make a difference, because they are impacting others (awareness of consequences). Thirdly, the person has to experience a certain level of perceived behavioral control, the believe to be able to do something about the situation. On the other hand, the person in question can formulate arguments to defend him-/herself for not undertaking action while the urgency and ability to influence consequences are present. These personality or situational factors are called responsibility denial: taking the negative consequences for granted because of high personal costs. The NAM is often applied to environmental behavior (e.g. Onwezen, Antonides & Bartels, 2013).

This theory is also based on one's norm in order to act and does not take further habitual or contextual factors into account, like the TPB. The research that has been executed according to the NAM show a certain variance in the results, especially with high behavioral costs, which can be explained by these factors (e.g. Bamberg & Schmidt, 2003).

2.1.3 Comprehensive Action Determination Model (CADM)

The TPB and NAM complement each other, since the variables of the NAM can be added into the framework of the TPB where personal and subjective norm are related. The shortcomings of both theories are similar and therefore some extended versions of the models circulated already, but the Comprehensive Action Determination Model (CADM) integrated these pieces into an elaborate model (Klöckner & Blöbaum, 2010).

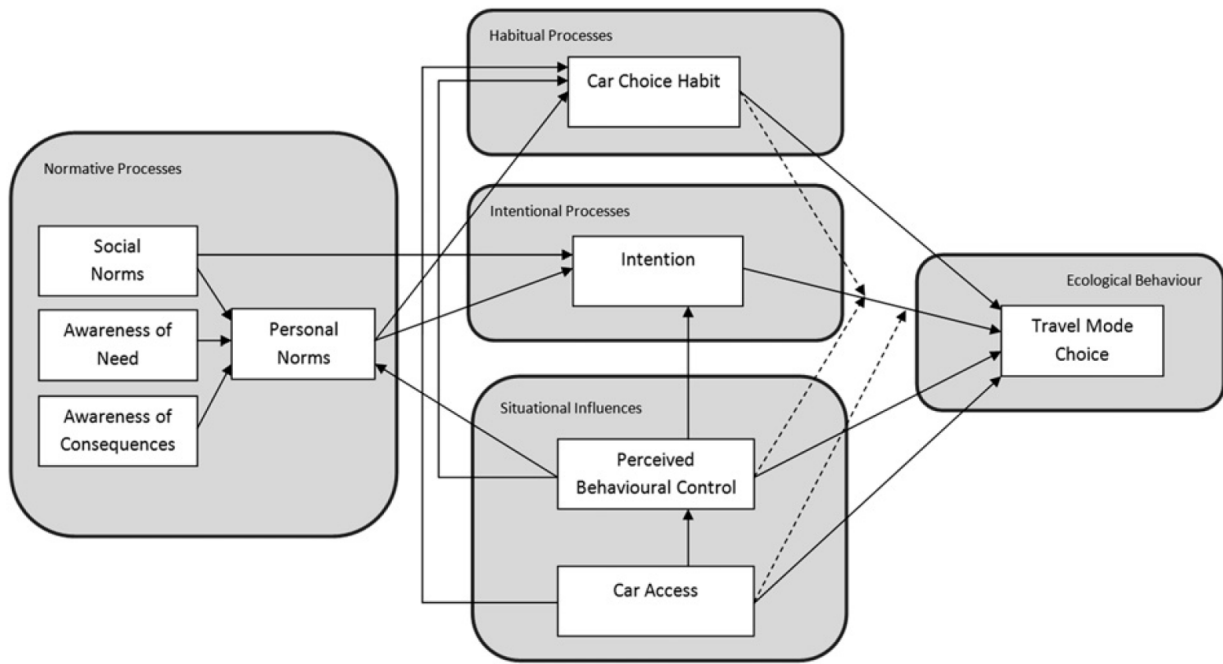


Figure 3: Comprehensive Action Determination Model (Klöckner & Blöbaum, 2010)

In the model, shown in Figure 3, the elements of the NAM can be recognized on the left, in the box of Normative Processes. However, the personal norm does not have a direct relationship with behavior but is mediated by intention. The relation between personal norm, perceived behavioral control and intention in the middle is taken from the TPB. A situational and habitual factor are added and already specified for travel mode choice behavior. This model proves to have a larger explanation of variance than both the TPB and NAM (Klöckner & Blöbaum, 2010), which emphasizes the role of habitual and situational factors in the behavioral process. These two types of influences will be discussed and concretized to a larger extent after situational-focused theories, travel demand and pro-environmental behavior in the segment of transport mode choice have been defined.

2.1.4 Practice Theory & Multi-Level Perspective

Until now, only theories have been discussed with individual intentions as most important factor for sustainable behavior, while also theories exist with a larger focus on situational factors, especially the Practice Theory (Shove et al., 2012). In this theory, the link between materials, competences and meaning is important, i.e. one needs to have the materials available to execute environmental behavior, be able to handle with those materials and attach certain values to that behavior (e.g. status, wealth, health, environment). This also related to the mentioned car access in the CADM. When these three elements are present and linked, the related behavior becomes a practice. In case of innovations, these links are broken and new links emerge, resulting in new practices. This role of innovations also relates to the Multi-Level Perspective of Geels (2002), shown in Figure 4. A certain landscape exists in societal context, containing a regime with various components in technology, culture, science, etc. If a successful innovation occurs, the regime is torn open, the innovation is incorporated and a new regime is formed, which also influences the landscape.

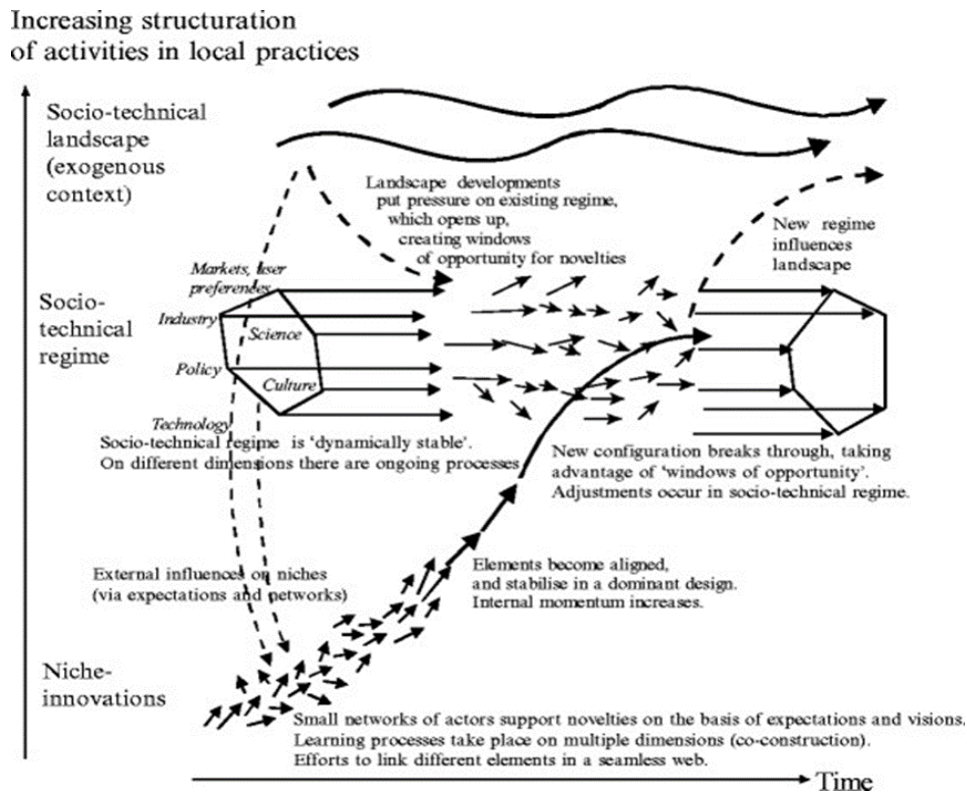


Figure 4: Multi-Level Perspective (Geels, 2002)

These theories show the strength of the combination of various components or situational influences in society, leading to a certain behavior. A large transformation can lead to an open window for new practices and behaviors. In all these theories, it is important to find which (contextual) factors actually influence sustainable travel behavior and the amount of car ownership.

2.2 Sustainable transport modes

2.2.1 Definition

The shown CADM (Figure 3) is already oriented towards transport mode choice, with an emphasis on car use as unsustainable behavior. This represents a larger assumption in research, where car and motorcycle (motorized private transport) are labeled as unsustainable transport modes and walking, cycling (both active transport) and public transport as sustainable transport modes. The level of sustainability of public transport varies according to occupation rate as well as type and model of a specific vehicle, but is considered as sustainable, since it is more efficient in most cases than motorized private transport and it has larger potential to establish a more sustainable transport system, because of the competition between providers, the magnitude of the vehicle fleet and the capacity per vehicle. A discussion has emerged in recent years about the sustainability of sharing systems, especially with non-electric motorized vehicles like scooters and cars, since an easier accessible vehicle can also increase the amount of travels with non-sustainable transport and can be used as an addition instead of a replacement of a private vehicle. On the other hand, if shared cars are used as a replacement of a larger number of private cars and require electricity instead of traditional fuels, this can contribute to a reduction in emission and private car possession (Firnkorn & Müller, 2011), which in return also impacts the amount of necessary parking space in streets. Shared systems are therefore preferable to a large percentage of car possession, especially considering electric vehicles. Electric private cars might be labeled as more sustainable, but in space and price it is not feasible to make everyone travel by private electric cars. Finally, not undertaking a travel at all is of course also a preferred alternative to non-sustainable transport modes. Concluding, the elimination of travel and the transport modes of walking, cycling, public transport and shared vehicles will be considered as sustainable choices in travel behavior in this research.

2.2.2 Travel demand: some situational influences

Travel demand usually precedes the choice for a certain transport mode, because it determines which aspects of a transport mode are most relevant or important at a specific situation. This demand can vary for example among different trip purposes (e.g. work, shopping, leisure), locations (e.g. high urbanized area vs. countryside, long vs. short distance) and personal circumstances (e.g. possession of driver license, situation of physical disabilities). Travel demand is a well-studied object in research, including these relations with for example land-use, adaptation to individual preferences and availability of transport modes. **Cervero and Kockelman (1997)** determined three interdependent factors influencing travel demand: density, diversity and design (the 3Ds). In later work, these three were extended with four other Ds: destination accessibility, distance to transit, demand management and demographics (**Ewing & Cervero, 2001; Ewing & Cervero, 2010**). Each of the 7Ds is briefly described underneath.

Firstly, *density* is the amount of units per area, which can be measured in dwelling units, building floor area, population, employment, or other variables. A high density implicates many destinations within a small radius and thus low speed transport modes like walking and cycling become very suitable. Secondly, *diversity* implies the differentiation in land use per area represented in employment or land or floor area per utilization. Also scales from low to high diversified and ratios of jobs-to-housing and jobs-to-population can be used. An area with a high diversity in land use generates short distance traffic because the needs of inhabitants in various segments (e.g. school, work, leisure, shopping, community) are all met in a relatively small area. Thirdly, *design* relates to street characteristics and the prioritization of transport modes in infrastructure networks. It can be measured in average block size, street width, number of intersections or pedestrian crossings per area, percentage of street surface occupied by car/bicycle/pedestrian/public transport, prioritization in traffic lights and other physical factors differentiating between various road users. The street layout can either support or discourage a specific transport mode by providing a certain degree of prioritization in right-of-way, traffic lights and amount of space on the street surface for this transport mode. The larger supply of support for a specific transport mode can generate a higher demand as well. Fourthly, *destination accessibility* is about the convenience to which destinations can be accessed, for example expressed in number of jobs or other utilities reachable within a given amount of travel time (referred to as regional accessibility (**Handy, 1993**)) or as distance to the closest store, where a low distance implies a high accessibility (referred to as local accessibility (**Handy, 1993**)). This destination accessibility is highly related with the earlier concept of diversity, since a high diversity also means many utilities in a small area or within a small amount of travel time and a low distance from home to the closest store. A high destination accessibility therefore increases the demand for low speed traffic. Fifthly, *distance to transit* is usually measured in terms of average distance to the nearest railway station or bus stop from residences or utilities in an area. It can also be determined as the density of transit routes, the distance between transit stops or the number of stations or stops within an area. The lower the distance to transit, the easier it should be to use public transport and the more demand can be generated for public transport along with this higher supply. Sixthly, *demand management* is oriented on other incentives than previously mentioned: economic and regulatory instruments. If parking is expensive or restricted for example, the demand to travel by car to this destination will be decreased. Finally, *demographics* are influencing a person's life situation and preferences. For instance elderly people are less capable of driving, cycling or long distance walking. Their demand of public transport on short distance is different than the demand of families with working parents and small children or the travel demand of students without a driver license.

How travel demand is influenced does not only depend on these 7Ds as situational factors, but also on how people react to these circumstances and what choices they make, sometimes despite the measures that have been taken. The habits and intentions of people can play a larger role in the actual behavior choices than these situational factors influencing demand. The largely

accepted assumption of travel as a derived demand only, a necessity to reach a destination based on rational choices, is questioned by [Salomon and Mokhtarian \(1998\)](#) in several papers (see also [Mokhtarian & Salomon, 2001](#); [Mokhtarian, Salomon & Redmond, 2001](#)). They mainly discuss the travel excess of people – unnecessary travel which is executed because of the attractiveness of traveling itself – but they also raise questions about the impact of urban density and the causality of behavior change and locations facilitating this behavior change. An important finding is that needs related to demography do not determine travel demand solely, but the demand is also significantly dependent on one's attitudes toward travel ([Mokhtarian, Salomon & Redmond, 2001](#)), which is in line with the earlier described theoretical frameworks as well. To dive into such complexities, exploring choice for a certain transport mode is preferred to only discussing demand which ultimately influences people's choices.

2.2.3 Behavior change in use of sustainable transport modes

The environmental knowledge about travel behavior is widely spread, but an increase in awareness hardly results in actual behavior change ([Steg & Vlek, 2009](#)). This is also shown in the previously described CADM: the relation awareness of need/consequences and environmental behavior is mediated and moderated by many other variables, hindering the process of change. It is therefore useful to look into the influence of various factors on the choice of sustainable travel behavior. [Steg & Vlek \(2009\)](#) also address the need systematical planning, implementation and evaluation in behavioral interventions in order to establish an effective behavior change. For this research, the situational factors are most relevant, because they can be designed by the municipality of Nijmegen, but also other variables as habit and intention play an important role and should therefore be considered. Accordingly, a well-designed planning, implementation and evaluation is important in this design. Now that a number of relevant developments in sustainable transport mode choice have been laid out, a closer look is taken at the moldable factors in the CADM, habitual and situational influences, which can be seen in [Figure 3](#), and of which the importance is recognized in the Practice Theory and Multi-Level Perspective.

Firstly, the role of habit is relevant in the resistance to change, because the longer the same behavior is executed, the less likely it is to change. [Yalachkov, Naumer & Plyushteva \(2014\)](#) address the relation of habit with neuroscience and note that physical measures alone are not enough to change car driving behavior. Since travel mode behavior is often executed in a very repetitive way, a behavior change becomes very rare. This is because of the stable context, e.g. the same route to work every day, and the low degree of necessary consciousness to make a travel decision. Individuals with a stronger habit are less likely to look into travel alternatives than individuals with weaker habits.

The habit discontinuity hypothesis discusses the moment where disruptions happen, such as a new family member, change of school, new job or new place of residence. Because the old patterns of travel behavior are no longer relevant, there is space for change in transport mode because the travel behavior is reconsidered ([Verplanken et al., 2008](#)). In the case of Vossenpels-Noord, new inhabitants will move to this area and are therefore in a process of reconsidering transport modes. This provides potential for stimulation of sustainable transport modes if these modes are attractive car alternatives on the moment people move to the new neighborhood. Since further habit discontinuities like a new job or new family member cannot be influence by the municipality, the new place of residence is marked as a positive opportunity for sustainable travel mode choices, implicating the need for a well-established mobility system from the beginning, but this factor will not be an important component of the further investigation.

Secondly, situational factors concern a large spectrum of possible influences, which are often not further defined in literature. In the issue of car use and ownership, a division in situational categories can be found in the work of [Buehler \(2011\)](#), comparing car use and ownership between Germany and the USA, since a large difference exists while the countries are comparable on many aspects. In these factors, the earlier mentioned 7Ds are also concerned.

Firstly, demographic and socio-economic factors (*demographics*) have a high influence, as has been acknowledged before. The income, household size, age and gender do matter to a great extent. This can be influenced by the type of houses built and the selection of inhabitants, although discrimination should be prevented. Secondly, spatial development (*density, design*) especially influences the car use in cities, where the space for cars can be limited and transformed into living areas or other facilities. Building density, parking locations and design and purpose of the public space are considered under this category for example. This relates to the third category, transport and land-use (*density, diversity / destination accessibility, distance to transit, demand management*), which considers the building density as well, but also space for various transport modes, variety in available facilities, cost of transportation, convenience and travel time, design of infrastructures, etc. Finally, culture and attitude influences the way various transport modes are valued in terms of health, status, environment, social interaction, toleration of innovation, etc. These four categories provide concrete measures to influence the car ownership and can be used to operationalize the situational factors. The earlier mentioned perceived behavioral control is also incorporated in these categories, because it has a physical as well as a social component and both (physical restrictions/stimulations in infrastructure and public space, societal culture and attitude towards transport modes) are included.

2.3 Concluding theoretical framework

From the discussed literature and applicability of the factors to the case of Vossenpels-Noord, the following theoretical framework is shown in [Figure 5](#).

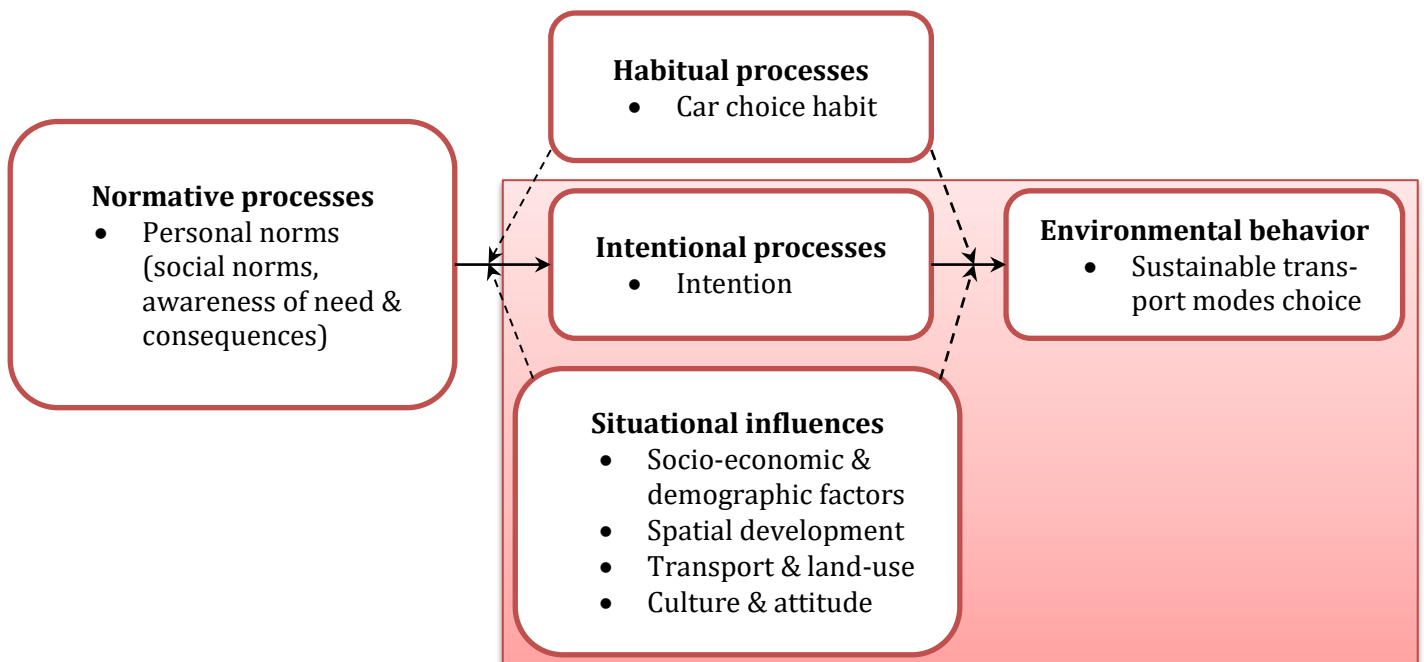


Figure 5: Theoretical framework

The theoretical framework has a simplified structure of the CADM ([Figure 3](#)), but the situational influences are taken from the concepts in the paper of [Buehler \(2011\)](#). Furthermore, ecological behavior is replaced by environmental behavior because this term is more used in research and implies not only behavior with a direct influence on nature, but also indirect consequences. Then the connections between the concepts: the most direct process leads from normative to intentional to actual behavior, but the transformation from one stage to the next is influenced by the role of habitual and situational factors. This influence is stronger when the step is made from intention to behavior, because stimulating circumstances are necessary for executing behavior in order to avoid high behavioral costs, than from normative to intentional processes, indicated by the thickness of the arrows. Many other relationships visible in the CADM might exist, but these are the main relationships for now. Moreover, the rectangle in the background is used to

indicate which part of the model is investigated in the rest of the research. The situational influences are the main topic, but the intentional process is important to such an extent that it cannot be excluded, although a part of intention is also included in the culture & attitude factor since culture determines social norms, which directly influences intention according to the CADM (Klöckner & Blöbaum, 2010). The aim is to look for a combination of situational influences that are facilitating in such a way that no or only a small amount of intention is necessary to establish sustainable travel behavior, like created opportunities in the Practice Theory and Multi-Level Perspective (Figure 4), but it can also be possible that intention is determining behavior to a larger extent, as described in the behavior-oriented theories.

This theoretical framework will be used in the rest of the research to design the content of the methodology by focusing on the factors in the model. To be able to do so, the factors will be conceptualized and translated into concrete questions, which can be found in the next chapter. After the data is gathered and analyzed, the results will be compared to this model in order to know whether this model is correct or adjustments have to be made, e.g. concepts or relationships have to be adjusted, added or removed according to the data of this research. From there, some conclusions can be drawn about what is most relevant or important for the case of Vossenpels-Noord.

3. Methodology

In this chapter, the methodological choices of this research are discussed, which concern crucial decisions for the execution of the research. Firstly, the philosophical context of these decisions in the Critical Theory spectrum is defined. Following from there, the choice for case investigation, expert interviews, neighborhood interviews and an implementation workshop are explained, with afterwards a description of the execution of these forms of data collection and the accompanying analysis. Finally, the reliability, validity and ethical considerations for this research are described.

3.1 Research paradigm

Paradigms are defined as “*basic belief systems based on ontological, epistemological and methodological assumptions*” according to Guba & Lincoln (1994, p107). One’s worldview is represented in a paradigm, attempting to answer fundamental questions about what truth is and how it can be found. These paradigms are also said to be human constructions, since there is not one paradigm more demonstrable or excluded than another and because paradigms exist in human minds and are therefore vulnerable for human error.

3.1.1 Ontology

The ontology considered as fundamental assumption for this research is that there is not one “real” reality, but these are dependent on various characteristics in both social and physical constructions, including the relation between them, and shaped by these characteristics over time. Moreover, these realities can be conceived in a transactional way and the findings will be value-mediated, but not created. This comes down to the Critical Theory perspective (Guba & Lincoln, 1994), which will be used as fundamental assumption to find answers to the research question.

Farthing (2015) however notes that in research in urban planning, it is often assumed that there is one “real” reality. He also describes the criticism on this view, e.g. with the position of Fischer (2003) that multiple social realities exist alongside each other and the perspective of the actor must be attempted to be understood by the researcher. The research outcomes are then an estimation to understand the considered social reality. This research however has none of these (outlier) positions as fundamental starting point, but falls in between, while closer to Fischer’s interpretivism view than to the (post-)positivist view described by Farthing (2015) and others (e.g. Guba & Lincoln, 1994; Chalmers, 1999).

3.1.2 Epistemology

In this paradigm, the influence of the researcher on the participants is inevitable, which can also be recognized in the considered methodology. It is necessary to be aware of this influence, including possible steering in conversations. While the aim of positivism is to describe the set of methods in such a way that the research could be reproduced by another researcher or in other settings, with the same (type) of results as outcome, the aim of interpretivism is to understand the motivations for people’s behavior and the meaning of social phenomena from the perspective of the actor (Fischer, 2003; Bryman, 2016). In this research, the dialectical role of the researcher leads to certain results, which are expected to be different when executed by another researcher. Also the open perspective of the research aim and research question lead to a larger role of the researcher in collecting data, because there is no prescribed list of conditions to check, so it depends on the conversation between the researcher and the participation which topics are suitable to discuss. On the other hand, this research is not completely about understanding one’s specific behavior and motivations, but about drivers which generally steer people towards a set of certain preferred behaviors. Another aspect of the interpretivism perspective, however, is the focus on the large variation in constructs and situations, which also needs different approaches and a lot of adaptation from the researcher (Bryman, 2016). This is included in this research, since the researcher attempts to distinguish between different

constructs and situations in conversations, in order to find the suitable conditions related to the discussed case of Vossenpels-Noord.

3.2 Strategy and research design

The literature study described in the previous chapter is the starting point for the rest of the methodological process, presented in **Figure 6**, set up chronologically from left to right. This process is explained first, after which the various methods will be discussed more extensively.

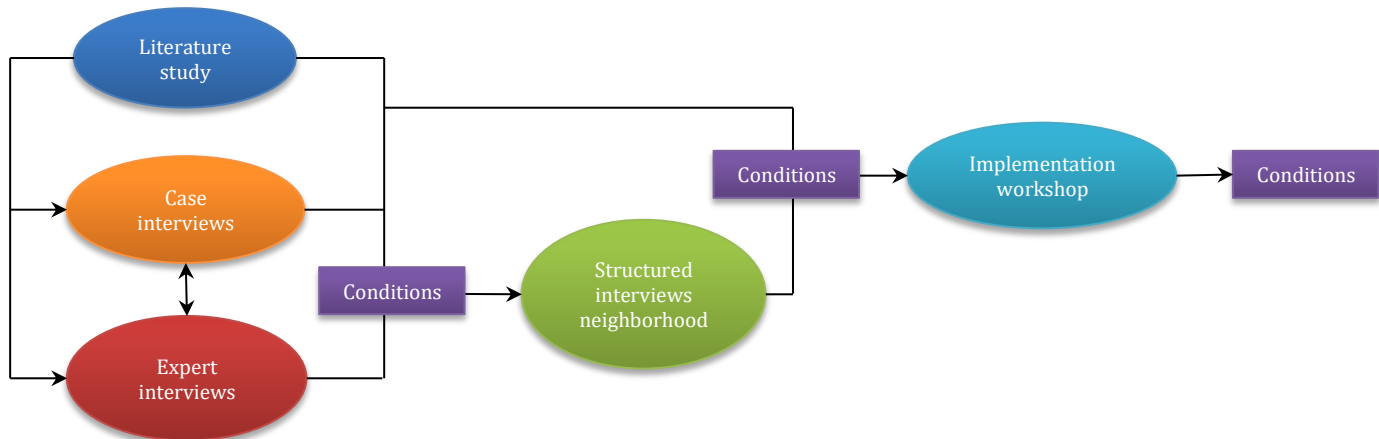


Figure 6: Overview of methodological process

This literature study provides the basis for two components: case interviews and expert interviews. For the case interviews, neighborhood developments with more similarities with Vossenpels-Noord than the earlier discussed city centers of larger Dutch cities are looked for, of which a small number of suitable cases is selected. Interviews are then executed to investigate these cases in order to collect practical learning lessons for the design of Vossenpels-Noord by recognizing concrete success and failure factors. Furthermore, expert interviews are held to look at the design for Vossenpels-Noord from various perspectives, with experts having experience with the trends, policy issues and implementation challenges in the field of mobility and/or sustainability. Guba & Lincoln (1994) formulate some criteria for judging the quality of a research in the spectrum of Critical Theory, including the historical situation, i.e. taking into account the social, political, cultural, economic, ethnic and gender antecedents of the case into account. By collecting reflections and recommendations from a large number of different backgrounds, this criterium ought to be met. A reciprocal connection between case and expert interviews is also shown in the figure, because these processes take place at the same time in an iterative process and the lessons from one interview can be tested, emphasized or concretized in another interview. After these interviews, some conditions can be defined according to the available data, which are used as input to ask inhabitants of neighborhoods surrounding Vossenpels-Noord about to which extent these people would be willing and able to change their car travel behavior or even ownership and which criteria should be met to realize this. In this way, more insight is created in the travel behavior of people living in this area and their willingness to live more sustainably. This is done in the form of structured interviews to make it possible to compare the results. The earlier formulated conditions could be adjusted according to these structured interviews and are input of the last method: an implementation workshop. The aim of this workshop is to apply the formulated conditions, which are still rather abstract and general, to the case of Vossenpels-Noord, while checking their feasibility as well, together with representatives from the municipality of Nijmegen and other experts. This leads to a conclusion whether a concept of low car ownership is feasible for this planned neighborhood and contains tested, concrete and applicable conditions under which the neighborhood should be developed for the municipality of Nijmegen. The final recommendations concern a transformation in the existing structures of mobility behavior, a stimulation to action, relating to another criterium of Guba & Lincoln (1994). Because of the triangulation in these various

methods, the interim results are tested various times, relating to the final criterium to avoid misconceptions. The selection stage of each method, excluding the literature review which has already been executed, will be discussed next.

3.2.1 Selection

In this research, the case of Vossenpels-Noord in Nijmegen is the main subject, while other cases are used to learn from. This approach concerns an embedded single case study (Yin, 2009). These other cases concern neighborhoods with similar characteristics, i.e. the intention for low car ownership and the location and surroundings of Vossenpels-Noord. Relevant neighborhoods in the Netherlands or other West-European countries have been found via internet research, news articles, contact with experts and literature from studies done in other cases (e.g. Kodransky & Hermann, 2011; Wikipedia, 2019). Some used key words are *low parking ratio*, *sustainable mobility*, *sustainable neighborhood*, *parking policy*, *car-free settlement*, *low car ownership* and *parking problems*. From the resulted list, a selection is made with help of Multi Criteria Analysis (Dodgson et al., 2009). The formulated criteria can be found in Figure 7, together with the scale division on each criterium. The focus in the criteria on outer urban areas and low car ownership is derived from the research question in 1.5, where this is explicitly mentioned because of the uniqueness of these characteristics, so cases which score high on these two criteria are seen as suitable to find conditions which can be applied to Vossenpels-Noord. The criterium about establishment is added for the ability to analyze cases which actually have lower car ownership, not only in planning, but also in execution. This criterium is however not content related and therefore marked as less important than the two content related criteria. Furthermore, the first and second criteria are quantitative and can therefore be determined precisely, while the third criterium is qualitatively determined by the researcher, on the basis of available documents and articles. The results of the analysis are given below.

Case criteria for Multi Criteria Analysis

The case should be in existence and utilized for some time to be able to evaluate the design and process.

1 - 2 - 3 - 4 - 5
not established utilized for >10years

The spatial context should be comparable to Vossenpels-Noord, e.g. distance to public transport or facilities.

1 - 2 - 3 - 4 - 5
>6km difference <1km difference

The case should not just be aimed to lower car use, but to decrease car ownership.

1 - 2 - 3 - 4 - 5
just lower car use lower car ownership

Figure 7: Case criteria for Multi Criteria Analysis

City	Case	Country	Quality of evaluation			Comparability to case of Vossenpels-Noord		Total	
			Weight	0,5	1	1		Unweighted	Weighted
			Time of establishment		Situation	Behavior			
Almere	Floriadeterrein	NL	1		2	4		2,33	2,60
Amsterdam	GWL-terrein	NL	5		2	3		3,33	3,00
Arnhem	Parkeermaatregelen Alteveer / 't Cranevelt	NL	2		3	2		2,33	2,40
Darmstadt	Mobilität und Verkehr	D	2		1	2		1,67	1,60
Den Haag	Central Innovation District	NL	1		1	4		2,00	2,20
Den Haag	Energiekwartier	NL	2		2	3		2,33	2,40
Eindhoven	Strijp-S	NL	4		2	2		2,67	2,40
Freiburg	Vauban	D	5		3	5		4,33	4,20
Utrecht	Kersentuin	NL	5		4	5		4,67	4,60
Utrecht	Merwedekanaalzone	NL	1		2	3		2,00	2,20
Wien	Aspern Seestadt	AT	4		5	5		4,67	4,80
Wien	Floridsdorf	AT	5		5	5		5,00	5,00
Zürich	Genossenschaft Kalkbreite	CH	3		2	5		3,33	3,40
			Scores	1	Very bad				
				2	Bad				
				3	Average				
				4	Good				
				5	Very good				

Figure 8: Multi Criteria Analysis of considered cases

Four cases in Utrecht, Freiburg (Germany) and Vienna (Austria) stand out above the other selected cases, scoring high on all three criteria. After some contact with a developer in Vienna,

one of the two selected cases there, Floridsdorf, turns out not to be such an ambitious development according to the interviewee as it seemed to be in the preliminary study, so it is removed from the list of selected cases. The three cases that will be further looked into are the Kersentuin in Utrecht, Vauban in Freiburg (Germany) and Aspern Seestadt in Vienna (Austria). For the investigation of these cases, it is necessary to know more about the circumstances under which these cases have been established, the current characteristics and the most important factors for the success (or failure) according to involved parties. To describe the situation in the neighborhood, the concepts from the theoretical framework are used.

The experts were selected on the basis of searching for related organizations (connected to research on parking, operating in the field of mobility, parking and/or sustainability, etc.), gathering contacts from the municipality and asking experts for further interesting contacts (snowball sampling; Bryman, 2016). For the structured interviews in the neighborhood, people living in this area in and around Vossenpels-Noord were selected. Finally, the participants of the implementation workshop were selected on the basis of their expertise on the case, either as representatives of the municipality of Nijmegen (involved in mobility, sustainability or the case of Vossenpels-Noord) or as participant of an earlier expert interview.

3.3 Data collection and analysis

Now that the strategy and brief design of each method has been discussed, the data collection and analysis of every method is described in this paragraph.

The concepts that have been introduced in the theoretical framework are used to formulate questions and to categorize the data. To use these rather abstract concepts in concrete interview questions to increase the measurability of the concept is defined as the operationalization process. In this process, the research questions are used as basis, then linked to theoretical concepts, from there formulated in theoretical questions and finally translated into interview questions. This is done for each of the four research sub-questions, see for an example Figure 9 below. The full interview guide is available in Appendix A.

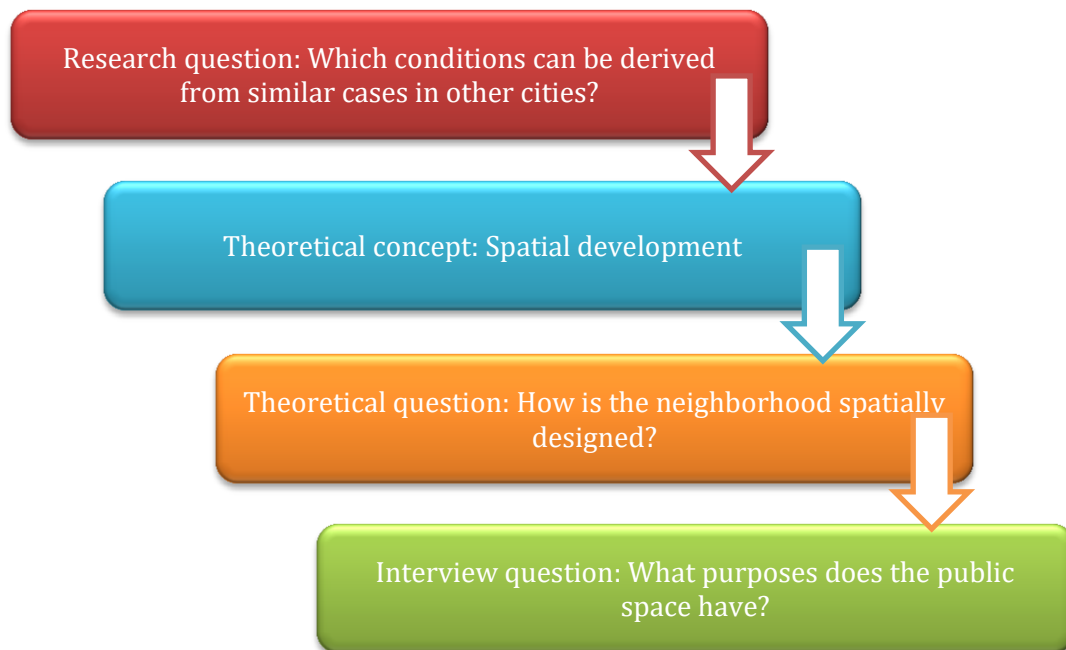


Figure 9: Example of operationalization

3.3.1 Data collection in case interviews

One or two interviews per case are held with government representatives (De Kersentuin, Vauban and Aspern Seestadt), a development party (Aspern Seestadt) and an inhabitant (De Kersentuin, same person as the government representative), where multiple types of interviews are used. More organizations have been contacted, but there were some obstacles to get in touch from distance. Recorded in-depth interviews were used as main method, but also an unrecorded telephone interview and interview questions answered by e-mail are included, as well as an explanation tour around the Kersentuin. These interviews followed a semi-structured format, with an open character because of the large amount of case-specific information and relevant factors, see for specific questions [Appendix A](#). The interviews varied in duration from 15 to 75 minutes. The gathered information, together with the available information from documents and websites is used to understand the establishment process and the important success factors. The participants were given some information about the research and interview in advance ([Appendix B](#)), which was also used for the expert interviews.

3.3.2 Data collection in expert interviews

The expert interviews were more focused on the case of this research, Vossenpels-Noord, and how it should be designed according to experts in various relevant fields. Eleven recorded interviews and one unrecorded interview have been held with experts active at a parking or mobility consultancy (4), a municipality or province (2), universities (2), CROW – mobility knowledge platform (1), PBL Netherlands Environmental Assessment Agency (1), in the field of energy transition (1) and the field of shared mobility (1). The format of these interviews was somewhat less structured, since the experts in these fields were supposed to have a large variation in experiences and ideas, but still followed a semi-structured interview format. This comes down to a format with rather general and open questions, in many ways answerable, in order to not push the participants into a certain direction of answering and leave room for exploring a certain brought-up theme, see for specific questions [Appendix A](#). The duration of the interviews was generally about an hour, but varied from 30 to 105 minutes.

3.3.3 Data collection in structured interviews around Vossenpels-Noord

The information gathered from the case and expert interviews is used to formulate questions about travel behavior and potential for change of car ownership if certain conditions are met. The number of questions was kept as low as possible, to make it easy for inhabitants to participate. In the form of a structured interview, the same questions are asked to every participant for the comparability of the results, but there is enough room to give extensive answers, because the questions invite for the generation of qualitative data. See for the full interview structure [Appendix D](#).

The first questions were about the available travel modes, the usage of these modes, reasons for (not) using the car (open question) and the extent to which several factors influenced the choice for a trip by car. Also a statement about the routine of car usage was included to check the role of habit (*“Using the car is something that belongs to my routine,”* – [Haustein et al., 2009](#)). These questions were meant to give insight in the travel behavior and reasons for doing so. The next part included a statement to check the intention for sustainable behavior (*“I intend to seek out more opportunities to be more environmentally active in the future,”* – [Swaim et al., 2014](#)), an open question about which changes could make the participant get rid of the car and a few statements with possible situational influences on car ownership. In this way, all three precedents for behavior (habit, intention, situational factors) from the CADM ([Klößner & Blöbaum, 2010](#)) are estimated. Finally, some questions on age, gender, household size, education, street of residence and distance to job/school were included. Most answers are subjective, since self-reporting never is completely accurate, especially for expected behavior in fictive circumstances ([Fadnes et al., 2009](#)).

All questions or statements with an answer where an indication of a certain extent was required were set up with a 5-point Likert scale, except the usage of travel modes, where 10 points had to be distributed among the travel modes available to their household. This was done to estimate

the usage of various modes compared to each other, so that a certain percentage can be drawn per transport mode.

The interviews were done on a Saturday afternoon to include participants with a full time job as well. Because there were not many people out on the street, houses in the area were randomly selected to ask for participation. The interviews took about ten minutes. It was not possible to conduct results with a representative sample of the neighborhood, because of a lack of time. Therefore, the results are used to get an indication of existing travel behavior and opinions in the neighborhood.

Seven interviews were held. All participants were above 30 years old, ages varying from 31 to 80. The division between males and females questioned is 4/3. Most households were two persons without children, with also one one-person household and one three-persons household (including two children). Education varies from lower vocational education (*vmbo* in Dutch) to a university's master degree, but is skewed to the left, so there are more responses on the high education level side. There are more responses for the distance to work, because the distance to work for the partner could be given as well. Of the seven participants, two households did not own a car and one household had two cars in possession. All participants live in or directly around Vossenpels-Noord.

3.3.4 Data collection in the implementation workshop

Finally, an implementation workshop was done with a number of people from various disciplines within the municipality of Nijmegen (Mobility, Housing, project team Vossenpels-Noord with legal experts, urban development engineers, etc.) and a few representatives of external parties (consultant at Spark – parking consultancy, graduation intern at Stadkwadraat – integrated area development). In total, 13 people attended the workshop. The aim of the workshop was to test earlier findings on feasibility for this case and deepen and concretize these findings on how they could be applied to this specific case of Vossenpels-Noord.

This workshop had the characteristics of a focus group. [Bryman \(2016\)](#) describes the focus group method as an interactive group session with a moderator or facilitator and several persons with relevant knowledge discussing a rather specific topic. In this case, the researcher served as moderator, introducing the research, presenting the available research findings and introducing discussion questions as basis from where the group discussions about the specific case started. The experts from the municipality of Nijmegen and other parties were distributed among two groups to spread the fields of expertise and put various opinions and approaches together in one group. The groups discussed different questions proposed by the researcher. After the group discussion, a short presentation or summary of the discussion was given by both groups, with also room for questions. This part of the workshop was recorded in order to be able to note most of the ideas and results. This process of group discussion and presentation was done twice, with firstly rather social topics (inclusion of inhabitants in design process, deciding on agreements) and afterwards rather physical topics (financial measures, design of public space, design of transport facilities). Paper and printed maps of the neighborhood and surroundings were provided as well to be written or drawn on in the discussions. Because of the short presentations after the group discussions, the room for asking questions to the groups and an observing role with additional explanations from the moderator if necessary, it was ensured that all concepts were understood well and the created ideas or proposed challenges were fitting in both the research results and the circumstances of Vossenpels-Noord.

The workshop took 2.5 to 3 hours and was seen as very valuable by the participants as well, because of the bringing together of various disciplines and discussing a project in an early stage in this way. The reliability and valid

3.3.5 Data analysis

The case and expert interviews were fully transcribed. Two interviews were not recorded, but a summary based on notes was written. These interviews were not recorded due to practicality, since these conversations were not planned but occurred spontaneously. Also (additional) written answers by e-mail from three participants are included. The analysis of the case and

experts interviews was done in a similar way, based on the theoretical concepts recognized in the theoretical framework. The main categories were already determined, but the subcategories are based on what topics are brought up in the interviews. These main categories are defined as *Socio-economic & demographic factors*, *Spatial development*, *Transport & land-use* and *Culture & attitude*. Example of subcategories are *Age*, *Design public space*, *Quality public transport* and *Sustainability orientation*. The coding is done with the data analysis program ATLAS-ti.

In the iterative process of data collection and analysis, as described in the Grounded Theory by Glaser & Strauss (1967), this rather deductive approach of applying the theoretical concepts onto the data created a chaotic structure in the data, because many recommendations could be classified into various categories or did not fit to any of the categories at all. Furthermore, a mismatch between the theoretical framework and its context and the generated data and its context was recognized. Firstly, the factors, used as main categories, drawn from the study of Buehler (2011) are based on large scale country-wide numbers, while this study is about a very specific small scale neighborhood. Secondly, Buehler's study focuses on the modal split – the use of various transport modes – with car ownership as side note or cause of change in car use, where this study has car ownership as main object and car use as side-issue. Moreover, many participants discussed the need for motivated inhabitants to establish such a non-natural situation, while the study of Buehler (2011) in Germany and the USA is about naturally derived travel behavior caused by some circumstances. Finally, Buehler (2011) studied already existing travel behavior with circumstances derived from this situation, while this study aims to establish a new situation with future circumstances causing particular future behavior.

Therefore, the data from the case and expert interviews is categorized according to the main topics among all interviews, concerning an inductive approach. The full code list can be found in Appendix E.

The analysis of the structured interviews in the neighborhood is done by translating all multiple choice or numerical answers into numbers, to be able to compare them more easily. Averages were also calculated to compare scores on several factors. Due to the small number of participants, it would not give reliable outcomes to calculate more results based on this data. The generated qualitative data was not further processed, because it could be analyzed and compared manually. Finally, a summarizing report was created from the implementation workshop, including the workshop design and all noted or recorded findings. These findings from the structured interviews and the implementation workshop were then categorized according to the established coding structure from the inductive approach.

3.4 Reliability and validity

Now that it is set out why and how this research is executed, it is important to discuss to what extent the findings are reliable and valid.

3.4.1 Internal reliability

The internal reliability is in the first place ensured because the execution of transcription and analysis is done by one researcher. Since almost all the in-depth interviews are transcribed and coded precisely, the variation in interpretation is also minimized. The intonation and non-verbal communication however are not described in these transcriptions. Two conversations are described in notes instead of a full transcription, but these notes are checked with the interviewees. The variation in interpretation is also minimized in the multiple choice questions in the structured interviews in the neighborhood and the clear summaries of participants answers on open questions. In the implementation workshop, the presentations of the discussions and ideas are recorded, so that in combination with the notes of the researcher and drawings made by the participants, the right conclusions can be reported.

3.4.2 External reliability

The external reliability relates to the possibility of replication of this research. Because of the large amount of qualitative data and the important role of the researcher in generating this data, this research cannot be replicated in exactly the same way. Also the neighborhood Vossenpels-Noord, still in development process, will be developed in the coming years and can therefore not be subject to a similar research. However, the general findings can be replicated in another research, since this kind of expertise exists in the field of mobility and sustainability, various topics returned in different interviews in the same way and the findings are tested in various methods. Also the methods are described in such a way that they should be available for reproduction.

3.4.3 Internal validity

As laid out in the methodological review, triangulation was used to gather data in various types of methods. This enables a comparison in content, to check whether the data from different methods result in the same conclusions. This is an important part of the research design.

Because of the open and dialectical character of the interviews and the freedom of participants to talk about their experience and knowledge, it might not always be that all theoretical concepts are laid out in the interviews. On the other side, the analysis of the interviews is closely related to the theory, in the categorization of the codes from transcriptions, even with the inductive approach, because participants came up with these theoretical concepts as well.

To ensure that data is understood, categorized and used in the right way, respondent validation is done. This is done in checking the detailed transcription of the interview or the used quotes for the report with the participant and/or sending the full report before finishing. Furthermore, some results were also tested in other interviews, since information from one interview could be brought up in another. However, it was not meant to steer the participant in a certain direction in the conversation, but brought up as confirmation.

For the statements about theoretical concepts in the structured interviews in the neighborhood, statements from literature have been taken and translated. For the other questions, the required information was asked as directly as possible and explained if necessary.

From the implementation workshop, a short report was made and sent to all participants, to check whether the information was documented with the right interpretation.

3.4.4 External validity

Since much data is collected about the general phenomenon of low-car oriented developments in outer urban areas, this research can be useful for all cases falling within this description. The variation in methods results in widely applicable knowledge, since many parties involved in this subject from different perspectives are included. Of course the recommendations for the case of Vossenpels-Noord specifically might be less applicable and situational or cultural differences might appear in other cities and countries, but this research can be very useful for other municipalities with similar ambitions as the municipality of Nijmegen. This applicability to other cases was also one of the aims of this research. However, this applicability should not be the most important object, as Yin (2009) notes, because there are always problems with comparing one case to another. The generalization of this research ought to concern analytical generalization by *“generalizing a particular set of results to some broader theory”* (Yin, 2009, p36). The implications of this research for generalization will be discussed further in Chapter 5.

3.5 Ethical considerations

Ethical issues have been put into four main areas by Diener and Crandall (1978): harm to participants, lack of informed consent, invasion of privacy and deception.

Firstly, harm to participants is under no consideration of this research. The only effects in this category could be a larger consciousness of unsustainable travel behavior of inhabitants or challenged opinions of experts.

Secondly, all participants were aware of the subject of the research. Preceding the case and expert interviews, the participants were given elaborative information about the aim and content of the research, shown in [Appendix B](#). For the structured interviews with inhabitants, the aim was briefly explained and there was room for further questions. At the implementation workshop, an extensive presentation was given of the research aim, design and results so far.

Thirdly, the privacy in the case and expert interviews was guaranteed by a consent form about the implications of participation, the rights to refuse to answer and to stop the recording and the permission to use some personal data, shown in [Appendix C](#), but no participants had problems with having their name and position published. During the structured interviews with inhabitants, it was told that this data would only be used for the research and that participants could terminate the interview at any time. The two recordings at the implementation workshop were also announced.

Finally, deception is hardly relevant in this research, since there are no false expectations purposefully created at participants. The only things that could be noted here are the expectations of experts about the possible implementation of their ideas, while nothing has been decided yet. The same accounts for possible expectations of inhabitants about the development of transport facilities in their environment, when various possible influences were proposed. It is therefore important to be clear about the early stage of the development.

4. Results

This chapter contains the interpretation of the gathered data from various methods in order to formulate an answer on the research question. Firstly, the main findings from the expert interviews are presented, after which the findings will be discussed more in depth and are illustrated with some relevant quotes from the interviews. This still concerns rather abstract information and therefore the case interviews will provide more evidence and concrete examples, which is why the two methods are changed in presentation order. Furthermore, the structured interviews in the neighborhood will give another reflecting perspective on these findings. Finally, the implementation workshop provides a validation and concretization of the findings for the applicability on the case of Vossenspels-Noord. Each of these paragraphs will have a short conclusion, after which a concluding paragraph finishes this chapter by reflecting on the presented findings in the beginning.

The main research question concerned in this study was formulated as follows: *'How can the conditions for Vossenspels-Noord be designed in order to create a neighborhood with low car ownership in an outer urban area?'*

4.1 Enabling factors: expert views

In order to answer the research sub-question *'Which conditions are proposed by experts?'*, twelve interviews have been held with representatives from a parking or mobility consultancy, a municipality or province, universities, CROW – mobility knowledge platform, PBL Netherlands Environmental Assessment Agency, in the field of energy transition and the field of shared mobility. The number of and variety in interviews with experts from different backgrounds generated a large amount of data with many proposed conditions and approaches, but still in a quite abstract form. These themes will be concretized in the later paragraphs in this chapter.

The various factors and sub-factors will be displayed graphically with an explanation for every (sub-)factor. In this argumentation, quotes from the interviews are used in English translation. But before all this data is laid out, the feasibility of the case of Vossenspels-Noord is discussed first.

4.1.1. Feasibility

Although it was not directly asked in the interviews, many experts brought up their opinion about the fruitfulness of this project. Most of the experts were skeptic about the choice of the municipality of Nijmegen to establish such a project on this location with a low number of facilities, quality of public transport, density and lack of parking space. A few examples:

If the municipality starts such a project, so if it is going to work with a lower parking ratio in the outskirts so to say, not exactly in the outskirts but not in an urban area, then it is quite ambitious and there are large risks attached. I would firstly advise a municipality to do this kind of projects in more urban areas. Because that is where it already goes wrong.

Pieter Delleman (Spark, parking consultancy)

[A lack of] facilities, there is no parking pressure, no reason to change their behavior. Because if they are satisfied with their car and there is enough space to put it in the public space, which does not cost anything and you live in a sleeping village or a sleeping neighborhood [only for living, no other facilities], with your work and facilities located elsewhere, why would you want to change something about that? The parking issue is the last element where you have to look back first: what is the whole story of the neighborhood again?

Robert Boshouwers (REBEL, mobility consultancy)

These quotes display an opinion shared among many experts, that these kind of projects should first be established in more urbanized areas, with all facilities present and also more pressure on the division of public space. Moreover, many ideas were initiated to do something in between, like having a maximum of one car per household, no reduction in car ownership but in car use by putting cars on distance or allowance on electric cars over more polluting cars. However, the role of habit was seen as a factor with some potential, because people are evaluating their transportation options again when they move to a new neighborhood, which has been explained in the theoretical framework as well. Furthermore, there was one remarkable opinion about the feasibility from another perspective:

That motivation behind your choice to establish a little amount of parking spaces does not really matter, eh? If the result is a low number of established parking spaces, then that is the result. The only question is whether you succeed in organizing the related policies, that has to do with the enforcement, has to do with stimulating those alternatives, if you organize that, then it will work.

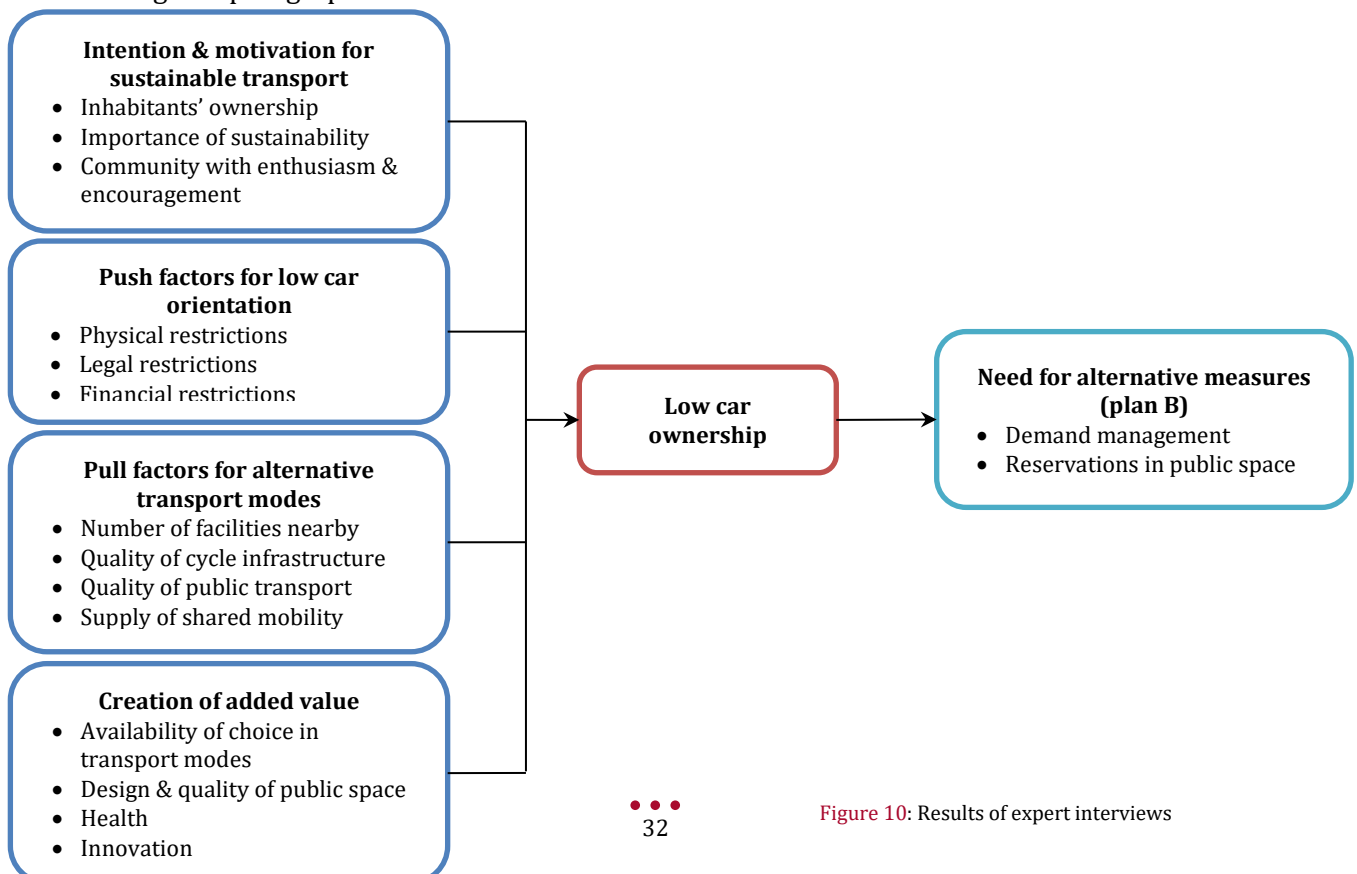
Marco van Burgsteden (CROW, mobility knowledge platform)

This quote already shows some of the necessities that were also mentioned by other experts and will be discussed in the next sub-paragraphs. Many of the experts disagreed on this opinion about the lack of need for motivation, because they emphasized the importance of attracting people with a certain idea or vision, for example:

Especially in Nijmegen and north of the Waal, everything there is quite green and spatially designed, so that is... Spatial quality is very important, that is something else than in the inner city. [...] Well, that is what people then choose for. If you then also add a sort of sustainability and healthy, then it is fairly possible that people say: 'Yes, but okay, then there is also another type of mobility more suitable. Of course I can try to maybe use the car a bit less... And then I understand it does not belong in the street view or I have to take a walk for parking my car.'

Robert Boshouwers (REBEL, mobility consultancy)

So far, the experts' opinions about the vision and feasibility have been discussed briefly. The findings, not focused on why but how this project should be executed, are summarized in **Figure 10**. The figure is not aiming to present a ranking of the factors. Its content is discussed in the following sub-paragraphs.



4.1.2 Intention & motivation for sustainable transport

Of all factors in Figure 10, this seems to be one of the most important aspects. The experts have a large agreement on this point, that the future inhabitants need to be motivated in some way (already motivated by themselves or boosted to be intrinsically motivated) in order to establish a neighborhood with low car ownership. Like the opinions about the feasibility illustrated, a low car orientation comes more naturally in a high urbanized area, while some more motivation is necessary to have a low car oriented neighborhood in a less urbanized area.

- **Inhabitants' ownership**

One part of motivation is responsibility. If inhabitants are given the space to bring in and execute their own ideas about mobility solutions, agreements among each other, design of the public space and so on, it becomes their solution, their agreements and their public space. In this way, it is done in such a way that it gives extra value to the neighborhood and inhabitants are motivated to come up with new ideas and maintain the facilities in a good way. One interviewee who recognized the difference this concept of ownership could make in a project, said this:

The most important thing according to me is that people feel it is theirs. That is really the utmost important thing. [...] I use a quote of Gandhi, formulated as follows: 'Everything you do for somebody, but not with them, is perceived very quickly as against them. Whatever you do for me but without me, you do against me.'

Ferenc van Damme (province of Overijssel)

This also requires a different role from a municipality. It needs to share its knowledge about the project with the inhabitants, provide space for generating and executing own ideas, connect people who are not intrinsically motivated to join such a process and change its policy about and attitude towards development.

- **Importance of sustainability**

An issue that was also addressed in the discussion of feasibility was the reason behind this low car concept. The need for sustainable transport needs to be put in a larger context of sustainability to complete the big picture. In this way, various aspects of the neighborhood are consistent with each other in a similar vision, like design and materials of housing, energy generation, use of greenery, waste handling, etc. The following quote illustrates this point:

But you are not going to live there because of the mobility. You are going to live there, because you want to live in a green, wholesome, healthy living, urban mobility is what they call it in Utrecht. That is the reason they are... And there is also a mobility concept belonging there. If you appeal to people in that way, I think they would earlier be willing to... [...] That is like, what type of area would you like it to be? That is a totally different story and will appeal to much more people, because that is what people are concerned with.

Robert Boshouwers (REBEL, mobility consultancy)

Various experts argue that mobility should not be the goal, but a means to establish a sustainable neighborhood on various aspects. In this way, more sustainable oriented people are attracted to live here and the concept would then be more likely to turn out successful.

- **Community with enthusiasm & encouragement**

If the inhabitants of the neighborhood are intrinsically motivated to travel more sustainably and also have good relations with each other, it is more likely that they can encourage each other, combine several travels, make a new (shared) mobility system feasible and perceive sustainable traveling as more common. The combination of all these aspects in the form of community building would lead to a strong network of motivated people to behave sustainably. Especially because other contextual factors (number of facilities, quality of public transport) are not abundantly present in the case of Vossenpels-Noord, this community culture can be a more

natural driving factor. If this community building is not the case, the concept would lead to problems with new inhabitants, for example:

What I have also seen happening is that you set up an ecofriendly neighborhood with a selected group inhabitants. When I was working in Culemborg, that was the case for example. They have a really low parking ratio, central parking, just at the edge of the neighborhood. The parking places were at the same time an infiltration instrument for water and more of those things, all nicely combined. And what happened after a while, a number of those people gets old, the house is becoming too large, those people move. A new group is coming in and starts complaining at the municipality until they can put the car in front of their house. There used to be a shared courtyard and after a while the garden fences came in, because: 'It is MY part of the garden.' [...] So you see very often that every area undergoes kind of an evolution through its inhabitants. Yes, it happens and it is very difficult to estimate what will occur in advance.

Marco van Burgsteden (CROW, mobility knowledge platform)

Therefore the social pledging and the connection between inhabitants need to be strong in order to make this concept work over a larger period of time. This brings together the former two sub-factors of ownership and sustainability. These three discussed factors are therefore related and should also be taken into account when considering other factors, because the design of certain restrictions or stimulations need to be seen in the perspective of sustainability, inhabitants' ownership and community building.

4.1.3 Push factors for low car orientation

Another category in [Figure 10](#) are push factor restricting car oriented behavior. Inhabitants can be motivated to show sustainable travel behavior, but if it is still very tempting to get into the car, it might become difficult to live up to their promises. According to many experts, people will merely choose the cheaper or easier option, even if they would like to travel more sustainably. Therefore, there are some stimulations necessary (see the next sub-paragraph [4.1.4](#)), but definitely also some restrictions to make it more difficult to choose the unsustainable option and to give a push in the right direction.

- **Physical restrictions**

The physical measures concern the design in the neighborhood, e.g. the location of car parking, bicycle parking, pedestrian routes, playgrounds, etc. These measures are aimed to make sustainable transport modes more attractive and the private car less attractive. An example is to put parking places for private cars on distance, while bicycles, public transport stops and shared cars are more easily accessible. But as we have seen in the case of Culemborg ([Community with enthusiasm & encouragement](#)), it needs to go hand in hand with the motivation and ideas of inhabitants, otherwise it is just perceived as problematic and not as stimulating. This might be one of the most visible measures, but it certainly is not the most important one, since it acts more in a supportive than motivating way. *"Because people do not let you steer them by your design of the neighborhood."* is how [Marc Moonen](#) (Moonen Parkeeradvies, parking consultancy) formulated this position of physical restrictions.

- **Legal restrictions**

To prevent people from behaving otherwise than was foreseen, even if they are motivated to travel sustainably, legal agreements can be made, for example with every household or with the owners' association, to define certain rights and responsibilities about car ownership, obligations about shared cars, maintenance of public space and allowed parking spaces or times, but also necessary measures if car ownership or parking problems increase, authorization to change the legal agreements in the future, etc. In this way, the concept of the neighborhood is enhanced, the municipality can invoke those agreements if problems occur and future developments can also be anticipated on (e.g. if shared cars make place for other mobility systems). These agreements of course need to be communicated clearly to all involved parties.

In this way, all efforts are made to prevent what happened in Culemborg, as was mentioned earlier. One interviewee was involved in many projects where this type of concepts were not implemented successfully and his learning from the past included the establishment of detailed agreements:

This is one of the first problems with parking places you have to pick up. [...] So [we need those agreements] what parking capacity [is realized] where, how it is used and when these things are realized, how they become responsible, also in maintaining the parking facilities, because that has to do with changes in inhabitants and the maintenance phase later, how they are being informed about the preconditions, so that is about the main users, the buyers, the shop owners, and finally, how we are going to put this on record, especially juridical, because making agreements is one, but you also have to point them at it.

Pieter Delleman (Spark, parking consultancy)

If the agreements are worked out in detail and clearly communicated before people buy a house, new inhabitants should not have wrong expectations about the impossibility to bring many cars and the current inhabitants know what they are allowed or obliged to do and not to do. But the same message applies here; people should be motivated to have these agreements with each other, the developer or the municipality, otherwise it is just seen as problematic and not as stimulating.

- **Financial restrictions**

Financial stimulations and restrictions can have quite some impact on which transport mode is chosen, because people are usually influenced by the prices of products (e.g. see Townsend, 1996; Andrewewa et al., 2010), although this is not systematically the case for car use and especially not for car ownership (see de Groot & Steg, 2006; Dargay, 2007). This type of measurements is often enforced by governmental organizations to influence for example the use of cars and parking spaces. The interviewee quoted below recognizes the power of this instrument, as many other experts do, although it is necessary to use a combination of several measures. He refers to these measures in the perspective of a research done by the Ministry of Infrastructure and Water Management (Janssen et al., 2019).

If something can influence car ownership, it is indeed paid parking in combination with road pricing, those are of course the two things. Also on the positive side, with lease cars and electric driving, also on the negative side. So if you charge extra, people are going to show different behavior. So if you develop those concepts with lower parking ratios as well as regulation with accommodating policies at the same time, then you have the ideal composition in order to accelerate in applying or boosting or whatever.

Pieter Delleman (Spark, parking consultancy)

One other remark was that small financial stimulations or discouragements, like differences in parking fees in the city center, do not make such a difference in people's behavior, while larger financial measures, like subsidized electric cars, have much more impact. This accompanies the argument of the quoted interviewee above.

In all three of the push factors discussed above, it was seen that these factors on itself do not have enough power to influence car ownership, but they should be combined with other measures or they need a motivation from the inhabitants to make it work. These other measures could be pull factors, decreasing the necessity for private car use, which will be discussed next.

4.1.4 Pull factors for alternative transport modes

The aim of this development for Vossenpels-Noord is to decrease the necessity for a private car drastically. Many of the pull factors below (from Figure 10) were largely mentioned topics in the interviews, but not labeled as leading to discourage car ownership, similar to the previously discussed push factors. The focus is more on the combination of these influences as well and the

necessity for their presence, but they were no drivers to show sustainable travel behavior, as mentioned by **Robert Boshouwers** (REBEL, mobility consultancy): “*Actually, if you are going to press on car parking, like a waterbed effect, you need to make sure that other facilities are improved.*” This is illustrated in the following quote as well:

It is very dependent on the public transport availability and the cycle distances and those sort of things on the one side and how strict you design the parking policy in your spatial concept. So if you have a place that is not too far from good facilities, so that people can cycle, and you have a well working and well connected public transport stop, and there is not just one bus with a trashy transfer and low frequency and so on, but really, yes, easy to travel further, and you do something about the parking policy by not having too many parking spaces, you have a firm enforcement and that kind of things, then you see in my opinion that people tend to think about it thoroughly, like: ‘Do I really need that car?’

Marco van Burgsteden (CROW, mobility knowledge platform)

Most experts agree that the factors described below have to be present, but are not leading in having people making less use of their car, since they need to be motivated to travel more sustainably or largely discouraged to travel by car as well, i.e. in terms of price and travel time.

- **Number of facilities nearby**

However, the number of facilities in the neighborhood does have quite some impact. If many facilities are nearby, people have to travel only short distances to their job, the school of their children, shopping facilities and recreational facilities. For short distances, it is much more likely to go by foot or bike than for medium or long distances. This is also the case in city centers, where many facilities can be found within a small radius. But the nearby presence of all types of facilities is important for travel behavior, as was mentioned by **Robert Boshouwers** (REBEL, mobility consultancy): “*It is really about the closeness, density and compactness of all those elements: housing, jobs, recreation. Otherwise there is just housing and recreation and no jobs, then there is still going to emerge car commuting traffic.*” Many experts recognize this complexity of mobility, since there are so many different types of travels people make by car, it is hard to anticipate all of them. If a wide range of facilities are available within short distance, the complexity of this issue can decrease significantly.

- **Quality of cycle infrastructure**

The quality of three alternative transport modes for the private car is seen as important, of which the cycle infrastructure is discussed first. The experts agree largely that good cycle facilities had to be present to implement a low car oriented concept, but a high quality cycle path and storage facility are not leading in whether people decide to get rid their car. However, it can stimulate to take the bicycle more often, especially when bicycles with larger ranges (e.g. electric bicycles) are available, making it easier to travel medium distances by bicycle, and when the bicycles can be stored in an attractive, near, indoor, comfortable, easily accessible shed.

- **Quality of public transport**

The same message of cycle facilities applies on public transport facilities, but it was even less often emphasized. It is important to have good public transport available in order to offer people various transport alternatives for the car, especially in terms of price and travel time, also for long distances, but it is not going to get people out of their car. Research has also shown that the availability of high quality public transport does not affect the car ownership, where degree of urbanization and size of household do (**van de Coevering et al., 2008**). Furthermore, it is important to have the public transport system available from the beginning, to prevent that people already get used to travelling by car.

- **Supply of shared mobility**

The discussion of shared mobility was mainly about cars, but also some ideas about bicycles came by, especially with special ones like electric or carrier bikes. For the cars, there is a difference in people sharing their own car with neighbors and an external party with a supply of a shared car system. Both were mentioned as good options, where people have to recognize the advantages compared with a private car, for example the availability of various types of cars which is also discussed in 4.1.5.

A shared car system can replace the need for a car if walking, cycling and public transport do not offer reasonable alternatives. However, it can also attract more car users who would normally use other modes of transport, like how Uber created more car use and car ownership instead of a reduction (Schaller, 2018). This can be the case if a high quality shared car system is available from the beginning, easy and not too expensive to use, always available and nearby, which is also necessary to attract current private car users. To help people to make use of shared system, a trial period or credit can help to have a first experience, from which people can get enthusiastic. Also a visible location is important to make the system attractive. Similar to earlier remarks, this system needs to be combined with a motivation to travel more sustainably, because it could otherwise just result in more car use. The financing of such a system has also been discussed by multiple experts, for example as part of the development budget since fewer parking places are necessary or as a contribution in the owners' association.

4.1.5 Creation of added value

Once the concept of low car ownership is designed in such a way that motivation and push and pull factors are present, people also need to see the benefits of this concept. These are additional advantages which are not directly leading to lower car ownership, but create a positive perception of the concept, displayed as the lower block in Figure 10.

- **Availability of choice in transport modes**

A large variety of available transportation can generate a feeling of freedom and make it possible to pick a suitable transport mode or vehicle type for every situation. In this way your possibilities are not limited by not owning a car, but enriched. The enjoyableness of transport also depends on the perception of the user, whether a transport mode is seen as restrictive or giving freedom, so that is where the mindset of the inhabitants comes in again. An example is given by an interviewee:

Here in Rotterdam we now work for De Verkeersonderneming, there we call it mobility happiness. There is a kind of happiness in mobility, just like, maybe a bit silly, if you ride on your bicycle with sunny weather and suddenly it is enjoyable. That is a kind of experience of happiness, because you can just go wherever you want. It is also very important, you surely should not try to restrict it.

Robert Boshouwers (REBEL, mobility consultancy)

- **Design & quality of public space**

If less parking spaces are realized, there is more public space available for other purposes, like greenery, gardens or playgrounds. If the inhabitants get space to develop their own ideas for these areas and are responsible for maintaining it, as has been discussed previously, it is designed in a way with the most additional value for them. Furthermore, this public space can serve as a motivation to keep car ownership low or even reduce it, because the greenery or playground for example has to be diminished if more parking spaces are necessary than planned. The value of the quality of public space and the role of inhabitants in maintaining it is illustrated in the following quote:

That is absolutely, yes, because then you should not use shame greenery and you should really, you know, robust... And the same applies, it should be a brilliant plan, not immediately having the department of maintenance of the municipality: 'Well, butterfly garden, screw you, I come here with my mower and I go over it, bam, twice a year!' It sounds simple, but that is how it goes. [...]

Yes, so you need to think about: ‘Shouldn’t we give the occupation of that greenery to the inhabitants, so that they can do the maintenance?’ [Interviewer: Yes, own responsibility.] Yes, I would steer on that more often and not put away the problem at the government, but make developers and users responsible for everything in their living environment and that used to be the occupation of the government.

Pieter Delleman (Spark, parking consultancy)

- **Health**

Another benefit of less car driving is that other transport modes are more healthy. Clear examples are walking and cycling, but also in public transport people walk a lot more than when travelling by car. This can also be used in the image of the neighborhood – a green, healthy and sustainable area – and notice of this aspect can generate positive feelings for the traveler.

- **Innovation**

In the development of a new neighborhood with sustainable concepts, innovations can be implemented to make it sustainable for future developments as well. A provision of a shared car system anticipates the development of paying for usage instead of paying for ownership for example, but facilities for charging future vehicles can also be thought of, as well as user oriented or data integrating technologies. Because of the cut in costs in parking realization, a larger budget for innovative system is feasible and might give an extra advantage, when recognized by the inhabitants.

4.1.6 Need for alternative measures (plan B)

When all these described factors are established, the neighborhood is built and people are living there, still a chance exists that the concept does not work or future unseen developments can make it incompatible, leading to a rate of car ownership that is not fitting in the neighborhood (see **Figure 10**). In the paragraph about **Feasibility (4.1.1)** the large risks in the development of Vossenpels were emphasized, because of the car-oriented location, the low number of facilities around, the low density, etc. Since these developments in city centers already encounter many obstacles, this development should definitely take the risks into account. In the case of failure, i.e. car ownership is higher than was agreed or planned on, an alternative plan needs to be ready to be carried out. This plan can contain a range of solutions for various kinds of problems possibly occurring, but it needs to be designed before the concept is realized, in order to create physical space, legal notations or other necessary preparations. One interviewee speaks from experience:

Everything can be arranged, but we have to secure it. And then comes maybe the most important thing, especially for your outer urban area, you can secure everything well, but you then actually need a plan B for if it goes wrong. Because again, you need to make sure it does not go wrong. Because reliable government and it has to do a reliable spatial development, it has to be able to realize the development and make sure that it never ever leads to a huge parking problem in the environment. So, what is plan B?

Pieter Delleman (Spark, parking consultancy)

- **Demand management**

But when does the moment of interference come? Some criteria need to be determined to define under what conditions the concept is running well and when it does not work. Because the surrounding neighborhoods currently do not have any parking regulations, inhabitants can easily park their car in those areas if there is no spot left in their own neighborhood. Therefore, a monitoring tool to estimate whether the demand gets too high can be the determination of the percentage of parking places used in the surrounding area. Of course, this can also be the number of cars registered for every household. In case these numbers exceed a certain number set in advance, alternative measures are carried out. Some ideas are mentioned for these measures; a parking regulation system can be enforced for example to have power over which

inhabitants get a parking permit. Another more convenient idea in this outer urban area is to make a backup plan for increasing the parking capacity, which will be discussed next.

- **Reservations in public space**

Another possibility is to reserve public space for future parking places in the neighborhood itself if demand increases, regarded as a necessity in this case according to many experts. Like mentioned in **Design & quality of public space**, this can also be a motivation to not increase car ownership, because valuable public space otherwise has to be turned into parking spaces. These spaces need to be determined and communicated in advance, in order to be legally able to change the function of those spaces and to prevent a perception at inhabitants that they are entitled to have certain public space in front of their house. This can be a tough assignment in case land is scarce, but it is necessary in order to be able to adapt to future developments.

4.1.7 Conclusion

The research sub-question concerned in this paragraph was formulated as follows: *'Which conditions are proposed by experts?'* In the first place, it has to be noted that the establishment of such a neighborhood is a risky undertaking, which was emphasized by the number of relevant influencing factors and their interdependence. A whole system needs to be created with motivated inhabitants, the right push and pull factors, creation of added value and a backup plan in case the situation does not work out. Moreover, all these factors are supplemental and therefore necessary in combination with each other, while they also depend on the perception and willingness of the inhabitants. If they are aiming to travel more sustainably, open-minded, seeing the positive side of things, willing to put some extra work into shared spaces and able to encourage each other, the rest of the instruments will also be used in the way they were envisioned. However, if this is not the case, i.e. inhabitants think they are forced to get rid of their car and feel obliged to depend on other transport modes, all instruments aimed for positive stimulation towards sustainable behavior might become idle or even be used in a bad way. This emphasizes the influence of intention in the theoretical framework (**Figure 5**) and the little power of situational factors on environmental behavior. It seems that situational factors in itself are not able to positively influence environmental behavior sufficiently in order to make a car-reduced concept in an outer urban area feasible.

4.2 Lessons learnt from similar cases

The case investigations and interviews were done to gain insight in how this concept of a low-car oriented neighborhood could turn out in practice and which lessons could be drawn from similar areas in establishing such a neighborhood. The research sub-question related to this part of the research was *'Which conditions can be derived from similar cases in other cities?'*, so various telephone and e-mail conversations, in-depth interviews and a tour (De Kersentuin) were held to collect information.

Now that the important factors for establishing a neighborhood with low car ownership have been discussed, the three investigated cases are described briefly and are then used to reflect on the factors suggested by the experts with concrete examples or evidence. The structure of this reflection is similar to the previous paragraph, where the factors were categorized per group.

4.2.1 Case descriptions

Each of the cases is described according to available information in documents and from collected data in the interviews and a tour.

- **De Kersentuin, Utrecht**

De Kersentuin (literal translation: the Cherry Garden) is a small part of Leidsche Rijn in Utrecht with 94 houses in different types, from one-person apartments to single family housing. It is about 2 kilometers to get to station Leidsche Rijn or station Terwijde (both have commuter trains and shop facilities) and 5 to 6 kilometers to the central station of Utrecht, where the city

center is also located. The idea for this neighborhood emerged in 1998 at a group of enthusiastic, high educated people and was not only aimed at environmental sustainability, but also at social sustainability. A mission statement was created that had to be signed by every (new) inhabitant, in order to keep the same goals over the years. The development was done in the form of a collective private commissioning of housing (Dutch: *Collectief Particulier Opdrachtgeverschap*) and many ideas for a sustainable neighborhood were designed and executed by the inhabitants themselves (architecture, solar panels, greenery, partnerships, etc.), so it is quite a unique case. They have their own waiting list for new inhabitants and potential new inhabitants first have a conversation with the current inhabitants before they can move in. Now, sixteen years in operation, they still have the same vision and ideas. The public space contains much greenery, a spices garden, playground and amphitheater, while the housing density is high (see Figure 11). This is firstly because of the low car ownership rate, which is much lower than in surrounding neighborhoods, where it is relatively high, and lower than in Utrecht on average. The parking ratio is 0.7 per household, including parking capacity for visitors, with 0.3 reserved in greenery. Inhabitants have access from the beginning to good cycling connections, various bus lines to the city center with high frequencies, a carrier cycle, two pull carts and a shared car system. Secondly, for 75% of the parking capacity, a parking garage was built. The use is obligatory for car owners and users (car owners and leased cars) and registered in the membership for the inhabitants' association. Car users have to buy or rent a parking place (30-50 euros a month) while the surrounding neighborhoods have no parking regulation. The greenery is maintained by the inhabitants and the amount of greenery can increase or decrease according to a decreasing or increasing car ownership, which motivates inhabitants to decrease the amount of cars. Next to the aim to reduce car ownership, the inhabitants have solar panels, central heating, housing adaptation to various life stages, a shared meeting and project building, much social interaction outside and in project groups and boards (e.g. ownership association) and some events like a summer festival (de Kersentuin, 2018).



Figure 11: Researcher's photos of de Kersentuin

- **Vauban, Freiburg**

Freiburg is a city in the southwest of Germany, between Zürich and Strasbourg, with 220,000 inhabitants. This neighborhood Vauban was also established on the basis of an initiative from motivated inhabitants in collaboration with the municipality and in 2001 the first inhabitants moved in. In 2013, there were about 2,500 households with 5,500 inhabitants (Lutz, 2013). The aim is to reduce motorized traffic as much as possible, ideal would be to have none anymore. Many buildings were established in cooperation and community and social commitment are still important aspects. The inhabitants had a large role in designing the neighborhood. In addition to Freiburg's low energy building requirements, most households have a limit on their energy consumption. A combined heat and power plant supply is also present, as well as green roofs and a wind anticipated ventilation design. The neighborhood is designed with much greenery and space for children, since there are many families living here (see Figure 12). Many streets are designed in U-



Figure 12: Vauban, Freiburg. (Schick, 2018)

form and no parking is allowed, only handling of groceries for a short moment. The streets are often used as playgrounds and by bicycle or foot there are many more connected paths within the neighborhood. Some parking for visitors can be done along the main street of Vauban, but the parking for inhabitants is done in parking garages at the edge of the neighborhood. Two parking garages are realized and space for a third is reserved in case this becomes necessary. If you own a car, you are obliged to buy a parking place in one of the two parking garages. This costs € 15,000 and an additional monthly fee. Vauban is about 3 kilometers from the city center and central station of Freiburg. There are good connections with public transport by tram or bus and a car sharing concept with dedicated parking spots. An association for car-free living exists as well. The neighborhood has many facilities nearby, like schools, shops and work, but also recreational nature areas. In 2010, there were 160 cars per 1000 inhabitants compared to 300 cars in a comparable neighborhood of Freiburg, while car-owners also use their bicycle more often than before moving into Vauban (Field, 2011). The parking ratio is therefore about 0.5 per household. In 2013, it was estimated at 172 cars per 1000 inhabitants, with 430 households choosing to live without a car (Lutz, 2013). Later, it slightly raised to 202 cars per 1000 in 2017 inhabitants, compared with 390 for Freiburg and 566 for Germany (Schick, 2018).

- **Aspern Seestadt, Vienna**

In the capital of Austria a former airfield in the district Donaustadt was transformed into a neighborhood from 2009 onwards and in 2013, the first inhabitants moved in. Most housing concerns single family housing. The area is a little over 10 kilometers from the city center and central station of Vienna, but there are two well established metro line connections with a duration of about 20 minutes to those destinations. The development side is not finished yet, but there are about 2,000 people working and approximately 6,800 people living in 3,000 flats in Aspern (Spörk, 2018). The high building density can also be seen in Figure 13. The aim is to extend to 20,000 residents and the same amount of work places. For the current inhabitants, 2,200 parking spaces have been established, resulting in a parking ratio of about 0.7 per household. These parking spaces are all realized in community garages, with low space for cars on the streets (both in car lanes and car parking). The aim was to have 30% motorized traffic in the neighborhood, with cycling, walking and public transport accounting for the rest of the modal split. The public space is filled with a lake, squares, recreational areas, sport facilities and a large walk and cycle infrastructure. Furthermore, the public transport in Vienna is very affordable with a year of unlimited travel for only € 1 a day. Some recycling was used in building materials, but the main driver was to save space because of the urbanization of Vienna and its



Figure 13: Aspern Seestadt, Vienna. (Schaub-Walzer, n.d.)

surroundings. The inhabitants were therefore not enthusiastic about the mobility concept at the beginning, because they expected to get two or three parking spaces for every household in front of their door, since the area is at the edge of the city in a quite rural environment. There is no parking regulation existing as well. Because of many stimulations towards sustainable mobility and the degree of urbanization, it now seems to work out. These instruments include similar prices as Vauban in hiring or purchasing a parking space in the garage, which become contributions to the mobility fund, of which other the measures are paid: availability of shared cars, shared bicycles, shared cargo bikes; every household gets a shopping trolley when they move in; there is shopping delivery; the mobility card can be used for free if transport modes are used for less than 30 minutes; there is a high quality bike storage for every apartment with bike shopping trolleys available. The car is still used a lot for travels outside Aspern, but within the neighborhood it seems people rely on other transport modes.

In Vienna, there have been other projects in the past with the purpose to be car-free or innovative (see [Chorherr, n.d.](#)), on which the interviewee did not elaborate. A number of scientific papers include the success of one car-free settlement, of which the name is not mentioned ([Hertwich & Ornetzeder, 2005](#); [Ornetzeder et al., 2008](#); [Späth & Ornetzeder, 2017](#)), but which seems to be Floridsdorf, which was earlier included in the analysis. This neighborhood is smaller with 244 apartments, includes a lot of social cohesion and sustainability awareness, has a very low rate of car use, but the investigated difference in emissions per capita is not that large, because there are more travels by plane and more is spent on other objects. It was also noticed that many people already did not possess a car for a long time when they moved into this neighborhood. This neighborhood, of which the name is not published, is more similar to the other two cases and the case of Vossenspels-Noord, but was recognized in a later stadium of this research.

4.2.2 Feasibility

Now that each of the cases has been described, the information given in the interviews will be related to the factors from the previous paragraph, but firstly, the possibility for replication of the concepts in these cases was also discussed.

While the developer in Vienna suggested their goal was to implement these type of concepts in other locations, especially big city development project areas, the representatives of the other two cases were more skeptical on replication, with the limited amount of people willing to live in such a neighborhood as largest argument for both. They would suggest to find people with the intention to live in a low car concept first, before developing such a concept. The importance of inhabitants' motivation relates to the perspective of the results of the expert interviews in the previous paragraph, because it was described how the motivation and perception of inhabitants could make the rest of the instrument system work.

4.2.3 Intention & motivation for sustainable transport

For de Kersentuin and Vauban, the concept was initiated by inhabitants, while Aspern Seestadt was developed in this way because of the ideas of government and development agency.

- **Inhabitants' ownership**

In de Kersentuin, the inhabitants arranged many of the designing and building aspects themselves. Their knowledge and experience was seen as a large advantage in the establishment, as well as the space they had been given by the municipality. The whole neighborhood is driven by the initiation and responsibility of their ownership, so this neighborhood would not have existed if they had not been able to decide on many things for themselves. In Aspern however, the inhabitants had nothing to do with the design of the neighborhood and the public space and were in the beginning not in favor of the concept either, so the success is contributed to the developer, since they have the means to implement an integrative approach:

And this is only possible because we are responsible as a development agency. So if this is a non-steered development, without a development agency, so everyone can do what he wants to do, only related to the zoning plan or something like that, then all those strategies and all these car reducing initiatives wouldn't be that heavy weighted in the end.

Marvin Mitterwallner (Wien 3420 Aspern Development)

The situation in Freiburg is a bit in between, with inhabitants giving space for greenery and playgrounds, but also having the municipality decide on many aspects. Relating to the discussed feasibility, this aspect seems to be quite important, especially in a less urban context.

- **Importance of sustainability**

While the focus in Aspern is more on use of space and implementation of innovations in order to create a future-proof high quality of living, Vauban and de Kersentuin are clearly addressed as neighborhoods with a focus on ecological sustainability, with many extra measures, like isolation, heat pumps, solar cells, water recycling, greenery and in de Kersentuin also social sustainability in the form of a community in organizing events together, building relationships and sharing the vision. In all three cases, a vision document was created to establish the neighborhood in a car-reduced way, but this was just one of the aspects in executing this vision. The idea behind the mobility concept should be in line with the implementation of other aspects in the neighborhood, either in the field of sustainability or in the perspective of short distances and scarcity of space. The obligation for signing the mission statement in de Kersentuin when people move in for example has made it possible to keep values clear and make no concessions. Sustainability can therefore act as an important driver of a sustainable mobility concept.

- **Community with enthusiasm & encouragement**

The presence of an enthusiastic community is most clearly visible in de Kersentuin, but also in Vauban a motivated group of people started with this initiative. Because it seems to go more naturally now, this is less dominantly present, while in de Kersentuin the cohesion of the neighbors is important in keeping up with the vision of low car ownership. In Aspern Seestadt, this is not the case at all, since the neighborhood is realized from a totally different perspective. The differences between the neighborhoods seem to be related to the gap between naturally shown behavior in these neighborhoods and the behavior that was aimed for. If the (physical) neighborhood structures can rely on a naturally emerged low car ownership, there is no motivated community necessary to bring it even lower, while on other locations with a naturally high car ownership, the motivated community can be the driver to realize low car ownership, including a larger extent of responsibilities and a mission statement.

4.2.4 Push factors for low car orientation

All cases have several restrictions to make it more difficult or less financially attractive to be in need of a parking space.

- **Physical restrictions**

Especially in Vauban and Aspern Seestadt, the car has to be parked at some distance, at the edge of the neighborhood. In all three cases it can be seen that the space for greenery, playgrounds, public transport, cycling and walking is given priority over the space for cars to drive and park. The neighborhoods are designed in such a way that car travel is often less convenient than other travel modes and that it is almost impossible to park second, third or fourth cars, or only at unreasonable distances. This is perceived as stimulating to take other transport modes than the car.

- **Legal restrictions**

In all three cases, the legal restrictions and obligations are extended compared to an ordinary neighborhood. This can especially be seen in forbidden and obligated locations to park your car and the financing of the parking places by car owners and users, as most important topics, but

other subjects can be thought of, like a declaration for agreeing with a sustainable vision document, the maximum time a car can be busy handling in front of a house, a maximum amount of energy that can be used, responsibility for certain maintenance in the neighborhood, etc. In de Kersentuin, their legal agreements almost become part of their DNA:

[Conversation on the need for increase in parking capacity in the area around de Kersentuin] *So we really are an exception on this. But that is really because we are a specific target group, with so to speak all regulations being drilled into our smallest actions. New buyers, like what I just said about tenants, but also new buyers, we have a conversation with them. Before the contract of sale is closed, our board has a conversation with the new owner, like: 'Do you know what you are getting yourself into? Do you know for sure... You really have to pay for your car and you cannot escape from that.' You know, that idea.*

Rob Tiemersma (municipality of Utrecht & inhabitant)

In the case of de Kersentuin, a not well informed person once went to court and lost the trial because the legal agreements were clear enough, showing the necessity to have clear and detailed agreements. But again, the strictness of these agreements only works because the inhabitants are in favor of them, since the system is preserved by the inhabitants themselves. This can create a conflict in the legitimacy of the agreements, so they have to be designed in such a way that they are binding and difficult to change (e.g. by municipality or majority of the owners' association), even if you created them yourself.

- **Financial restrictions**

In all cases a distinction is made between people who own or use a car (also leased cars) and people who do not. People in the first category need to buy or hire a parking space, regardless of the presence of any parking regulation, because it is included in the housing contract, emphasizing the necessity for detailed agreements on this subject. This monthly fee can put people to thinking: 'Do I really need that car?', while people with a purchased place are less willing to do so, since they already own the place and may not have to contribute a monthly fee. The financial consequences of a transport mode can have a large influence on the travel behavior. The revenues of these fees are often used to establish or maintain the public space or other mobility services, stimulating the attractiveness of the pull factors, which will be discussed next.

4.2.5 Pull factors for alternative transport modes

The three cases include all or most of the mentioned factors underneath. Whilst in the expert interviews these factors had to be present, but were not motivators for less car ownership, in the context of the cases they were given a more dominant role, as was noticed by **Peter Schick** (municipality of Freiburg) in Vauban: *"I think first the really good public transport and cycle network and that it is close to the city center. It is not necessary to own a car because of the good circumstances."* However, the pull factors are addressed in the same way as in the expert interviews: the combination of these different kinds of facilities together with the push factors makes the system work. The factors are therefore not discussed separately, but in a coherent description.

Firstly, all three cases have more facilities in and around the neighborhood than is the case in Vossenpels-Noord and these concern all types of facilities (jobs, schools, shops, etc.). Of course not at the level of a city center, but for many people it is sufficient to what they need. These are mentioned as necessary in order to be not in need of a car. Furthermore, the infrastructure for other transport modes is very well developed, with a large cycle and walk network, high frequency direct bus (de Kersentuin), tram (Vauban) or metro lines (Aspern) and several bus lines in addition. Important was that these networks were available right from or right after the beginning. Moreover, on top of these high quality facilities for traditional transport modes, several systems or available vehicles are added, like cargo bikes, bike trolleys, a shared bicycle

system and a shared car system, sometimes even with different types of cars available. These can be combined with the storage locations for bicycles, to make it easy to go shopping by bicycle for example. It is both physically and financially made attractive to make use of these transport modes. In short, all pull factors proposed in the expert interviews are available in high quality in these three cases and are important to make the system work, but no drivers for implementing a car-reduced concept in a less urbanized area.

4.2.6 Creation of added value

Some examples of extra available types of transportation in such a neighborhood have just been discussed. Furthermore, especially for de Kersentuin and Vauban it is mentioned that it is important to add value to other aspects with the means you save by not establishing more parking spaces. This is most directly applied to the design and quality of public space, but also in a smaller extent to community building and a positive image, illustrated in the following quote:

I would say the most important is that you try to deliver benefits that are related to car-free living. So nice streets, extra space for children to play and extra green. It should not be a punishment to live without a car, but generate positive feelings.

Peter Schick (municipality of Freiburg)

This means the added value created in these cases overlap somewhat with the factors indicated in the expert interviews, but do not correspond completely. The design and quality of public space was seen as the most important way to add value, followed by the availability of choice in transport modes. Some more aspects can be used to create added value, but these do not necessarily have to be health and innovation.

4.2.7 Need for alternative measures (plan B)

Next to the review of many aspects of the current system, the plans to anticipate future developments are also seen as a necessary part of the concept. The cases are all prepared on situation changes in case the car ownership would increase. These preparations concern reservations for possible future parking capacity in public space, although demand management was also brought up in the expert interviews. The latter might be only relevant for consideration at the municipality, because it was not mentioned in any of the cases. The direct relation between car ownership and reservation for parking spaces is emphasized in de Kersentuin:

I am a big fan of own responsibility of the public space and also a direct relation between greenery and parking. [...] So we established a parking ratio of 0.7 and we made a reservation of 0.3 in greenery in between those parking places. In case that the car ownership increases, we are obliged to transform those spaces to parking places. Of course we do not want that, so you see already... Then you have a very direct motivation, like: 'Do you really need that vehicle? Because of your car ownership, I might get a car in front of my door as well', you know. In that way, you can have that conversation with each other. It is barely necessary, because the motivation is still very high, but that very direct relation, it works out very well.

Rob Tiemersma (municipality of Utrecht & inhabitant)

The relation between the different factors can also be seen in this quote, because the reservations in public space are not an independent aspect, but combined with the physical design of the neighborhood, creation of added value in public space, the social control in a community and the motivation of inhabitants.

4.2.8 Conclusion

The research sub-question related to this paragraph was 'Which conditions can be derived from similar cases in other cities?', so three comparable cases in various countries have been discussed, but there are differences in a number of aspects of the neighborhoods compared to Vossenpels-Noord as well. The number of facilities nearby, the quality of transport alternatives

and either the motivation of inhabitants or the degree of urbanization is much higher. This emphasizes the risks in the development of a low car ownership concept in Vossenpels-Noord. On the other hand, compared to the conditions proposed by experts, many similarities could be recognized, also in the need for a combination of push and pull factors and the importance of motivation in the other factors. However, in the case of Aspern Seestadt it could be seen that also without inhabitants' motivation it is possible to establish a car-reduced concept. The developer of Aspern seems to be able to deal with the lack of motivation from inhabitants, because of all restrictions and inconveniences for cars, so that people are forced to travel with other modes of transport. This is interesting to compare with the theoretical framework (Figure 5), since the model is centered around the intention for sustainable behavior, so apparently it is possible to realize particular behavior largely because of situational influences. However, due to Aspern's scale, the high urbanization in the area and the large number of facilities within the neighborhood, this might not be reproducible for Nijmegen. As addressed in the other two cases, a leading motivation of inhabitants can be an important driver in establishing such a concept in a less urbanized area and makes the rest of the push, pull and additional factors work as well, although the number of available facilities or the quality of public transport for example is much higher than in this part of Nijmegen. This also shows that without these factors, it is not that easy to establish such a car-reduced concept.

4.3 Willingness and ability of inhabitants to travel more sustainably

Now that a number of important influences have been presented and confirmed, a small investigation was done in the area of Vossenpels-Noord in order to indicate whether inhabitants are willing and able to reduce their car ownership, which was formulated in the research sub-question *'Under which conditions are inhabitants of surrounding neighborhoods willing and able to change their car ownership?'*. Short structured interviews were executed in which various factors were presented, on car use as well as car ownership. The push and pull factors were an important part of these interviews, because they could be investigated very concrete and directly and are therefore discussed before the other factor groups. The absence of these factors can also function as a threshold of being willing to get rid of the car and it is therefore valuable to find out which influences overcome these thresholds and make inhabitants willing and able to travel more sustainably. Some general remarks will be given about the questions and participants' answers and afterwards the factors will be discussed in the same structure as used in the previous paragraphs.

4.3.1 General remarks

The first part of the questions was focused on car use rather than car ownership, to make a clear distinction between them and to get some insight in travel behavior (use of travel modes as well as influencing factors in choice of travel mode). An open question about influencing factors preceded, so that participants were not steered towards certain factors. Then two other factors from the theoretical framework (Figure 5), habit and intention, were estimated by one statement each to see whether intention and habitual and situational factors might be strengthened by each other.

The indication from participants in possession of one or two cars is that their car(s) is/are used for 55% of the time. Some participants dealt with health issues and were therefore limited in their choice for transport modes. From all participants, the car is used for 39%, bicycle for 31%, public transport for 17%, walking for 9%, shared car for 3% and mobility scooter for 1%. The most important factors in choosing whether to use the car or not are travel time and health. Status symbol is the least important. In the neutral area all factors were relatively close, in descending order: distance, parking facility, comfort and travel purpose, habit, weather, environment, availability and safety, price. The scores of these factors are given in Table 1. Half of the participants claim not to have car driving belonging to their routine, the other half does have it in their routine. Most participants have the intention to be more environmentally active in the future.

Factors influencing car use (n=7)						
Factor	Status	Price	Car availability	Safety	Environment	Weather
Score	1.7	2.2	2.5	2.5	3.0	3.1
Routine	Travel purpose	Comfort	Parking space	Distance	Healthy	Travel time
3.3	3.4	3.4	3.5	3.7	4.0	4.2

Table 1: Factors influencing car use in ascending order (score: 1 = lowest, 5 = highest)

The second part consisted of statements about car ownership, with factors from the expert and case interviews included. A preceding open question to inform about influencing factors without steering the participant was included here as well. Not all factors presented by experts are included, roughly said: the ones which have more to do with actions done by the municipality, which are too complex to explain in short or which are hard to imagine if you have not experienced them are excluded. Remaining were nine influences which were all addressed in a statement in combination with “If ... then I do not need a car” or “If ... I would be better off without a car”, except for the factor on inhabitants’ ownership, where the statement was about willingness to cooperate in the design of sustainable transport. The results are presented in Table 2.

For three households, it was unthinkable to get rid of their car, although some of them announced before that they intended to behave more sustainably in the future. Two households currently do not possess a car and the other two participants would not need their car if public transport would be better, work obligations would not be car-related and family visits would be easier with shared cars (mentioned in the open question). The willingness to live without car seems to be a better indicator of intention for sustainable behavior, because at the question about the intention itself, people seem to give socially desired answers. The scores in Table 2 are therefore split according to a) no car owners or car owners willing to live without car and b) car owners not willing to live without car. The results of all statements are discussed in the following sub-paragraphs according to the earlier discussed factor groups (see Figure 10), of which not all factors will be discussed separately. The creation of added value and the need for alternative measures were not questioned, because it would be necessary to give more information about the case, so they are left out of this analysis.

Factors influencing car ownership (n=7)					
Factor	Societal norm	Parking facility at home	Design neighborhood	Shared cars	Price car vs. public transport
Total score	2.1	2.7	2.7	3.0	3.1
a) (willing to live) without car (n=4)	2.8	3.3	3.3	4.3	4.3
b) with car (n=3)	1.3	2.0	2.0	1.3	1.7
Factor	Quality public transport	Quality cycle infrastructure	Facilities nearby	Execute own ideas	
Total score	3.4	3.6	3.6	3.9	
a) (willing to live) without car (n=4)	4.5	3.8	4.3	4.3	
b) with car (n=3)	2.0	3.3	2.7	3.3	

Table 2: Factors influencing car ownership in ascending order (score: 1 = lowest, 5 = highest)

4.3.2 Push factors for low car orientation

Of the three restrictive factors, the legal aspect was not discussed. Two statements were about physical restrictions: the influence of availability of parking places near their house (parking facility at home in Table 2) and the influence of the design of the neighborhood with more space for sustainable transport modes (design neighborhood in Table 2). These two questions resulted in the same score in the lower segment, with only societal norm having a lower score, meaning participants did not see these factors as large influencers of their car ownership. In an earlier question however, availability of parking space was seen as a rather important influence for car

use (Table 1). Therefore, these physical restrictions should be seen as supplemental, but not as motivators for lower car ownership, as was concluded earlier.

On the other side, the financial aspect was estimated to have some more effect. On the statement whether people would be better off without a car if the cost of having, using and parking a car is higher compared to the cost of using public transport (price car vs. public transport in Table 2), the people without a car and those willing to reduce car ownership score very high, while the people who do not want to get rid of their car score very low. This measure therefore seems only effective if people are already willing to use more sustainable travel modes, although the influence of price on car use (Table 1) scored rather low.

4.3.3 Pull factors for alternative transport modes

The influence of the discussed pull factors on car ownership was estimated as relatively high compared to other questioned factors. Firstly, the score of the statement about the influence of the number of facilities nearby (Table 2) is relatively high; for almost all participants above average, with a somewhat lower score for people who do not want to decrease their car ownership. Distance as influence on car use (Table 1) also scored rather high in an earlier question. This emphasizes the importance of short distances to a wide range of facilities. Secondly, the statement about cycle facilities and infrastructure (Table 2) also results in a relatively positive score. Many people seem to be willing to travel by bicycle if they are able to. Thirdly, the score of quality of public transport (Table 2) is comparable to the previous two, but slightly lower. Remarkable is that people willing to reduce car ownership score much higher than people not willing to change their car use or ownership. This is also the case in the fourth influence, in an even clearer distinction: the score of the availability of shared cars (Table 2) is largely spread and results in a neutral score. Similar to financial restrictions and public transport, people without a car or willing to reduce car ownership score high, while the people who do not want to get rid of their car score low. The availability of shared mobility therefore only seems to be effective if people are already willing to travel more sustainably, which also seems to be the case for quality of public transport, only slightly less distinguishable, and for number of facilities nearby, with smaller differences.

4.3.4 Intention & motivation for sustainable transport

The willingness to cooperate in the establishment of sustainable transport if inhabitants can create their own ideas and solutions is very high and is therefore emphasized as important factor. Since most participants also had the intention to be more environmentally active in the future, sustainability is an issue people are concerned about. However, the environment was not seen as an important influence on car use (Table 1) in an earlier question and not all people who claimed to have sustainable intentions were willing to get rid of their car. Contrasting to the high willingness for cooperation, the societal norm (Table 2) scores lowest of all factors, indicating people do not think the car ownership of other people in their surroundings influence their own car ownership. In short, apart from the high willingness for cooperation in designing sustainable transport, the intentions do not seem to be conclusive.

4.3.5 Conclusion

This paragraph aimed to answer the research sub-question *‘Under which conditions are inhabitants of surrounding neighborhoods willing and able to change their car ownership?’*. A few remarks will be made about the results.

Intention for sustainable behavior does not appear to have an effect on other results, but while most people claim to be willing to act more sustainably, not all are willing to reduce car ownership, possibly because people give a desired answer. However, if the intention for sustainable behavior is measured as the willingness to reduce car ownership, this intention appears to influence the other factors to a much larger extent. This is clearly seen in the influence of financial restrictions and supply of shared mobility, but also in quality of public transport and in number of facilities nearby. For the other factors it is higher as well, but with a

lower difference. This again indicates the importance of motivation for sustainable transportation in order to use other instruments in a successful way.

Regardless of the aim for sustainable behavior, the willingness to cooperate in sustainable transport in the neighborhood is high. This emphasizes the importance of inhabitants' ownership. Furthermore, it was seen that there is not one factor able to influence the car ownership on its own, but the combination of stimulations and restrictions is necessary to reduce car ownership.

Due to the low number of participants, the interpretation of results of these structured interviews is limited. Therefore, the conclusions are formulated as suggestions rather than hard statements and this method is used as verification of earlier information rather than testing.

4.4 Concretization and application to Vossenpels-Noord

A large amount of data has been gathered in the expert, case and neighborhood interviews. The general findings so far were presented to a group of people with expertise in a various fields, from parking consultant to urban development engineers. In total, 13 people attended the workshop. Since the gathered data was aimed to apply to any situation comparable to Vossenpels-Noord, an applicability test and process of concretization were executed in this workshop, in order to answer the fourth research sub-question *'How can the proposed conditions be applied to Vossenpels-Noord?'.* The aim was to find ways to implement the results from other methods in the development of Vossenpels-Noord and to identify barriers in doing this. This was done in a workshop or focus group form where several questions about the addressed results were proposed by the researcher, while the participants were divided into two groups and discussed the possible application of these factors to Vossenpels-Noord. The researcher served as moderator in this session. After each group discussion, a summary was presented by both groups and there was room for questions. Two rounds were held. The results will be discussed according to the earlier used structure of factor categories, although not all factors are discussed separately.

4.4.1 General remarks

Not all 13 people were present during the whole session. During the group discussions, around 10 people participated in two groups which discussed different questions. In the first round, social topics like inhabitants' ownership and establishment of agreements were discussed. The second round consisted of physical oriented topics, i.e. financial measures and the design of public space and transport facilities.

4.4.2 Intention & motivation for sustainable transport

As an introduction of the group session, a plenary discussion was started what kind of people would be suitable for Vossenpels-Noord, since a selection of certain target groups can take place if necessary by including specific conditions in the housing contracts. On the one side, sustainable oriented people are assumed to be more likely to adapt to car-reduced travel behavior, but on the other side it should become a rather ordinary neighborhood, without extreme sustainability goals. It might therefore be a good solution to find a way in the middle, to put some sustainability oriented people, who are willing to travel sustainably, together with rather 'ordinary' people, who can be motivated by the more ambitious people. In the conclusions of earlier used methods however, it was seen that the motivation for sustainable travel behavior is an important driver to make the concept of low car ownership work, including the implementation of other instruments. It would therefore not be preferable to put too many people in this neighborhood who are not motivated to travel sustainably. This raises a challenge in what profile Vossenpels-Noord should have; a sustainable neighborhood to attract people with this motivation or a rather ordinary newly built neighborhood with some greenery, which was aimed for by the municipality?

Furthermore, one group discussed the inclusion of inhabitants in the design process, especially when the inhabitants are not in the picture yet and when they are not intrinsically motivated to cooperate in such a process. The first issue, raised because the neighborhood is designed without knowing yet which inhabitants are going to live there, can be addressed in various forms. This can for example be done in the form of a collective private commissioning of housing (Dutch: *Collectief Particulier Opdrachtgeverschap*), perhaps in combination with an owners association for the neighborhood, consisting of inhabitants, which is responsible for the shared space and maybe other matters. Moreover, conditions can be given to the developer in order to give space for inhabitants to decide on certain aspects. If inhabitants have to be included in an earlier stage, opinions of potential buyers can be investigated on the city-wide housing fair for example, which is held once a year. With the aim to have inhabitants initiate, design, execute and maintain as much as possible, the best suitable structure would be a collective private commissioning of housing, but then a motivated group of people (or community) is necessary as well. In the other forms this is no necessity, but the role of the inhabitants then becomes smaller too.

The inclusion of inhabitants who are not intrinsically motivated to cooperate, which is important to establish a real inhabitants' ownership instead of only a pretense, is generally done by good communication about the various aspects of the neighborhood and the differences with ordinary neighborhoods. This communication also needs to be secured if it is done by a developer, real estate agent or landlord. Also the consequences of this reduced-car concept need to be clear, combined with an explanation on the advantages and related disadvantages in everyday life. A clear communication in combination with inhabitants' ownership for all inhabitants should establish the inclusion of less intrinsically motivated people as well, although it is questionable whether these people will be attracted by such a sustainable concept with many own responsibilities.

4.4.3 Push factors for low car orientation

The legal restrictions were discussed in the first round by one group. They talked about the responsibility for and content of agreements that had to be made. It was mentioned that the agreements have to be made in such a way that inhabitants correct themselves if unwanted behavior is shown. Furthermore, there are two covenants that have to be arranged. Firstly, the zoning plan needs to define the number, location and users of parking spaces, together with alternatives for the private car. This plan concerns public law, while secondly, several matters relating to preservation, duty to inform and maintenance are described in a private law contract. In case the municipality creates a private law contract, any future alterations can be made more easily than in public law, but the process for enforcement and rectification in case the agreements are not complied with is more complex. In case the car ownership gets higher than was aimed for, the agreements have to be clear in order to make it possible for the municipality and inhabitants to rely on them, also about parking in surrounding neighborhoods. That means many details need to be included as well. It was noted that private law agreements in Nijmegen are already organized very well compared to other municipalities.

In the second round of the workshop, the physical factors were discussed. These included the location of various transport modes and other facilities, design of the public space and location of parking spaces. Except for the latter, these will be discussed in the next sub-paragraphs, although some factors are strongly related. The parking spaces can be located on a centralized spot at the edge of or outside the neighborhood, to create more greenery on various locations in the neighborhood. This centralized parking lot can be combined with a pick-up delivery service, waste collection and the supply of shared cars. A discussion emerged whether people would want to live next to a large parking lot, but others argued there are always people who would like to have these facilities nearby. The other inhabitants are stimulated to walk longer distances to their car and it should therefore be easier to travel with other transport modes. A second option is to allocate greenery to various locations throughout the neighborhood with a possible parking utilization in the future, while not so many parking places are established yet in the

beginning. If the parking demand increases, these locations have to be transformed into parking spaces. Although this approach seems very flexible, the resistance of inhabitants once they are used to their green views can hinder this process significantly. Furthermore, when inhabitants increase their car ownership and these reservations have to be transformed into parking places, the whole low-car concept of the neighborhood is gone, because all parking places are then nearby the houses in the neighborhood itself. Another possibility is to realize some parking spaces spread throughout the neighborhood and reserve one location for additional parking capacity in centralized form. In this way, the most vital parking spaces are located close to the houses, while in the future possible additional parking spaces for less often used cars can be realized further away.

If parking spaces are realized at some distance, the rest of the infrastructure needs to be designed in such a way that parking cannot be done on other locations than where the cars are supposed to be parked, for example by making roadsides inaccessible by car.

Unfortunately, doubled use of parking spaces (e.g. business related cars during working hours and inhabitants' cars outside working hours on the same parking facility) is almost impossible, because the other functions in and around this neighborhood concern mostly recreational and sport facilities, usually visited outside working hours, so when inhabitants of Vossenpels-Noord are at home as well. For future development of other facilities, doubled use of parking spaces needs to be taken into account to enable a lower parking ratio.

Some financial restrictions were also discussed in the second round. They can include to have inhabitants mandatorily subscribed for a shared mobility system in order to push them to make use of it, provide discounts on public transport (temporarily or permanently) and provide delivery services for the whole neighborhood at once (e.g. groceries). For the latter, the municipality should be careful with governmental support for a private company.

4.4.4 Pull factors for alternative transport modes

There are no further facilities planned for Vossenpels-Noord, but around the railway station Nijmegen Lent, there are some plans for a small shopping center. For the location of various facilities in terms of services and transport modes, discussed in the second round of the workshop, an example can be seen in [Figure 14](#). For every few buildings, a built-in bicycle shed is made, which can be combined with other services like delivery points, storage of shared goods or tools, bicycle repairation, shared (e-)bicycles, etc. The number of these sheds is therefore high, to have one nearby for every inhabitant. For each of these services, it is important to have initiative, support and responsibility from the inhabitants, to make it their own facility, to have more social control and to reduce the maintenance costs for the municipality. These bicycle storage places should be very close to the related housing and have good quality (ease, safety, indoor, capacity), because people will otherwise put their bicycles in their own garden. The cycle infrastructure should also be well established, as it is in the surroundings of Vossenpels-Noord.. The proposed locations for shared cars are a little further, but nearer than the private cars parking spaces, and spread throughout the neighborhood. A suitable car sharing system should be found for this neighborhood. Related to the next transport mode, there are no bus lines planned within the neighborhood itself due to the residential character of the neighborhood, although this possibility needs to be investigated. The stops of the two current bus lines located around the edges of the neighborhood, can perhaps be relocated to make the first and last mile travel as short as possible and can also be made attractive to travel by bicycle if storage places are realized next to the stops. Furthermore, parking of the private car should all be on one location in the neighborhood (e.g. in the middle) and therefore the least attractive. This possible parking design was already discussed in another group among other possibilities. The difference between these options (all established on distance, some established nearby or mostly just planned as reserved parking spaces) might be linked to the earlier raised question, what kind of neighborhood Vossenpels-Noord should be. The more sustainably the neighborhood is set up, the more ambitiously the parking can be

designed. Finally, the location of a service delivery point (e.g. southwest corner) can also be located at the edge instead of a combination with the bicycle shed, to avoid delivery transportation in the neighborhood itself.

Although these ideas seem to be the most ideal situation on this location, there is still a lack of facilities around the neighborhood except schools and recreational facilities, the travel time by public transport is relatively long and this area is highly car oriented. Compared to the discussed cases, it is less attractive to go to work or to go shopping by bicycle or public transport. Since this location does not offer many more possibilities, people should be highly motivated in order to travel more sustainably, because traveling by car still seems to be the most convenient.



Figure 14: Various transport modes drawn on the draft of Vossenpels-Noord with bus connections (red lines), pick-up delivery point (blue circle in southwest corner), central parking locations (green square in the middle), shared cars (spread red squares) and bicycle sheds combined with shared facilities (green blocks as parts of the buildings)

4.4.5 Creation of added value

The creation of added value can be assigned to many aspects and is therefore already partly discussed, for example in the possibilities for bicycle storage facilities. Furthermore, the additional public space available if parking is diminished or located further away can be used for other purposes, like more greenery, vegetable gardens or playgrounds. A neighborhood designed without cars can also add value in terms of street view, larger social interaction and safety because of a lack of traffic. However, because the design of Vossenspels-Noord is already largely greenery oriented, the addition of more greenery probably would not create more value, so it might be more meaningful to focus on value in other aspects, like playgrounds, health, innovation, integrated services or a wide range of transport modes. The question here is whether inhabitants can see the added value of more available public space for shared interests if there is already plenty of public space or whether they would prefer more parking spaces near their houses.

4.4.6 Need for alternative measures (plan B)

Finally, the reservations for additional parking spaces in public space was seen as a necessity and therefore already incorporated in the ideas about parking locations, e.g. a reservation on a centralized location or consisting of multiple smaller spaces spread throughout the neighborhood. Moreover, for the legal agreements, it was also discussed that it should be determined in advance how the municipality and inhabitants have to deal with changing rate of car ownership and other future developments, which measures should be taken in those situations and under what conditions the legal agreements can be changed if necessary. Because the municipality recognizes the risks of this project, the need for a plan B is taken very seriously.

4.4.7 Conclusion

In the workshop, the aim was to answer the research sub-question *'How can the proposed conditions be applied to Vossenspels-Noord?'.* Many of the proposed conditions were therefore discussed during the workshop, of which a clear overview is given in [Table 3](#). However, various challenges in importance of sustainability, inhabitants' ownership, community building, number of facilities nearby, quality of public transport and creation of added value were recognized. The combination of the earlier results and the discussed situation of Vossenspels-Noord lead to some barriers. Most importantly, the motivation of inhabitants is important to make other instruments work, even if they are not optimally designed in a less urbanized area, as concluded earlier. In Vossenspels-Noord however, the aim is to create a rather normal neighborhood without a large emphasis on sustainability in other aspects and car ownership should be reduced in a natural way. This is not very likely to happen naturally, according to the earlier results and given the location of the neighborhood. Furthermore, the optimization of the pull factors is difficult to implement, given the low number of facilities and lack of possibilities for high quality public transport, for which the location and its surroundings do not offer many opportunities for improvement. Moreover, the creation of added value in this already largely greenery oriented neighborhood is a challenge, because a reduction in parking spaces gives some extra public space for other purposes, but those purposes can also be incorporated in the already available public space. Therefore, other ways to create added value, like technological innovations, integration of systems or availability of choice in different transport modes should be sought. These barriers also raise some feasibility questions about the current plans for Vossenspels-Noord.

In overcoming these barriers, the mismatch between the results and the development plan for Vossenspels-Noord should be diminished. The first option is to make the motivation of inhabitants as highest priority in this project, in other to realize the rest of the project the way it was envisioned. This also means a neighborhood focused on sustainability and community building with many responsibilities for inhabitants and a large extent of freedom to design the other aspects of the neighborhood, while this was originally not the plan of the municipality.

A second option is to stick to the plan of the municipality with a rather ordinary neighborhood with some extras, although the ambitions for low car ownership should be adjusted, because the

location and its circumstances naturally do not cause this low car ownership. Even with some push and pull factors, the motivation is probably not present to such a large extent and if there is some motivation, the facilities are not sufficient to bring this motivation into practice, like the situation of some current inhabitants shows (willingness to behave sustainably and to get rid of their car, but there are some restricting circumstances). It might be better to only focus on using the car less often or to make it more difficult to have a second car instead of reducing first car ownership.

A third scenario is triggered by the case of Aspern Seestadt, where inhabitants also had no motivation to travel more sustainably, but the concept seems to work out. This appears to be due to the size of Vienna, the degree of urbanization, the density of the neighborhood, the large number of facilities available and the strong push and pull factors. The magnitude of this project in such a large city is not easily applicable to this outer urban area of Vossenpels-Noord, but might contain some recommendations for the center area of Nijmegen, like a well-organized parking regulation (financial consequences for car users/owners), limited space for cars on roads and in parking capacity nearby, the availability of car alternatives (also for travel purposes like shopping) and investments of the car/parking budget savings in the sustainable travel modes. Because of the low applicability to Vossenpels-Noord, this scenario is not investigated and discussed further.

Summary results implementation workshop		
Intention & motivation for sustainable transport	Inhabitants' ownership	Collective private commissioning of housing, conditions for developer to include inhabitants in designing process, investigate opinions of potential buyers
	Importance of sustainability	Sustainability oriented people are more likely to decrease car ownership and can positively influence others, but are originally not the target group in the development plan
	Community with enthusiasm & encouragement	Does not exist yet and was not planned
Push factors for low car ownership	Physical restrictions	Centralized parking on one location / Currently lower amount of parking spaces and reservations for future spaces throughout the neighborhood / Currently some vital parking spaces nearby and reservations for future spaces only on distance. No parking possibilities along infrastructure
	Legal restrictions	Clear agreements in public and private law about parking places, responsibilities in communication and maintenance, etc.
	Financial restrictions	Obligatory subscription for shared cars, discounts on public transport, integrated and cheap delivery services
Pull factors for alternative transport modes	Number of facilities nearby	Some facilities are planned around station Lent
	Quality of cycle infrastructure	Well established infrastructure with high quality shed facilities
	Quality of public transport	Optimize the two bus connections around Vossenpels-Noord
	Supply of shared mobility	Locate shared cars closer than private car parking
Creation of added value	Availability of choice in transport modes	Combination of services in bicycle sheds, high quality supply of shared cars
	Design and quality of public space	More greenery, gardens or playgrounds
	Health & Innovation	Service delivery point at the edge of the neighborhood to prevent delivery traffic
Need for alternative measures (plan B)	Demand management	Municipality needs to determine criteria at which point the parking problems or car ownership get too high and measures need to be taken
	Reservations in public space	Either spread in the neighborhood or at a centralized location

Table 3: Summary of the results from the implementation workshop

4.5 Conclusion

Now that the findings presented at the beginning of the chapter have been evaluated from various perspectives, an adjusted version of these findings is the result, which can be found in **Figure 15**. An explanation on how to read the figure will be given in combination with a discussion of the alterations compared to the first figure with findings. This chapter will end with some final remarks.

The most important mutation is the position of the **Intention & motivation for sustainable transport**, because of the large role it played in the implementation of the other instruments, or differently formulated: the other instruments were much more likely to be successfully implemented when a high intention preceded. Also the other way around, the intention could only be put into actual reduced car ownership when the other instruments were present. This was somewhat recognized in the expert interviews, but most clearly seen in the case interviews and confirmed in the neighborhood interviews. The other instruments therefore have the role of moderator, influencing the relation from intention to low car ownership. The relation between car ownership and need for alternative measures indicates that a changing car ownership (either increasing or decreasing) always leads to the need for alternative measures at hand. In addition, a small adjustment has been made in the creation of added value, because some of the indicated factors were just examples of this category and not explicitly necessary to create added value, since it could also be established in other ways. Therefore, the two most important factors are mentioned and space is left for more ideas to create added value. Finally, it is important to notice that there is no ranking between the factors or categories and that the mutual relations between various factors have not been investigated further.

It was emphasized various times that the factors have to be implemented in combination with each other, because these factors on themselves do not lead to lower car ownership. However, not all factors suit in the defined ambition for the neighborhood of Vossenpels-Noord. Therefore, two scenarios are created as recommendations for this neighborhood, because a third scenario was considered not applicable to this area, which are presented in the next and final chapter.

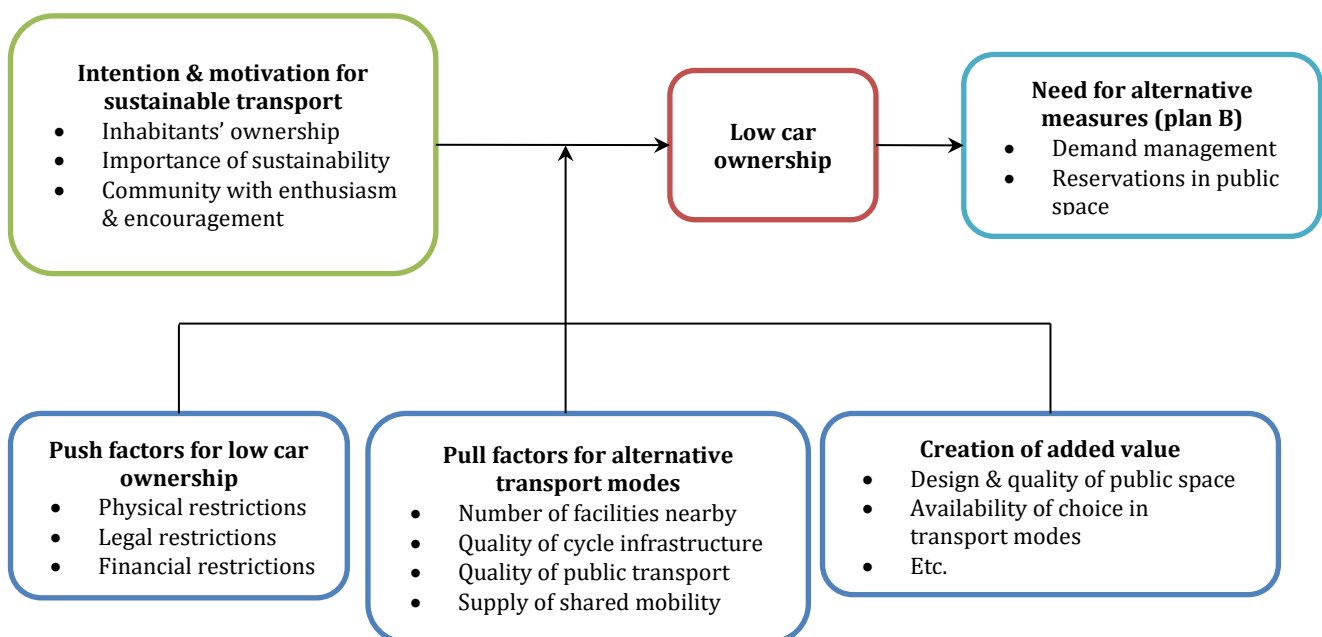


Figure 15: Revised overview of results

5. Conclusion and discussion

In the results, a large number of factors which have to be considered in establishing a neighborhood with reduced car ownership were discussed. The presented results are put together in a final conclusion in the beginning of this chapter to answer the research question. Afterwards, this research is discussed according to the interpretation, implications, limitations and recommendations.

5.1 Conclusion

The main research question concerned in this study was formulated as follows: *'How can the conditions for Vossenpels-Noord be designed in order to create a neighborhood with low car ownership in an outer urban area?'*

In the first place, it has to be noted that this plan for Vossenpels-Noord concerns a risky project and it would be better to execute such a concept with low car ownership in more urbanized areas first, where the need for these concepts is also much higher, because of the high development costs, the low amount of available space and the capacity of the infrastructure. The location and surroundings of Vossenpels-Noord do not invite for low car ownership and an implementation of certain instruments to naturally establish low car ownership does not exist. The municipality should therefore consider this plan of low car ownership thoroughly before looking into the precise design of the neighborhood, especially because the foreseen target group is not concerning extremely sustainability oriented people.

When the municipality of Nijmegen still want to implement a low car ownership concept, this research has shown that a large number of factors, presented in **Figure 16**, are important to consider when designing a neighborhood with low car ownership in an outer urban area, of which the motivation of inhabitants is necessary to stimulate other instruments towards effectiveness, because these instruments cannot stand on themselves. The connection between these instruments is strong in such a way that one instrument cannot influence car ownership

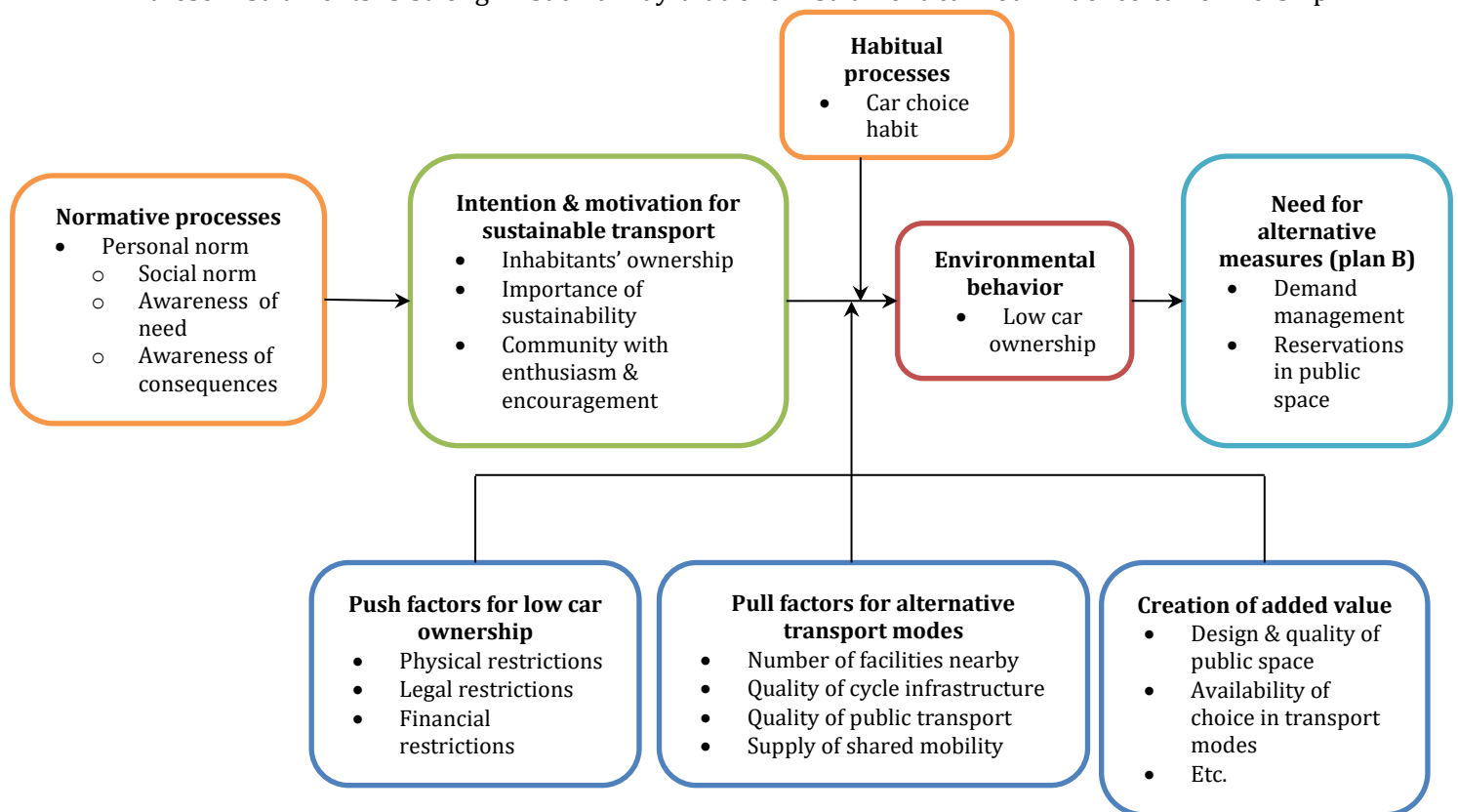


Figure 16: Combination of theoretical framework and results

on itself, but only the combination of all these instruments can turn intention into action. The crucial position of these instruments is emphasized in occasions where the willingness to travel more sustainably was present, but the facilitators were lacking and thus this willingness did not transform into action. The position of the need for alternative measures (plan B) is because in case the car ownership increases or decreases significantly, alternative measures have to be taken, which should be designed in advance of the development process. Furthermore, some factors in the graph might not be fully moldable by the municipality, like the composition of the inhabitants, although some selection can take place, but the establishment of a real community is dependent on the inhabitants. Also the number of facilities and quality of public transport can be increased slightly, but it is not feasible to develop these factors to an ideal level in the time span of this development. Finally, it has to be noted that many of these factors concern spatial planning topics, which have to be established on larger scale, while other factors are more individually oriented (car ownership) or on group level (intention & motivation for sustainable transport). An elaborative description of each factor was given in the beginning of [Chapter 4](#).

The used methods to come to these findings were in-depth interviews with involved people at cases similar to Vossenspels-Noord, in-depth interviews with experts in this field of knowledge, structured interviews with inhabitants of the Vossenspels area and an implementation workshop with parties involved in the development project, which were all described in [Chapter 3](#). Compared with the development plan of Vossenspels-Noord, this resulted in two main scenarios to answer the research question: a full program with all factors implemented in the most effective way possible, leading to a sustainable, self-organizing neighborhood, or a small program with some factors implemented to a smaller extent than others, leading to a rather ordinary but innovative neighborhood. These two main scenarios are explained below.

5.1.1 Scenario I: sustainable neighborhood with low car ownership

The first scenario is mostly built on the results from the experts and other cases and can be considered as implementing the full program with all factors from [Figure 16](#) included. This contains a driven group of inhabitants with a lot of responsibilities, best suitable in the form of a collective private commissioning of housing (Dutch: *Collectief Particulier Opdrachtgeverschap*), and with a large focus on sustainability. The inhabitants are then also responsible for the design, development and maintenance of the neighborhood. Furthermore, clear agreements have to be made about these responsibilities, but also about the location and utilization of parking spaces, financing of various instruments and reservations for future developments. All mentioned push and pull factors should be implemented according to the ideas of the inhabitants and the municipality should help with these factors as far as possible, for example with the number of facilities nearby and quality of public transport and cycle infrastructure. The creation of added value, e.g. in public space, can be initiated, designed and maintained by the inhabitants. Furthermore, a plan B with alternative measures, like reserved parking space in greenery, should be made by the inhabitants in cooperation with the municipality. Finally, the selection of inhabitants should be related to their sustainability intentions and willingness to live in an community.

The result is a highly sustainability oriented neighborhood with inhabitants already involved in the designing and development process and valuing the environment as very important, so solar panels, water recycling systems and heat pumps are no exception. The social interaction and commitment is high, which is seen in the amount of activities in the neighborhood, both in functional (e.g. maintenance) and social way. The public space is designed with much greenery, some playgrounds, large (open) gardens and small shared sport facilities (e.g. table tennis table). The low amount of private cars is feasible because many travels are done by bicycle and some by public transport or shared cars. Carrier bicycles, pull carts and tandem bicycles are also available, next to an integrated shared car system. The low amount of parking places is hidden in greenery at the edge of the neighborhood and the inhabitants have made agreements about not parking in adjacent neighborhoods. To avoid inflation of the concept, the agreements on

obligations, responsibilities and prohibitions about a vision document, car ownership, parking and shared spaces have to be secured and can only be changed when all inhabitants agree. This scenario is considered as the most effective way to reduce car ownership according to the case and expert interviews, but does not fully correspond with the current desires for the neighborhood described by the municipality. It is therefore necessary to adjust those ideas, especially relating to the role of the inhabitants, in order to achieve low car ownership.

5.1.2 Scenario II: car-on-distance neighborhood with lower car use

The second scenario is more related to the prescribed desires for the neighborhood of Vossenpels-Noord, i.e. a rather ordinary neighborhood with some sustainable ambitions related to mobility, but not to other areas, and focused on greenery, culture and health. In this smaller program, a little lower parking ratio than average can be implemented, but it does not result in an ambitious project. The focus should be on less car use instead of less car ownership. This scenario would concern inhabitants with less motivation and responsibilities, although they can cooperate in the design and maintenance of the public space and a shared mobility system, since this can lead to a larger motivation for sustainable transport. This means the municipality has a larger role in the design of the neighborhood itself, the implementation of mobility concepts and the establishment of agreements than in the first scenario. Firstly, some agreements can be made in a private law contract about parking at distance or/and the non-allowance of more than one car per household. Secondly, the design of parking locations should be less ambitious than in scenario I, e.g. more parking nearby, in order to prevent inhabitants from complaining. Thirdly, some pull factors from [Figure 16](#) are necessary to encourage less car use, like a shared car system, but they should not be considered as drivers for less car ownership. Fourthly, the creation of added value is quite difficult, because the neighborhood already plans to have much space and greenery. Therefore, other ways to add value to the neighborhood should be found, e.g. in technology integration. Fifthly, the risk for the low car concept in this neighborhood might also be larger, so a plan with alternative measures definitely needs to be worked out. Furthermore, this concept should be clearly communicated to new inhabitants, the restrictions as well as the advantages, in order to prevent wrong expectations at inhabitants.

A possible design of the neighborhood can be to make the living area totally car-free, with much greenery and many cycle and walk paths between the houses. The private cars are parked on distance, at the edge or just outside the neighborhood, to discourage car use but also to create a high quality living area with much shared space or larger gardens, encouraging social interaction (inhabitants pass each other walking or cycling instead of driving), safety (children can play outside without danger) and an atmosphere of peace (without the sound of motorized vehicles). This means there is also no space for service delivery and other traffic in the neighborhood itself, so a service delivery point is located at the edge of the neighborhood. The creation of added value is then not explicitly in the amount of available extra space, but in the positive atmosphere of a car-free area, comparable with vacation parks consisting of chalets and small roads where it is not possible to park your car nearby for a longer time. If you need to move some heavy baggage or furniture, it is possible to drive your car to your house, but if you park your car there for a longer time, it really becomes an obstacle for others. Shared cars can be provided and made attractive by a system which is easy to use and can be unlocked by smartphone. A free trial period and visible location will help people to start using this system, which can eventually lead to less private cars. The car use can be discouraged by promoting cycling in high quality cycle facilities and infrastructure, offering high quality public transport (in price and travel time) and develop more facilities in and around the neighborhood. The amount of agreements that have to be made is smaller than in the first scenario, because the parking ratio follows the car ownership and therefore the risk to park in other neighborhoods is smaller, except when those parking spaces are closer by. However, the agreements about where inhabitants are allowed and prohibited to park still have to be established. The responsibility for the maintenance of the public space has to be discussed with the inhabitants, whether they would like to do that themselves or not. The challenge is to prevent complaints about the distance to the parking lot by generating stronger positive feelings due to the car-free area.

The car ownership might not decrease significantly. The parking ratio will therefore not be as low as was envisioned by the municipality, but the design of the neighborhood can still be innovative and car-free, because the cars are located elsewhere and new concepts related to design and supply of shared mobility are implemented in order to decrease the car use of inhabitants. In this way, the design of the neighborhood is more like it was envisioned by the municipality, but the sustainability targets as formulated will not be met. The municipality therefore has to decide which of the two components (car ownership or target group) is most important in Vossenpels-Noord.

5.2 Discussion

Now that the research question has been answered, interpretation of these findings and the implications, limitations and recommendations of this research will be discussed in the final part of this thesis.

5.2.1 Interpretation

First of all, it has to be noted that this development was labeled with a high failure potential by many participants and that it is difficult to do these type of developments on large scale, because more urbanized areas are more suitable. Secondly, the intention or motivation plays a much larger role in this context than was estimated in advance, since almost all other factors can show a difference in whether they are effective and used according to their purpose or not, related to the degree of motivation the inhabitants in the neighborhood have to use sustainable transport modes. Moreover, many factors which seemed to play a dominant role in advance, like the quality of public transport, turn out to be only supportive factors and do not emerge sustainable travel behavior.

When the results model (Figure 15) is compared to the theoretical framework (Figure 5), it is noticed that the relation between intention and behavior has not changed, but the factors around this relation and of intention itself have become clearer. The situational factors as formulated in the theoretical framework concerned abstract concepts, because more concrete literature on this topic was lacking. This research has filled in these knowledge gaps and formulated concrete factors in supporting the relation between intention and behavior as seen in the CADM (Klößner & Blöbaum, 2010). Also the need for a backup plan when actual behavior is pursued differently than estimated, was not seen in the concerned literature. The combination of the theoretical framework and the results leads to a larger framework (Figure 16) with the preceding role of personal norms and the additional role of habit included, while the situational factors are made very concrete.

Furthermore, the estimated situational factors in the theoretical framework, taken from Buehler (2011), created a mismatch with the gathered data. This mismatch concerning large versus small scale, car use versus car ownership, naturally derived behavior versus consciously pursued behavior and existing behavior versus future behavior demanded another approach of the data, because the formulated factors did not cover some of the most important results. This ended up in an inductive analysis approach, of which the results are in line with the theoretical framework, i.e. a large role of intention, emphasizing the validity of the results.

Furthermore, four different methods are used in this research to generate statements and confirmations or denials about various factors. These methods were also considered as suitable to discuss both the theoretical and the practical side of the case. Because of the number of used methods, these results can be seen as reliable.

5.2.2 Implications

This research has proven to be valuable in various ways. In the problem statement, the need for this research was recognized. The derived threefold research aim to a) provide the municipality of Nijmegen with insights on how to design their case, b) contribute to the literature about this relatively new topic and c) on a larger scale, provide other organizations with knowledge about this phenomenon in an outer urban area, has been achieved. Firstly, the municipality of

Nijmegen received some insights on how to address their ambitions, which conditions are necessary to realize a neighborhood with low car ownership and how this has worked out in other cases. From this point, a concrete design for the neighborhood can be made including the role of inhabitants, various push and pull factors, creation of added value and an alternative plan. But to make this design, the municipality first needs to decide which direction they want to go, either keeping the sustainability ambitions high or aiming for a more ordinary neighborhood with some innovative aspects. Secondly, the existing literature about realizing low car ownership is limited, mostly restricted to highly urbanized areas. This research gives another perspective on this topic, with a different situation for this concept and therefore other drivers and influencing factors. The concretization of the situational factors in this type of development, which is hardly done in research, significantly contributes to the existing theory, because a large knowledge gap was recognized in advance. Furthermore, the results are not just applicable to one case, but can be used for other similar projects as well, which brings us to the third point. Although Yin (2009) emphasizes the preference for analytical generalization over practical generalization, which is why the contribution to literature is more important here than the application to other cases, cases similar to the one of Vossenpels-Noord can make use of this research to design their neighborhood. Because this specific type of literature did not exist until now, this research can make a large contribution in designing more of these neighborhoods in other areas, while it has to be noticed that the focus for this development should first be on more urbanized areas and that for outer urban areas, people need to be willing to live in such a neighborhood, because these type of projects are estimated to have a high failure potential.

5.2.3 Limitations

Of course there are some limitations to this research as well. Because of the large scope in considered topics, the resulting factors themselves and the relations between them have not been investigated in depth. The extent to which each factor is recommended to be implemented is therefore still rather general. Moreover, some methods are executed to a smaller extent because of the lack of time and the combination of various methods, leading to some missing representative parties in the interviews (e.g. cyclists' union, developers), distance and language barriers with parties in Germany and Austria and a low sample of structured interviews taken in and around the neighborhood of Vossenpels-Noord, so it could be argued that these results do not represent the situation to the fullest. Furthermore, a gap between theory and data was recognized in the analysis, emphasizing the need for further research on this topic, but also making it hard to compare the results with specific instead of just general literature. In addition, the results were presented in a linear form for the clarity, while the research process was more iterative, with several tracks running at the same time, so this could mislead the interpretation of the data generation. Finally, only the mobility aspect of the new neighborhood was considered, while an integrative approach is necessary to develop this concept of low car ownership, so more attention for the housing, sustainable development, communication with developer and inhabitants, etc. would have been valuable, but the scope of this research did not allow an elaborate discussion on all those topics.

5.2.4 Recommendations

In the first place, the municipality should decide on which track it will continue for the development of Vossenpels-Noord, concerning the amount of ambition level and type of target group, for which two scenarios have been created. When this decision has taken place, it should look into all described factors, in what way they will work out and how they should be implemented. Secondly, the municipality should not aim for further implementations on locations which are not nearby many facilities and high quality public transport and do not have space conflicts, but focus on more urbanized areas where low car ownership can be part of the solutions of more problems (division of public space, livability, infrastructure capacity, development costs, housing density) than only sustainability. Moreover, the neighborhood of Vossenpels-Noord should be monitored carefully in order to learn from successes and/or failures, keep the agreements as arranged and be aware of the need for alternative measures.

Evaluations should be done on the effectiveness of the instruments, the car use and ownership of the inhabitants and the restrictions in transforming their willingness into action.

To expand the literature about establishments with low car ownership, this type of research should be executed for more areas with other circumstances, e.g. different degrees of urbanization and type of housing, where other factors might play a role or currently included factors might play a smaller or larger role. In this way, the created framework in [Figure 16](#) can be tested in other circumstances. It would also be valuable and interesting to look at this topic in areas where cycling is less common or where the attention for sustainability is much lower for example, so to apply the framework in other cultures. In addition, the earlier excluded scenario without willingness of inhabitants to travel more sustainably, but with a large scale development and many push and pull factors, forcing inhabitants to establish sustainable travel behavior, should be further explored. Moreover, relating to the lack of time to investigate the influencing factors and the relations between them more in depth, more research can give answers to those knowledge gaps in order to create more insight in the influence of each factor and the combination of factors. Furthermore, the focus was on the relation between intention and behavior in this research, but the influence of habit and situational factors on the relation between normative processes and intention should also be investigated. Finally, the transitions going on in the fields of mobility and sustainability provide opportunities for reinvestigation once the use of transport modes has shifted significantly or new transport modes have been implemented.

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Appendix A: Interview guide

Research question	Theoretical concept	Theoretical question	Interview questions
1. Which conditions can be derived from similar cases in other cities?	Socio-economic and demographic factors	What are the socio-economic and the demographic characteristics of the inhabitants?	What age do the inhabitants have? Which size are the households? Which educated level do inhabitants have? Do inhabitants have a driver license? What is the ratio between rented houses and owner-occupied houses?
	Spatial development	How is the neighborhood spatially designed?	How much space does each transport mode have? How and where are the parking spaces located? What purposes does the public space have? How is the public space designed? What is the density of buildings?
	Transport and land-use policies	What is the number of or quality of transport and facilities?	Which infrastructures exist? Which ones are most used? How much time does it take to travel to a large number of facilities? Which costs are connected to car ownership? Which facilities exist in the neighborhood?
	Culture and attitudes	What is the culture and attitude towards adoption of sustainable travel modes?	What is the opinion of inhabitants about sustainability? How strong is the cohesion in the neighborhood? To what extent are inhabitants positive about innovations? What influence does the government have on the activities?
2. Which conditions are proposed by experts?	Socio-economic and demographic factors	Which socio-economic and demographic characteristics of inhabitants are suitable for Vossenpels-Noord?	What age/life stage(s)/education level(s)/household size is (are) preferred?
	Spatial development	How should Vossenpels-Noord spatially be designed?	How should the public space be designed? Where should parking facilities be located?
	Transport and land-use policies	Which quality or number of facilities should be present in the transport and land-use in and around Vossenpels-Noord?	Which types of transport should be made available? How close/far should various types of transport be located from the houses? How important are the presence of school, work, shopping and recreational facilities? Which financial or regulational policies can be implemented to stimulate sustainable modes of transport?
	Culture and attitudes	How can a more positive culture and attitude towards sustainable travel modes be established in Vossenpels-Noord?	How can sustainable transport modes get a more positive image in the new neighborhood? How can inhabitants stimulate each other to use sustainable transport modes?
3. Under which conditions are inhabitants of surrounding neighborhoods willing and able to change their car ownership?	Socio-economic and demographic factors	What are the socio-economic, demographic and car habit characteristics of current inhabitants?	What is your age? What is your gender? What is the size of your household? What is your education level? What is the distance (in km) to your job or school? Which transport modes are in your range of possibilities? How often do you use these transport modes? Why would you use or not use your car? To which extent is price/distance/travel time/comfort/environmental impact/weather conditions/habit/availability/parking facility/travel purpose/health/safety/status symbol important in your choice? Is using the car something that belongs to your routine?
	Spatial development	Which spatial measures could influence car ownership?	To which extent is the spatial focus on walking, cycling and PT influencing your car ownership?
	Transport and land-use policies	Which transport and land-use related measures could influence car ownership?	Which changes could make your car unnecessary? To which extent is the number of facilities/quality of bicycle facilities/quality of PT/availability of shared cars/parking facilities at your home/costs of car vs. PT influencing your car ownership?
	Culture and attitudes	Which attitude towards sustainable modes of transport is present?	Do you intend to seek out more opportunities to be more environmentally active in the future? To which extent is the societal norm influencing your car ownership? Would you be willing to contribute to more sustainable transport if you had the room to develop your own ideas in the neighborhood?

4. How can the proposed conditions be applied to Vossenpels-Noord?	Socio-economic and demographic factors	What kind of inhabitants should be attracted?	Would it be preferable to attract already very suitable people (sustainability oriented, no car possession) or to tempt the 'average' citizen to use more sustainable modes of transport?
	Spatial development	How can Vossenpels-Noord spatially be designed?	How can the public space be designed in such a way that it adds value to the neighborhood? How can space be reserved for future developments? What is the backup plan if the demand for parking spaces becomes higher than estimated?
	Transport and land-use policies	How can the use of sustainable transport modes be stimulated?	Which financial measures make other transport modes than private car more attractive? Where could bicycles, PT, shared cars and private cars be located in order to stimulate the sustainable transport modes? Where do other target groups, like delivery services, taxi services and elderly people, get space to move or deliver?
	Culture and attitudes	How can the inhabitants be involved in the design process? How can clear agreements be established in order to use all concepts in the way they were designed?	How can inhabitants be involved when there are no inhabitants yet? How can people without an intrinsic participation motivation be involved in the design process? Who is responsible to design and adjust specific agreements? What should/can the agreements be about?

Appendix B: Interview information

Uitleg van het onderzoek

Achtergrond

De afgelopen jaren is de focus in mobiliteit steeds meer komen te liggen op duurzamere vormen van vervoer dan de privéauto, vooral in de grote steden. In combinatie met andere ontwikkelingen in grote steden, zoals verdichting door binnenstedelijke uitbreiding, hoge kosten voor het aanleggen van parkeerplaatsen, lage gebruikspercentages van parkeerplaatsen en –garages en investeringen in andere vormen van vervoer, worden de stadscentra steeds autoluwer. Bijkomend voordeel is deze ontwikkeling ook goed is voor het milieu.

Bij een ander uitgangspunt, waarbij duurzaamheid vooropstaat, wordt dit een heel ander verhaal. De beoogde autoluwe wijk in Nijmegen ligt namelijk niet in het centrum of vlakbij een treinstation. Verder is er geen druk van hoge kosten door parkeergarages of stedelijke verdichting en gaat het vooral om koopwoningen, waardoor grote huishoudens worden aangetrokken die vaak ook de meeste auto's hebben. Er zullen ov-verbindingen en fietsroutes zijn, maar voorzieningen zijn niet om de hoek. Vossenpels-Noord zal als voorbeeldwijk dienen voor andere stedelijke ontwikkelingen in de omgeving.

Onderzoek

Mijn onderzoek gaat over welke factoren belangrijk zijn in het succes van zo'n experiment, om te kunnen bepalen of deze casus in Nijmegen kans van slagen heeft en hoe de wijk ontwikkeld zou moeten worden. Daarom ben ik op zoek gegaan naar vergelijkbare casussen – buitenwijken van (middel)grote steden – om met betrokken partijen in gesprek te gaan over welke factoren essentieel zijn geweest en hoe verschillende aspecten in de praktijk hebben uitgewerkt. Dit betreft de Kersentuin in Utrecht, Vauban in Freiburg en Aspern Seestadt in Wenen.

Daarnaast ga ik in gesprek met experts op allerlei gebieden die van invloed zijn op deze casus, met name partijen die betrokken zijn bij de algemene trends in parkeergebied, om hun praktijkervaring en kennis te gebruiken in het kenmerken van belangrijke invloeden op de ontwikkeling van een autoluwe wijk.

Interview

Het interview heeft een relatief open karakter om te voorkomen dat de resultaten vooraf gestuurd worden. Daarbij is sprake van een iteratieve ontwikkeling van de onderzoeksopzet: de resultaten van de eerste interviews worden verwerkt, om vervolgens tot een verdere specificering van het onderzoek te komen. Wel is er al op voorhand een aantal onderwerpen te benoemen dat in het interview aan bod zal komen:

- Wat is uw achtergrond? Wat is uw huidige functie en hoe bent u hierin terecht gekomen?
- Op welke manieren bent u betrokken bij projecten met minder autobezit en/of lagere parkeernormen?
- Wat is er de afgelopen jaren veranderd op het gebied van autobezit en parkeren? Hoe spelen gemeentes in op deze trends?
- Hoe zou u zo'n ambitiegestuurde vraag van de gemeente, een autoluwe wijk in het kader van duurzaamheid, aanpakken?
- Welke voorwaarden of condities zijn naar uw idee van belang voor de ontwikkeling van een autoluwe buitenwijk?
- Hoe en in welke maten zijn de volgende factoren van belang in de ontwikkeling van zo'n wijk?
 - o Sociaaleconomische en demografische factoren
 - o Cultuur en attitude
 - o Ruimtelijke ontwikkeling
 - o Transport en land-use
- Heeft u nog verdere vragen, opmerkingen of aanbevelingen?

Appendix C: Structured interview neighborhood

In het kader van de nieuwe wijk Vossenspels-Noord onderzoek ik het reisgedrag en de onderliggende motivaties van omwonenden om inzicht te krijgen in het mogelijke reisgedrag van een nieuwe wijk.

Uw gegevens worden anoniem behandeld en alleen gebruikt voor dit onderzoek.

Over welke reismogelijkheden beschikt uw huishouden?

1

- ☐ Auto
- ☐ Tweede auto
- ☐ Openbaar vervoer
- ☐ Fiets
- ☐ Lopen
- ☐ Deelauto
- ☐ Anders, namelijk _____
- ☐ Anders, namelijk _____

Wilt u een indicatie geven in welke mate uw huishouden deze middelen gebruikt? Verdeel 10 punten over de aangekruiste reismogelijkheden:

2

- Auto
- Tweede auto
- Openbaar vervoer
- Fiets
- Lopen
- Deelauto
- Anders, namelijk _____
- Anders, namelijk _____

Wat zijn voor u de belangrijkste redenen om wel of niet de auto te gebruiken?

3

In welke mate zijn de volgende factoren belangrijk in die keuze om wel of niet de auto te gebruiken?

4

	Erg onbelangrijk	Onbelangrijk	Neutraal	Belangrijk	Erg belangrijk	Geen mening
Prijs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Afstand	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Reistijd	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Comfort / gemak	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Milieu-impact	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Weeromstandigheden	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Gewoonte	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Beschikbaarheid	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Parkeergelegenheid	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Doel van de reis	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Gezondheid	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Veiligheid	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Statussymbool	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

In hoeverre bent u het eens met de volgende stellingen:

5

Autorijden zit in mijn routine.

Ik wil meer mogelijkheden zoeken om in de toekomst duurzamer te zijn.

Helemaal niet mee eens	Niet mee eens	Neutraal	Mee eens	Helemaal mee eens	Geen mening
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Welke veranderingen zouden ervoor kunnen zorgen dat u uw auto wegdoet?

6

In hoeverre bent u het eens met de volgende stellingen over autobezit:

7

Als er een grote hoeveelheid voorzieningen in de buurt is (winkels, scholen, werk, etc.), heb ik geen auto nodig.

Helemaal niet mee eens	Niet mee eens	Neutraal	Mee eens	Helemaal mee eens	Geen mening
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Als de kwaliteit van fietsvoorzieningen hoog is (netwerk en stalling), heb ik geen auto nodig.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Als de kwaliteit van het openbaar vervoer hoog is (combinatie van afstand, frequentie, reistijd), heb ik geen auto nodig.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Als het aanbod van deelauto's groot is, heb ik geen auto nodig.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Als de parkeergelegenheid bij mijn huis laag is, kan ik beter geen auto hebben.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Als de kosten voor het bezitten, gebruiken en parkeren van een auto hoger zijn in vergelijking met de kosten voor het gebruik van openbaar vervoer, kan ik beter geen auto hebben.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Als het maatschappelijk gewenst is om geen auto te hebben, heb ik geen auto nodig.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Als in de inrichting van de wijk fietsers en openbaar vervoer prioriteit krijgen ten opzichte van auto's, kan ik beter geen auto hebben.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Als de gemeente ons als bewoners de ruimte geeft eigen oplossingen te bedenken en uit te voeren, wil ik meewerken aan duurzamer vervoer in de wijk.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

8

Wat is uw leeftijd?

- ☐ < 18 jaar
☐ 18 – 30 jaar
☐ 31 – 40 jaar
☐ 41 – 50 jaar
☐ 51 – 60 jaar
☐ 61 – 70 jaar
☐ 71 – 80 jaar
☐ > 80 jaar
☐ Anders / geen mening

9

Wat is uw geslacht?

- ☐ Man
☐ Vrouw
☐ Anders / geen mening

10

Hoe groot is uw huishouden?

- ☐ 1 persoon
☐ 2 personen zonder kinderen
☐ 2 personen inclusief kinderen (in de leeftijd van _____)
☐ 3 personen of meer zonder kinderen
☐ 3 personen of meer inclusief kinderen (in de leeftijd van _____)
☐ Anders / geen mening

11

Wat is uw hoogst afgeronde opleiding?

- ☐ Basisschool
☐ VMBO
☐ Havo
☐ Vwo
☐ MBO
☐ HBO
☐ WO Bachelor
☐ WO Master
☐ Gepromoveerd
☐ Anders / geen mening

12

In welke straat woont u?

- ☐ In Lent: _____
☐ In Nijmegen
☐ Buiten Nijmegen
☐ Anders / geen mening

13

Hoe ver woont u van uw werk of opleiding?

- ☐ < 5 km
☐ 5 – 15 km
☐ 15 – 40 km
☐ 40 – 80 km
☐ > 80 km
☐ Anders / geen mening

14

Heeft u nog verdere opmerkingen?

Appendix D: Interview privacy contract

1. Momenteel werk ik aan mijn afstudeeronderzoek voor mijn master Environment & Society Studies (Milieu-maatschappijwetenschappen) aan de Radboud Universiteit. Dit betreft een onderzoek voor de gemeente Nijmegen naar de mogelijkheden in lagere parkeernormen en minder autobezit in een nieuwe buitenwijk van de stad, waar de voorzieningen niet zo optimaal zijn als middenin een stadscentrum. Het doel van het onderzoek is om voorwaarden te formuleren waaronder een dergelijk experiment succesvol zou kunnen zijn. Hiervoor worden experts in verschillende vakgebieden geïnterviewd.
2. Ik zou u graag willen interviewen over uw visie op trends in autobezit, parkeren, duurzaam vervoer en de inrichting van een nieuwe wijk. Het interview zal maximaal een uur in beslag nemen.
3. Ik zou het interview graag willen opnemen zodat ik het op een accurate en zorgvuldige manier kan verwerken. Alleen mijn begeleider(s) en ikzelf zullen toegang hebben tot de audio-opnamen en de transcripties van de interviews.
4. Al uw opmerkingen tijdens het interview zullen vertrouwelijk worden behandeld. Uw naam en functie kunnen worden opgenomen in mijn masterscriptie. Mocht u hier echter bezwaar tegen hebben, dan kunt u dit aangeven en worden de gegevens gedeeltelijk of volledig geanonimiseerd.
5. De resultaten van het onderzoek zullen worden gebruikt in mijn masterscriptie. De scriptie zal worden gepubliceerd op de website van de Radboud Universiteit.
6. Als u instemt met deelname aan dit interview heeft u de volgende rechten:
 - a. Het weigeren te antwoorden op een vraag, het op elk moment beëindigen van het interview en het op elk moment uitschakelen van de opnameapparatuur.
 - b. Het stellen van verdere vragen over het interview of het onderzoeksproject, tijdens het interview of daarna.
 - c. Indien u daar prijs op stelt, het gedeeltelijk of volledig anonimiseren van de gegevens van het interview. Elke informatie die uw identiteit zou kunnen prijsgeven zal in dit geval worden uitgesloten van publicatie of andere verwerking van de gegevens, met uitzondering van gevallen waarin u uitdrukkelijk toestemming verleent om uw gegevens wel op te nemen.
 - d. Het stellen van verdere vragen, telefonisch via 06 11 41 50 41 of via e-mail: t1.van.dam@nijmegen.nl.

Verklaring

"Ik stem in met deelname aan dit interview op basis van bovenstaande voorwaarden"	Ja	Nee
"Ik geef toestemming om mijn naam en functie te noemen"	Ja	Alleen functie Nee
"Ik wil graag een exemplaar ontvangen van de bevindingen van het onderzoek"	Ja	Nee

Plaats en datum:

Naam participant:

Handtekening participant:

Naam interviewer:

Handtekening interviewer:

Appendix E: Coding results

Cases

Code group	Code	Amount
No group	Case description	18
	Feasibility	6
Intention & motivation for sustainable transport	Inhabitants' ownership	7
	Importance of sustainability	3
	Community with enthusiasm & encouragement	9
Push factors for low car ownership	Physical restrictions	8
	Legal restrictions	7
	Financial restrictions	4
Pull factors for alternative transport modes	Number of facilities nearby	6
	Quality of cycle infrastructure	4
	Quality of public transport	4
	Supply of shared mobility	8
Creation of added value	Design & quality of public space	3
	Availability of choice in transport modes	1
	Health	0
	Innovation	0
Need for alternative measures (plan B)	Demand management	1
	Reservations in public space	2

Experts

Code group	Code	Amount
No group	Feasibility	31
	Habit	9
Intention & motivation for sustainable transport	Inhabitants' ownership	18
	Importance of sustainability	22
	Community with enthusiasm & encouragement	6
Push factors for low car ownership	Physical restrictions	16
	Legal restrictions	19
	Financial restrictions	18
Pull factors for alternative transport modes	Number of facilities nearby	10
	Quality of cycle infrastructure	12
	Quality of public transport	9
	Supply of shared mobility	23
Creation of added value	Design & quality of public space	10
	Availability of choice in transport modes	6
	Health	3
	Innovation	2
Need for alternative measures (plan B)	Demand management	15
	Reservations in public space	10