The shift to post car mobility

Looking for innovation supporting the development of car free city design

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university of groningen

Colophon

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Acknowledgements

“We’ve come to think about street space as space for movement and speed to the detriment of all other uses [...] We often tend to forget about urban space as a common good, a truly common good that we all participate in shaping.” – Philippe Crist, 2023

I have developed a deep interest in the ongoing urban transitions. Last year, I completed my HBO bachelor thesis on the circular economy in a harbour area. I have just finished a bachelor's thesis on mobility in three major cities. These two pivotal shifts significantly impact our daily lives and are a foundation for my academic pursuit of a master's degree. My research in the Society, Sustainability, and Planning at the University of Groningen has given me valuable insights and will soon come to a close.

I am grateful to several individuals who have supported and contributed to my academic endeavours. First and foremost, I am immensely thankful to the researchers, policymakers, and experts in the field of mobility who generously shared their expertise and provided me exclusive access to their knowledge. My research was only possible with their willingness to participate in interviews and their fascinating insights. Although the abundance of information they shared posed challenges in condensing it into a concise 6,000-word study, it was undeniably valuable.

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Huub Raspe

Groningen, June 2023

Summary

Cities are seeing increased population growth, leading to a greater dependence on cars. This negatively affects accessibility and the environment. One solution is to redesign cities as "car-free." This thesis explores "How can car-free urban design be supported by innovations in transportation and mobility?"

The thesis focuses on three case studies of car-free neighbourhoods, examining their unique characteristics, challenges, and the role of technological innovations as well as innovative strategies and policies in reducing car mobility. To compliment the case studies and get in-depth view on the neighbourhoods, the case studies are supported by expert interviews. As the research is defined as qualitative, there was a total of nine expert interviews.

The research delves into mobility innovations: Mobility as a Service (MaaS), Shared Mobility, and Mobility Hubs. Key findings include the impact of delivery services on urban mobility, challenges with e-bikes and delivery vehicles on cycle paths, and the influence of societal goals into the private organization of mobility hubs. A key component it the successful implementation of MaaS, but it requires collaboration between public and private partners, though data sharing and concessions may pose challenges.

Shared mobility options, like scooters, have gained popularity, but concerns about their financial viability and user behaviour still need to be addressed. Policy documents associated with the case studies emphasise creating space for pedestrians, cyclists, greenery, and public transport rather than outright car bans. Altering traffic structures and enhancing shared spaces are essential, with customisation supporting smart mobility. Collaboration between the municipality, developers, and service providers is crucial for success, not solely relying on the market or developers.

In conclusion, developing car-free neighbourhoods and promoting sustainable urban mobility requires considering supply flexibility and addressing governance and collaboration issues. Continuous monitoring and assessment are necessary to meet the mobility needs of various professional groups effectively.

Key words: Car free, innovation, city, government, neighbourhood, automobility

Inhoud

1. Introduction

1.1 Background

People like to live in cities: A European Commission (2016) study confirms that the EU is urbanising but only slowly. Between 1961 and 1991, the EU's population share of urban areas (cities, towns and suburbs) increased from 65% to 71%. Between 1991 and 2011, however, this share grew by one percentage point to 72%. Projections show that cities, especially capital cities, will continue to grow with higher levels of migration and natural change. At the same time, the rest of the EU will start to lose population (ibid). An urbanising population brings several benefits, but on the contrary, it also brings several contradictions. For example, the accessibility of cities, due to the increasing number of cars, is expected that time lost due to congestion will increase from 48% in 2018 to 78% in 2024 (Ministry of Infrastructure and Waterstaat, 2019).

The evolution of automobility in cities has profoundly shaped urban landscapes, altering transportation patterns and impacting the daily lives of residents. Urry's study (2004) indicates automobility's effect as a source of freedom, the 'freedom of the road'. Its flexibility enables the car driver to travel at any time in any direction along the complex road systems of Western societies that link together most houses, workplaces and leisure sites (and are publicly paid for). The manufactured object, 'the car,' brings status to its owner and has extraordinary linkages to technical and societal industries. However, it is also one of the most important causes of environmental resource use. However, the existing, unchangeable car-dominated system may be reaching its tipping point. Minor changes are happening, which could tip the current car system into a post-car mobility system if done in a specific order.

Cars have always been a direct contender for space in cities. Parking has far-reaching consequences on urban life (Ostermeijer et al., 2019). In cities, where land is scarce, the opportunity cost of parking is high, as on-street spots compete with pedestrian, cycling, commercial, residential and recreational uses. Nevertheless, cities allocate a significant amount of space to implicitly subsidized parking, potentially leading to excessive vehicle demand (ibid). This is further reinforced by a strong inclination towards faster, individual mobility within the urban landscape, resulting in a low public acceptance of (sustainable) alternatives (Szabó, 2020).

Recently, some cities have been seeking to shift their focus away from cars and towards greener, citizen-focused mobility solutions that may also be healthier (Niewenhuijsen & Khreis, 2016). The study done by Nieuwenhuijsen focuses on the effects of policies towards car-free cities and their likely effects on public health. The likely effects of such policies are significant reductions in traffic-related air pollution, noise, and temperature in city centres.

In literature, the concept of car-free cities is not new. In 2000, Crawford introduced his book 'Car-free Cities', a view on creating a car-free city. As mentioned above, Crawford indicates the tremendous health benefits a car-free city provides. Many cities around the world have picked this up. Hamburg, Oslo, Helsinki, and Madrid have recently announced their plans to become (partly) private car-free cities (Niewenhuijsen & Khreis, 2016). Other cities like Paris, Milan, Chengdu, Masdar, Dublin, Brussels, Copenhagen, Bogota, and Hyderabad have measures that aim at reducing motorised traffic, including implementing car-free days, investing in cycling infrastructure and pedestrianisation, restricting parking spaces and considerable increases in public transport provision (ibid).

A lot of global cities indicate the need for a car-free city. If both the need and added value are high, what are the challenges and requirements to create a thriving car-free environment?

The thesis aims to investigate three case studies of car-free neighbourhoods. Each case study highlights the unique features and challenges of the neighbourhood and provides insights into understanding car-free neighbourhoods and how technologies and policies can support car-free urban design. While some studies have assessed the impact on regional and city levels, there is a need to look at these innovations impacting the urban area level. Ultimately, this collection of case studies aims to learn from urban planners, policymakers, and other stakeholders about the potential of car-free neighbourhoods as a sustainable urban development strategy.

1.2 Research Problem

Looking at three representable neighbourhoods allows adjusting the vision into a car-free narrative. This thesis aims to gain insight into the successes and failures of car-free neighbourhoods and compare these.

Main research question

The direct aim of the research is to investigate the factors contributing to a thriving, future-proof car-free neighbourhood. By researching policies of existing car-free neighbourhoods, we try to understand the successes and failures of such endeavours. This helps us understand what design concepts must be included in a car-free neighbourhood. The main research question is therefore defined as follows:

> "How can car free urban design be supported by innovations in transportation and mobility?"

Secondary research questions

The secondary helps to investigate the problem at hand. They are defined as follows:

1. What sort of niche practices contribute to mobility innovation?
2. What role can urban planning policies play in promoting innovation in transportation and mobility?
3. How can urban design be used to encourage the adoption of sustainable modes of transportation in cities?

Car free

This study uses car-free to explain the concept of a neighbourhood without cars. Nevertheless, in most policies surrounding the use of cars in neighbourhoods, car-free means 'few to no cars. In Dutch, we generally use the term 'autoluw', which means 'relatively few cars' (Van Dale, 2023). For lack of a better word in English, the term 'car free' means 'few to no cars', although this word suggests 'no cars at all'.

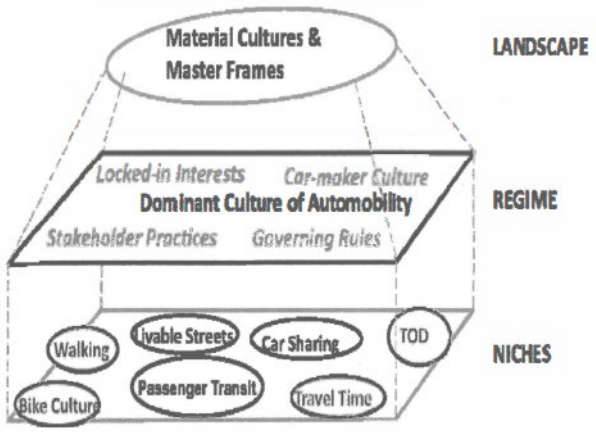
2. Theoretical Framework

2.1 Innovation towards a new mobility system

A car-free environment has many advantages. Car-free cities or neighbourhoods will reduce air pollution and noise levels, increase physical activity, and create room for green space, thereby reducing heat island effects and improving public health (Nieuwenhuijsen, 2021)

However, on the other hand, automobility can be conceptualised as a self-organising autopoietic, nonlinear system that spreads worldwide and includes cars, car drivers, roads, petroleum supplies and many novel objects, technologies and signs (John Urry, 2006). The system generates the preconditions for its self-expansion (ibid). It is a system that is so fundamental and gives a lot of different ways of 'creating' your day. The flexibility of the car will always be one of the selling points, and that will always be a fundamental way of mobility for some social groups.

Removing cars from a neighbourhood should not be a disadvantage. People should implement car-free policies willingly and support them (Doheim et al., 2020). Several innovative urban solutions with mobility aim to make cities more efficient and accessible. In which they have a direct impact on neighbourhoods. To encourage people to reduce their dependency on private cars, a well-developed and integrated transportation system that reaches all parts of the city is essential (Doheim et al., 2020). New mobility services (NMS) (e.g., mobility as a service (MaaS), mobility hubs, shared mobility concepts and innovative bike solutions) are therefore part of an incremental shift in travel behaviour toward a multimodal system, particularly in urban areas (Storme et al., 2021).



The principle of Geels

The study done by Geels et al. (2012) explains transitions. The basic premise of the transitions are non-linear processes that result from the interplay of multiple developments at three analytical levels. These analytical level interact between three levels: (a) niche innovations, (b) changes at the landscape level and (c) destabilisation of the regime.

Figure 1: Dominant cultural structure for mobility (Geels et al., 2012)

In the case of this research, it is about creating a car-free neighbourhood by looking at the transition from the current dominant car-based system to another system; in other words, we are looking at a regime transformation. Car use is never simply about rational economic choices but is as much about aesthetic, emotional and sensory responses to driving, as well as patterns of built environment, political process, sociability, habitation, family and work (Sheller, 2004a). Through the method set up by Geels (2012), seen in figure 1 and worked out by Sheller depicts the multi-level perspective on interactions between the niche, regime and landscape levels, but in this case gives each one a cultural inflection rather than simply a structural mapping.

2.2 Innovative solutions

As was already mentioned, the mobility industry is constantly evolving. Three developments are examined in the next section to lay the framework for the investigation.

Mobility hubs are at the neighbourhood level where at least two sustainable travel modes are connected, such as bus stops and train stations (Zhou et al., 2022). A mobility hub is a recognisable place offering different and connected transport modes supplemented with enhanced facilities and information features to attract and benefit the traveller (Arnold et al., 2023). The choice of location for single hubs or those in a network is integral to the decision-making process. Consideration needs to be given to the requirements of an area concerning its existing facilities, such as tourist attractions and businesses, and also to the size of the hubs, which can be small, medium, or large, depending on local needs. (ibid) The overall impact of the introduction of mobility hubs on their own, however, appears quite limited, which is because the use of mobility hubs induces a longer travel time (Zhou et al., 2022). Limitations in the usability and actual use of the mobility hubs meant that the hubs were not able to deliver their full potential. On the other hand, study shows that decentralized mobility hubs provide substantial support for carsharing when their amenities can be used regularly (Czarnetzki and Siek, 2022).

Shared mobility, both in ride-hailing and car sharing, is now well-developed and widespread worldwide, although it still represents a low share of trips in most cities. However, on-demand ride-hailing is increasing rapidly in many places. (Fulton, 2018). The main factors to which the significant adoption rates can be attributed are respondents' satisfaction with low waiting and travel times, ease of use, and the convenience of smartphone-based service (Oh et al., 2021). Some more radical models entail individuals not only sharing a vehicle but travelling together at the same time, which is promising in terms of congestion and CO2 emissions reductions but also the most challenging one, given the disbenefits in terms of waiting and travel time, comfort, and convenience, relative to the private car (Santos, 2018). There is the potential to integrate autonomous vehicle (AV) technology and ride-sourcing platforms as part of AV-based on-demand shared-ride services, which has been well-recognised by major technology companies (Oh et al., 2021). Road accidents can be reduced by using driverless cars, as the security of our roads significantly increases by almost 90% (Radwan, 2022)

Mobility-as-a-Service (MaaS), integrated with forms of ride-hailing and mobility hubs, has been argued to solve prevalent transportation problems (Karlsson et al., 2020). MaaS can integrate various modes (even within a single trip) into a single service, accessible on demand within a single payment application (Zhou et al., 2022). Seamless digital planning makes combining multiple modes within a single trip attractive for the traveller (Jittraprom et al., 2017). The development and implementation of MaaS is a process embedded in institutional settings that are both formal and informal, and as such, requires institutional changes at many different levels within (and between) different organisations (Karlsson et al., 2020). The novelty and fuzzy natures of MaaS make it challenging to ascertain what MaaS is, its implications and how to address them (Jittraprom et al., 2017).

The discussed innovations could all be determined as a startup concept, as they are relatively new innovations. The process by which a startup's innovative product or service develops is related to startup development. The literature often identifies four stages necessary for scaling up the innovative product.

1. **R&D:** The stage during which a new idea is developed, designed, and put to use

2. **Prototyping**: During this stage, the produced product is rendered market-ready. In addition, it needs to be developed, a company needs to be established, and depending on the product, licenses need to be applied for.
3. **Test- or niche market:** At this point, the product or service is really made available for purchase.
4. **Mass**: The product is then widely advertised, and scaling up actually happens.

Figure 2 summarises the steps that business and innovation undergo. When a startup's innovations are scaled up (see green line in Figure 1), there is often an S-curve (Rogers, 2003). As many of the innovations (mentioned above) undergo the innovative process, it is essential to remember this during the research.

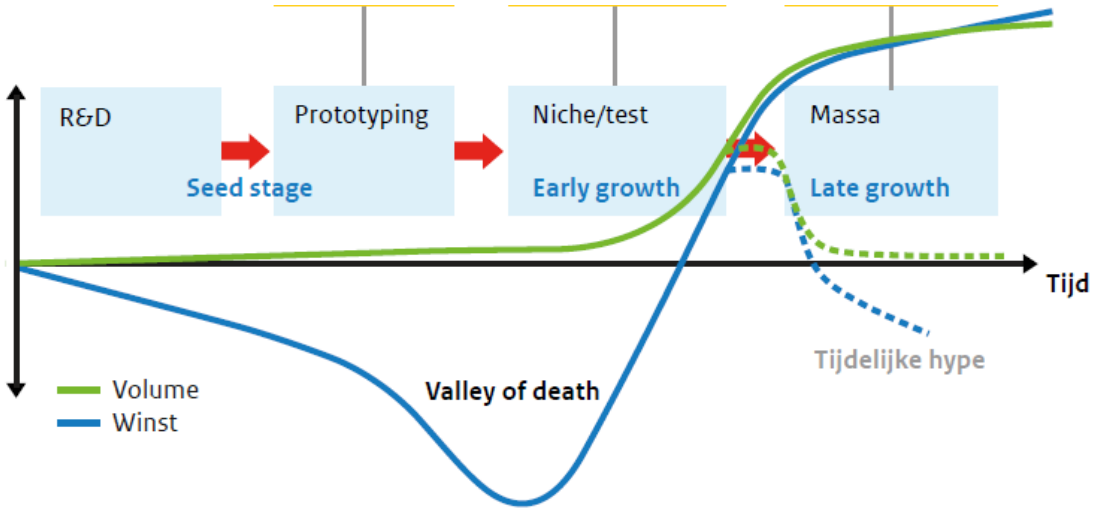


Figure 2: Phases in the development of a mobility startup (source KiM, 2013)

2.3 Research gap

The goal of creating an inner-city free of automobiles is shared by many cities worldwide (Nieuwenhuijsen et al., 2016). Some cities have already begun this and are keen to increase car-free areas in the city (Municipality of Groningen, 2021. Municipality of Utrecht, 2021. Municipality of the Hague, 2020). It marks the beginning of an innovative shift in our core automobile-based system. However, what will happen after this systemic transformation is still being determined. This thesis attempts to respond by addressing the central research question: *"How can car-free urban design be supported by innovations in transportation and mobility?"*

Generally, it is striking that different types of mobility startups often experience different obstacles and success factors, and the extent to which they identify problems also differs among startups (Kim, 2020). The research will identify these problems on different urban levels and aim to understand ongoing difficulties and successes.

2.4 Conceptual model

The choice of mobility is influenced by our urban environment, the presence of alternative mobility solutions, creating infrastructure for alternatives, using strategies of mixed development to support better accessibilities to services, and the cultural acceptance of alternative mobility options is one way to investigate the problem.

Only if the given options are not accepted by the local public support its challenging to implement new strategies, it takes time to implement new strategies and experiment with

alternative ways of liveable spaces. The right side 'residents' support explains that many residents are willing to tolerate the conditions they have found and do not want any change. Naively held ideas and simplistic plans will succumb to violent backless unless schemes for liveable streets are developed with political awareness and a concern for equity (Appleyard, 1980).

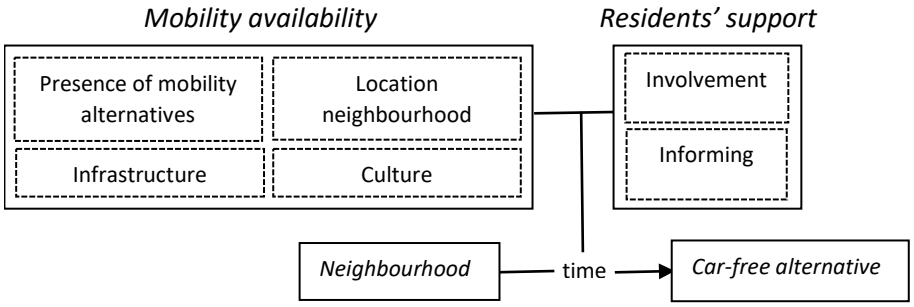


Figure 2: Conceptual model, illustration made by the author

2.5 Hypotheses

The implementation of car-free development has the potential to effectively reduce traffic congestion and air pollution. However, in cities with efficient public transit systems, car-sharing initiatives have not proven successful from a business standpoint. Research by Kushner (2005) suggests that new residents in car-free developments initially anticipate using a car for various trips. However, as they become familiar with their neighbourhood and explore alternative options, their reliance on automobiles diminishes. This hypothesis implies that cities or communities that prioritize walking, cycling, and public transit over private cars through car-free development strategies are likely to experience noticeable reductions in traffic congestion and improvements in overall liveability.

Car-free development will lead to increased social interaction and community cohesion. As Appleyard (1980) mentioned in his study: The street should become a symbolic, if not a legal, sense of territory that the residents believe belongs to them, for which they have a sense of pride and responsibility. This hypothesis suggests that if a city or community implements car-free development strategies, such as creating more public spaces, promoting mixed-use development, and prioritising pedestrian and cycling infrastructure, there will be a measurable increase in social interaction and community cohesion. This increase could occur because car-free development can create more opportunities for people to interact with one another and can create a more attractive and liveable urban environment..

3. Methodology

In this research, the aim is to use a qualitative research method. The thesis will use different case studies around the Netherlands. It aims to discuss the successes and failures of the projects with expert interviews on mobility innovations in these case studies.

There is a general distinction between the three cases to understand better how car-free urban development is created in different project stages and urban environments.

3.1 Case study

The thesis is explorative; by using case studies, we use an in-depth investigation to explore the phenomenon of the car-free neighbourhood. Using the case study method, we are working with a qualitative research method, the overall strategy which encompasses a range of empirical data collection and analysis methods (Taylor, 2016). To understand the complex system of a car-free neighbourhood, we are researching the theory behind the phenomenon, in which a case study is the best research option.

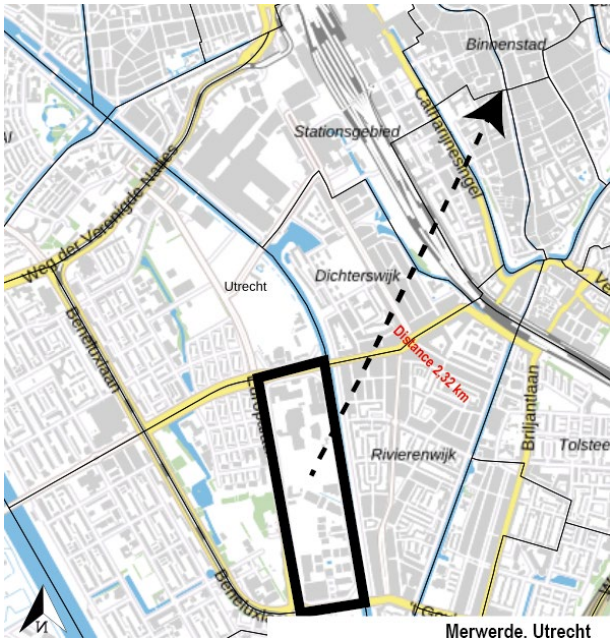
For the case study, we use practical examples. It gives us an insight into the context in where the phenomena occur, like the social, cultural and geographical factors influencing the phenomenon. By testing theory with practical application, we try to understand the validity of the theory.

There is a general distinction between the three cases to understand better how car-free development is created in different project stages and urban environments.

A. A car free neighbourhood that is intended to be car free from the start, but is not yet implemented.
B. A car free neighbourhood that focuses on already existing urban development, but slowly changing the landscape through a social process with inhabitants.
C. A car free neighbourhood that has already succeeded.

Three cases were chosen to try to counter the disadvantages of case studies. For example, the researcher's subjectivity and interpretation of the data can influence the findings. Also, we are subject to generalisation because of the small sample size. However, because of the time-consuming nature of case studies, it is concluded to work with three cases. The following case studies policy documents will be investigated:

#	Policy document	Level	City
1	Hague memorandum mobility	Municipality	The Hague
2	Smart Mobility vision document	Municipality	The Hague
3	Implementation plan “Center-North”	Neighbourhood	The Hague
4	Mobility vision document	Municipality	Groningen
5	Shared mobility implementation programme	Municipality	Groningen
6	Zoning plan “Ebbingekwartier”	Neighbourhood	Groningen
7	Mobility vision 2040	Municipality	Utrecht
8	Smart mobility vision document 2019-2023	Provincial	Utrecht
9	Urban Plan Merwerde	Neighbourhood	Utrecht



Merwerde. Utrecht

A. Utrecht, Merwerde

Merwerde is a neighbourhood in Utrecht. The "cyclist-first" city of Utrecht is constructing the Netherlands' first high-density, car-free residential district for more than 12,000 people, making it one of the largest of its type in the world (The Guardian, 2020). This lays the foundation for an exciting project. Demographically, Merwerde showcases a mix of age groups, making it an inclusive and dynamic neighbourhood. Young professionals, families, and retirees have all found a place in this community, contributing to its lively and multi-generational atmosphere. The neighbourhood's proximity to educational institutions, such as Utrecht University and various schools, has made it particularly appealing to students and academics. This has added a youthful energy to Merwerde, with many students choosing to reside in the area.

Merwerde also emphasizes sustainability and environmentally friendly practices. The neighbourhood incorporates green spaces, cycling paths, and public transportation options to encourage eco-friendly living. This focus on sustainability has attracted individuals and families who prioritize environmental consciousness and wish to contribute to a greener future. Nevertheless, several residents of the Rivierenwijk, on the other side of the canal, directly opposite Merwede, are dissatisfied. They think it will increase the parking demand in their neighbourhood (J. Monster, 2021).

Archipelbuurt, The Hague

B. The Hague, Archipelbuurt

Den Haag is determined in their implementation vision, 'Centrum-Noord' (Municipality of The Hague, 2021), to tackle problems of air pollution and car dependency. The municipality is breaking up parts of the road infrastructure for greener and safer environments.

The neighbourhood attracts a diverse range of residents, including professionals, expatriates, and families. Many professionals are drawn to Archipelbuurt due to its central location and its close proximity to major business districts and government institutions in The Hague. The presence of international organizations and embassies in the city adds to the cosmopolitan character of the neighbourhood, attracting a significant expatriate community.

The city is determined to create a more liveable space through what the municipality calls: "another look on mobility' by promoting more sustainable alternatives with citizens. The initiative started during Corona when more often, people decided to go for a walk or a cycle around.

Ebbingekwartier, Groningen

C. Groningen, Ebbingekwartier

Ebbingekwartier is a neighbourhood closely located next to the city centre of Groningen. The neighbourhood is created with compact residential blocks and discourages using cars on ground level. This is seen by the parking standard of 0,5 cars per household and underground parking garages.

The parking garages were created due to the pollution from a large factory. The factory was demolished, and the polluted soil was removed, which gave the perfect opportunity for extensive parking facilities. On the ground level, this gave much space for creating mixed development and a car-free environment (Municipality of Groningen, 2011).

Ebbingekwartier attracts a diverse range of residents. It is known for its appeal to young professionals, artists, students, and families. The presence of nearby educational institutions like the University of Groningen contributes to a sizable student population, creating a youthful and energetic atmosphere. The neighborhood also welcomes individuals from various ethnic backgrounds, resulting in a multicultural community.

Some other neighbourhoods were considered cases for this research, in Den Bosch, Amsterdam, Zwolle and Vlieland. However, these were less suitable because of the difference in the use of the area (residential was preferred), the size of the neighbourhood and the accessibility of information. In the selection, city centres and parts of residential areas were considered, but it was not easy to find helpful information during the selection process.

3.3 Semi-structured interviews

In order to gain a deeper understanding of the success of car-free neighbourhoods, semi-structured interviews will be conducted with policymakers, architects, and local government employees. While a prepared list of questions will guide the interviews (see Appendix 1), the semi-structured format will allow flexibility and openness in the questioning process. Questions will be posed in an open-ended manner to encourage meaningful and detailed responses. The following respondents were interviewed:

#	Respondent		Date	Mode
1	Lennert Bonnier	Project manager at Goudappel Coffeng	10-05-2023	Online
2	Finn van Leeuwen	Projectmanager Mobility, Municipality of Utrecht	10-05-2023	Physical
3	Taede Tillema	Special professor of transport geography at RuG, researcher at KiM and ministry of Infrastructure and Water management	16-05-2023	Online
4	Thijs Oost	Quartermaster Shared Mobility at Municipality of Groningen	22-05-2023	Physical
	Jacco Kuper	Policy Advisor at Municipality of Groningen		
5	Marije Hamersma	Researcher at KiM for Transport Policy Analysis	24-05-2023	Online
6	Emiel Groenhagen	Urban Designer at municipality of Groningen	01-06-2023	Physical
	Jasper Schweigman	Urban Designer at municipality of Groningen		

Figure 3: Table of interview respondents, illustration made by the author

The information presented in this text is derived from a qualitative study, aiming to understand the challenges associated with the mobility transition. The insights provided by the respondents will contribute to our understanding, benefiting decision-makers who seek to navigate the shift to new commuting modes while considering both successful and unsuccessful innovations.

During the research, a number of participants were interviewed, allowing for the collection of their personal experiences. Prior to final submission, the results were shared with the interviewees, and anonymity measures were implemented as needed, respecting the participants' privacy.

To ensure active participation during the interviews, recording software was utilized. The transcripts of all recordings will be used to validate the interviewees' responses. Prior to each interview, explicit permission was obtained from the participants, and the interviews were subsequently transcribed for thorough analysis.

As part of the research process, our interviewees will be requested to sign a consent form. By signing the form, the interviewees voluntarily agree to participate in the study without any obligations. Their privacy and confidentiality will be upheld throughout the research.

3.4 Data analysis

One of the main tools used is interviews. After conducting and recording these interviews, they will be transcribed. Because of the research in the first secondary research question, there is already a familiarisation present with the context of the interviews. So after the interviews, the interviews will be analysed through coding.

The coding involved has identified different labels within the different concepts of the case studies. Because of the semi-structured interviews, there will be general labialisation based on the conceptual model beforehand. Nevertheless, the interviews determine their interpretation of the meaning behind the labels.

It is determined to use labels in the research to create framing because of time management. These are used to compare information between the case studies. See figure 4 for the coding scheme.

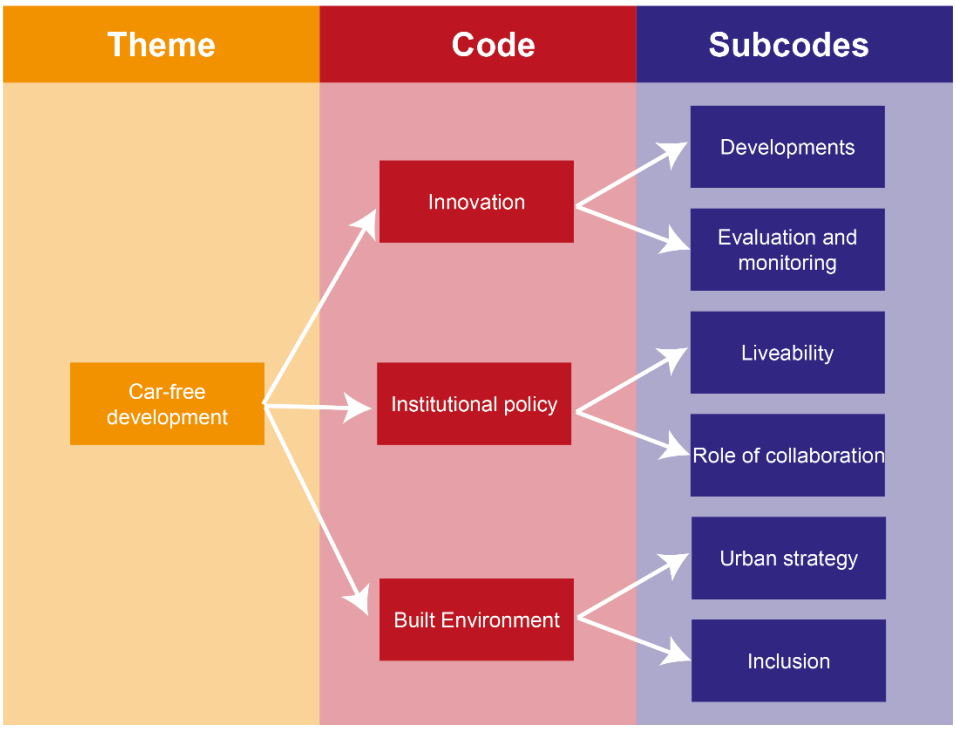


Figure 4: Data coding scheme, illustration made by the author

4. Results

As a result of the research setup, the case studies were input for the interviews to gain insight into the more practical side of the mobility transition. In this, respondents were asked about their experience and knowledge of the case of mobility transition based on open questions. The following chapter describes the results of this data.

4.1 Niche practices contributing to mobility innovation

Mobility innovation is a broad spectrum to investigate. As determined in the theoretical framework, three distinct innovations were chosen: MaaS, Shared Mobility and Mobility Hubs. Nevertheless, as research instigates, it is sometimes good to create a brought perspective.

One of the most significant developments often overlooked is the impact of delivery and flash delivery services on our mobility. Since Corona, the fleet of flash delivery vehicles has grown exponentially. The speed of the change has been such that not only city planning and policies are lagging in addressing the consequences, but in the same way, there is yet to be an established business model for such services (Morganti et al., 2017). We must start investing in and protecting the publicness of urban markets as collective infrastructures before workers and consumers remain vulnerable to new and unimagined predatory formations (Shapiro, 2022). However, they have been popping up as mushrooms and are determined to stay (NOS, 2021).

Along with the development of (electric) bikes, the cycling path is getting increasingly crowded. E-bike promotion policies target young age groups, those around retirement age, and people living in rural areas. To facilitate a greener modal shift in cities, policies aim to improve cycling conditions by smoothening the flow for cyclists while calming car traffic (Sun et al., 2019). As such, they are also part of broader urban transformations and may be driven by particular imaginaries of urban futures (Nikolaeva, 2019). Both developments of flash delivery and e-bike encouragement impact the cycle paths. Both forms are increasing speeds, so there is, to some extent, a perceived insecurity happening.

> *"They impact the cycle path because they often cycle fast, so there is some perceived insecurity. You can try to regulate it, but you have almost no control over it."* - Lennart Bonnier.

On the other hand, mobility hubs are being introduced. It is not among the newest innovations, as the Netherlands has had a node policy "knooppuntenbeleid" for over 30 to 40 years. There are different types of hubs depending on the size and type of neighbourhood or district. It depends on location and supply and what you get in return. It is an idea that has many customisation options. Due to this customisation, developing mobility hubs cannot be seen in isolation but are part of a broader policy package (Kim, 2021).

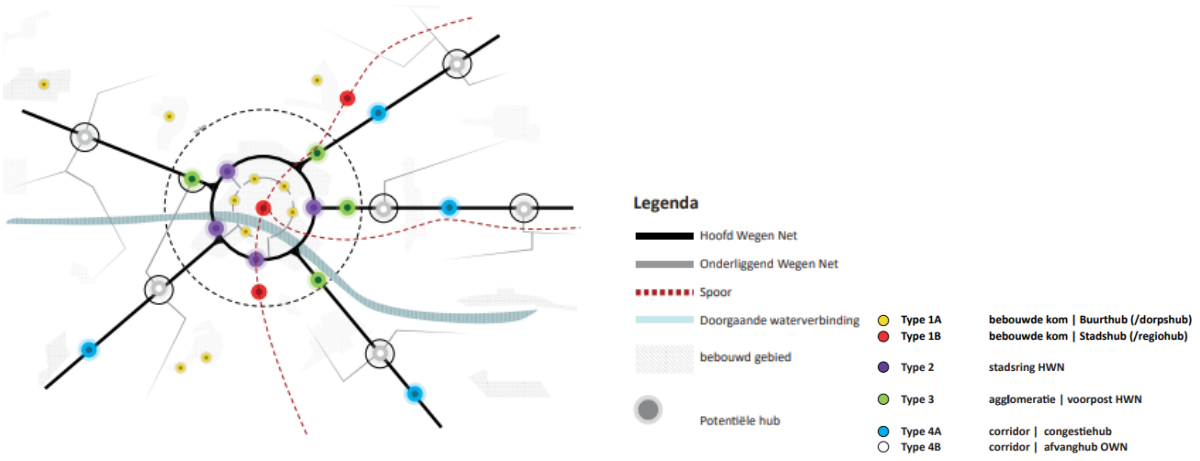


Figure 5: Different types of mobility hubs (source: VenHoevenCS, 2020)

Next, societal goals are projected onto the space, and you cannot just leave that to the market. As determined by research done by the KiM (2020) and through interviews, some prerequisites could be set to support the development of a mobility hub. As shown in the following table:

MICRO	MESO	MACRO
❖ Spatial concentration and branding	❖ Quality pre- and onward transport	• Pricing of car ownership and use
❖ (Social) safety	❖ Access restrictions city centre	• Development of MaaS
❖ Pricing of services	❖ Access pricing and parking policy	• Fiscal treatment multimodality
❖ White label	❖ Coordination with spatial planning	• Developments in supply of shared mobility
❖ Space for commercial versus social functions	❖ Coordination with local entrepreneurs	• Separation of regular public transport and target group transport
❖ Flexibility versus structuring effect		• Electrifying mobility

Table 1: Perquisites Mobility Hub (source: KiM, 2020)

MaaS could play an essential role in the concept of mobility hubs, but it requires much collaboration between public and private partners. It often goes through different concessions, creating ambiguity and reluctance among parties. In addition, private parties often need to be more open to sharing market-sensitive information and data to analyse the data of partial mobility providers. Fortunately, this is also improving in recent years.

> *"The question is: what makes hubs so popular in policy at the moment? I think it has to do with reducing resistance to changing public transport, and MaaS can play an important role."* – Taede Tillema.

Finally, the concept of shared mobility. As could be determined by the interviews, the most popular option is the scooter. The sharing options of cars and bicycles are rising but must catch up. The biggest concern is the financial feasibility of the total package. Most vehicles are placed in locations where income is high, and education levels are also high. Municipalities would also like to see the vehicles placed in neighbourhoods that could be more commercially attractive, in which municipalities like Groningen are increasingly trying to play a role.

Users' behaviour is often a challenge. This is because users can, when seeing a nicely designated place, still manage to put down their bikes or scooter inappropriately, causing a disturbance. You would like a free-floating system where everyone can put their vehicles down and take them where they want. Nevertheless, that is a tricky reality to realise.

> *"The image of the car has changed; the reason is not unambiguous. The car used to be seen as something important, and much space was devoted to it, but that is no longer the case today. Perceptions have changed, and this is due to several developments, for example, shared mobility."*
> – Jacco Kuper

4.2 Role of urban policies in promoting mobility innovation

It could be determined that in policy, as seen in the policy documents connected with the case studies, it is most often not about banning cars in a neighbourhood. Instead, it creates more space for pedestrians, cyclists, greenery, and public transport. This is by applying a modified traffic structure that will not allow cars to drive straight through the city but will ensure accessibility. As seen in the policies of the cities of Utrecht, Groningen, and The Hague, most often, it is about approaching it from the perspective of public space. Where is the pressure the highest, and where must we adjust? This happens at different scales: on the city, district, and neighbourhood levels.

> *"You want a place like a community room for a neighbourhood that also meets mobility needs but does not exist yet. Mobility is never an end in itself, but a means to achieve your goals, which is very much related to your objectives and how to handle mobility."* – Lennert Bonnier.

Collaboration

Every city has its approach to supporting smart mobility, and it indicates the need for customisation in every city. In this, some national cooperation programs are being set up to support integrating different policies and set a baseline for intelligent mobility. For smaller cities, a basic template is needed to create uniformity in the availability of intelligent mobility methods. This basic template is to create some criteria in which developers will have the ability to support the widespread availability of intelligent mobility.

Throughout these projects, you can have different developers, and the interests of these developers are crucial to the success of a car-free area. In Utrecht, for example, a large part of the land was owned by the municipality, so a contract could be concluded to cooperate with different partners, making the beginning of the project challenging. Nevertheless, it gave a system in which all the interests were the same direction from the start. After all, an investor finds it irritating to realise parking facilities for his neighbours. On the other hand, if many private organisations own an area's development, you can only encourage cooperation, but financial aspects will always be decisive. Bringing together all the parties involved, including the municipality, developer, and service providers, is a big challenge. It is a total system. Once it works, then residents will make sure it is used. Throughout, there is a need in this system for flexibility of supply to adjust when necessary.

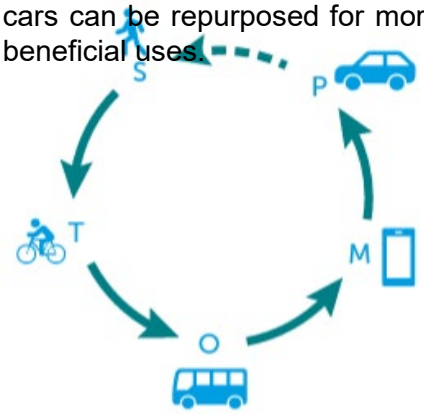
We have all kinds of societal goals that we project onto that space. Moreover, you can argue that you cannot leave it to the market. You cannot just leave that to the developer. That space becomes a hub where all kinds of governance and collaboration issues come together; we need to get used to that.

4.3 Urban design and integration

Changing an urban environment is contentious. One particular issue that often sparks controversy is the removal of parking spaces. Car owners expect convenient and free parking wherever they go, leading to conflicts. However, it is essential to address the problems associated with parking and car ownership, and many cities are actively working towards reducing them. This endeavour involves prioritising elements within the built environment.

Urban Strategies

The key is to ensure that everyday necessities like supermarkets, bakeries, schools, and sports clubs are conveniently located within walking distance of residential areas. By encouraging this proximity, we aim to discourage car usage. One approach involves placing parking areas on the outskirts of neighbourhoods, prompting residents to walk or cycle to nearby supermarkets rather than relying on their vehicles. Consequently, the space previously allocated for cars can be repurposed for more beneficial uses.



Principle of STOMP

According to the STOMP principle, these can be divided into Steps, Stairs, Public Transport, Mobility as a Service, and private cars. The human being is central to this. Applying function mixing and compactness wherever possible creates walkable areas 9S). Together with cycling (T), these journeys are preferred at shorter distances, as they are healthy and clean journeys. For longer distances, cycling and public transport offer solutions as clean and space-efficient modes. MaaS can facilitate and further stimulate this use. As MaaS involves an intelligent integration of trips across different modalities, trips via M affect trips via S, T, O, and P. The private car counts as the final element. That does not mean, by the way, that there should be no room for cars. (Source: CROW, guide to sustainable development)

Step 1	**S**	(Stappen) Walking	How to set up an area where many amenities are within walking distance?
Step 2	**T**	(Trappen) Cycling	Connecting cycling route network to destinations and facilities
Step 3	**O**	(OV) Urban Transit	How to combine public transport facilities and area functions
Step 4	**M**	(MaaS) Mobility as a Service	What forms of MaaS are offered in the area
Step 5	**P**	(Privéauto) Car	How to position the private car so that other mobility options are more attractive (without 'car bullying')

Figure 6: The principle of STOMP (Source: CROW)

A strategy in this complex case (shown above), which many cities have used, could be the STOMP strategy. The mobility transition consists of three main aspects, people's needs, changes in behaviour patterns and the emergence of a platform economy. Nevertheless, it also increasingly has an analogue side, making different choices regarding the space in our immediate environment. It is about the individual value-added component in people's lives, which brings much value.

> *"Mobility is subservient to your system, and it is never an end. Mobility is never an end in itself, but a means to achieve your goals, and that depends a lot on your goals and how you should deal with mobility."* – Lennert Bonnier.

Transitioning to the next phase can be challenging for residents, and it largely depends on the choices made when moving into a residential area. The availability of parking options, such as parking space in front of your house and a reasonably priced monthly parking permit, greatly influences decision-making. In contrast, the absence of such options can lead to different choices altogether.

Once you become a car owner, parting ways with your vehicle becomes difficult. This contrasts with individuals who consciously decide against owning a car when moving into a new home, where car ownership is impossible. In such cases, switching to a car-free lifestyle is easier since it becomes a transformative experience. Therefore, remaining vigilant and consistently reflecting on this aspect is crucial.

Creating an appealing public space facilitating leisure activities, children's play, and socialising with neighbours contributes to a pleasant living environment. To establish a functional mobility system, this enjoyable living environment must be so compelling that residents can weigh the trade-off between having a car conveniently parked nearby, parking at a slightly distant location, or even forgoing car ownership altogether.

The strategy primarily revolves around not portraying it as an imposition on car owners but instead highlighting its additional benefits. After all, it is universally essential to reside in a neighbourhood where one feels comfortable and at ease.

Inclusiveness

Inclusiveness holds great importance when considering urban planning. It is essential to ensure that accessibility remains intact and does not deteriorate over time. While we possess ample knowledge about traffic patterns and those who are mobile, we often need more understanding about individuals who need the means or opportunity to move freely. This includes those who choose to stay at home and those who face financial constraints or limited access to public transportation, preventing them from visiting friends and family.

The cost of parking has undergone significant changes over time. In some districts, renting a parking permit and space amounts to around 12 euros per month. However, the actual price escalates considerably if we consider the actual parking costs, such as environmental damage, social impacts, the expenses associated with car ownership, and space utilisation. It can reach amounts as high as 250-300 euros per month. These figures are substantial. Consequently, different income groups may need to make choices in the future. As a government, it is crucial to ensure that even with reduced car ownership, adequate mobility options are available to the population.

Shared cars present a viable alternative in this context. However, the costs are often compared to those of new cars, neglecting that a significant portion of the population relies on second-hand vehicles. It is essential to consider how certain professional groups can maintain their mobility. Therefore, ongoing monitoring and assessment are necessary to address this concern effectively.

5. Conclusion

This thesis aims to provide valuable insights into the role of transportation and mobility innovations in supporting the transition towards car-free urban design. This was accomplished through a comparative analysis of three case studies and conducting semi-structured interviews to identify both successful and unsuccessful aspects of the transition process. The central research question guiding this investigation is: "How can car-free urban design be supported by innovations in transportation and mobility?"

It is essential to acknowledge that the innovations examined in this research are still in the early stages of development. Consequently, defining a definitive "final product" is challenging as transitioning to a car-free city is ongoing. Moreover, it is crucial to recognise that the ideal car-free urban design will vary based on the specific context of each neighbourhood, whether it is urban or rural.

During the research, various car-free innovations were explored, and it became evident that creating a comprehensive package of mobility solutions and establishing a new mobility system is essential. While leaving this task solely to the market is an option, it requires substantial governmental intervention to bring together different stakeholders. Encouraging residents to adopt more sustainable transportation options is critical, but it is essential to acknowledge that achieving a completely car-free city is not feasible. For instance, delivery services are necessary to ensure accessibility to stores, and emergency services rely on the flexibility provided by cars.

In this context, it is evident that the urban landscape is gradually shifting its focus towards creating more liveable spaces by considering mobility aspects. It is worth reiterating that mobility is a means to achieve broader goals and should not be seen as an end. The approach to mobility depends heavily on the specific goals and objectives of the urban environment.

This thesis highlights the importance of transportation and mobility innovations in facilitating the transition to car-free urban design. It emphasises the need for ongoing development and adaptation, recognising that a universal solution or an utterly car-free city is not feasible. The urban landscape is evolving, with mobility as a tool to create liveable and sustainable spaces that align with specific goals and objectives.

5.1 Recommendations

Based on research, some of the recommendations for further research:

- **Have attention to effectiveness.** As found in literature and research, virtually none of the policy documents assess the expected effectiveness. This could be explained by the startup culture of the current mobility transition; due to a lack of experience, there still needs to be more knowledge of the implications.
- **Research into proposing innovation as a package.** The packaging of different measures is essential. To conclude in research, the playing field of the mobility transition is interconnected, and good timing is essential, together with clear communication and stakeholder participation.

Research into short-term propositions. Many of the innovations in the research are partly startup concepts, which should be implemented accordingly. It would be interesting to see a startup's effects in an ever-changing urban environment. For example, what influence would shared mobility have at times of road closure and residents being forced to walk further to

their car? This could be done to research the feasibility of shared mobility in non-favourable neighbourhoods.

5.2 Discussion

This thesis aims to investigate what it would take to achieve a car-free city. However, during the research and interviews, it was determined that something like a car-free city is impossible. Identified measures are aimed at contributing 'towards' a low-car city. A completely car-free city will require a more radical change in the urban environment. Instead, it is all about creating more space for pedestrians, cyclists, green spaces, and public transport, with a modified traffic structure that no longer allows cars to drive straight through the city but remains accessible.

Regarding effectiveness, this thesis had a strong focus on innovation. However, many of the developments researched are still in their early stages, in which it is difficult to determine what is needed to improve the product. It takes time to investigate and improve the innovation. We are currently in a generation of area development, where projects like Merwerde offer great opportunities. When these projects are one or two years away, we will have learned a lot and can learn from each other's experiences—a collection of good and bad practices.

This thesis is a snapshot of current events and developments in mobility transition. The research offers a brief insight into the ongoing events related to this transition. However, it is essential to acknowledge that a comprehensive analysis of the transition was not feasible due to word count limitations (with the thesis being restricted to 6,000 words). This limitation underscores the necessity of establishing more precise boundaries at the outset of the research to ensure a more specific and focused study.

Furthermore, considering the time constraints, a qualitative research approach was chosen. While this approach has advantages, it should be noted that not all relevant information regarding ongoing car-free innovations could be covered. Recognising that the mobility transition is an ongoing and complex process, it is evident that further research is required to develop a clearer understanding of the subject matter. Each of the innovations explored in this research has the potential for further investigation, and it is essential to recognise the interlinkages between these innovations.

To paint a comprehensive picture of the mobility transition, future research should delve deeper into individual innovations while examining their connections and synergies. This will allow for a more holistic understanding of the broader transformation.

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Appendix 1: Interviewstructure

Duur:
Geïnterviewde:
Datum en tijd:

Bedankt dat je de tijd hebt genomen om aan dit interview deel te nemen. Het zal ongeveer 30 minuten duren. Door de vragen te beantwoorden, help je mee aan mijn onderzoek naar de mobiliteitstransitie naar autoloze omgevingen.

In het kort heeft de onderzoek de volgende hoofdvraag en deelvragen: *"How can car free urban design be supported by innovations in transportation and mobility?"*

1. What sort of niche practices contribute to mobility innovation?
    a. Ex. Shared mobility, mobility hubs & MaaS
2. What role can urban planning policies play in promoting innovation in transportation and mobility?
3. How can urban design be used to encourage the adoption of sustainable modes of transportation in cities?

Dit wordt op basis gedaan van drie case studies: Ebbingekwartier in Groningen, Merwerde in Utrecht en Archipelbuurt in Den Haag. Voor bij dit interview is het bijvoorbeeld interessant wat uw ervaringen waren met de betrokkenheid bij het project Merwerde, maar waar nodig zijn ook andere ervaringen aantrekkelijk om over te hebben.

De interviews worden opgenomen om de aandacht vast te houden tijdens het interview en achteraf te controleren of alles goed is neergezet. Deze procedure wordt gebruikt om de antwoorden van de geïnterviewde dubbel te controleren. Gegevens zullen op een veilige manier worden behandeld. Na het interview worden alle persoonlijke gegevens, zoals de naam van de geïnterviewde, verwijderd. De opname zal worden getranscribeerd en bij aanvraag kunnen resultaten gedeeld worden met de geïnterviewde.

Voorafgaand aan het interview zal van elke respondent een toestemmingsformulier worden gevraagd. Met zijn of haar handtekening ondertekent de respondent geen toezegging. Het wordt alleen gebruikt om te bevestigen dat de respondent actief heeft deelgenomen aan dit onderzoek. Alle deelnemers mogen het onderzoek op elk moment verlaten.

Vragen

- Kunt u iets vertellen over uw achtergrond en ervaring bij Goudappel Coffeng?
- Kunt u een project of ervaring beschrijven die volgens u exemplarisch is voor uw werk of prestaties?
- Hoe blijf je up-to-date en op de hoogte van nieuwe ontwikkelingen of trends op het gebied van mobiliteit?

Innovatie in stedelijke mobiliteit

- Kunt u enkele specifieke nichepraktijken of innovaties beschrijven die belangrijk zijn geweest voor **mobiliteitsinnovatie** en hoe deze een impact hebben gehad op transport- en mobiliteitssystemen? Bijvoorbeeld mobiliteitshubs, gedeelde mobiliteit en MaaS-innovatie? Heeft u ook meegedaan aan een bepaalde in het bijzonder?

- Hoe kan **samenwerking tussen verschillende sectoren**, zoals technologie, vervoer en stadsplanning, worden ingezet om duurzame mobiliteitspraktijken en innovaties in steden te bevorderen?
- Welke rol kunnen publiek-private partnerschappen volgens u spelen bij het bevorderen van innovatie op het gebied van mobiliteit?
- Hoe kunnen nichepraktijken en innovaties worden **opgeschaald** om een bredere impact te hebben op vervoers- en mobiliteitssystemen?
- Wat zijn de **grootste uitdagingen** op het gebied van innovatie voor de **toekomst** van de transitie in ons mobiliteitssysteem?

Het realiseren van mobiliteitsinnovatie in de gebouwde omgeving

- Wat zijn volgens u enkele **belangrijke elementen van stedelijk ontwerp** die de invoering van duurzame vervoerswijzen in steden kunnen stimuleren?
- Hoe ziet u opkomende technologieën zoals elektrische en autonome voertuigen, fietsdeling of ride-sharing die de ontwikkeling van autovrije stadsplanning beïnvloeden?
- Hoe kunnen **evaluatie en monitoring** worden gebruikt om het effect van stedenbouwkundige strategieën op de toepassing van duurzame vervoersmiddelen te beoordelen, en hoe kan deze feedback worden gebruikt om toekomstige ontwerpinterventies te verfijnen en te verbeteren? *Hoe was het, hoe is het en wat kan het worden?*
- Hoe kan publieke betrokkenheid en inbreng van de gemeenschap worden geïntegreerd in stedelijke ontwerpprocessen om ervoor te zorgen dat duurzame vervoersoplossingen inspelen op lokale behoeften en voorkeuren?
- Wat zijn de grootste uitdagingen in de bebouwde omgeving voor de toekomst van de transitie in ons mobiliteitssysteem?

Institutioneel beleid ter bevordering van innovatie in stedelijke mobiliteit

- Hoe denkt u dat **stedenbouwkundig beleid** kan worden gebruikt om innovatie in vervoer en mobiliteit te bevorderen?
- Kunt u voorbeelden noemen van stedenbouwkundig beleid dat met succes innovatie in transport en mobiliteit heeft bevorderd?
- Welke **strategieën** kunnen stadsontwerpers volgens u gebruiken om de invoering van duurzame vervoerswijzen in steden aan te moedigen?
- Kunt u uitdagingen of obstakels beschrijven waarmee stedenbouwkundigen te maken kunnen krijgen wanneer ze innovatie in transport en mobiliteit proberen te bevorderen via beleid?
- Kun je een moment beschrijven waarop je je moest aanpassen aan een nieuwe situatie of omgeving, en hoe je die overgang hebt doorstaan?