From Streets to Spaces

Designing sustainable mobility to improve liveability and accessibility in post-war neighbourhoods

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TU Delft - Urbanism

Colophon

From Streets to Spaces: Designing sustainable mobility to improve liveability and accessibility in post-war neighbourhoods

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This report made responsible and transparent use of Artificial Intelligence (AI) tools, notably ChatGPT, to assist with text summarisation, language refinement, and initial brainstorming of content and structure ideas. At no point did AI replace the author's own critical analysis, original ideas or ethical reflections. All content generated or edited with AI has been critically reviewed, verified, and adapted where necessary to ensure accuracy, relevance, and alignment with the author's own insights and intentions.

Abstract

This graduation project investigates how spatial design for sustainable mobility can enhance liveability and accessibility in post-war neighbourhoods, using Hoge Vucht in Breda as a case study. In the context of climate change, urban densification, and the transition towards more sustainable cities, mobility plays a key role in shaping liveable neighbourhoods. Post-war areas in particular are dominated by car-oriented structures, reflecting the era in which they were built. This car-dependency creates a vicious cycle, causing air pollution, is not human-centred and takes up a lot of the land use in the city.

Two frameworks were developed to assess liveability, consisting of safety, spatial quality, health, community and accessibility, and a separate framework that zooms in further on accessibility, consisting of proximity, mobility, time and inclusiveness. These frameworks provide a structured lens to evaluate the spatial impact of design interventions.

A research-by-design approach was used with the case study area Hoge Vucht. Four scenarios are maximised, each emphasising one mobility type and one value of liveability or accessibility. These scenarios are assessed using the frameworks and combined into a single final design.

Key findings indicate that sustainable mobility and liveability reinforce one another: reduced car dominance creates space for play, social interaction, and nature. Reducing private car use does not automatically improve accessibility, but carefully designed sustainable mobility options help maintain and even enhance it. Improved proximity and high-quality walking and cycling paths ensure accessibility within the neighbourhood, while a well-connected cycling network, frequent and fast public transport, and a wide range of shared mobility ensure accessibility for longer distances. This transition requires time to change both public spaces and people's travel behaviour. Starting with small-scale implementations and followed by larger infrastructure changes, a transition can be made from functional, car-dominant streets to valuable public spaces.

Keywords
Sustainable mobility, liveability, accessibility, post-war neighbourhoods, public space, mobility transition.

Glossary

Neighbourhood:
Hoge Vucht (in Dutch “wijk”)

Sub-neighbourhood:
Smaller part of a neighbourhood (in Dutch “buurt”) (Biesdonk, Geeren-Zuid, etc.)

Scooter:
Two-wheeler without an engine propelled by foot or electricity (in Dutch “stepje”)

Moped:
Motorised two-wheeler that can be powered by either petrol or electricity (in Dutch “scooter”)

Preface

Before you lies the report *From Streets to Spaces*, the result of my year-long graduation project for the Master’s track *Urbanism*.

My interest in how mobility shapes so much of our public spaces sparked my curiosity to explore this subject in greater depth for my graduation. I am interested in how the design of public spaces affects people’s everyday lives, and how this can stimulate more sustainable modes of mobility. Within the context of climate change and urban densification, this transition to more sustainable mobility is very relevant. It was interesting to combine this from both spatial, technical and social perspectives. Especially in post-war neighbourhoods, we should rethink the car-oriented urban structures and break the cycle of car dependency. This thesis reflects my interest in contributing to more people-oriented and sustainable urban development.

This project would not have been possible without the support of several people. First, I would like to thank my mentors from TU Delft, Rients Dijkstra and Machiel van Dorst, for their guidance and feedback throughout this project. I would also like to thank Maiara Uliana, my internship supervisor, and the other colleagues at TNO for their insights about mobility.

I want to thank my study friends Esmee, Eva, Annika, Maaike, and Lotte for all the time we spent together studying and for always being the cheerleaders in the last row during presentations. Thank you for all the fun we had, for helping me when I got stuck, for pointing out how to pronounce *analysis*, and for the endless cups of tea and snacks.

I also want to thank Ard for the love, support and motivation during this graduation. Thank you for listening to my struggles and cooking dinner when I did not have time. Finally, I would like to thank my parents for their endless support and encouragement throughout my academic journey.

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01
INTRODUCTION

This chapter explains the problematization and the urgency for this research. Cars dominate public spaces, creating environmental, social and spatial problems in our cities. This is especially evident in post-war neighbourhoods. Hoge Vucht in Breda is such a post-war neighbourhood and will serve as case study area for this research. When cities transition towards more sustainable mobility systems, it is essential to ensure that liveability and accessibility within neighbourhoods are prioritized, to create environments where people, rather than cars, are central. This research aims to explore how sustainable mobility can improve liveability and accessibility in post-war neighbourhoods through spatial design, both now and in the future.

Parking lot next to shopping centre Hoge Vucht, Breda (Author's image, 2025)

1.1 Introduction

In the 20th century, the car became the dominant mode of transportation. As shown in figure 1, today, 69% of all travel kilometres in The Netherlands are made by car (CBS Statline, 2024b). Our dependence on the car is a vicious circle where more cars lead to a better car infrastructure, leading to spatial spread, leading to more car dependence (Zijlstra et al., 2022). This shift fundamentally changed how cities are planned. Cities are designed for the car, and streets are no longer places for children to play or for neighbours to meet, but property of the car, with wide street profiles and many parking places.

In recent years, there has been increased criticism of this approach to planning. Excessive car use has negative effects on environmental, social, and spatial dimensions. In the next section, these negative effects of the car are discussed. There is a need for a mobility transition to shift the current approach to city planning from car-oriented to human-oriented.

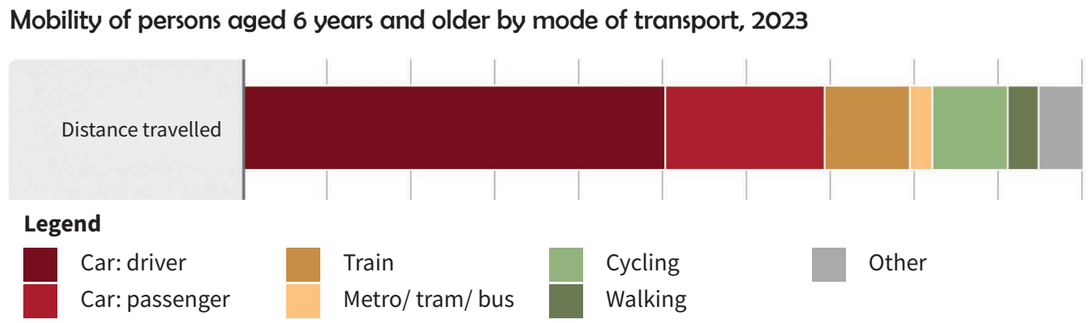


Figure 1: Mobility of persons aged 6 years and older by mode of transport in 2023 (CBS Statline, 2024b, edited by author)

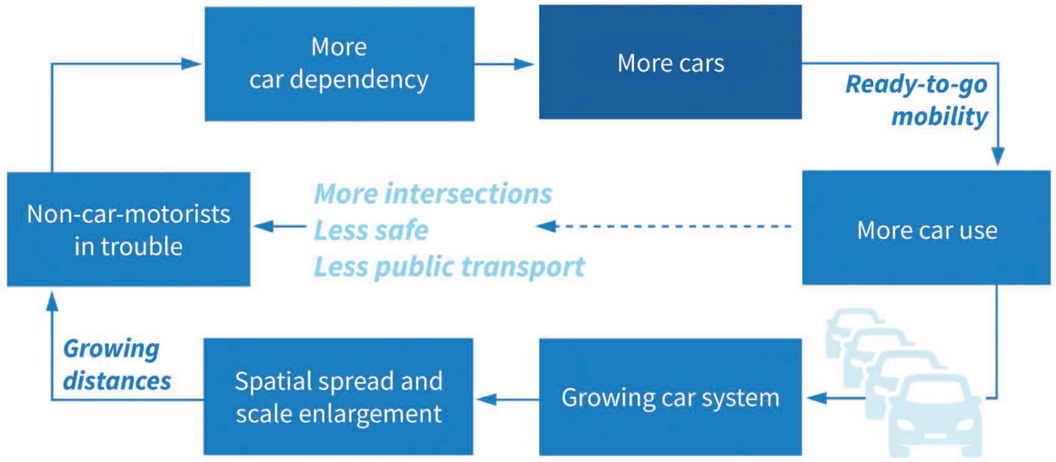


Figure 2: Vicious circle of car dependency (Zijlstra et al., 2022)

Environmental problems

In 2023, the mobility sector accounted for 24% of the total CO2 emissions in The Netherlands (CBS Statline, 2025). Of these mobility emissions, 45% came from private cars (see figure 3). The emission of CO2 in the atmosphere enhances the greenhouse effect, leading to climate change. As part of the 2019 EU Green Deal, targets were set to reduce transport-related greenhouse gas emissions by 90% by 2050 (European Commission, 2019). To achieve a 90% reduction in CO2 it is not enough to just change to electric vehicles. To achieve this goal, a modal shift and reduction in overall travel kilometres is needed. Some calculations about the CO2 reduction are in appendix A. Cars are also responsible for the emissions of pollutants, such as nitrogen and particulate matter, causing air pollution affecting the health of humans, animals and nature. Also, infrastructures such as highways or train rails harm ecology by changing and loss of habitats, isolation of habitats (because of barriers), and an impact on habitats because of pollutants, noise, light, vibrations, heavy metals, and road salt (Kirsten et al., 2003).

"90% reduction in transport-related greenhouse gas emissions by 2050"

~ EU green deal (2019)

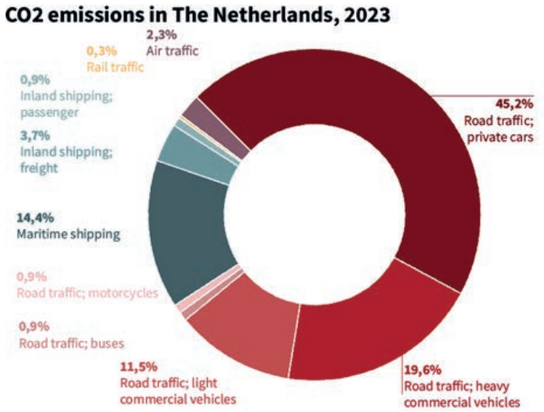


Figure 3: CO2-emissions by mobility in The Netherlands in 2023 (Author's image, data from CBS Statline, 2025)

Social problems

In addition, there is a call for more human-centred urbanism. The first to advocate for more human-centred city planning were Jane Jacobs and Jan Gehl. Jacobs and Gehl both advocate for more active mobility (walking and cycling) and a decrease in car usage in the city (Gehl, 1971). Nowadays, the ideas of more human-centred urbanism and more focus on the slow mobility are represented in the 15-minute city concept by Carlos Moreno (2016) and Transit-Oriented Development. More active mobility in the city creates more possibilities for social interaction (Kennedy & Buys, 2010) and it promotes healthier lifestyles. Moreover, by reducing car dependency, cities become more inclusive for people who can't drive, due to cost, physical ability, age, or personal circumstances (Bastiaanssen & Breedijk, 2022; Elewa, 2019).

"Cities must urge urban planners and architects to reinforce pedestrianism as an integrated city policy to develop lively, safe, sustainable and healthy cities."

~ Jan Gehl, Cities for People, (2010, p. 6)

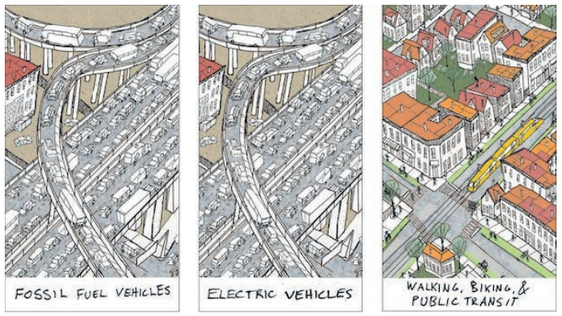


Figure 4: The need to change our travel behaviour (Huerta, 2023)

Spatial problems

Additionally, there is a limit to the amount of space available in Dutch cities. Urban areas in the Netherlands are becoming increasingly dense, while the country simultaneously faces a major housing shortage. The Dutch government has set the target of building 1 million new homes before 2030, which places even more pressure on the already scarce urban space (Ministry of Housing and Spatial Planning, 2023). These houses need space to be built, and will also increase the number of people living, working and moving in the city. For mobility, there are substantial differences in the amount of space required by different modalities, as shown in figure 5 and 6. A person walking only needs 2m2, a bus (50 km/h, 20 passengers) uses 8m2 per person, and a driving car (50km/h, 1,4 persons per car) takes up 80m2 per person (Gemeente Amsterdam, 2019). And that is only the space while driving; a car is parked for 96% of the time on average (Zijlstra et al., 2022). This also requires a lot of space for parking.

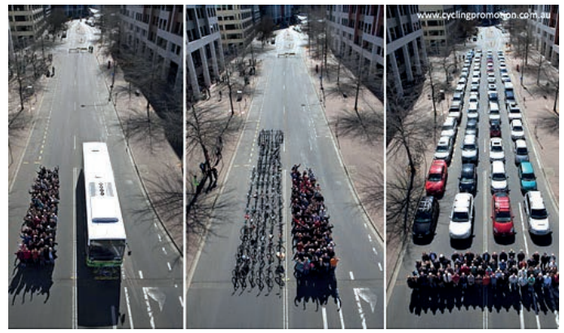


Figure 5: Road space: bus vs bikes vs cars (Cycling Promotion Fund, 2012)

A mobility transition is needed

From environmental, social, and spatial perspectives, it is clear that current transportation practices are unsustainable in the long term. The excessive use of cars causes air pollution and noise pollution, is not human-centred and takes up a lot of land use in the city. This excessive car dependence is a vicious circle. There is a need for an active mobility transition where we move from our dominating fuel cars to more sustainable forms of transportation, for example, active mobility (walking and cycling), public transport and shared mobility.

Figure 6: Road space (Gemeente Amsterdam, 2019, p.18, edited by author)

1.2 Problem context

Post-war neighbourhoods

Many studies about the mobility transition are focused on high-density city centres. This is a logical place to start, since this is where the density of people and facilities is highest. However, for the mobility transition, a transition is also needed for suburban and rural areas. Therefore, more research is needed on other typologies, for example, post-war suburban neighbourhoods (CROW, 2021). This research will focus on these post-war neighbourhoods.

Post-war neighbourhoods are designed with the car as the main mode of mobility in mind. In post-war neighbourhoods, there is a lot of space. There are wide roads and many parking places. These neighbourhoods on the edges of cities usually have a high density. When looking at the housing challenge, there is even more potential for densifying these neighbourhoods. According to KAW (2020) there is a possibility for 500.000 – 700.00 extra houses to be built in the next 10 years in post-war neighbourhoods.

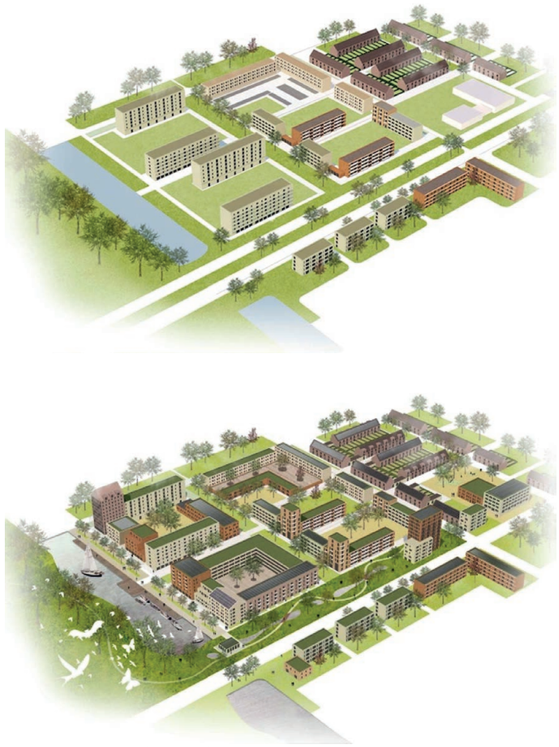


Figure 7: Densifying of post-war neighbourhoods (KAW, 2020)

Figure 8: Cars in post-war neighbourhood Den Haag Zuidwest (2023)

Figure 9: Post-war neighbourhood (Vlietnieuws, n.d.)

Case study area

Breda

The case study area in this research will be the neighbourhood Hoge Vucht in Breda. Breda is a city in the south of The Netherlands with almost 190.000 residents (CBS Statline, 2024a). It is well connected by train to cities such as Rotterdam (22 minutes), Tilburg (14 minutes) and Antwerp (34 minutes). With the Intercity Direct, it is possible to be in Amsterdam Zuid in exactly 1 hour in Amsterdam Zuid (NS, 2025; NS International, 2025).

However, within the city, car usage is relatively high compared to similar cities in the Netherlands (KiM, 2015). In figure 10, the modal split for several Dutch cities is compared. The share of public transport in Breda is lower than average, and car usage in Breda is higher than average in comparable cities.

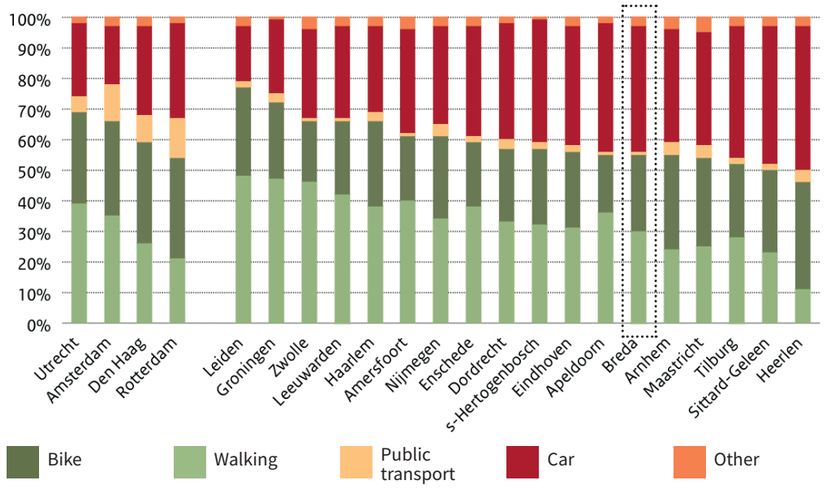


Figure 10: Modal split of Dutch cities (2010-2014) (KiM, 2015, p.36, edited by author)

Hoge Vucht

Hoge Vucht is a post-war neighbourhood from the 1960s on the northern edge of Breda. It is a mix of apartment buildings and single-family homes. The neighbourhood has a high number of people with a migration background, and the average income in the neighbourhood is lower than in the rest of Breda (Alle Cijfers, 2025). The liveability score from the Leefbarometer is the lowest in all of Breda, mainly because of problems with safety and criminality (Leefbarometer, 2023). Because of the low liveability score, the neighbourhood is already part of the plans of *Verbeter Breda* (Verbeter Breda, 2024). *Verbeter Breda*, for example, has helped establish a new community library in Hoge Vucht.

Figure 11: Location of Breda in The Netherlands

Figure 12: Location of Hoge Vucht in Breda

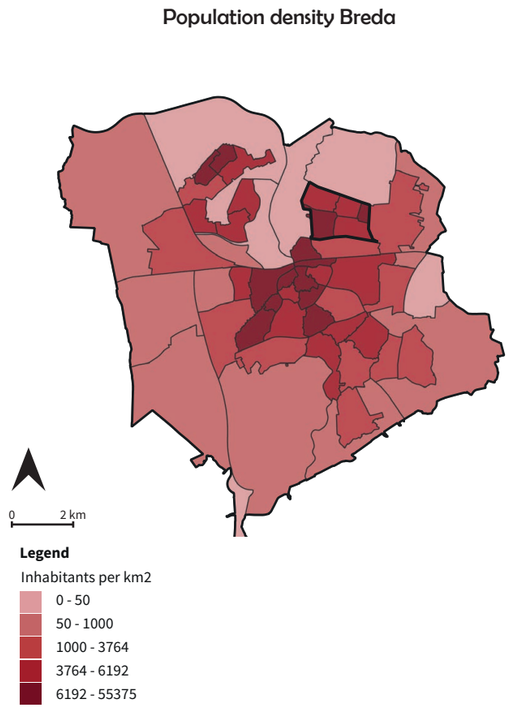


Figure 13: Population density 2023, data from CBS Staline (2024a)

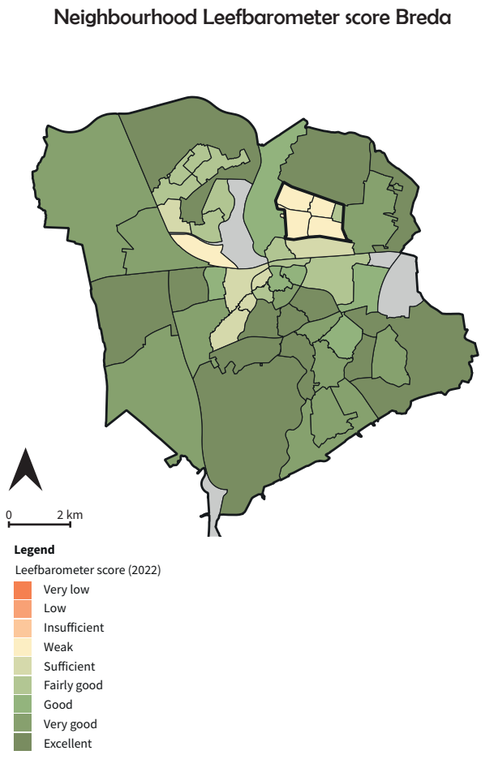


Figure 14: Leefbarometer score 2022, data from Leefbarometer (2023)

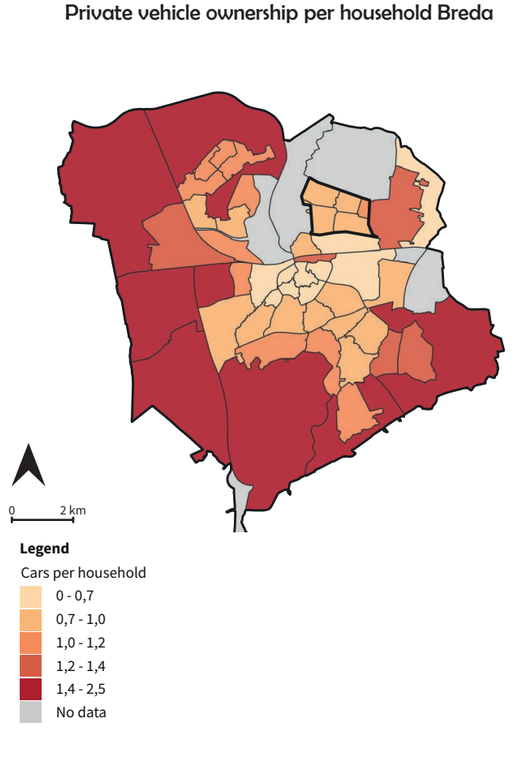


Figure 15: Cars per household 2023, data from CBS Statline (2024a)

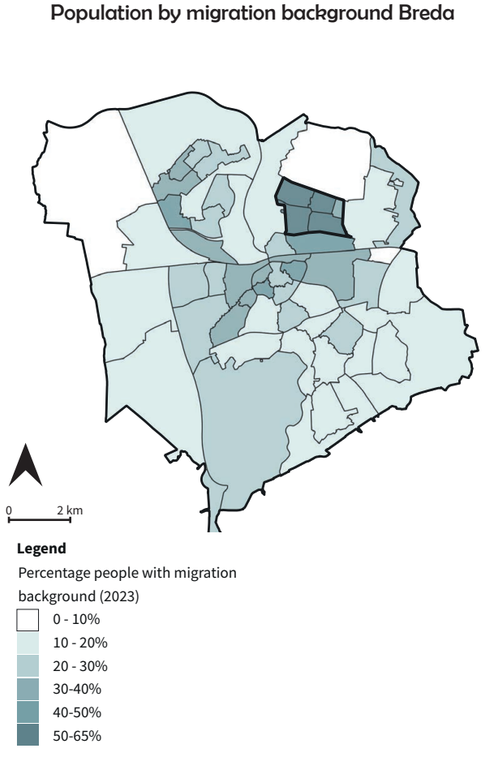


Figure 16: Population by migration background 2023, data from CBS Statline (2024a)

1.3 Problem statement

This transition to more sustainable mobility is something we should address from both an environmental, social and spatial perspective. When designing the mobility system, the focus should not be on the efficiency of the infrastructure, but on liveability and accessibility (Rli, 2020). Therefore, understanding how strategies for more sustainable mobility influence liveability and accessibility is vital to understand the impacts on the people living and working in the neighbourhood.

Most municipalities are aware of the need for a mobility transition and want to do this in a way that improves liveability and accessibility. In many visions on the national, regional and local levels, this mobility transition is described as one of the future goals. However, how this transition can be done is still uncertain. Changes in the mobility system will also create changes in the liveability and accessibility of an area. What exactly will change is not always clear beforehand. For municipalities, the impact certain spatial designs will have on aspects like liveability and accessibility for the people working and living in the city is unclear.

Therefore, it is needed to get more insight into the effects of mobility design on liveability and accessibility in post-war neighbourhoods.

"The key to such a shift in thinking is the creation of spaces and localities in the city that are attractive and affordable, as neighbourhood quality is central to sustainable mobility"
~ Banister (2008, p.75)

1.4 Research questions

This leads to the main research question:

How can sustainable mobility improve liveability and accessibility in post-war neighbourhoods through spatial design, both now and in the future?

To answer this question, there are three sub-questions:

1. What spatial conditions influence liveability and accessibility in post-war neighbourhoods, and how can they be assessed?
2. How can strategies to stimulate sustainable mobility be designed, and what are their effects on liveability and accessibility in post-war neighbourhoods?
3. How can a sustainable mobility design be implemented in a post-war neighbourhood in the time frame between now and 2050?

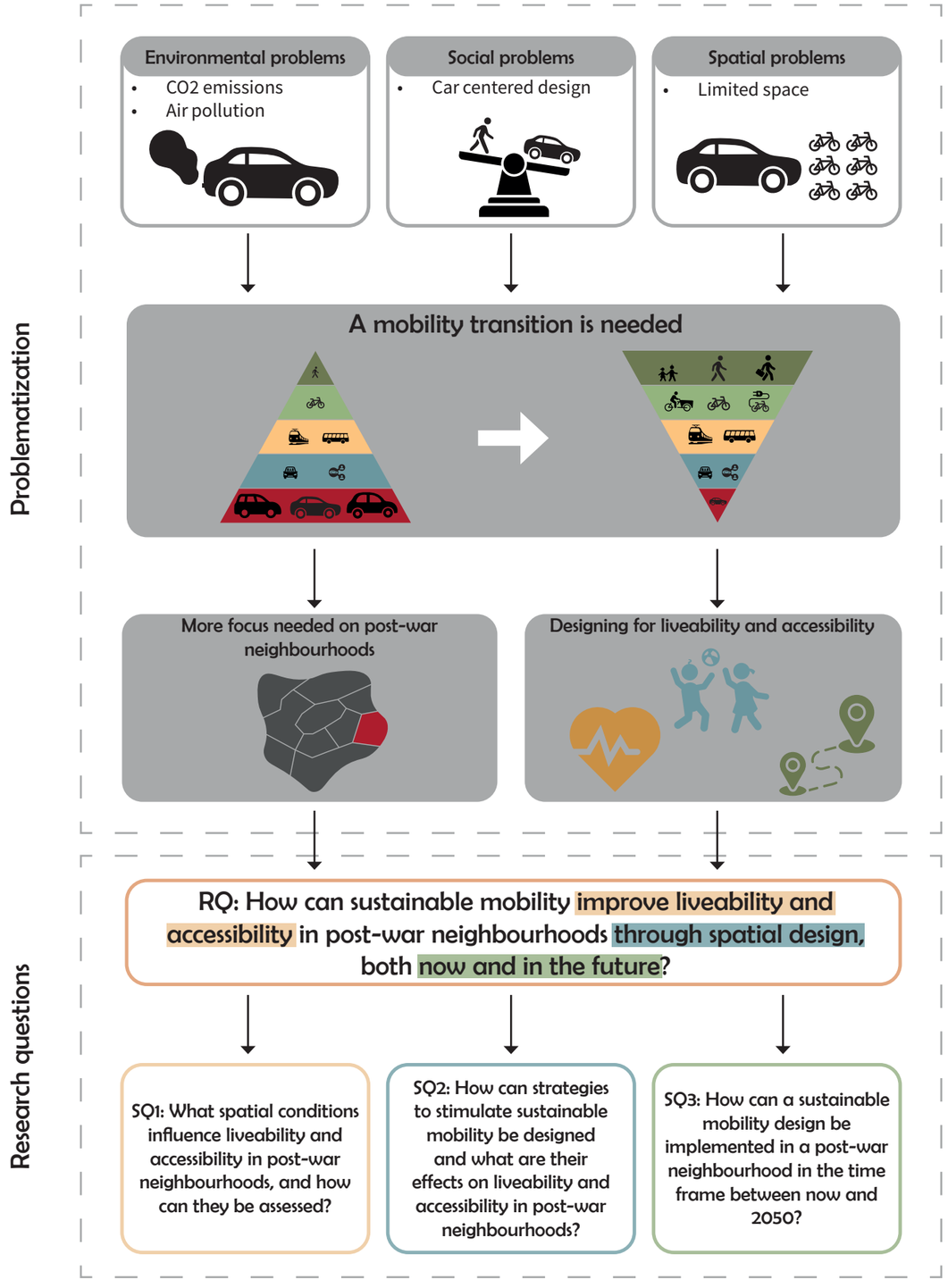


Figure 17: Problem framework

02
METHODOLOGY

The methodology chapter describes the approaches to answering the research question and sub-questions. In the methodological framework, the methods that will be used are described, and some of their limitations are mentioned. The conceptual framework shows how the most important concepts are interconnected.

Edge street between low rise and high rise in Hoge Vucht, Breda (Author's image, 2025)

2.1 Methodological framework

Figure 18 shows the methodological framework for this research.

The goal of the main research question is to investigate how sustainable mobility strategies can be spatially implemented to enhance both liveability and accessibility in post-war neighbourhoods. To answer this question, a case study area will be used: Hoge Vucht in Breda.

The first subquestion will define and operationalise key values and indicators of liveability and accessibility. To answer this question, **literature research** will be used, and this will be applied to two frameworks with relevant values about liveability and accessibility for this research. For liveability, the main sources will be from Leidelmeijer & van Kamp (2003) and Vonk Noordegraaf et al. (2021). For the framework of accessibility Geurs & van Wee (2004) will be the main source. A limitation of using literature is that it describes a general view on these terms, while residents of the case study area might prioritise other values as of higher importance for liveability. An advantage of this is that the research will be more widely applicable for more than only the case study area.

The second subquestion aims to explore, value and translate strategies into spatial design for a case study area (Hoge Vucht, Breda). This question will be answered through **analyses** and **research by design** with the Maximisation Method.

Analysis will be done with several **site visits** and **photos** to experience the neighbourhood, **GIS spatial analysis** to collect data about buildings and a **historical analysis** from Steenhuis et al. (2009) comparing the original and current neighbourhood structure in Hoge Vucht. The mobility vision of the municipality of Breda will not be used as a source, since the vision is not very spatial. By doing this analysis, the design can make use of the existing strengths and make it a location-based design.

After the analysis, there will be research by design with the **Maximisation Method** and elements of **The Delft Approach**. The Maximisation method describes a way of research that separates the final de-sign into different subtopics and takes these subtopics as separate lenses. One by one, these lenses are maximised by looking only through that lens. These separated lenses can be combined and optimised for one (or several) final designs (Aalbers et al., 2025). In this research, this will be applied with **different scenarios** that all have a focus on one type of mobility and one value of liveability. These different lenses will first be designed separately, compared to see where they have spatial conflicts and overlap, and finally combined in one design. This method is helpful in not being restricted by the complexity of the situation, but also has the risk of losing the integration between the lenses. For these designs, elements of The Delft Approach, like **Atomising** design elements in very small essential drawings and the repetitive loop of ***Analysis-Design-Presentation*** (Dijkstra et al., 2021) will be used. With this method, many different options can be explored. A limitation is that these different options are all very simplified.

The third subquestion will be about developing a phasing strategy for the design (from SQ2) for Hoge Vucht. This will be a combination of back-casting and fore-casting. The third sub-question will be guided by the **X-curve transition model** (Silvestri et al., n.d.). This model describes a transition where the old system declines, and a new system is built up. A limitation is that this only focuses on one transition and does not consider other external influences.

Together, this methodological framework provides a structured and design-driven approach to investigate how sustainable mobility strategies can be spatially implemented to improve liveability and accessibility in the post-war neighbourhood of Hoge Vucht.

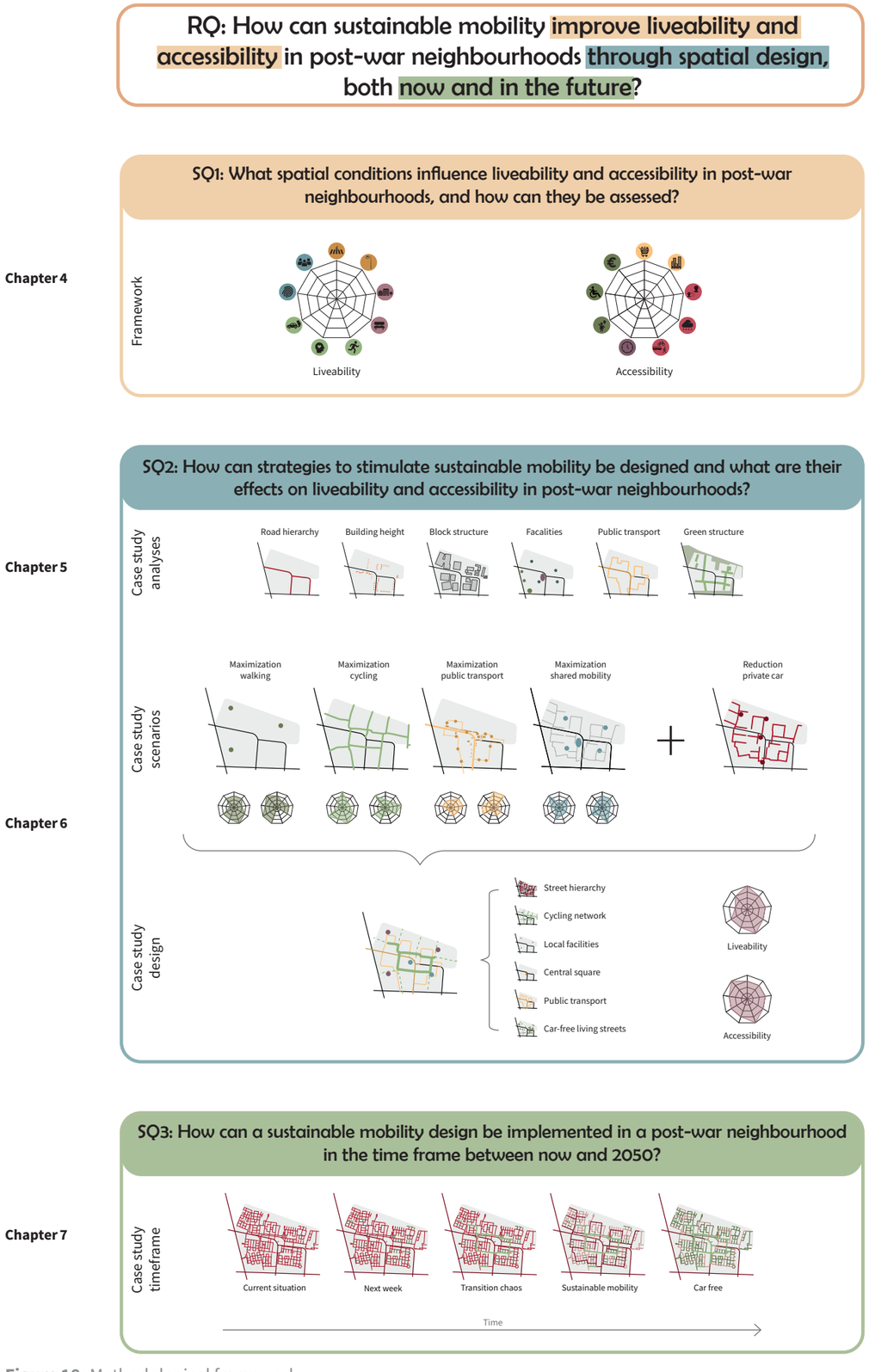
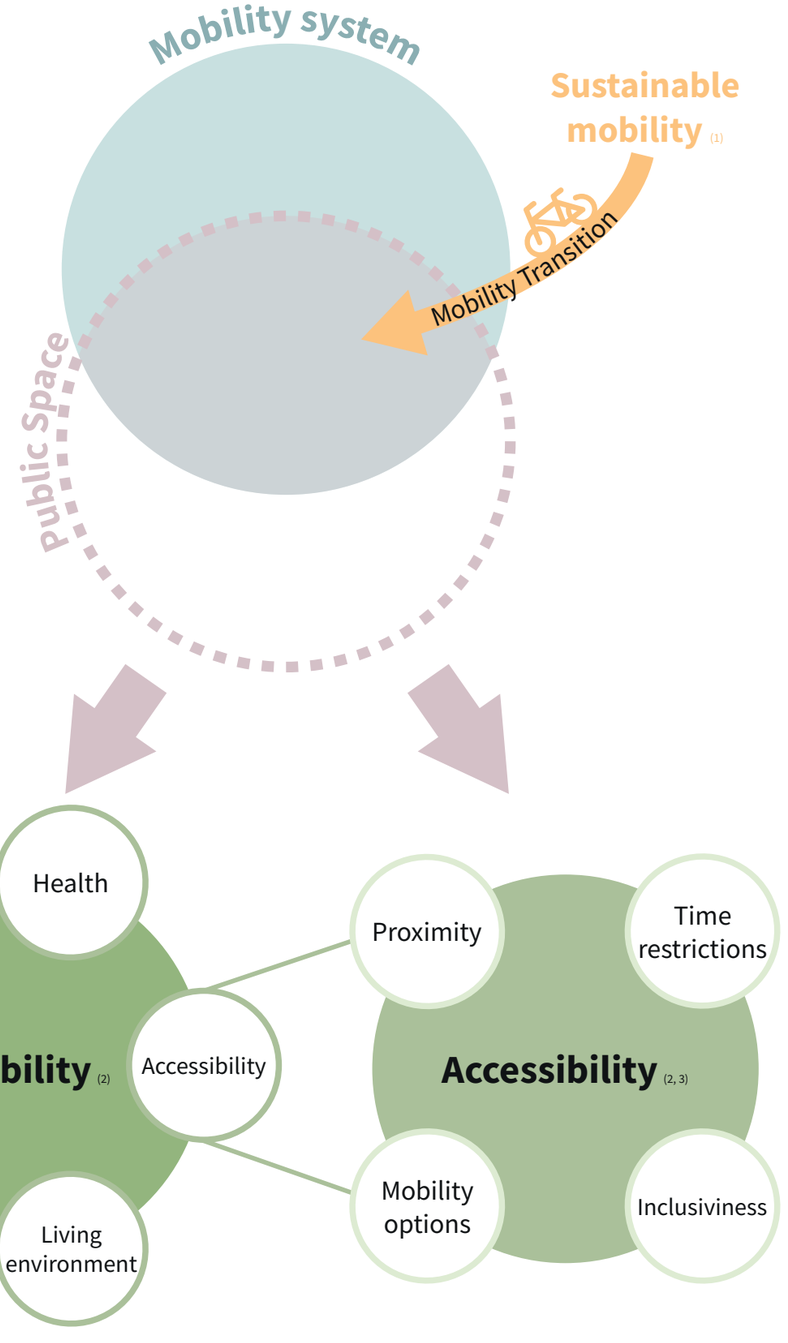


Figure 18: Methodological framework

2.2 Conceptual framework

In the conceptual framework, the most important concepts are interconnected. The central concept is *public space*. The *mobility system* includes the physical infrastructure, policy, travel behaviour, public transport systems, etc. The intersection between public space and the mobility system represents the spatial design of mobility. This is the infrastructure, with streets, parking spaces, stations, pavement, bike parking, street lighting, etc. The sustainable mobility transition will change this mobility system to a new one, with new infrastructure. This public space has a direct impact on the neighbourhood's liveability. Liveability consists of different aspects. One of the aspects of liveability is accessibility. Since accessibility is a key factor in mobility, this value will be zoomed in on separately.



1. SHARE-North (2021)
2. Vonk Noordegraaf et al. (2021)
3. Geurs & Van Wee (2004)

Figure 19: Conceptual framework

03
BACKGROUND

This chapter provides an overview of the background of mobility. To understand the current and future challenges in achieving sustainable mobility, it is essential to first look back at how our mobility system developed over time, how people move around today, what we consider to be sustainable mobility, and how travel behaviour can be influenced to support this transition to a sustainable mobility system in the future.

Bus in Hoge Vucht, Breda (Author's image, 2025)

3.1 History of mobility

Understanding today's mobility system requires a look into the past. For centuries, people in Dutch cities primarily moved on foot or by boat. Transport was slow, local, and labour-intensive, and streets were shared spaces where trade, social life, and movement all took place together. During the Industrial Revolution in the 19th century, new infrastructures such as canals, railways, and trams reshaped urban and regional connections. Travel became faster and cheaper, allowing cities to expand beyond their historic cores and enabling workers to live further away from their workplaces. The bicycle soon followed, offering affordable, flexible mobility for a broad segment of the population and becoming a defining feature of Dutch daily life (Filarski & Mom, 2008).

In the 20th century, the automobile fundamentally changed how people moved and how cities were built. Initially a luxury item, the car quickly became accessible to the middle class and came to symbolise freedom and modernity. Road design was focused on motor vehicles, with an increase in asphalt roads and urban ring roads (Mom & Filarski, 2008). After the Second World War, the Netherlands entered a period of rapid reconstruction and suburban expansion, caused by an urgent need for housing. Guided by the ideals of light, air, and space, planners created functional post-war neighbourhoods with open structures of repeating clusters surrounded by green and infrastructure. Reflecting the growing importance of the private car, roads and parking were integrated in the design, giving car traffic a central place in these neighbourhoods (Urhahn, 2025).

By the 1970s, this car-centric model began to show its downsides, and concerns arose. However, in the 1980s automobility resumed its growth, though at a slower pace. By the early 2000s, car ownership had become widespread, and the car remained dominant in Dutch mobility. In the early 21st century, passenger mobility in The Netherlands stabilised, both in travel kilometres and in modal share. Attention shifted towards sustainable and smart mobility (Mom & Filarski, 2008).

The COVID-19 pandemic marked another turning point. During lockdowns, travel declined sharply as people began working from home and conducting daily activities locally. Walking and cycling gained renewed importance. Even after restrictions were lifted, remote work and digital communication continued to reduce commuting travel kilometres (CBS, 2025).

This historical development shows how technological innovation, social change, and spatial planning continuously shape one another. After a century of car-oriented urbanism, the current challenge is to create human-centred, sustainable mobility systems that once again prioritise liveability and accessibility in the design of our cities.

Appendix B shows a more elaborate overview of the history of mobility in The Netherlands.

Figure 20: City traffic at the end of the 1920s at Hofplein in Rotterdam (Mom & Filarski, 2008)

Figure 21: Post-war neighbourhood Hoge Vucht, Breda (van Gurp, 1987)

Timeline

This timeline highlights the key developments in mobility, urbanism, and society. At the bottom, it shows the modal split of travel distances from 1800 to the present. Travel began at an average of only 5 km per person per day in 1800, with walking, horses or by boat, and increased, reaching 32 km per person per day by 2023, dominated by car travel.

Workers-class neighbourhood 1928 Willemstraat (Gemeente Archief Utrecht)

Post-war stamp structure Pendrecht (Rotterdam)

Vinex neighbourhood Ypenburg (Den Haag)

Garden City concept of Howard, 1902

Algemeen Uitbreidingsplan Amsterdam, 1935

Cul-de-sac neighbourhood Kievitsloop (Breda)

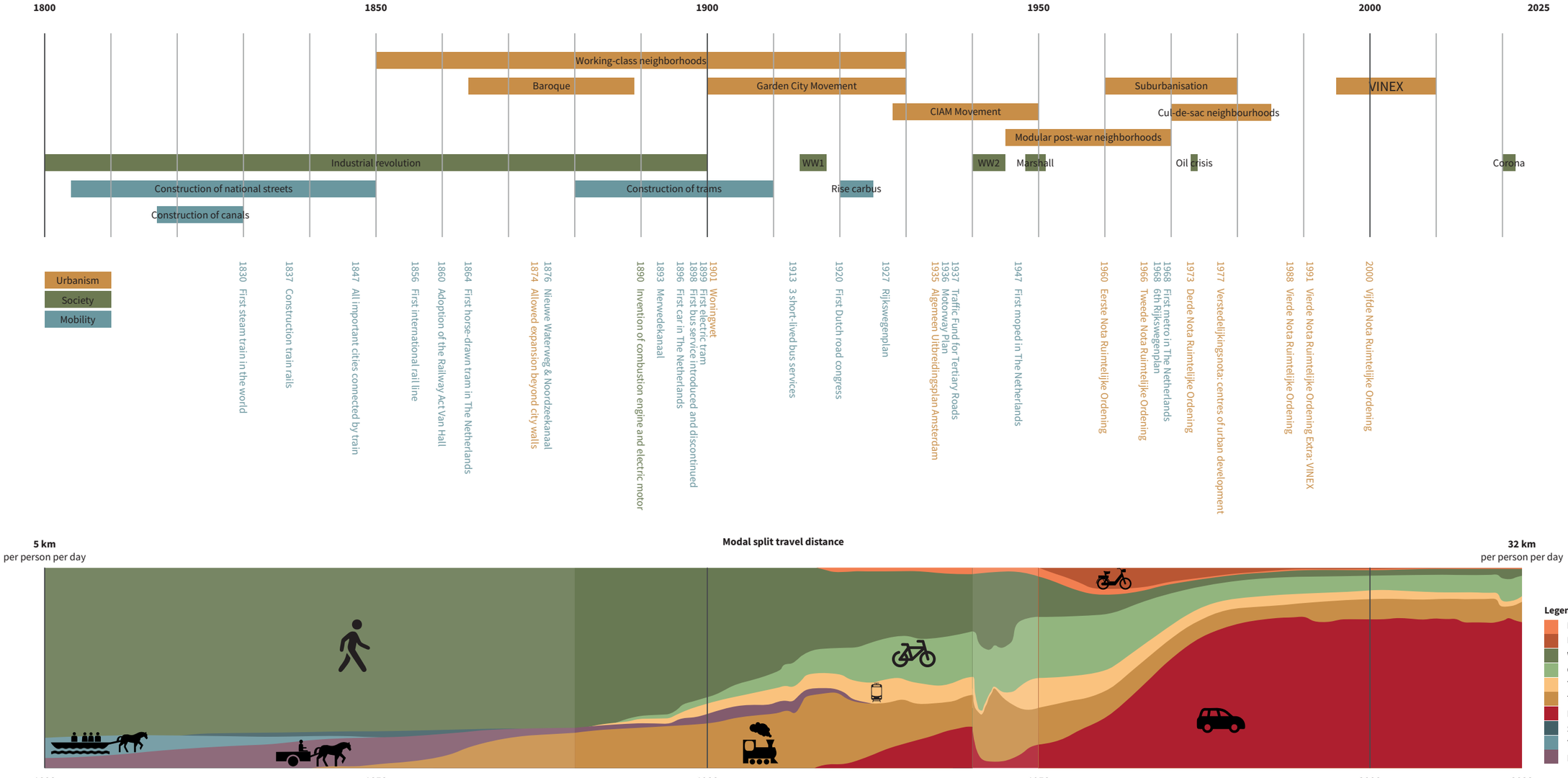


Figure 22: Timeline modal split mobility, data from CBS Statline (2024b, 2024c); Filarski & Mom (2008); Mom & Filarski (2008)

3.2 Current mobility patterns

After examining the historical development of mobility, it is important to understand how people travel today. This section explores current mobility patterns in the Netherlands by exploring which modes of transport are most commonly used, how travel behaviour differs between age groups, and for what purposes people make their trips. Together, these insights offer an overview of today's everyday mobility in the Netherlands.

When looking at how people travel today, three different ways to look at it can be used: travelled distance, number of travels and travel time. All three of these are shown in figure 23 for 2023. From all the travel trips, 45% is done by car, 27% by bike and 20% by foot. From the total travelled distance, 69% was in a car (CBS Statline, 2024b). The car is mainly used for longer distances, while cycling and walking are used for shorter distances.

There are significant differences in how various age groups travel. Figure 25 shows the average travel distance per person per day. The first clear distinction lies in the total number of kilometres travelled: people aged 18 to 65 cover the greatest distances on average. Differences also exist in the modes of transport used, although the car remains dominant across all age groups. Adolescents aged 12–18 travel the most by bicycle, averaging 6.2 kilometres per person per day, while young adults (18–25) record the highest share of train travel. This could partially be explained by the student public transport card. Adults aged 25–65 travel the longest distances as car drivers (CBS Statline, 2024b).

The main motivations for most trips are shopping/groceries (21%), leisure/sports/hobbies (18%), and commuting (16%). Figure 24 shows all travel motivations. Among these categories, business and services/personal care are the least common, each accounting for 3% (CBS Statline, 2024b). Many of these trips can be done within the city and neighbourhood, preferably within walking or cycling distance.

Overall, current mobility patterns in the Netherlands are strongly car-oriented, among all age groups. Important travel motives are shopping, leisure and commuting.

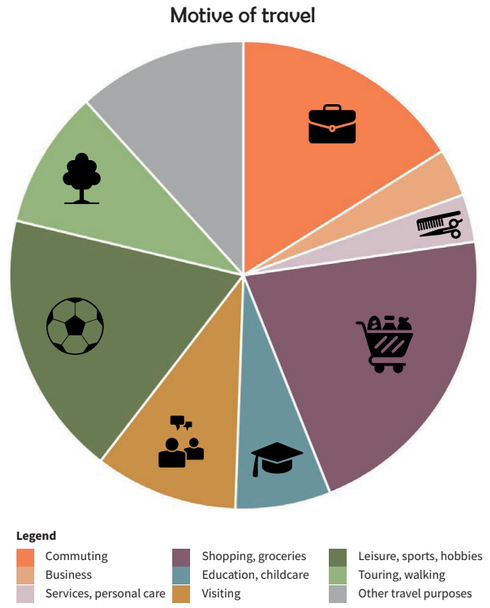


Figure 24: Motive of travel in 2023, data from CBS Statline (2024b)

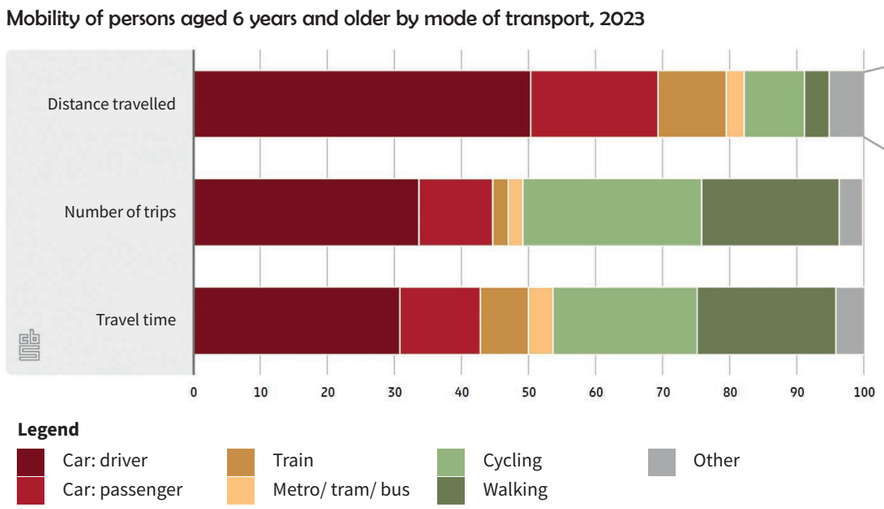


Figure 23: Mobility of persons aged 6 years and older by mode of transport in 2023 (CBS Statline, 2024b, edited by author)

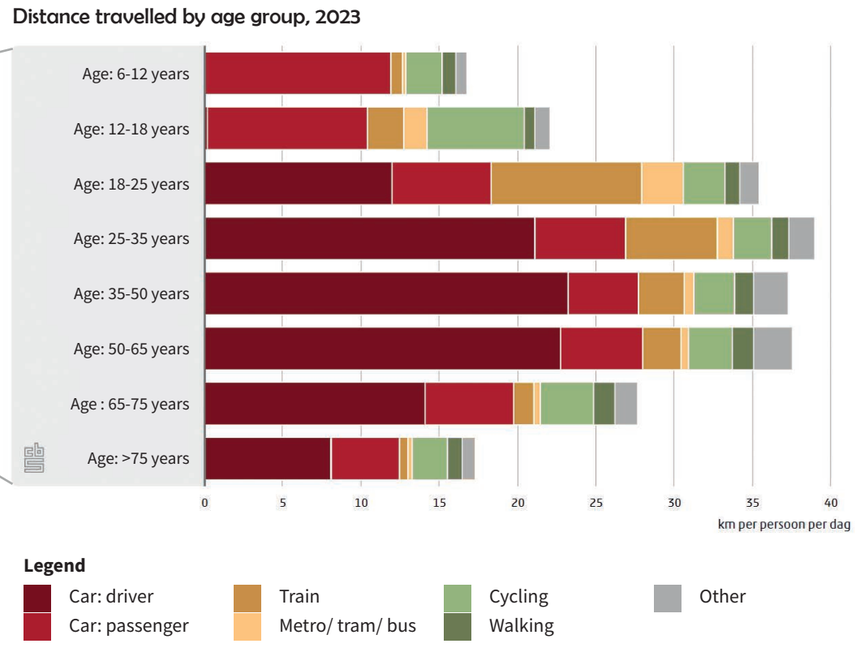


Figure 25: Travelled distance by age group in 2023 (CBS Statline, 2024b, edited by author)

3.3 Sustainable mobility

Moving from our current, largely car-dependent mobility system towards a more sustainable one requires a clear understanding of what "sustainable mobility" actually means. This section explores the concept by connecting sustainability principles with mobility, and examines how environmental, social, and economic dimensions together shape what is considered sustainable mobility.

Sustainable development

A popular description of sustainable development comes from the Brundtland Commission (Commission on Environment and Development, 1987). Here, sustainable development is described as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (p. 41). This is also the description that is used for the Sustainable Development Goals of the United Nations (United Nations, 2015). This description emphasises the need to balance current needs with the well-being of future generations. In the present, these could be challenges with poverty reduction, access to resources, and social well-being. It also recognises the importance of preserving resources and opportunities for future generations to meet their own needs. This includes ensuring that environmental resources remain healthy, that economic systems are resilient, and that social inequalities are addressed. This is connected to intergenerational equity, which ensures that present actions do not unfairly burden future generations.

Mobility

Mobility is a fundamental aspect of daily life and plays a key role in enabling access to jobs, education, healthcare, and social connections (Bastiaanssen & Breedijk, 2022). According to the Cambridge Dictionary, mobility is "the ability to move from one job, place, social class, etc. to another" (Cambridge Dictionary, 2025). Within sociology, mobility can refer to how easy it is to change from one social class to another. Within a health context, mobility can also refer to a person's ability to move effectively and independently in relation to physical health. Within spatial context, it refers to the physical movement of people or goods through time and space. Recently, the focus of mobility shifted from a focus on only efficient infrastructure to a focus on accessibility and mobility equality (Banister, 2008; Bastiaanssen & Breedijk, 2022).

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs"

~ Commission on Environment and Development (1987, p. 41)

This research will be about the mobility of people from one place to another. Mobility of goods is not considered. For 2023, the average distance travelled in The Netherlands in one day is 32 km per person. This is on average 2,7 trips a day (CBS Statline, 2024b). These trips are commuting, shopping, sports, recreation and more. This form of mobility typically occurs at the neighbourhood, urban, and regional scales.

Sustainable mobility

Combining the two concepts leads to the question: what is sustainable mobility? The United Nations has defined sustainable transport as "the provision of services and infrastructure for the mobility of people and goods— advancing economic and social development to benefit today's and future generations—in a manner that is safe, affordable, accessible, efficient, and resilient, while minimising carbon and other emissions and environmental impacts." (United Nations, 2016, p.7).

Banister (2008) describes four actions required to implement sustainable mobility. The first is reducing the need to travel by not travelling at all or travelling shorter distances. The second requirement is to create a modal shift through transport policy measures to stimulate walking and cycling, giving more space to public transport and implementing parking controls and road pricing. Thirdly, distances should be reduced by increasing densities, mixed-use development and design of buildings, space and route layouts. Lastly, technological innovations should increase the efficiency of mobility.

"The sustainable mobility approach requires actions to reduce the need to travel (less trips), to encourage modal shift, to reduce trip lengths and to encourage greater efficiency in the transport system."

~ Banister (2008, p.75)

From an environmental perspective, the main challenges in sustainable mobility are reducing CO_2 emissions, pollutants and fossil fuels. Also, materials and energy that are needed for the production of vehicles and infrastructure have an impact on the environment (Kirsten et al., 2003). From a social point of view, sustainable mobility is about fair and just mobility for all. Preventing mobility poverty and avoiding urban poverty areas because of spatial inequalities in accessibility (Elewa, 2019). Also, the spatial distribution of space needs to be fair. For example, giving space to all modalities and making space for kids to play (Natuur en Milieu, 2025). Economically, sustainable mobility concerns access to jobs and facilities. Having centres that are attractive places to stay can stimulate the local economy (CROW, 2021).

In all these perspectives, walking and cycling are considered most sustainable, since they emit no emissions, need little space and create places that are attractive to stay. For public transport, the vehicles themselves emit more emissions and need more space per vehicle than a private car, but divided by the number of people that use the public transport, it is a better option than a private car. The private car is considered least sustainable, since a lot of material is needed to move one person, emitting a lot of pollutants per person, and a private car needs a lot of space, especially when considering that a car is standing still 96% of the time (Gemeente Amsterdam, 2019; Milieu Centraal, n.d.; Zijlstra et al., 2022).

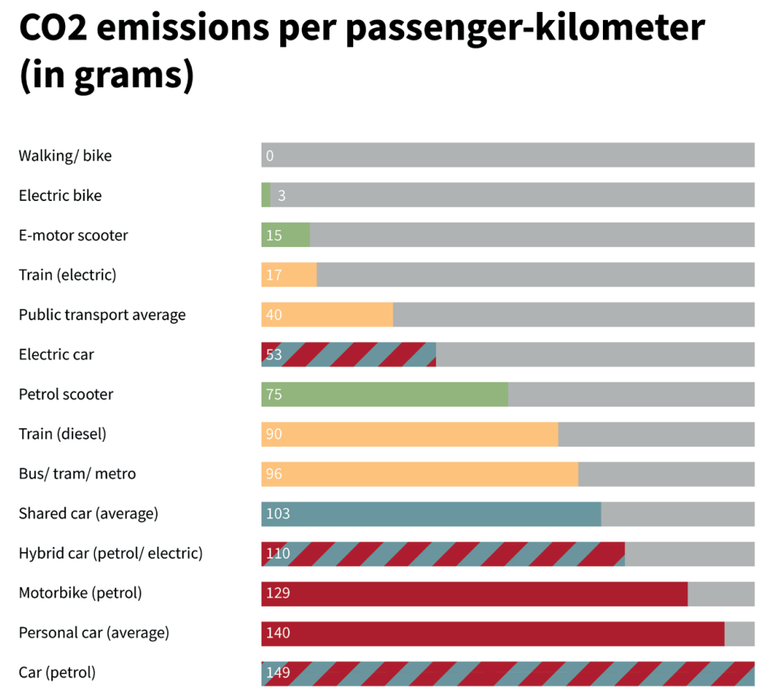


Figure 26: CO2-emissions per passanger-kilometer in grams (Milieu Centraal, n.d., edited by author)

Mobility pyramid

When combining the different perspectives on sustainable mobility, a hierarchy of sustainable transport can be made. The first ideas for the Green Transportation Hierarchy came from Canadian Chris Bradshaw in 1992. He proposed the mobility pyramid, where he created priority for the most sustainable and efficient means of transport. This new Green Transportation Hierarchy is (from most important to least important): *walk, cycle, bus, truck,* and *car*. Bradshaw states that this new mobility pyramid can have a positive impact on the physical, social and economic aspects of the city. Bradshaw acknowledged that while most people will find this hierarchy to be logical, the effect of applying it will seem radical.

"The author [Bradshaw] recognizes that, although readers will find the hierarchy to be logical, the effect of applying it will seem radical."

~ Bradshaw (1992)

This concept of the new mobility pyramid has developed ever since. Over time, the concept of shared mobility or Mobility as a Service became part of the mobility pyramid. In Dutch now the STOMP-principle is used. STOMP proposes the pyramid as *Stappen (walking), Trappen (cycling), OV (public transport), Mobility as a Service,* and *Personenauto (private car)*. SHARE-North also shows micromobility and planes in their mobility pyramid (SHARE-North, 2021). Although the names differ, the main idea is the same: the priority in our infrastructure and public space should shift. We should go from a perspective that is car-centred to a perspective where we design our cities with more priority to slow, personal traffic. This should be done not only do this from a technical sustainability perspective, but also because it is more sustainable from a social and economic perspective.

A limitation of this new mobility pyramid is that it does not distinguish between electric vehicles and fossil-fuelled vehicles. From a social and spatial perspective, the difference between electric and conventional cars or buses is limited. However, from an environmental perspective, there is a significant difference (Milieu Centraal, n.d.). Also, no differentiation is made between different types of public transport. Public transport on rails emits less CO2 and is generally perceived as more reliable and comfortable than buses (Scherer & Zurich, 2012). This suggests that rail-based public transport could be given higher priority within the mobility hierarchy compared to bus services.

This research adopts the following hierarchy as the working definition of sustainable mobility: *walking, cycling and micromobility, public transport, shared cars and shared ride,* and finally *private cars*. Planes are excluded from this analysis, as they are not relevant for mobility at the neighbourhood or city scale.

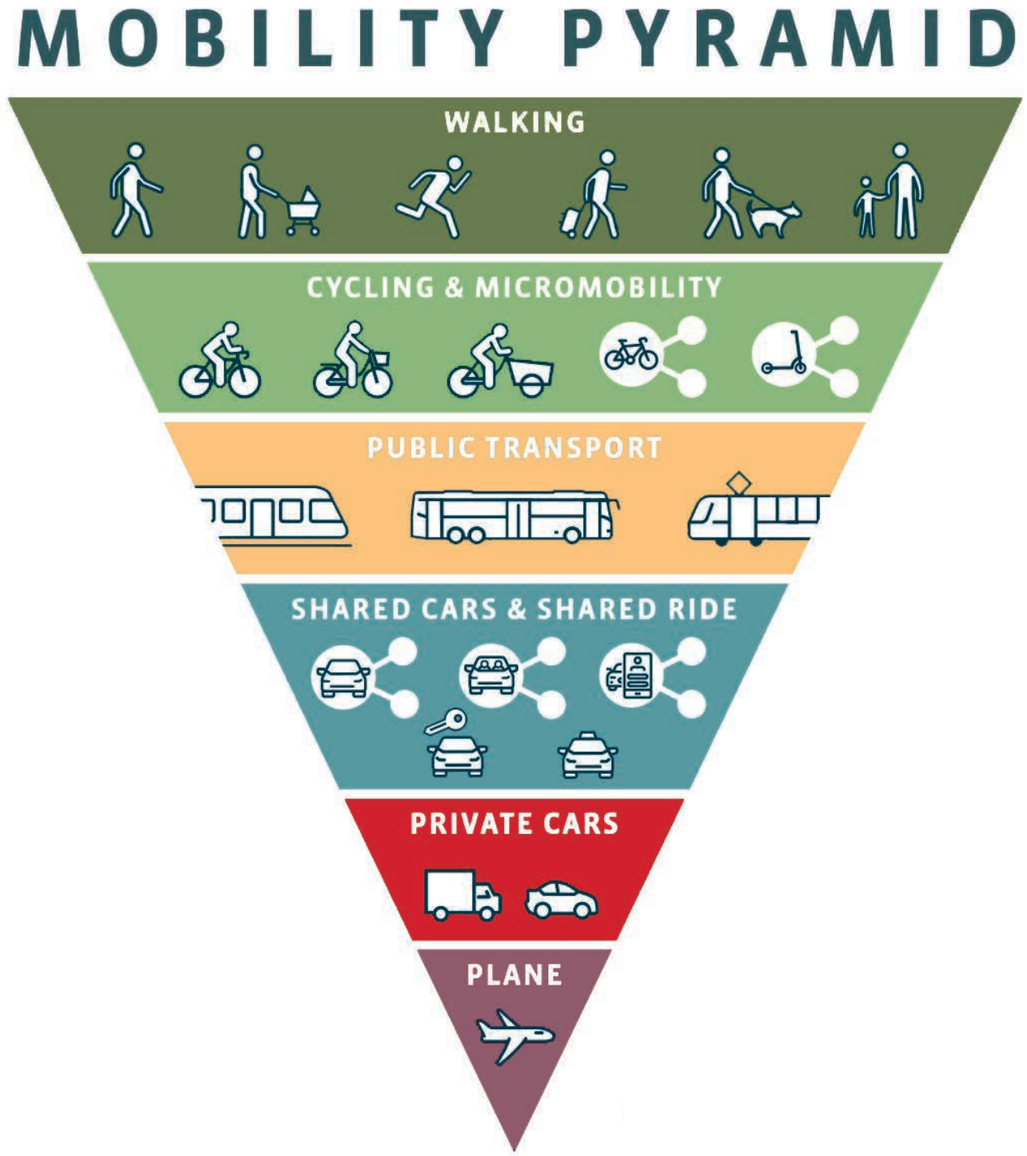


Figure 27: Mobility pyramid (SHARE-North, 2021, p.21, edited by author)

Walking

On top of the transportation pyramid is walking. Walking in the city is a great way of transport. It produces no emissions, is free, and requires little space. It is also accessible to many people; you don't need a special license or need to own a vehicle. Even kids can do it! It can, however, be difficult to walk long distances for the elderly or people with disabilities. Walking is also great because it has health benefits, it creates social interaction, and it does not need a lot of space (Speck, 2012). Walking is not a very fast way of transportation. On average, people walk 4-5 km/h. Since this is not so fast, the proximity of facilities becomes very important. Walking can be used as a way of transportation, but people also walk for recreation or to walk the dog. One-third of the walk trips are recreational (KiM, 2015). For recreational trips, the average distances are longer than for other trips. During the COVID-19 crisis, walking became more integrated into daily routines (CBS, 2025). Compared to other European countries, people in The Netherlands walk little. Interesting is that in The Netherlands, people with a non-Western background walk twice as much as people with a Dutch background (KiM, 2015).

Speck (2012) describes four requirements that are needed for pedestrian-friendly streets. First of all, there has to be a proper reason to walk; people need a destination to go to. This means that there has to be a good mix of essential services within walking distance. The second requirement is that the walk has to be safe and feel safe. This includes both physical safety and social safety. An example of physical safety is preventing people to get hit by a car, and an example of social safety is that people have the feeling they will not get mugged. The third requirement is that the walk should be comfortable. The street should be a cosy and welcoming place and not just a big open space. People prefer places that offer both prospect and refuge (Appleton, 1975). Lastly, the walk should be interesting. Rather than big monotonous building blocks, a street should have small and various buildings with signs of human life and an active ground floor.

With proximity to destinations and facilities, safe sidewalks and crossing places, and a comfortable and interesting environment, walking can be facilitated and stimulated.

Cycling

In the second place of the mobility pyramid is cycling. Cycling is a very sustainable urban transport mode that is feasible not only for short trips, but also for medium-distance trips that are too long to cover by walking. With e-bikes and speed pedelecs, even long distances can be covered by bike. Cycling emits almost no emissions, is healthy, takes up little space, and is a relatively cheap way of transportation. That cycling is good for health can be seen in reduced numbers of sick leave. One-fifth of the bike rides are recreational. For recreational trips, the average distances are longer than for other trips (KiM, 2015).

Overall, cycling is embedded in the Dutch culture. The number of trips made with a bike has been constant for the last 20 years. However, since 2004, the number of kilometres that have been cycled increased by 9 percent. The number of trips did not change, but due to an increase in the amount of e-bikes and speed pedelecs, the length of the trips did increase (KiM, 2015). Initially, e-bikes were mainly used for leisure by the elderly, but recently, younger people are using e-bikes as well for school and work-related trips. This increase is expected to continue. Distances on an e-bike are on average 75% longer than on a normal bike, with an average of 3,4 km per trip on a normal bike and 5,9 km on an e-bike (de Haas & Huang, 2022).

Especially in cities, this increase in the number of cyclists and bigger speed differences also causes problems. Extra-wide bikes (for example, cargo bikes) and bikes with different speeds lead to busy bike lanes, and this can even lead to cycle congestion. Broader bike lanes are needed to deal with the wider and faster bikes (KiM, 2015). Also, improvements such as more guarded bicycle parking, safe crossings, and showers and changing areas at the workplace stimulate bike and e-bike usage (Huang et al., 2024).

Public Transport

Third in the mobility pyramid is public transport. As seen in figure 28, currently, public transport is mainly used by workers and students. The age groups between 18-25 years and 25-35 years use public transport the most (CBS, 2023).

In general, rail-based public transport, such as trains, metros, or trams, is perceived as more reliable and comfortable than bus services (Scherer & Zurich, 2012). This suggests that rail-based public transport could be given higher priority within the mobility hierarchy compared to bus services. Other important factors, besides reliability and comfort, that make public transport attractive are frequent services, good availability in the evenings and at weekends, and affordable prices. For example, free travel cards for students and discounted fares for older adults can encourage more people to use public transport. Public transport is also dependent on the connection to the walking and cycling network and bicycle parking places around public transport stops. These can strengthen each other, with public transport for longer distances and walking and cycling for shorter distances, and the connection from public transport stops to the final destination (KiM, 2015).

Also, Transit Oriented Development (TOD) can be used to stimulate public transport. TOD describes developments that are centred around public transport nodes. On the one hand, it focuses on creating a higher population and building density near transit stations so more people can easily use public transport. On the other hand, it emphasises providing a mix of facilities around these transit stops. TOD makes public transport the most convenient and attractive travel option for daily activities, thereby reducing car dependency.

To stimulate public transport, a high-quality, reliable public transport system is needed, with good connections to the walking and cycling network and other modes of (public) transport. Also, transit-oriented development through higher densities and diverse facilities around public transport stops stimulates public transport usage.

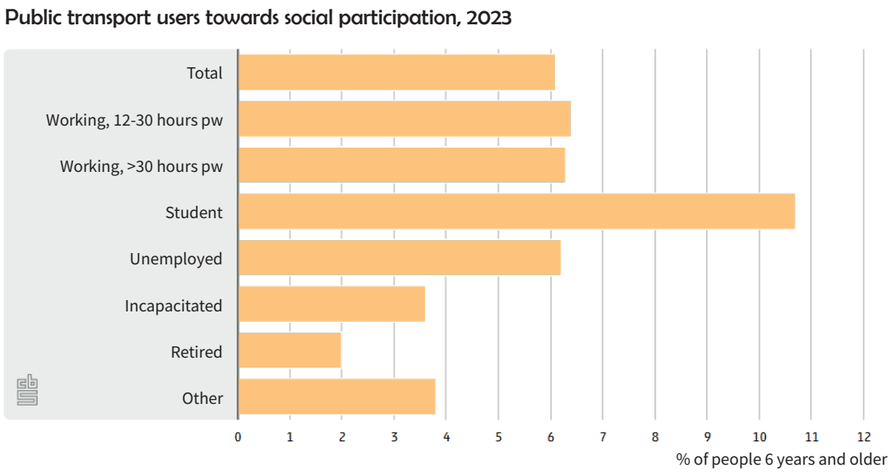


Figure 28: Public transport users towards social participation in 2023 (CBS, 2023, edited by author)

Shared mobility

Fourth in the mobility pyramid is shared mobility. Shared mobility includes transport services that are used by multiple people, such as shared cars, shared bicycles, and shared mopeds. Shared mobility can contribute to more efficient use of space and resources, as fewer private vehicles are needed when vehicles are shared. This can reduce congestion, parking pressure, and emissions in cities. Shared mobility is still in its early stages and is primarily found in large urban areas, with relatively few people using it.

Shared mobility is particularly suitable for short- and medium-distance trips and for situations in which walking, cycling, or public transport are less convenient. For example, shared bicycles and e-scooters are often used for the first and last part of a public transport trip. Shared cars can be an alternative to owning a private car, particularly in dense urban areas where parking space is limited, and car ownership is expensive (SHARE-North, 2021).

To stimulate shared mobility, shared services must be reliable, easy to use, and well integrated with other transport modes. Clear information, simple booking systems, and affordable prices make shared mobility more attractive to users. In addition, good physical integration is needed, such as designated parking spaces for shared vehicles near homes, workplaces, and public transport stops. Policies that limit private car parking and prioritise shared vehicles can further encourage people to choose shared mobility over private car use.

Hubs are physical locations where different transport modes meet, with shared mobility as a central component. By combining these hubs with other services and facilities, such as package points, a supermarket, a community house or flex study places, they can become multifunctional nodes that serve the surrounding area (Zwikker et al., 2021).

When shared mobility is combined with walking, cycling, and public transport, it supports a more sustainable and efficient urban transport system and helps reduce dependence on privately owned cars.

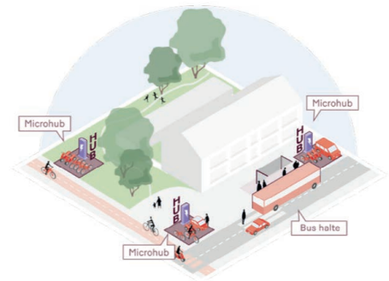


Figure 29: Micro hub along bike path and bus stop (Zwikker et al., 2021, p.107)

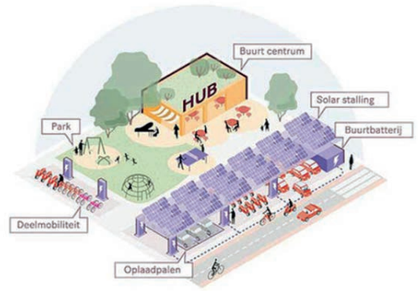


Figure 30: Small hub with neighbourhood centre and infrastructure for energy generation and storage (Zwikker et al., 2021, p.107)

Figure 31: Medium-sized hub with parcel pickup point, café, and flexible workspaces(Zwikker et al., 2021, p.104)

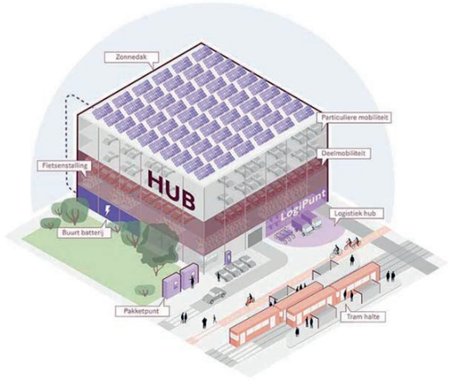


Figure 32: Large hub with space for logistics transhipment and remote parking for private vehicles (Zwikker et al., 2021, p.106)

Private cars

In the mobility pyramid, the car has the lowest hierarchy for urban mobility. Cars produce emissions that harm air quality (Milieu Centraal, n.d.), discourage social interaction (Kennedy & Buys, 2010), take up a lot of space, both while driving and when parked (Gemeente Amsterdam, 2019), generate noise pollution, cause congestion, and the private car is costly. Car use can also reduce physical activity and negatively impact public health.

However, the private car is currently the dominant mode of transport in our society (CBS Statline, 2024b). Cars offer high flexibility and convenience, allowing people to travel directly from origin to destination at any time. They are particularly useful for long trips, areas with limited public transport, or when carrying heavy goods. Cars are fast, comfortable, and widely available, which makes them a popular mode of transport.

Especially in highly urbanised areas, it is often not necessary to be dependent on the private car, as daily destinations can usually be reached by walking, cycling, public transport, or shared mobility. Martensen & Arendsen (2024) created five typologies of neighbourhoods based on car usage and car dependency. The centre and suburban neighbourhoods have many facilities in proximity and have the lowest travel kilometres by car. Rural neighbourhoods and the outlands have the fewest facilities close by and are most dependent on the car.

Limited and expensive parking discourages people from using the car. An increased distance to the parked car also discourages car use (Zijlstra et al., 2022). Low-emission zones and car-free streets can prohibit cars in certain areas. Also, compact, mixed-use neighbourhoods reduce the need for long car trips. Promoting alternatives makes sustainable options more attractive than driving, by offering faster, cheaper, and more comfortable travel options.

Nevertheless, when people remain structurally dependent on the private car, restrictive measures alone are insufficient to achieve lasting behavioural change. Therefore, a substantial reduction in car use requires the provision of high-quality, attractive, and reliable alternative mobility options, as well as more facilities in proximity.

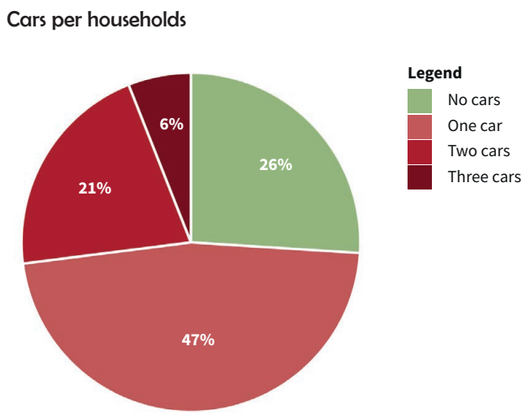


Figure 33: Cars per household, data from Zijlstra et al. (2022)

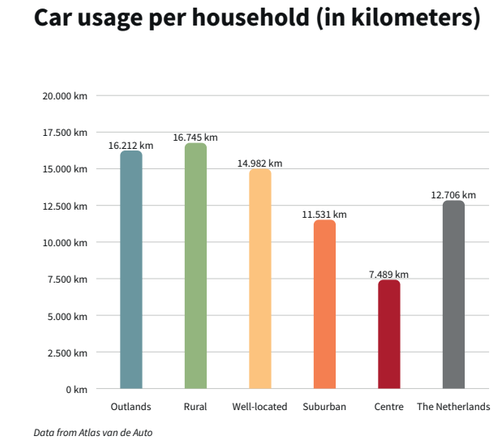


Figure 34: Car usage in different neighbourhood typologies, data from KiM (2024)

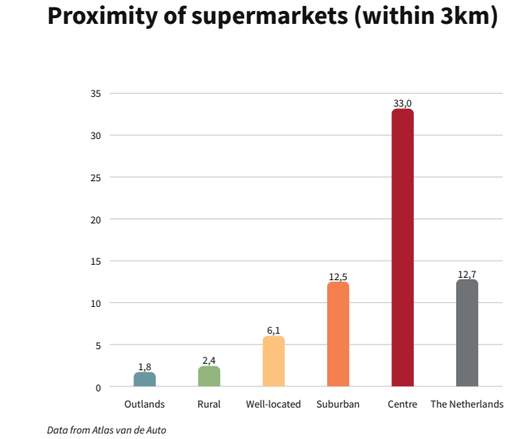


Figure 35: Proximity of supermarkets in different neighbourhood typologies, data from (KiM, 2024)

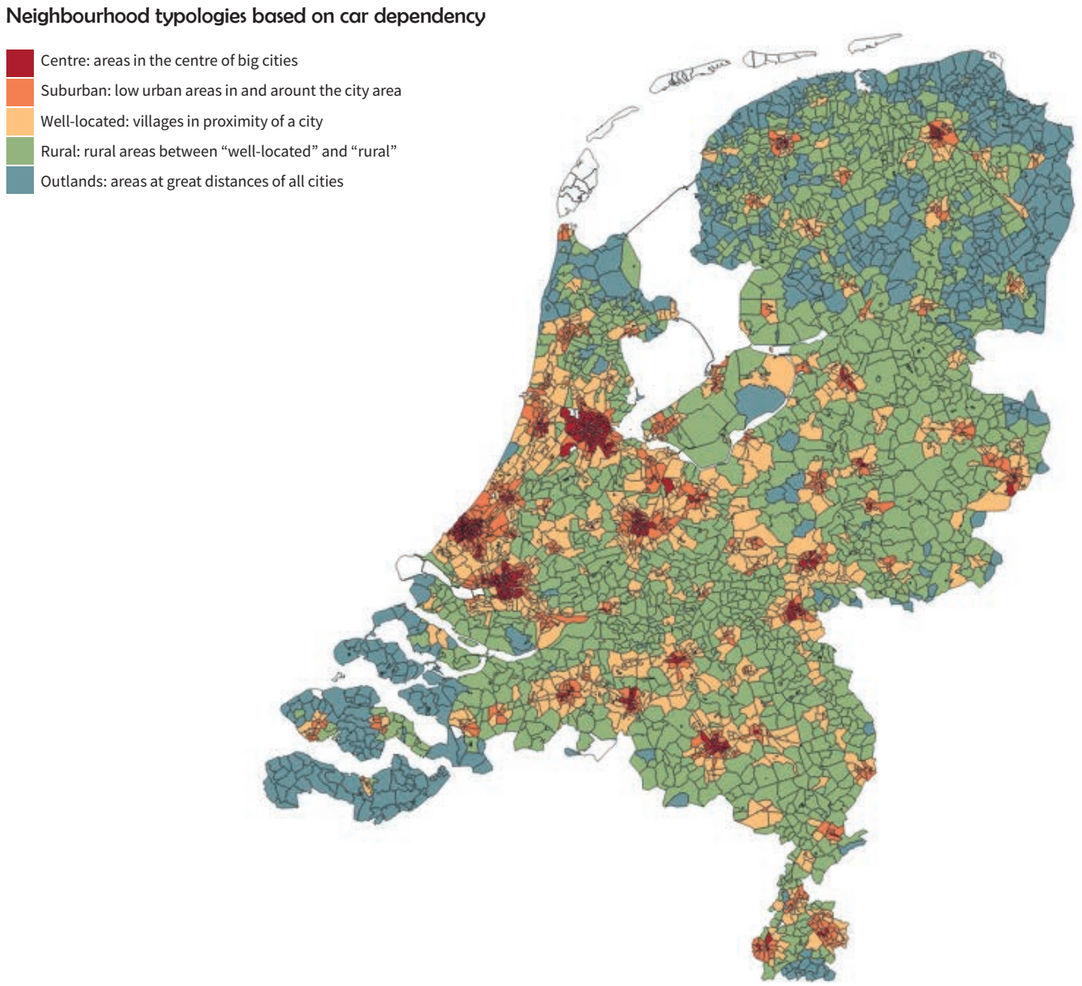


Figure 36: Five neighbourhood typologies based on car dependency (car usage and proximity of facilities), data from KiM (2024)

3.4 Travel behaviour

Achieving sustainable mobility ultimately depends on people's choices. Understanding why individuals select certain modes of transport, and how these choices can be influenced, is crucial for supporting the shift towards a more sustainable mobility system. This section provides a brief overview of travel behaviour research to explain how and why people move the way they do.

In many situations, people act out of habit and automated processes instead of making well-considered decisions, especially when they face the same choice repeatedly (Dijst et al., 2023). This is also the case with travel behaviour. People focus on information that confirms their choices, and tend to neglect information that is not in line with their habits (Dijst et al., 2023). This means that even when the context changes, people do not always choose the most logical option; they instead maintain their old habits.

Key moments in life are often points when travel behaviour can change. The start of working life, for example, is typically a time when people decide to buy a car (Hamersma & Roeleven, 2024b). However, when people stop working, they usually do not get rid of their car. Additionally, transitions, such as moving or having children, can be moments when habits change, and travel behaviour may shift. Also, changing the context significantly can make people reconsider their behaviour and habits. An example of this is temporarily forcing car drivers to alternative travel modes can also reduce car usage in the long term (Dijst et al., 2023).

People's feelings and emotions also play a significant role in determining their travel mode (Selzer & Lanzendorf, 2022). Time restrictions, costs and accessibility are other factors that affect travel behaviour (Cao et al., 2010). Financially, the employer's policy also plays an important role. People are much more likely to choose public transport to go to work when this is fully reimbursed by their employer. The physical environment also influences travel behaviour and may contribute to car dependence.

To move to a more sustainable mobility system, individuals need to change their travel behaviour. This is influenced by various factors, such as feelings, emotions, time restrictions, costs, accessibility and the physical environment. People's travel behaviour is also highly habitual, causing people not to always make the most rational choices. Key points in life, like moving, having children, and a new job, are moments when new habits are created, and travel behaviour can be easily influenced. Significantly changing the context can also make people reconsider their habits. This is a complex process that takes time.

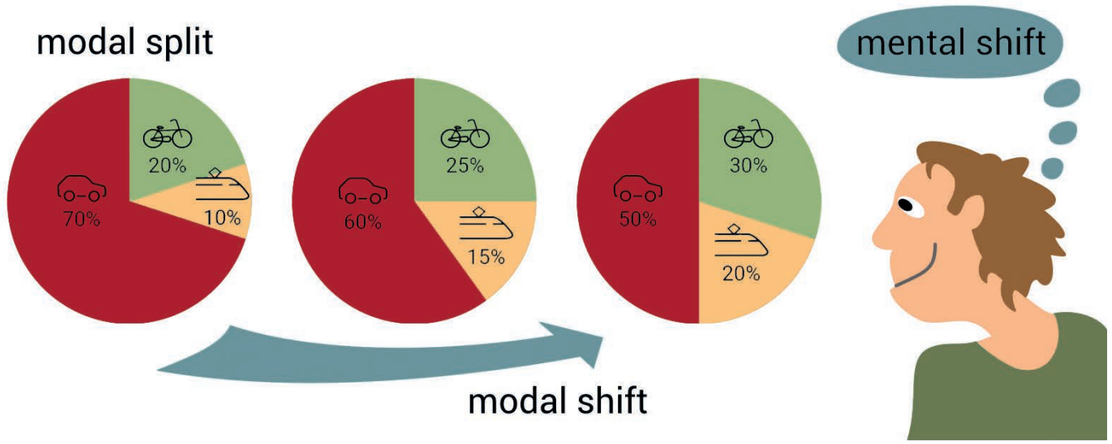


Figure 37: To create a change in the modal split, a mental shift is needed (Zorro Ringland, n.d.)

04
FRAMEWORK

This chapter will define the key values and indicators of liveability and accessibility. Literature about these concepts will be addressed comparing different definitions. For both liveability and accessibility, a framework will be developed with values that apply in the context of public space design and could be influenced with a changing mobility system.

Bus stop in Hoge Vucht, Breda (Author's image, 2025)

4.1 Literature liveability

Liveability is a broad and multidimensional concept, with meanings that differ across disciplines and contexts. In the literature, essential differences between liveability models relate to scale (individual vs. societal), the relationship between people and their environment, the use of objective versus subjective indicators, assumptions about causality, and the context-dependence of what constitutes a "liveable" environment in terms of place, time, culture, and personal characteristics (Leidelmeijer & van Kamp, 2003).

Defenition

Leidelmeijer & Van Kamp (2003) compared definitions and conceptual models of *liveability*, *quality of life*, and *environmental quality*. They conclude that these concepts all refer fundamentally to the relationship between humans and their environment. Liveability and environmental quality of life are complementary notions: while *liveability* refers to the degree to which the environment aligns with human wishes and needs, *environmental quality of life* concerns the extent to which the environment affects the quality of life of individuals. Liveability can be summarised as the extent to which the environment meets the demands and desires of the people who use it (Leidelmeijer & van Kamp, 2003, p.59). This is also the definition of liveability that is used in this research.

Needs and desires

What those needs and desires are varies across research fields, domains, cultures, and time. Needs can be understood as *requirements for a healthy human life*, while desires concern the *amenities of life*, the aspects that make life pleasant. The difference between 'needs' and 'desires' is not a clear distinction. Needs and desires gradually blend into one another.

Maslow (1943) created a theory explaining the hierarchy of human needs, usually visualised in a pyramid (figure 38). In this pyramid, different needs are placed in a hierarchy starting with basic needs (psychological and safety needs) at the bottom, psychological needs (belongingness and love needs and esteem needs) in the middle, and self-fulfilment needs at the top. The idea is that people must satisfy more basic needs before they can focus on higher-level needs (Maslow, 1943).

"Liveability is the extent to which the environment meets the demands and desires of the people who use it"

~ Leidelmeijer & van Kamp (2003, p.59)

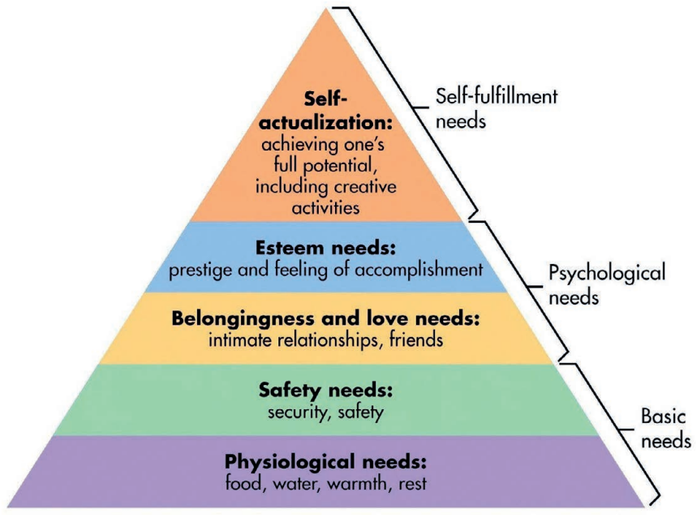


Figure 38: Maslow's pyramid of needs (Maslow, 1943)

Urbanism domain

Different domains, such as sociology, economics, health, and urbanism, have distinct perspectives on the definition of liveability, as each domain considers different components. Literature increasingly agrees that it is not meaningful to search for a single list of liveability components (Leidelmeijer & van Kamp, 2003).

Within urbanism, the focus lies on the relationship between the physical and spatial environment and how this is used by people. Also, sustainability plays a role in this urban context (Leidelmeijer & van Kamp, 2003). Usually, liveability within urbanism is quite conceptual, since it refers to designs that are not yet realised. Van Dorst (2012) refers to this as *presumed liveability*, because the actual results are unknown.

Scale

The relationship between people and their environment can be assessed at different scales, as shown in figure 39. This ranges from an individual scale to a societal or community scale (Leidelmeijer & van Kamp, 2003). The individual scale refers to the relationship between a person and their surroundings (community, artefacts and nature), while the societal or community scale refers to the relationship of this society or community to their environment (artefacts and nature). On an even bigger scale there is also the relationship between humanity (people and artefacts) and their natural environment (van Dorst, 2012).

There needs to be a balance between this individual liveability and societal liveability, since these do not always align. For example, being able to park your car in front of your house can improve individual liveability, while having a whole parking lot in the inner garden of your housing block decreases the neighbourhood liveability. Leidelmeijer & van Kamp (2003) find this local scale most interesting since this is where the interaction between people and their environment takes place.

Subjective vs objective indicators

To measure liveability, there are many lists with indicators, both subjective and objective. These objective characteristics of the environment and subjective evaluations of the perception should be combined to get a comprehensive insight into liveability (Leidelmeijer & van Kamp, 2003).

Causalty

It is complex to investigate the causality of liveability interventions. On smaller scale levels, with single interventions, this is still possible, but when the scale gets bigger, the causality gets more complex (Leidelmeijer & van Kamp, 2003).

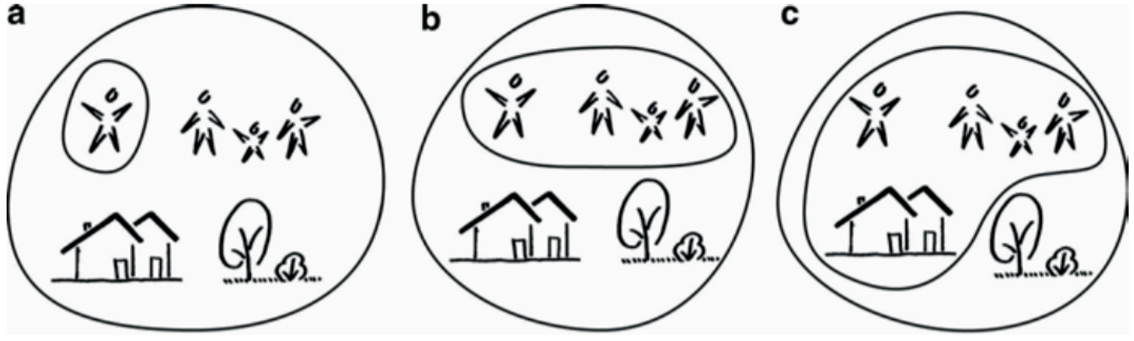


Figure 39: Different perspectives of liveability: (a) the individual liveability, (b) a community liveability and (c) humanity and our natural environment (van Dorst, 2012, p.255)

Context
Liveability is also very context-dependent. Needs and desires differ across cultures, societies and individuals. Preferences can also significantly shift over time (Leidelmeijer & van Kamp, 2003). In the 19th and beginning of the 20th century, livability in the city focused on improving hygiene, sunlight, space and greenery. At the end of the 20th century, the main focus of liveability shifted to well-being and the experience of the environment. In the 90s, this shifted to a focus on social-economic aspects and safety (Leidelmeijer & van Kamp, 2003).

Within urbanism, the lifespan of a design is usually over 50 years. However, people typically live only 10 years in the same house (Noorlag, 2024). Although this differs a lot between age groups and locations, this still means that when making a design within urbanism, the design will also be for the future inhabitants. This is a difficult group, since it is not possible to ask what their preferences are.

Liveability and mobility
Vonk Noordegraaf et al. (2021) applied the idea of broad prosperity, a concept closely related to liveability, to the mobility domain. Vonk Noordegraaf et al. admit that broad prosperity lacks a general definition. In this context, broad prosperity and liveability are closely related. Vonk Noordegraaf et al. created a list of approximately 50 indicators related to mobility that could be used to measure broad prosperity. The four dimensions described are *Living environment, Safety, Accessibility of activities* and *Health* (Vonk Noordegraaf et al., 2021).

Straatemeier et al. divided broad prosperity and mobility into five slightly different goals: Social inclusion, Health, Sustainability, Accessibility & Economy, and Living environment. They ranked Dutch municipalities on these themes. On average, the bigger municipalities and municipalities in the Randstad scored higher, mainly because accessibility to jobs and services is much higher. Smaller municipalities scored better on living environment and health, since there is better air quality and less noise pollution (Straatemeier et al., n.d.). It is interesting that Howley et al. state the opposite: they state that in general, places with high density score lower on liveability. However, it is not high density itself that generates this lower liveability, but other factors like environmental quality, noise, lack of community involvement, traffic and lack of services and facilities (Howley et al., 2009). This shows the complexity of liveability and shows that the hierarchy of values differs per domain.

Liveability and sustainability
Liveability and sustainability are two concepts that are closely related, but operate on different time horizons. Liveability focuses on how the environment meets the needs and desires of people in the present, while sustainability concerns meeting current needs without compromising the ability of future generations to meet theirs. In this sense, sustainability can be understood as the long-term continuation of liveability.

In urban and mobility contexts, tensions may arise between short-term liveability and long-term sustainability, for example, when interventions that improve immediate comfort or convenience negatively affect environmental quality and climate goals. At the same time, if sustainability measures overlook everyday use, they may reduce the perceived liveability. This makes flexibility in public space design essential, allowing future users to reinterpret and adapt spaces according to changing needs while remaining within sustainable limits.

In conclusion, liveability is a multidimensional and context-dependent concept that reflects the interaction between people and their environment. Achieving liveability requires balancing individual and collective needs, as well as addressing both current and future generations.

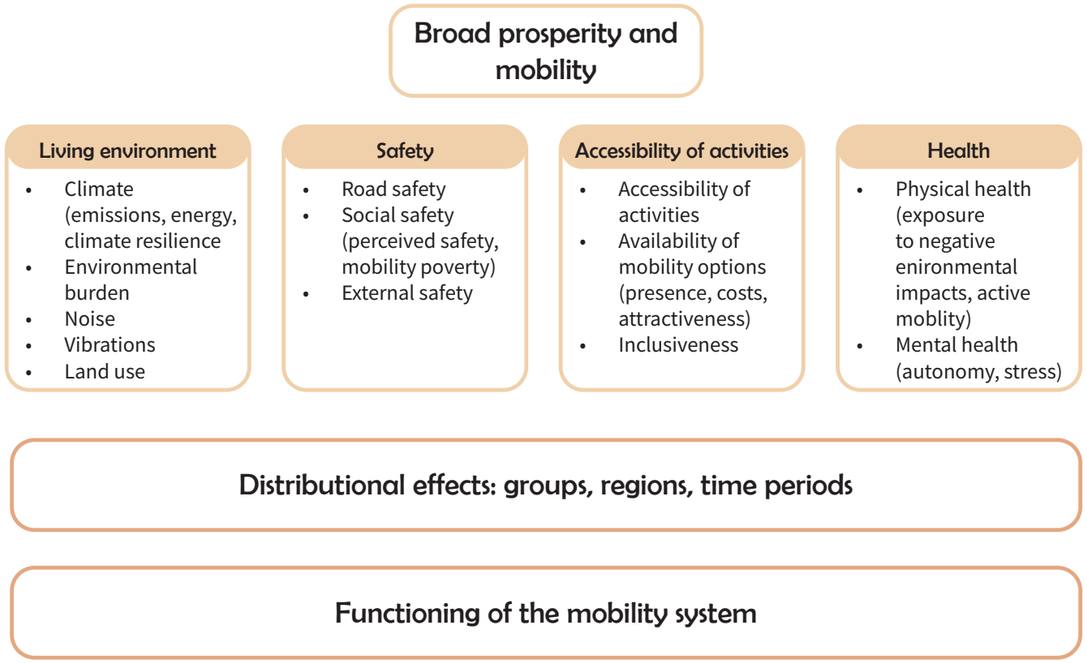


Figure 40: Conceptualising the components that make up liveability, based on Vonk Noordegraaf et al. (2021)

4.2 Framework liveability

There is no universal framework or a single list of indicators to measure liveability. Common themes among different literature and liveability rankings are *health, safety (physical and social), community, satisfaction with housing, services & facilities, environmental quality, accessibility, job opportunities, identity, litter,* and *infrastructure* (see Appendix C). Within all these different sources, there is also a lot of overlap or categories that could fit as a sub-category. For example, *Education* could be part of having good *Services & facilities*, and *Noice* could be part of *Environmental quality*.

To choose which elements of liveability are important for the framework for this research, there are two important limitations. First, the elements should be related to the public space. From these elements, the focus is then on the components that (either directly or indirectly) are influenced by mobility.

The broad prosperity indicators from Snellen et al. (2021) and Vonk Noordegraaf et al. (2021) were used as a starting point for this liveability framework, since these were already applied to mobility. They used the categories *Health, Safety, Living environment,* and *Accessibility*. *Community* is not included in the indicators from Snellen et al. (2021) and Vonk Noordegraaf et al. (2021). Although community is not something that the physical environment or mobility can force or stimulate, it is something the physical environment can facilitate. It is also related to mobility since the amount of traffic in a street has a negative relationship to the amount of social contacts (van Dorst, 2012). In Maslow's pyramid of needs (Maslow, 1943) *Belongingness and love needs* are ranked as third important need. Therefore, *community* is also included in this framework.

In the framework used in this research, five categories describe liveability: *safety, health, spatial quality, community* and *accessibility*. These all have different sub-categories, as shown in figure 41. Since accessibility is such an important component of mobility, its own framework is made. This is described in chapter 4.4.

The focus of this framework is the neighbourhood liveability. Some of the elements in this framework can be measured by objective indicators (for example, the amount of traffic accidents or air quality), and some elements are more subjective (for example, the identity in the neighbourhood or whether the public space is interesting). However, in this research, liveability is applied as presumed liveability, since it will be applied to future neighbourhood designs that can not be measured today.

The aim was to make the framework as comprehensive as possible, however there will be some aspects that are not included in this framework, since liveability is such a broad term, and is influenced in many ways.

Figure 41: Framework liveability

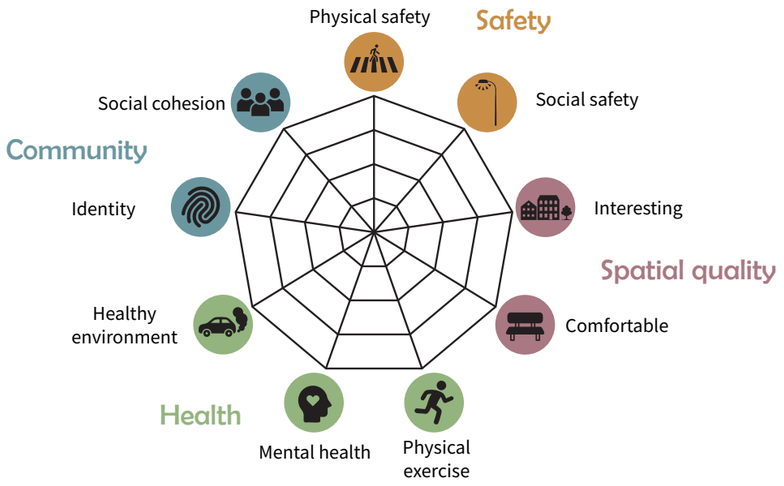


Figure 42: Assessment of liveability

Liveability framework

Safety

Spatial quality

Health

Community

Physical safety
Physical safety focuses on minimising the risk of traffic accidents. Enough and safe crossings, separated routes for cyclists and pedestrians and logical traffic flows help prevent confusion and reduce potential conflicts. Slowing down car traffic with smaller streets, different pavement or flower planters increases awareness and minimises the impact of accidents. Overall, good visibility is essential to ensure that everyone can move safely through the neighbourhood.

Social safety
Social safety is about creating environments where people feel comfortable and not threatened by others. Clear sightlines, easy wayfinding, and sufficient lighting contribute to a feeling of safety. The presence of other people, also called eyes on the street, enhances social control and reduces feelings of isolation. An example of this is having active ground floors. Well-maintained public spaces also help prevent neglect and discourage unwanted behaviour.

Interesting
It offers diversity in the type and height of buildings and variety in nature. Details in facades, short building blocks, and public art make the public space visually interesting. Landmarks or places of interest can be combined with sightlines, allowing them to be seen from a distance and encouraging exploration.

Comfortable
A comfortable environment is one that supports ease and pleasant conditions in the public space. It is characterised by good path quality, no barriers and continuity of routes. Also, having enough crossing opportunities and the absence of level differences contribute to this. Signs and routing can make orientation easier, and streets should not be too wide to make the place feel enclosed. There are support facilities, such as rest places and public toilets. Shelter from rain, sun and wind contributes to pleasant climate conditions.

Physical exercise
Stimulating physical activity is an essential part of the physical health of residents. Public spaces should invite people to move by offering opportunities for sports and play, and by promoting active mobility such as walking and cycling. Outdoor fitness equipment and well-designed routes for walking, jogging and cycling encourage residents to incorporate movement in their daily lives.

Mental health
Public spaces that support mental health provide opportunities for relaxation, social interaction, and connection with nature. The presence of greenery and nature close to home helps reduce stress and improve overall well-being. Spaces that encourage community activities and encounters can strengthen social ties and help prevent loneliness.

Healthy environment
A healthy environment is one with clean air and well-functioning ecological systems. Reducing emissions prevents pollution, and trees and biodiversity can contribute to air purification. Biodiverse and connected nature can also contribute to cooling and water management, creating a pleasant environment for both humans and nature.

Identity
A clear neighbourhood identity strengthens the connection residents feel with their environment. It is reflected in local landmarks, monuments, and historical elements that tell the story of the area. When people feel proud of where they live and share a collective “we-feeling,” it enhances commitment to and care for their environment.

Social cohesion
An environment that supports social cohesion provides opportunities for people to meet, interact, and build relationships. Public spaces that facilitate meeting opportunities, such as squares, parks, and community gardens, as well as indoor places like community centres or libraries, help strengthen social cohesion. A sense of ownership and connection to one’s street further enhances this cohesion with their direct neighbours. This creates a neighbourhood where residents look out for each other and feel at home.

4.3 Literature accessibility

The main goal of transport infrastructure and policy is to provide access to various activities across different locations. Usually, mobility itself is not the goal, only a means to get to a destination (Bastiaanssen & Breedijk, 2024). Exceptions are recreational trips where the goal is to go for a walk, bike ride or drive. However, this is only 9,6% of the number of trips and accounts for only 5,7% of all travel kilometres (CBS Statline, 2024a). Accessibility is an important requirement to reach and participate in work, facilities and social contacts. A lack of accessibility can lead to excluding people from society (Elewa, 2019; Geurs & van Wee, 2004). Accessibility is also needed for the economic functioning of cities and regions (Geurs & van Wee, 2004). In recent years, there has been a shift in the idea that mobility planning should go from only facilitating transportation to an increasing focus on improving accessibility, since this is directly related to people's opportunity and well-being (Rli, 2020).

Definition of accessibility

Geurs & van Wee (2004) describe accessibility as "the extent to which land-use and transport systems enable (groups of) individuals to reach activities or destinations by means of a (combination of) transport mode(s)" (p.128). This contains four components. The first component is the land-use component, consisting of the amount, quality and location of activities (jobs, services, health, social and recreational facilities, etc.) and the demand for these activities. The second component is the transportation component, describing the organisation of the transport system (for example, public transportation), including time, costs and effort. The temporal component distinguishes between different times of the day or week. The last component is the individual component, which describes the needs, abilities and opportunities of individuals (Geurs & van Wee, 2004). With different indicators, it is possible to measure accessibility for the spatial planning, the transport system and the time component at various spatial scales for different groups of people in different typologies. The individual component is more difficult to measure at these scales (Hamersma & Roeleven, 2024a).

> ***"Accessibility is the extent to which destinations (or activities) can be reached within a certain travel time, cost and effort"***
>
> ~ Hamersma & Roeleven (2024a, p.10)

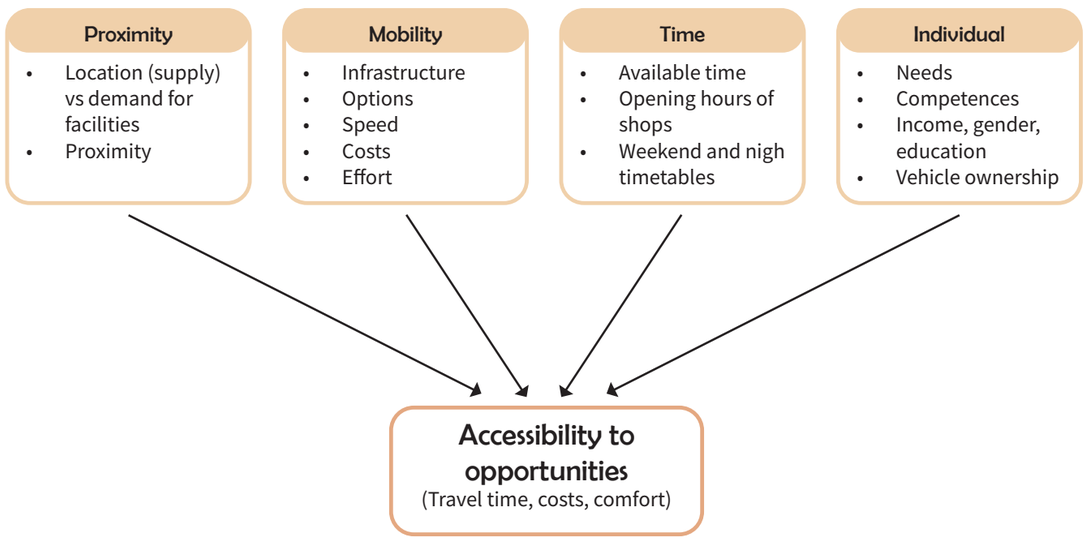


Figure 43: Conceptualising the components that make up accessibility, based on Geurs & van Wee (2004); Hamersma & Roeleven (2024a)

Hamersma & Roeleven (2024a) referred to the definition from Geurs & van Wee, but reframed accessibility as "the extent to which destinations (or activities) can be reached within a certain travel time, cost and effort" (author's translation) (p.10). They state that whether a destination is accessible is a combination of the location and the possibilities of getting there. Instead of "land-use component" and "transport component", they use "proximity component" and "mobility component" (with speed as the most important factor). The possibilities to reach a destination are a combination of the transport possibilities offered at that moment (time) and the possibilities of the individual. This interaction between proximity and travel opportunities determines travel time (distance × speed), travel costs, and travel comfort (or effort).

Local vs regional accessibility

Accessibility occurs at different scales: local, regional, national, and international. Different functions also require a different type of accessibility. Ideally, daily functions, such as supermarkets, schools, and sports facilities, are locally accessible. Regional accessibility concerns the broader scale, connecting different cities (for example, via train services). For functions that are used less frequently, regional accessibility could be important. Activities like culture, university and work are functions people are willing to travel longer for (Hamersma & Roeleven, 2024a). In between is the urban accessibility on the city scale. This scale is about accessibility to the city centre, other districts and facilities such as a train station. Elewa (2019) zoomed in on accessibility on a district level. Elewa made a distinction between inner destinations within the neighbourhood and outer destinations in the city and region. There needs to be a balance between these inner and outer destinations. When internal (or local) accessibility is poor, but facilities in surrounding areas are easy to reach, the limited accessibility within the neighbourhood becomes less problematic. The other way around, when connections to surrounding areas are weak, there is a greater need for well-developed local services and good internal accessibility.

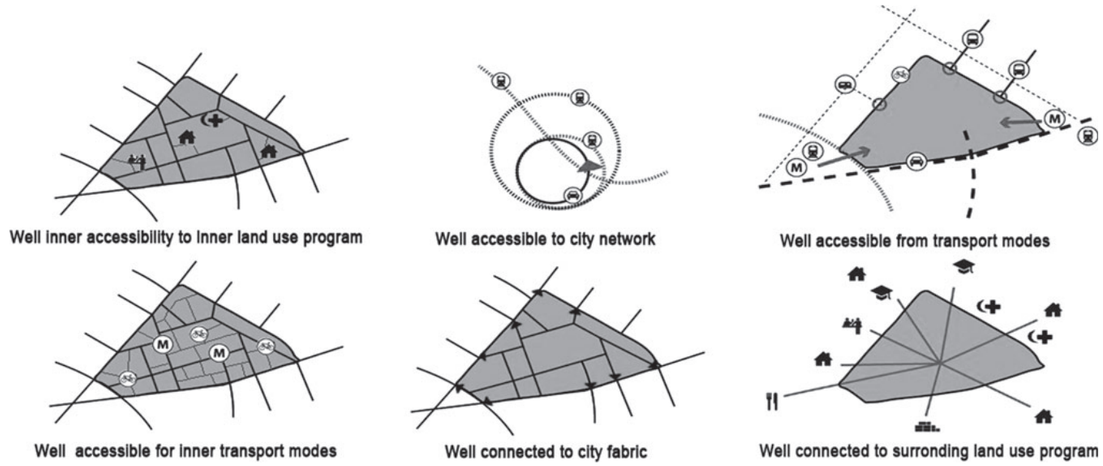


Figure 44: Accessibility in a city district to reach both inner and outer destinations (Elewa, 2019, p.342)

Preferred destinations

Even when having a facility within proximity, people do not always choose the nearest option, as shown in figure 45. Depending on the type of service, people are more critical of which location they choose. For a public transport stop, almost 90% chooses the nearest location; however, for a secondary school, approximately 50% chooses the closest option (Hamersma & Roeleven, 2024a). Here, not only proximity plays a role, but also quality and personal preference. There are also differences in which transportation modes should be able to reach certain functions, shown in figure 46. For hospitals, most people prioritise good accessibility by car, while walking access is considered less important. In contrast, for a secondary school, accessibility by bicycle is highly valued. When it comes to bus, train, or metro stops, accessibility on foot is the most important. These patterns show that proximity and good travel opportunities alone are not enough; the perceived quality and preferred travel mode strongly shape people's choices.

Work locations differ from other facilities because they are visited frequently and for extended periods of time. Even though people visit their work on an (almost) daily basis, people find it accessible to travel far outside their neighbourhood for their job. On average, people perceive 36 minutes by car, 47 minutes by public transport and 28 minutes by bike as acceptable travel time to their work (Hamersma & Roeleven, 2024a). Since the COVID-19-crisis working from home has also become more popular. When people have the option to work from home several days a week, they are more willing to accept a longer commute on the days they do travel (Hamersma & Roeleven, 2024a).

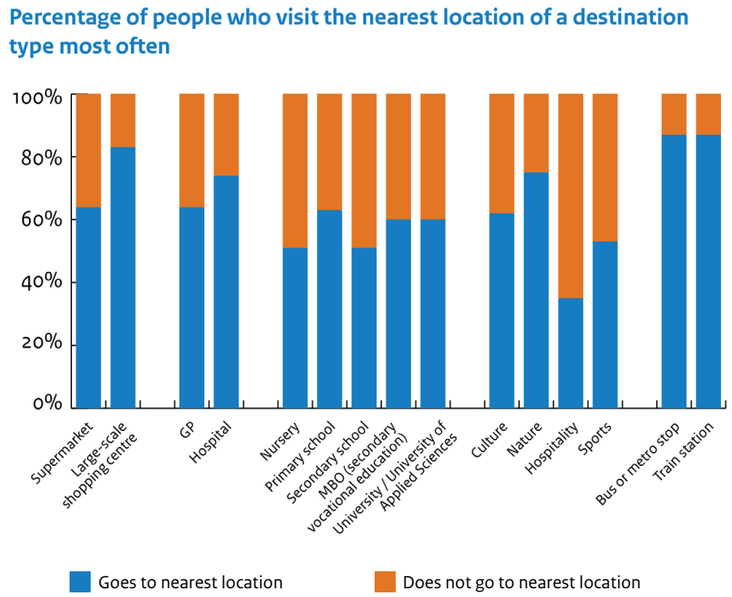


Figure 45: Percentage of people who visit the nearest location of a destination type most often (Hamersma & Roeleven, 2024b, p.11)

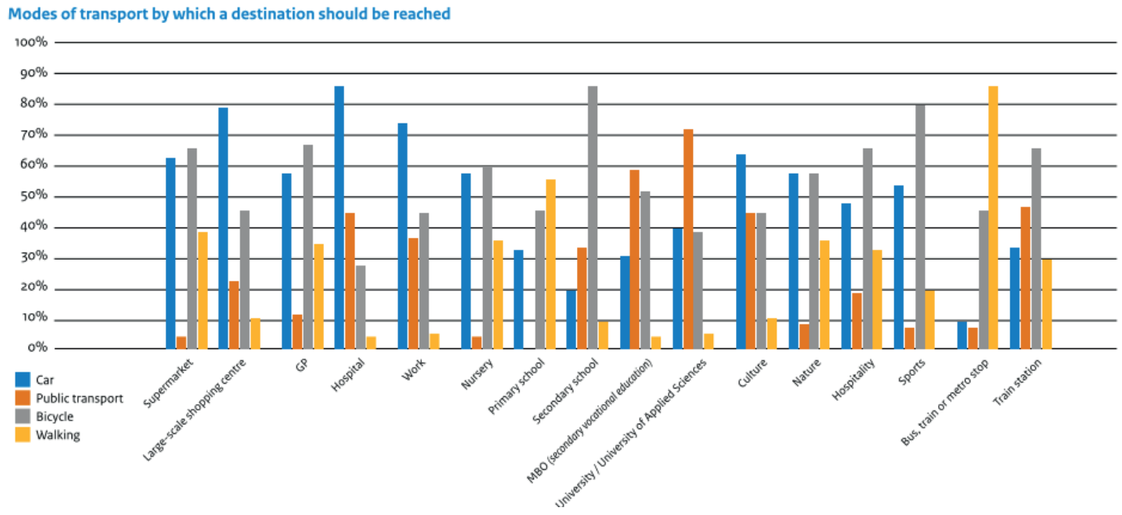


Figure 46: Modes of transport by which a destination should be reached (Hamersma & Roeleven, 2024b, p.6)

4.4 Framework accessibility

Accessibility is a very important component of mobility; the main goal of mobility planning should be to improve accessibility (Rli, 2020). Therefore, this research does not include accessibility in the liveability framework, but creates its own framework for accessibility.

To create a framework, the conceptualising of accessibility from Hamersma & Roeleven (2024a) is used as a starting point. They divided accessibility into four components: *proximity, mobility, time,* and the *individual*. For this framework, the components need to have a relation to spatial elements in public space.

Proximity
The proximity component refers to where people's travel destinations are localised. This means having the facilities people need in proximity to where they live. Examples of facilities are shops, education, healthcare, jobs, sports, social and leisure. In this framework this is divided into having facilities (supply) and having density (demand) to use these facilities. Different facilities require different proximity.

Mobility
The mobility component describes the mobility options, infrastructure, speed, costs and effort. In this framework, this is described as the travel time and distance that have a relation to the speed, mixed options, describing whether there is choice in mobility modes and travel comfort that describes the quality of the infrastructure and the effort.

Time restrictions
The time component is applied in this framework as the time restrictions in evenings, weekends or peak hours. This is closely related to the sense of freedom people experience when using a particular mobility mode.

Inclusiveness
The individual component is translated in this framework to inclusiveness. In public space, it is not possible to change the individual needs, competences or income. However, it is possible to create a pubic space that is inclusive for people with different needs, competences or incomes. An inclusive neighbourhood ensures that all residents, regardless of age, ability, or income, can move around safely and comfortably. Accessibility should extend to every member of the community, creating equal opportunities to participate in daily life.

Figure 47: Framework accessibility

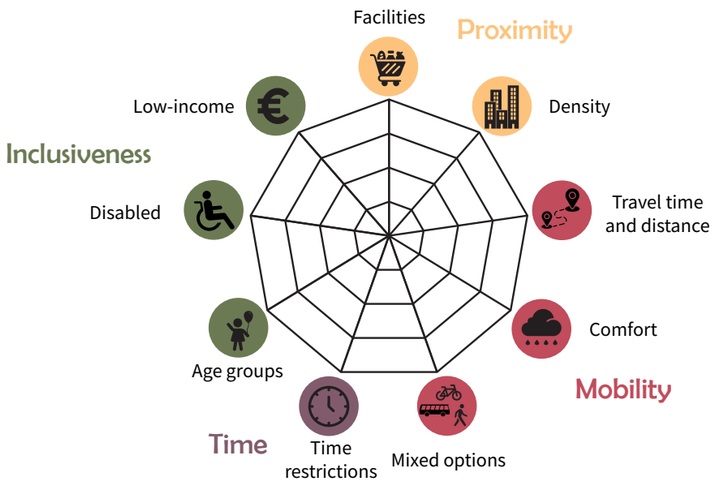


Figure 48: Assessment of accessibility

Accessibility framework

Mobility

Time

Proximity

Inclusiveness

Travel time and distance
A shorter travel time and distance will make it easier for people to access their destinations. Direct routes and shortcuts reduce travel time and distance, making it easier for residents to reach their daily destinations quickly and efficiently. Traffic lights or small roads can limit reaching a high speed and create longer travel times.

Travel comfort
The comfort of travel is influenced by both the design of public space and external conditions such as weather. Safe, well-maintained paths, sheltered waiting areas, and pleasant surroundings all enhance the travel experience, encouraging people to move around actively and sustainably.

Mixed options
An accessible neighbourhood offers a variety of travel alternatives, allowing people to choose the mode of transport that best suits their needs. Accessibility increases when an area can be reached not just by one mode, but through a mix of options such as walking, cycling, public transport, and shared mobility. Providing diverse and well-connected mobility choices ensures flexibility and resilience within the transport network. Also, good transfer options between these different modes further strengthen accessibility.

Time restrictions
Accessibility also depends on when and how transport options are available. Restrictions in evenings, weekends, or off-peak hours can limit usability. Reliable schedules and clear information about availability ensure that residents know when and how they can travel without uncertainty.

Facilities
Variety and proximity of facilities are key to a well-functioning neighbourhood. Having shops, schools, job opportunities, and recreational spaces nearby allows residents to meet their daily needs without relying on long or complex journeys, enhancing both convenience and inclusiveness.

Density
The number of people living and working in an area affects accessibility. A minimum population density is needed to support local facilities and services, ensuring they remain viable. However, a very high density can lead to congestion and overcrowding, reducing overall accessibility and comfort.

Age groups
Being inclusive across different age groups ensures that children and the elderly can also participate in public life. This includes providing facilities for children to play and learn, as well as nearby spaces for the elderly to socialise and receive care.

Disabled
For people with mental or physical disabilities, a legible and thoughtful design is essential for accessibility. Clear and legible public spaces, ramps, guidance for visually impaired residents, and effective wayfinding all contribute to a more navigable and understandable environment. In terms of mobility, inclusiveness also means providing options that do not require special skills, such as a driver's license, so everyone can travel independently and safely.

Income
Inclusiveness also means ensuring accessibility for people with lower incomes, helping to prevent transport poverty. Affordable transport options and accessible public spaces allow all residents to participate fully in social, economic, and cultural life within the neighbourhood.

05
ANALYSIS

This chapter zooms in on the case study area Hoge Vucht in Breda. This starts with the context of Breda and a little introduction to Hoge Vucht. To understand the current neighbourhood structure, it is necessary to look back at the original plans. An atomization of both the street elements and the neighbourhood structure reveals how different components of the urban fabric are organised. The three most common street typologies in Hoge Vucht are identified and described in more detail.

Gallery flat in Hoge Vucht, Breda (Author's image, 2025)

5.1 Analysis Breda

The case study area in this research will be the neighbourhood Hoge Vucht in Breda. Breda is a city in the south of The Netherlands. It is well connected by train to cities such as Rotterdam, Tilburg, Eindhoven, Antwerpen and Amsterdam (NS, 2025; NS International, 2025).

However, within the city, public transport plays a relatively small role in the modal split. In figure 51, the modal split for several Dutch cities is compared. The use of cars in Breda is relatively high compared to similar cities in the Netherlands (KiM, 2015).

Figure 49: Location of Breda in The Netherlands

Figure 50: Location of Hoge Vucht in Breda

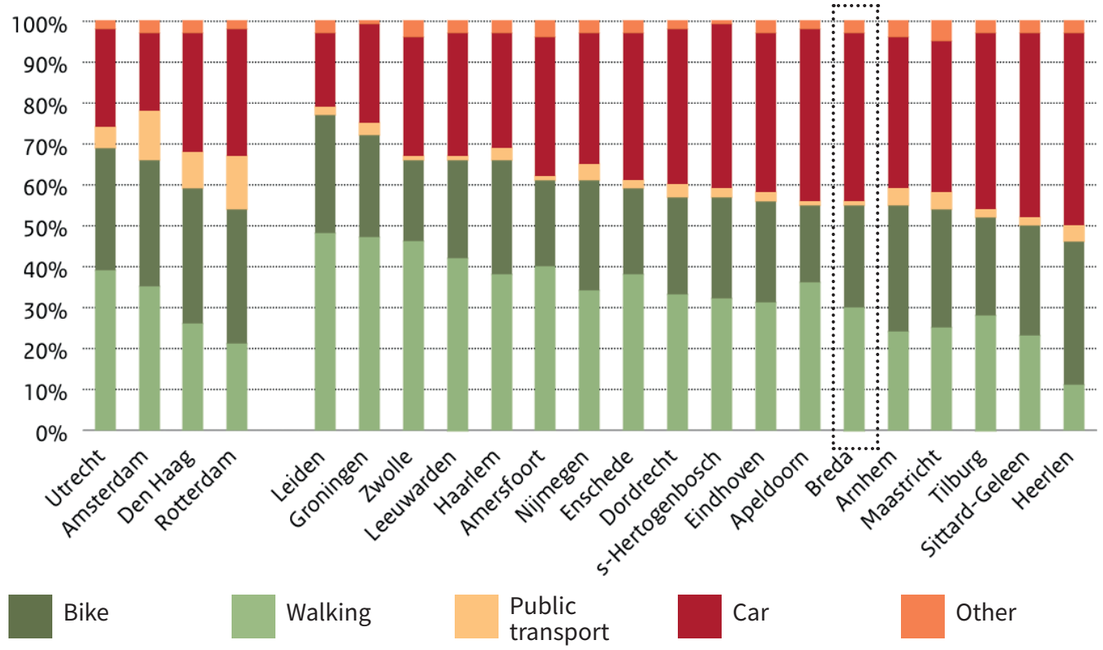


Figure 51: Modal split of Dutch cities (2010-2014) (KiM, 2015, p.36, edited by author)

Breda

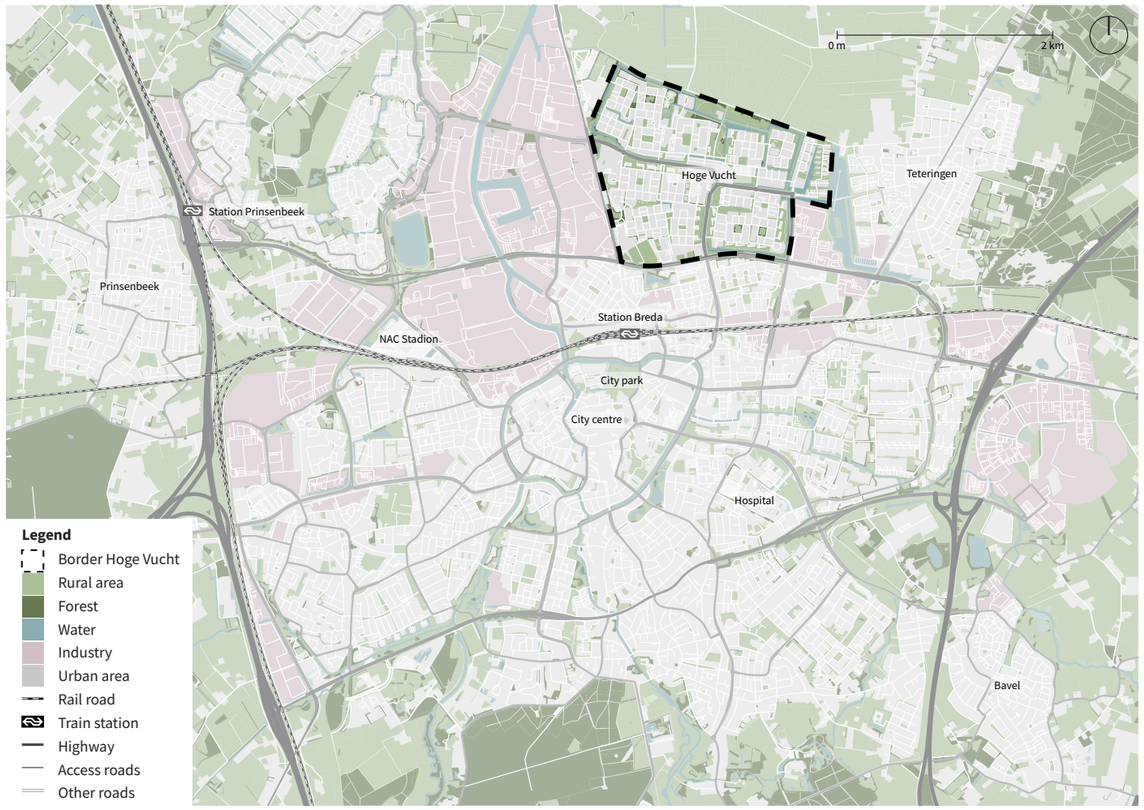


Figure 52: Spatial overview of Breda

Breda originated in the twelfth century as a small settlement where farmers and merchants came together. By the end of that century, a castle was built near the settlement, and in 1252, it developed into a small town and was granted city rights. Over time, it developed into a fortified town of strategic importance. From the 16th century, Breda became linked to the House of Nassau, giving it national significance. After the Eighty Years' War, the city expanded beyond its walls, and in the 19th century, its fortifications were replaced by the Singels that shape Breda today (Info Breda, n.d.). In 2023, there lived 186.438 residents in Breda, making it the 9th biggest city in The Netherlands (CBS Statline, 2024a).

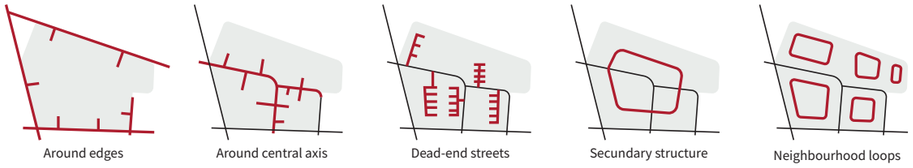
Figure 53: Concept for expansions of Breda, 1956 (Steenhuis et al., 2009, p.12)

After the Second World War, a lot of new houses were needed. Therefore, several locations for expansions of the city of Breda were explored. The locations of these expansions are shown in figure 53. The neighbourhood Hoge Vucht was one of these expansions on the north side of the city of Breda, numbered as expansion "1".

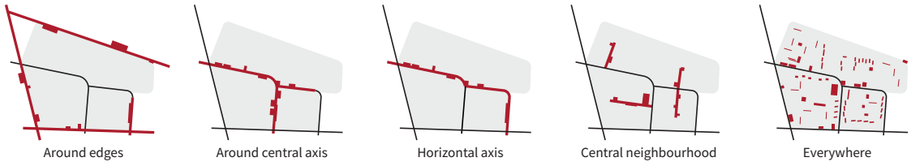
5.2 Neighbourhood structures

An atomization of the neighbourhood reveals how its different elements can be spatially organised. For most categories, variations can be identified that are centralised at the neighbourhood level, centralised at the sub-neighbourhood level, distributed throughout the area, or concentrated along the central axis.

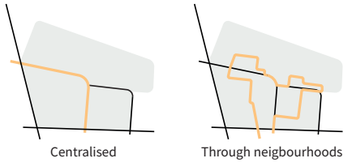
Car: street structure



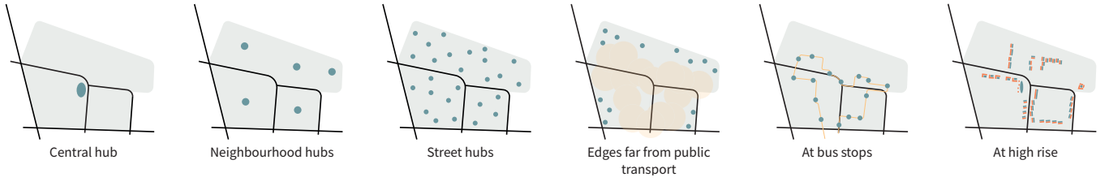
Car: Parking



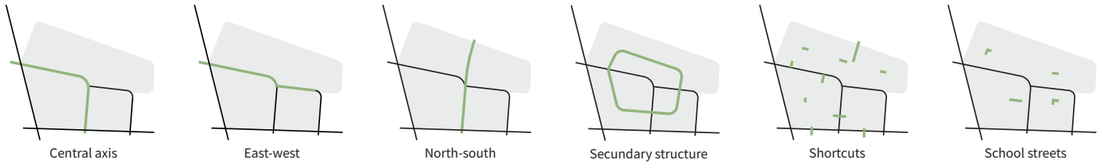
Public transport



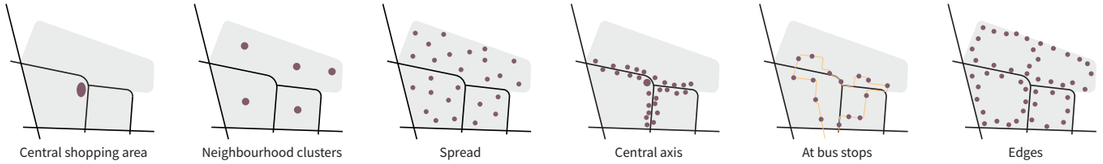
Shared mobility



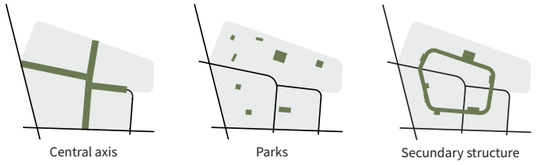
Slow mobility



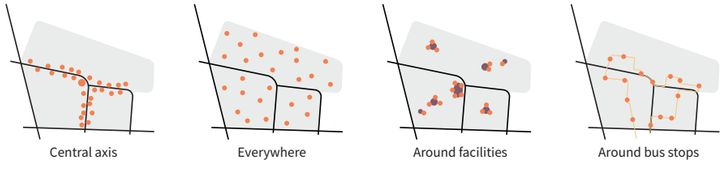
Facilities



Nature



Densify



5.3 Analysis Hoge Vucht

Figure 54: Spatial overview of Hoge Vucht

The neighbourhood Hoge Vucht is located on the northern edge of Breda. The neighbourhood was a big expansion of the city in the 60s. Before the 60s, the land was part of the Lage Vucht polder, however no traces of the original landscape are left within the neighbourhood.

To the north, the remaining part of the Lage Vucht polder is still present. To the west of Hoge Vucht lies a large industrial and commercial area. To the south, Hoge Vucht borders the neighbourhood Doornbos-Linie, and even further to the south, the train station and city centre of Breda are located. To the east is a small commercial area and beyond that the village of Teteringen.

Hoge Vucht is a typical example of a 1960s neighbourhood: functions are strongly separated, the road network is spacious and centrally organised, buildings follow strict and repetitive forms, and a large share consists of gallery flats. At the centre of the district lies the Hoge Vucht shopping centre, which plays an important role not only for the neighbourhood but also for the surrounding areas.

The main road structure and the green structure divide the neighbourhood into five sub-neighbourhoods: Biesdonk, Wisselaar, Geeren-Zuid, Geeren-Noord and Waterdonken. The first four were built in the 1960s, whereas Waterdonken was developed from 2008 onwards and has a noticeably different character, with larger houses and fewer apartment blocks. Wisselaar and Geeren-Noord are water-rich and border the Lage Vucht polder, while the southern sub-neighbourhoods have a more park-like setting with green corridors. Each sub-neighbourhood has small local squares and green spaces, though much of the greenery is non-functional “view-green”.

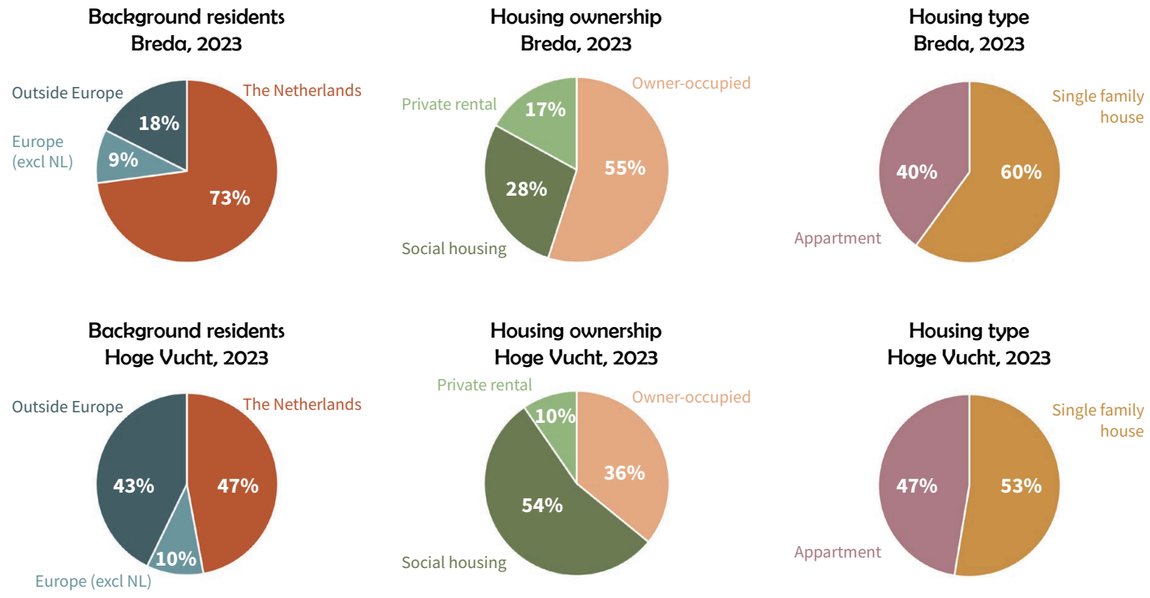


Figure 55: Statistics about Breda and Hoge Vucht, data from CBS Statline (2024a)

The statistics in figure 55 shown that Hoge Vucht has a high percentage of people with a migration background compared to the rest of Breda (53% compared to 27%). In The Netherlands, people with a non-Western background walk twice as much as people with a Dutch background (KiM, 2015), implying that a good walking infrastrucure is desirable in this neighbourhood. Hoge Vucht also has a higher percentage of social housing (54% in Hoge Vucht, 28% in Breda), and a higher percentage of apartment buildings (47% in Hoge Vucht compared to 40% in Breda) (CBS Statline, 2024a). The average income in Hoge Vucht is also lower than in the rest of Breda (Alle Cijfers, 2025). These socio-demographic characteristics indicate that Hoge Vucht is a relatively vulnerable neighbourhood where affordable mobility options, proximity of daily services, and high-quality public space are particularly crucial for maintaining liveability and accessibility in Hoge Vucht.

Figure 56: Neighbourhood structure original plans, based on Steenhuis et al. (2009)

Understanding the current structure of Hoge Vucht requires looking back at the original plans from the 1650s. Hoge Vucht is a typical example of a 60s neighbourhood, designed as a spacious neighbourhood based on the modernist principles of the time: strict functional separation and generous light–air–space standards. Large amounts of green space were included, but mostly as anonymous, uniform open areas rather than functional public spaces.

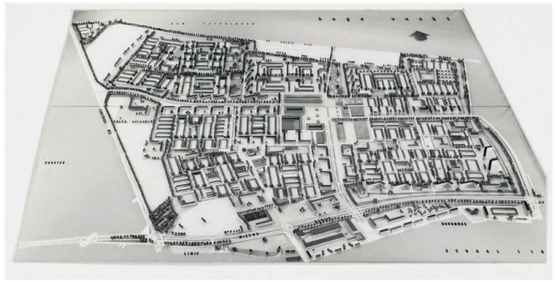
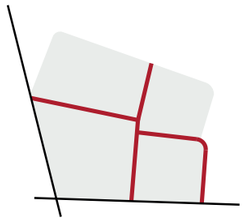
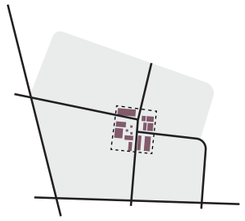


Figure 57: Scale model of the planned housing development in Hoge Vucht (Breukink, n.d.)



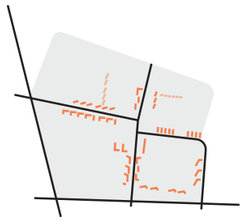
Parkways

Parkways
In the original plans, four parkways were designed. These wide roads were intended solely for traffic flow rather than parking and formed a clear border between the sub-neighbourhoods. The northern parkway allowed for a potential future extension of the neighbourhood.



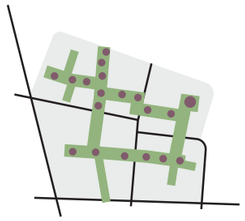
Centre

Centre
The parkways intersect in the centre of Hoge Vucht where many facilities are clustered. Originally, the centre was planned as shops and facilities placed within open space.



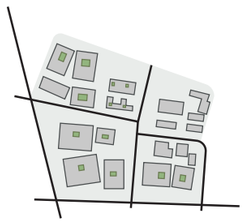
High rise

Hight rise
Medium-rise buildings were planned along the parkways to function as a buffer between the traffic roads and the sub-neighbourhoods. The apartment buildings were designed as freestanding blocks with little spatial enclosure. The medium-rise buildings were ultimately built as high-rise buildings.



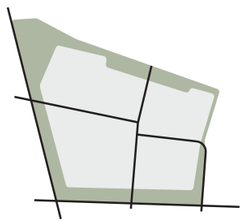
Green structure

Green structure
The four sub-neighbourhoods were divided into blocks through which the secondary green structure was designed. In this green structure, many facilities were planned.



Local green in blocks

Local green in blocks
The low-rise buildings consist of row houses arranged in clear, rectilinear block structures, and each block was planned to have a centrally located green field.



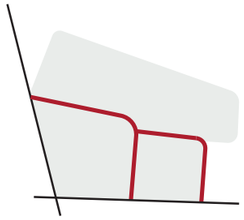
Green buffer

Green buffers
A continuous green buffer was designed to surround Hoge Vucht.

Figure 58: Neighbourhood structure of the current situation, based on Steenhuis et al. (2009)

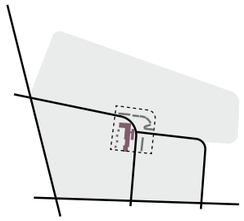
In the neighbourhood structure of today, a lot of the original structure remains visible in Hoge Vucht. A big difference between the original plans and the current situation is that the number of facilities that were planned was too much for the number of residents in Hoge Vucht. As a result, fewer facilities were built, and additional housing was constructed instead. Buildings were also added within the intended green structure and green buffer, which has led to a more fragmented and less cohesive green network. A more recent addition to Hoge Vucht is the sub-neighbourhood Waterdonken, built in 2008. This neighbourhood has a very different character from the original four, featuring larger homes and fewer apartment buildings.

Figure 59: Aerial photo Hoge Vucht (Aerophoto Schiphol BV, 1992)



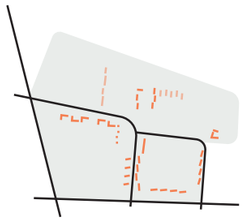
Parkways

Parkways
From the four originally planned parkways, only three were built. The northern parkway and the optional northern extension of the neighbourhood were never realised. The parkways still have a wide, green profile of trees and green strips without parking.



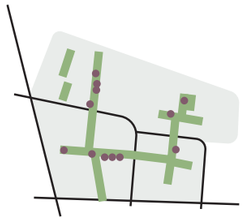
Centre

Centre
Although much smaller than originally planned, the neighbourhood's central point is the Hoge Vucht shopping centre. Unlike the original vision of an open and outward-facing layout, the shopping centre has become inward-oriented. Next to the shopping centre is a big parking lot.



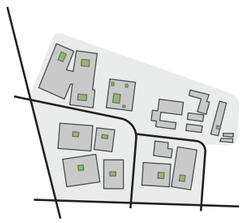
High rise

High rise
All the high-rise buildings planned along the edges of the sub-neighbourhoods and parkways were eventually realised, although their form and orientation differ slightly from the original plans. Even though the northern parkway was never built, the high-rise buildings that were planned there did get built.



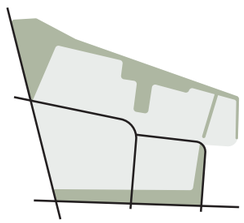
Green structure

Green structure
The original secondary green structure has become somewhat fragmented, because housing has been added in places where only facilities were originally intended; much of the remaining greenery now functions as anonymous "visual greenery" rather than usable public space.



Local green in blocks

Local green
The local green fields remain clearly recognisable throughout the neighbourhood, although many of them function mainly as anonymous open spaces that are too big to feel personal for residents.



Green buffer

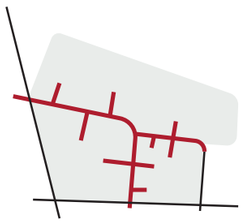
Green buffer
The original green buffer has also become fragmented. The northern edge still functions as a green buffer with a park and some recreational functions, but the western and southern edges of Hoge Vucht now consist mainly of sports and educational facilities. The eastern edge is now defined by the new sub-neighbourhood Waterdonken, along with a newly created water boundary to the east.

Access

Figure 60: Access roads Hoge Vucht

Access to Hoge Vucht by car is possible only via three parkways: Groenedijk, Doornboslaan, or Cornelis Joosstraat. These parkways have a wide profile, a speed limit of 50 km/h, and connect to the primary roads Terheijdenseweg and Nieuwe Kadijk. From these parkways, drivers can enter the various sub-neighbourhoods. Direct access to Hoge Vucht from the north by car is not possible.

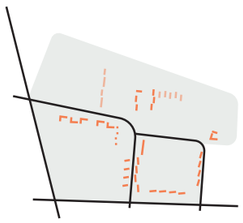
For cyclists and pedestrians, there are more entry points into Hoge Vucht. While several shortcuts connect to the primary roads, there are relatively few opportunities to cross them. To the south, a bus trap allows buses, cyclists, and pedestrians to cross the primary road towards Doornbos-Linie. Cyclists and pedestrians can also reach the Vuchtpolder to the north.



Building height

Figure 61: Building height Hoge Vucht

Most buildings in Hoge Vucht are of low-rise row houses, arranged in a clear block structure within the sub-neighbourhoods. High-rise apartment blocks are arranged in a regular pattern along the edges of these areas, creating a buffer between the row houses and the surrounding busy road. The facilities located at the centre and the edges of Hoge Vucht are generally low- or mid-rise.



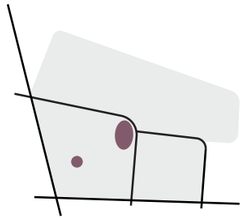
Facilities

Figure 62: Facilities in Hoge Vucht

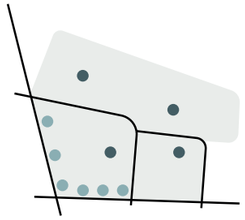
In the Hoge Vucht district, housing is the dominant function. To support this residential role, additional facilities are available, including supermarkets, schools, and shops. Most shops are concentrated in the centrally located shopping centre Hoge Vucht, which holds a strong position that reaches beyond Hoge Vucht itself. This shopping centre contains three supermarkets, a GP practice, a pharmacy, and numerous other shops.

Outside the central shopping centre, there are very few shops in Hoge Vucht. In Biesdonk, a small neighbourhood shopping strip offers an additional supermarket and a bakery. Other facilities, such as community spaces, healthcare facilities, and educational institutions, are scattered throughout Hoge Vucht, primarily within the original green structure between the residential blocks. Meeting places include community houses, a library, and a youth centre. In the sub-neighbourhood are two more GP practices, two dentists, a midwifery, and several nursing homes. Options for eating or drinking are very limited outside the main shopping centre: there are no cafés, and only one restaurant is located in Geeren-Zuid.

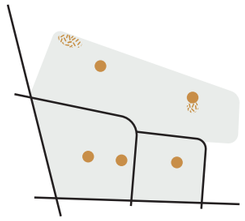
Primary schools are centrally located within each of the four sub-neighbourhoods, while higher education facilities are concentrated along the western and eastern edges of Hoge Vucht. All primary schools offer playgroups for children aged 2–4, but there is only one daycare facility for children aged 0–4, situated in the southern part of Hoge Vucht.



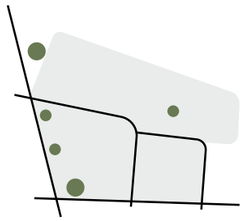
Retail



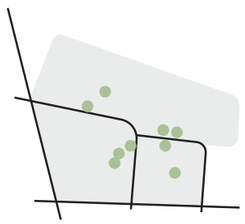
Education: primary school
Education: other



Community centre
Community garden



Sports



Health

Figure 63: Shopping centre Hoge Vucht, turned inwards (Author's image, 2025)

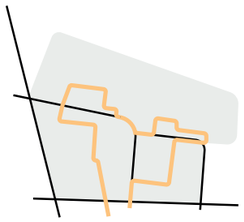
Figure 64: Shopping centre Hoge Vucht, turned inwards (Author's image, 2025)

Figure 65: Big parking lot at shopping centre Hoge Vucht (Author's image, 2025)

Public transport: Hoge Vucht

Figure 66: Public transport in Hoge Vucht

Currently, there is one bus line serving Hoge Vucht in both directions. In each direction the route passes the train station. From there, one line continues east toward Heusdenhout, while the other heads through the city centre toward Kievietsloop in northwest Breda. The bus runs every 15 minutes on weekdays and every 30 minutes on weekends. On weekdays, the bus drives in Hoge Vucht between 5.30 in the morning and 00:45 in the evening. At weekends, the last bus runs at the same time, but the first bus starts at 7.00 on Saturdays, and at 8.15 on Sundays. Breda is well connected by train to cities such as Rotterdam (22 minutes), Tilburg (14 minutes) and Antwerp (34 minutes). With the Intercity Direct, it is possible to be in Amsterdam Zuid in exactly one hour (NS, 2025; NS International, 2025).



Public transport: Breda

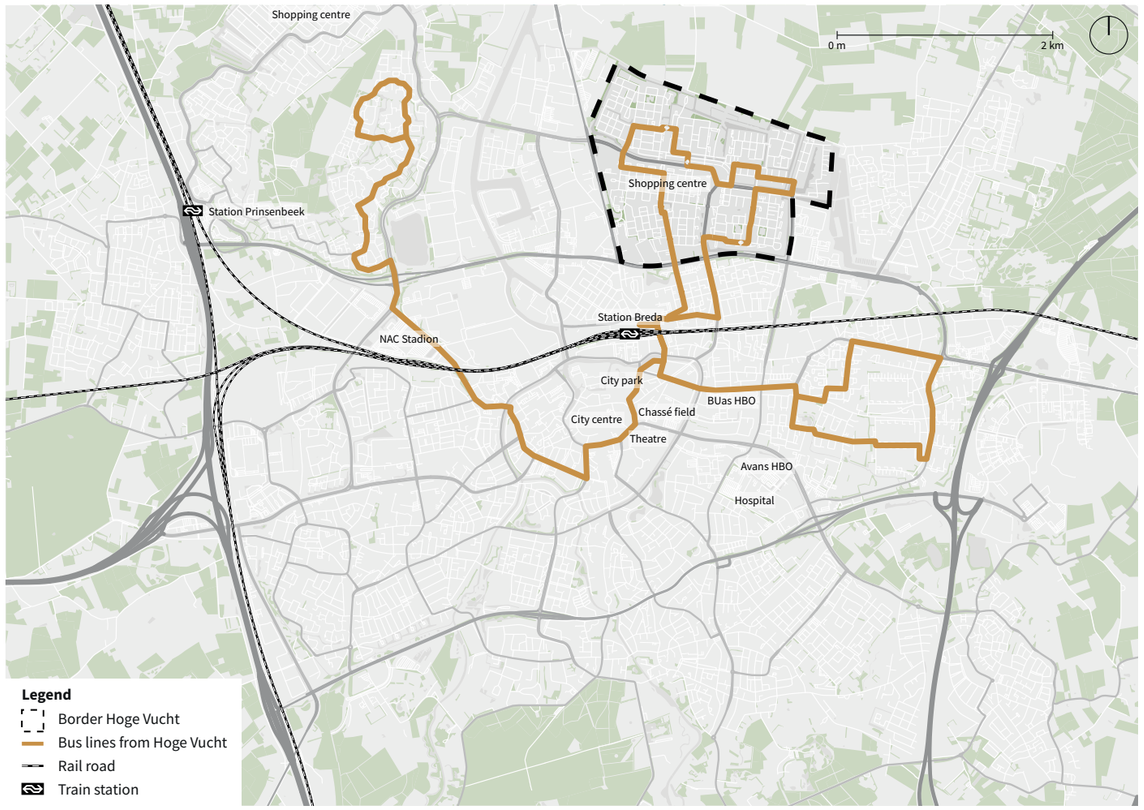
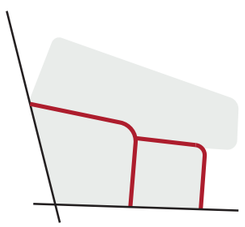


Figure 67: Bus lines running through Hoge Vucht

Street hierarchy

Figure 68: Road hierarchy Hoge Vucht

In the current situation, there is little street hierarchy in Hoge Vucht. There are many residential roads, all with the same character. The parkways have a clear different character. Within the sub-neighbourhoods, there are pedestrian shortcuts in the middle of housing blocks, creating pedestrian access to the back gardens.



Hoge Vucht in numbers

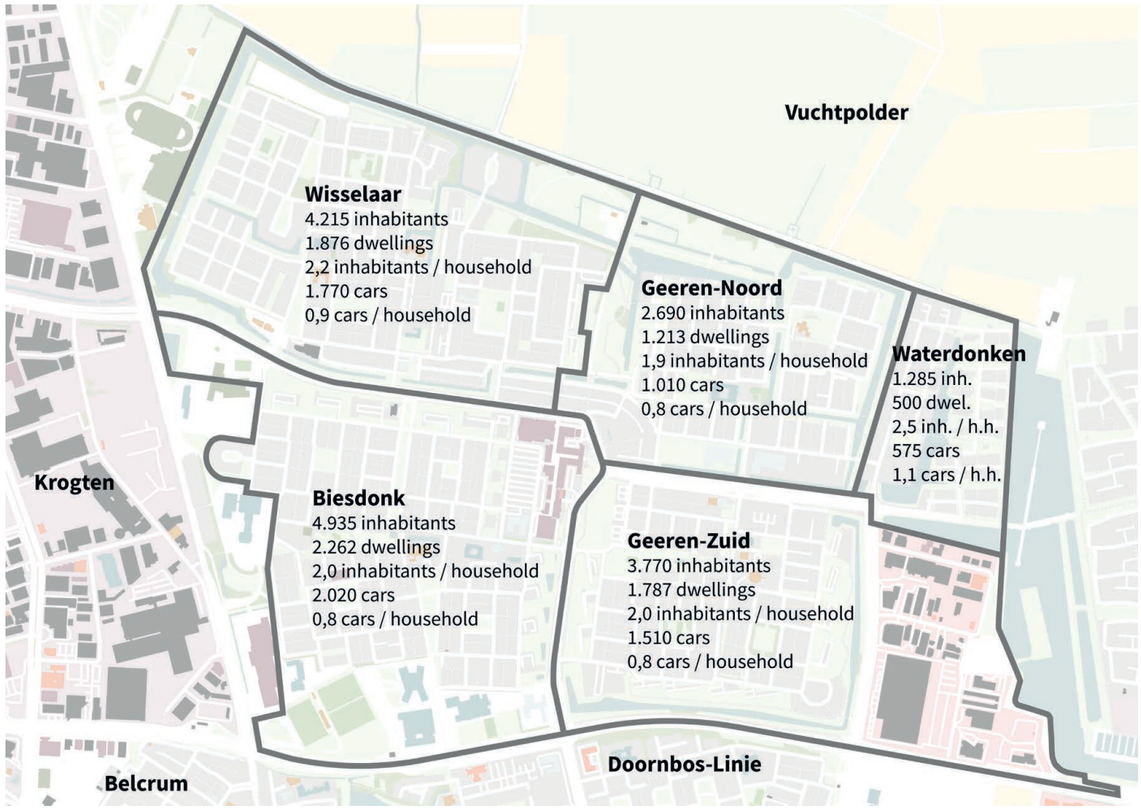


Figure 69: Statistics about Hoge Vucht, data from CBS Statline (2024a)

When comparing data across the sub-neighbourhoods of Hoge Vucht, it becomes clear that the four areas built in the 1960s, Biesdonk, Wisselaar, Geeren-Zuid, and Geeren-Noord, are very similar. Biesdonk is the largest sub-neighbourhood, while Geeren-Noord is the smallest. In contrast, Waterdonken is notably different from the others: it is smaller in size but has more inhabitants and cars per household, reflecting its more recent development and the bigger average dwelling size. In Waterdonken, the percentages of people with a migration background, apartment buildings and social housing are also lower compared to the other four neighbourhoods (CBS Statline, 2024a).

Hoge Vucht:

16.895
Inhabitants

2,12
Average houshold

0,85
Average car/houshold

Car-oriented neighbourhood
These pictures show the car dominance in the neighbourhood of Hoge Vucht. With numerous parking spaces, private garages, and wide street profiles, the car is prevalent in the neighbourhood.








Figure 70: Photos of the car-oriented streets and parking places in Hoge Vucht (Author's image, 2025)

Public transport

These photos show the public transport infrastructure in Hoge Vucht. Some bus stops do not have a shelter, and there is one bus stop with digital boards located next to the shopping centre.







Figure 71: Photos of the public transport infrastructure in Hoge Vucht (Author's image, 2025)

Bike infrastructure

The photos show the bike infrastructure in the neighbourhood Hoge Vucht. At many places, bike parking is (too) small, and one-way bike paths next to the parkways are used in two directions.

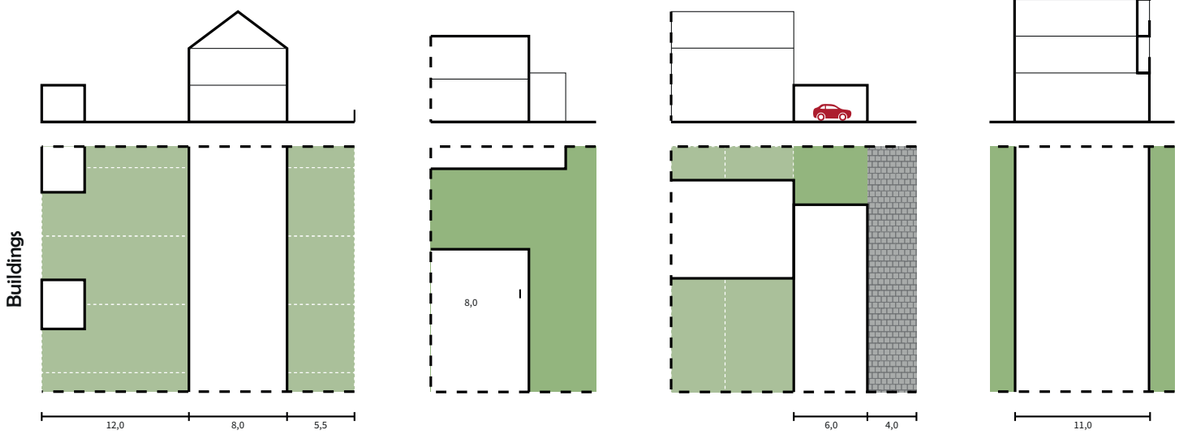





Figure 72: Photos of the bike infrastructure in Hoge Vucht (Author's image, 2025)

5.4 Street typologies

An atomization of the street shows the different elements that exist in streets, their dimensions, and materialisation. These elements can be used to describe typical streets in post-war neighbourhoods. These elements can also be applied during the redesign of these streets.

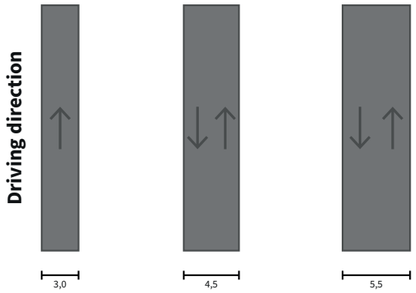


Row houses
3 stories high
Relatively large front gardens
Sheds in the back gardens (shared by two neighbours or continuous)

Facilities
Different hights (1-4 stories)
Located in original green structure

Private garage boxes
Placed at the ends of row houses
Wide sidewalk next to the garages

High rise gallery flats
7-13 stories high
Ground floor used for storage
Located in open green areas



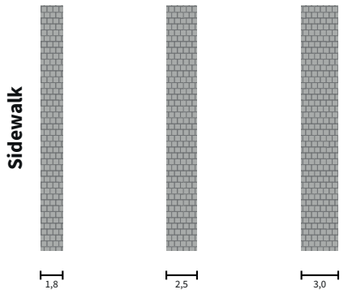
One way
Minimal size

Two ways
Minimal size

Two ways
Plus

Asphalted
Low water permeability
Encourages fast driving

Brick pavers
More permeable
Slows down traffic
In various colours and patterns



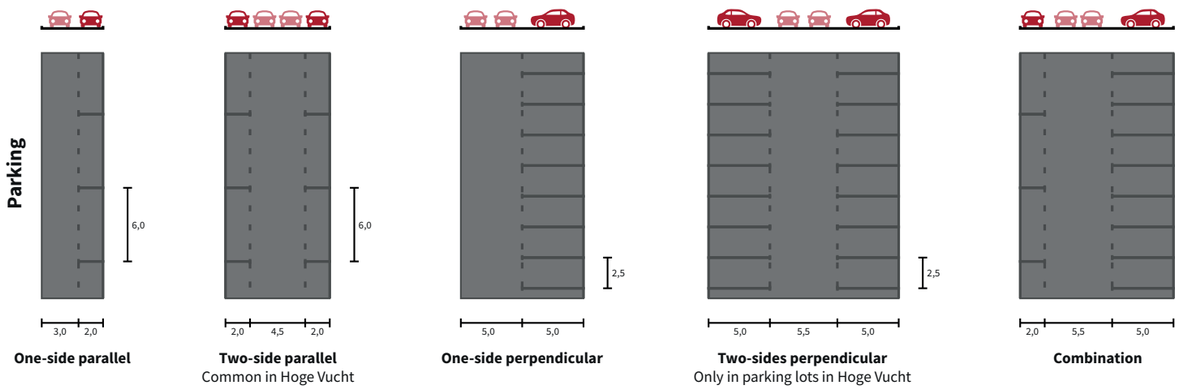
Minimal

Plus

With places to stay

30×30 grey concrete tiles
Cheap and efficient

Brick pavers
In various colours and patterns



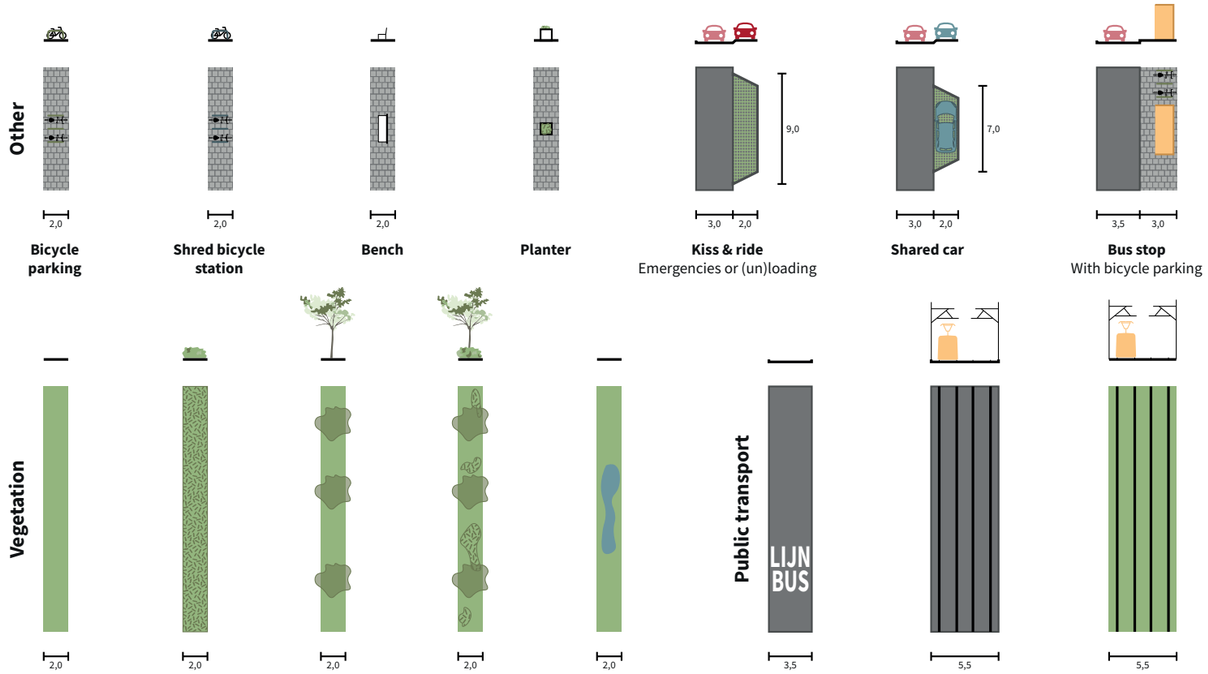
One-side parallel

Two-side parallel
Common in Hoge Vucht

One-side perpendicular

Two-sides perpendicular
Only in parking lots in Hoge Vucht

Combination



Bicycle parking

Shred bicycle station

Bench

Planter

Kiss & ride
Emergencies or (un)loading

Shared car

Bus stop
With bicycle parking

Grass strip

Shrubs

Trees

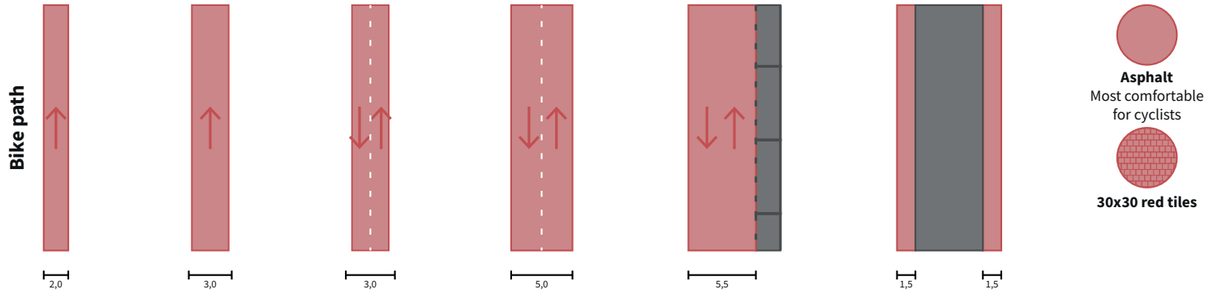
Combination
Best for ecology

Wadi
For water retention

Bus lane

Tram track
On the street

Tram track
In grass



One-way
Minimal size

One-way
Plus

Two-ways
Minimal size

Two-ways
Plus

Bicycle street
Cars allowed
Sometimes with parking

Along the road

Asphalt
Most comfortable for cyclists

30x30 red tiles

Asphalt

Brick pavers
In different colours and patterns

30×30 grey concrete tiles
Same as sidewalk pavement

Semi-paved surface
High water permeability

Street level

Raised
Sidewalk level
Visually narrows street

Informal parking
No markings
Only allowed if the street is wide enough

Parking zone

Parking places

Residential street

The most common street typology in Hoge Vucht is the residential street. These streets are very local, serving mainly the houses on that street. In Hoge Vucht, this consists of 3-story row houses, with a front garden adjacent to the street, and sometimes rows of private garage boxes on the ends of row houses. In Hoge Vucht, these streets all have a remarkably wide profile. Most of the public space in these streets is allocated to the car. Most streets have parking on both sides of the street, either parallel parking on both sides or perpendicular parking on one side and parallel parking on the other side. Some streets have some green strips, which are mainly used to make them look green, but lack ecological value. The streets themselves are all asphalted, but sometimes the parking spaces are paved with brick pavers.

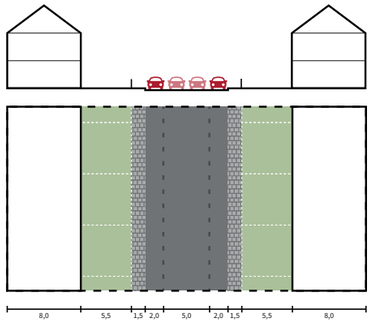
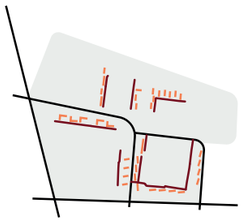


Figure 73: Typical residential street in Hoge Vucht (Author's image, 2025)



Edge streets

Another typology in Hoge Vucht is the edge street, which has row houses on one side and high-rise apartment buildings on the other. Most of these streets also form the edge of the sub-neighbourhoods. On one side are row houses with gardens, similar to the residential streets. On the other side, there are high-rise gallery flats. The gallery flats are located in open green areas and serve as a physical buffer between the low-rise sub-neighbourhood and a busy traffic street. The gallery flats all have a big parking lot. This parking lot is also surrounded by the open green strip that surrounds the high-rise. At most places in Hoge Vucht, these open green places consist of only grass fields and trees. Shrubs, flowers, relief, meeting places, or play elements are lacking in these places. The streets are wide dimensioned. Most streets do not have assigned parking spaces; however, on all streets, at least one side of the street is used for informal parking.

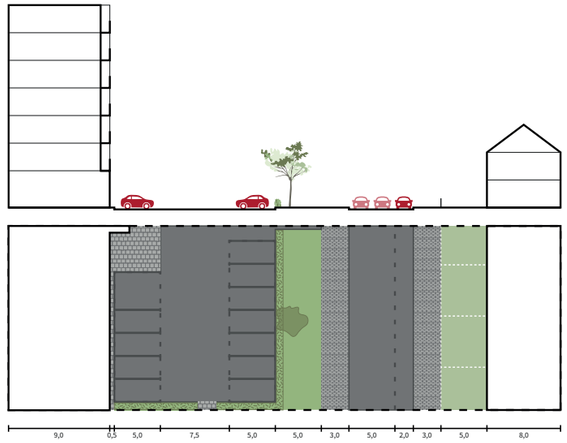
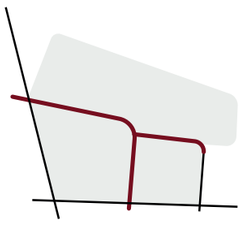


Figure 74: Edge street in Hoge Vucht (Author's image, 2025)



Parkways

In Hoge Vucht, there are three central parkways that provide access to the sub-neighbourhoods. These parkways have a wide profile with two wide, separate one-way lanes. Also, the bike lanes are two separate one-way lanes, although in practice they are used for both directions. There are multiple green strips with grass and trees separating the different lanes and the buildings. The parkways run alongside rows of high-rise gallery flats. There is no parking on these streets; they are intended for fast, through traffic and are not destinations.

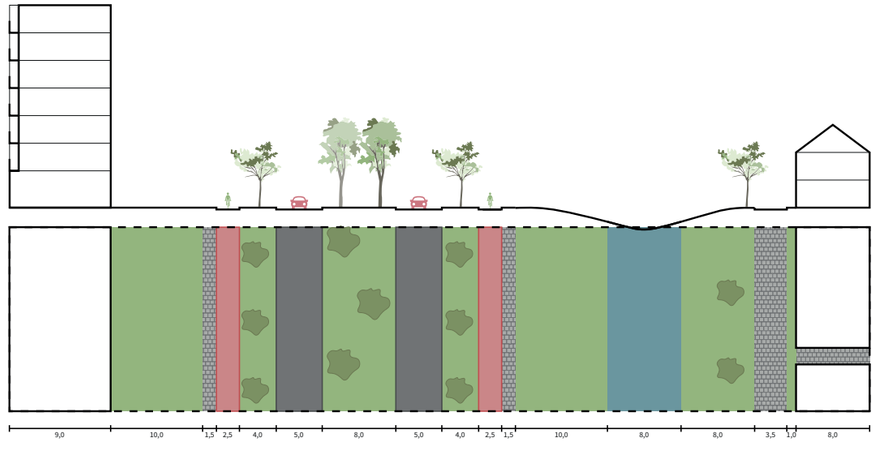


Figure 75: Parkway in Hoge Vucht (Author's image, 2025)

06

SPATIAL DESIGN

This chapter explores how in different scenarios sustainable mobility can enhance liveability and accessibility in Hoge Vucht. Four scenarios are designed, each focusing on one dominant type of sustainable mobility combined with a particular strength in liveability or accessibility. The scenarios illustrate the full spatial potential of each mode and value. To combine the different scenarios the conflicts and overlap between the scenarios are analysed. The final design is the combined version of the four scenarios combing their qualities to improve liveability and accessibility in multiple categories on several levels. This results in a neighbourhood where there is space for people and nature on both neighbourhood and street level!

Parkway in Hoge Vucht, Breda (Author's image, 2025)

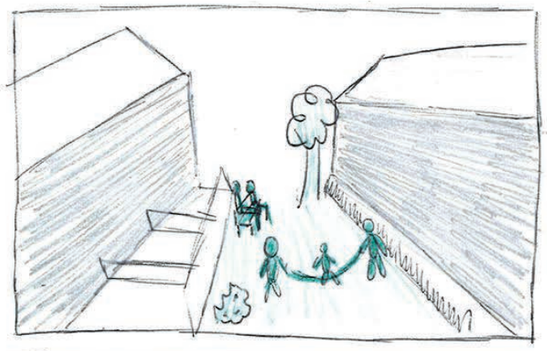
6.1 Scenario overview

To translate strategies into spatial design, the maximisation method is used for the case study area Hoge Vucht. In this method, different lenses are first designed separately, and later combined in one final design. For this research, different lenses of sustainable mobility and liveability are designed separately in four scenarios. The goal for all scenarios is to create a sustainable and liveable Hoge Vucht in 2050. Each scenario focuses on one dominant type of sustainable mobility combined with a particular strength in liveability or accessibility. The first scenario focuses on creating an inclusive neighbourhood while promoting walking. The second scenario focuses on a healthy neighbourhood while stimulating people to cycle. The third scenario creates a diverse and vibrant urban neighbourhood with high-quality public transport. The fourth scenario focuses on creating a community feeling in the neighbourhood, while shared mobility is introduced. The scenarios illustrate the full spatial potential of each mode and value. Appendix D presents a mood board for each scenario.

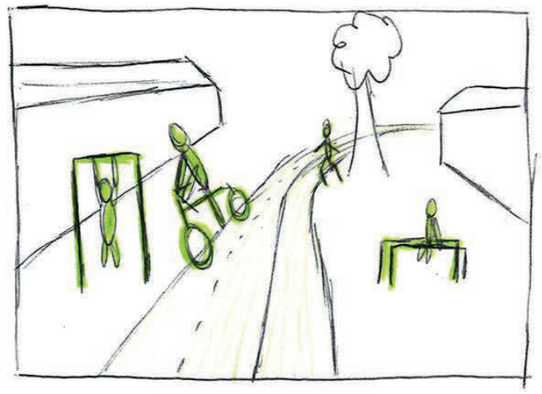
Each scenario is assessed on the liveability and accessibility frameworks created in chapter 4. Appendix F shows in more detail how these assessments were evaluated.

Vision: a sustainable and liveable Hoge Vucht in 2050

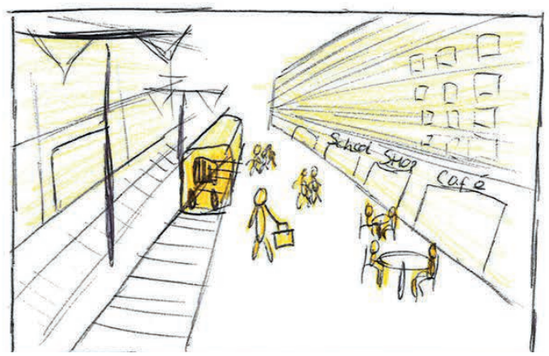
From young to old
The inclusive neighbourhood



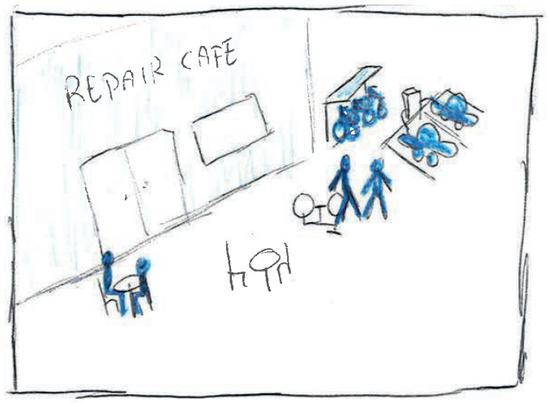
Active flow
The healthy neighbourhood



Urban life
The diverse urban neighbourhood



Shared roots
The community neighbourhood



6.2 Variant A: From young to old

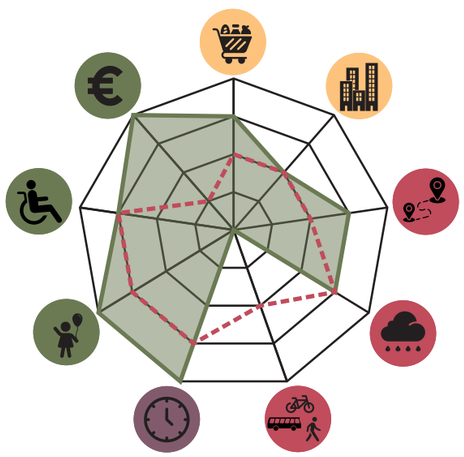
In this scenario, the goal is to create an inclusive neighbourhood. Most interventions improve the quality of the immediate living environment; the street people live. This is especially important for children and the elderly, as this forms the setting of their daily lives. For children, the emphasis lies on the development of cognitive skills with creating opportunities to play, while for the elderly, the goal is to prevent loneliness and promote independence with creating opportunities to meet. People with a migration background, who make up 53% of Hoge Vucht's residents, are also known to prefer walking over cycling. With local facilities in the sub-neighbourhoods, proximity to diverse facilities is facilitated. This is valuable in supporting access to daily needs for both the elderly and people with a migration background. Around primary schools, streets are car-free, so children can safely walk to school. By including these vulnerable groups, everyone will benefit from these implementations on improving the connection with their own street, proximity to facilities, and facilitating a more walking-oriented neighbourhood.

Walking & Inclusiveness

Liveability

This scenario improves liveability in almost all aspects. The biggest improvements in liveability are in stimulating physical exercise (mainly walking and children playing outside) and limiting emissions, since walking emits no emissions at all.

Accessibility



In accessibility, this scenario scores well in inclusiveness. Kids can play in the streets, and the elderly can walk to their GP and supermarket. Walking is free, making these facilities accessible for people who can not spend much money on mobility. In this scenario, walking is the central form of transportation, therefore this scenario does not provide a choice in mobility options.

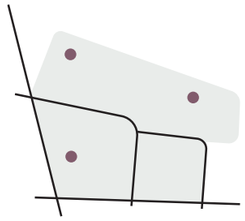
Neighbourhood implementations

	Number	Title	Time frame
Neighbourhood scale	A.1	**Facilities closeby** Ensure key facilities such as nurseries, schools, GP practices, and supermarkets are within walking distance, supporting accessibility for all residents.	●—●—●
	A.2	**School streets** Surround schools with car-free streets to encourage children and parents to walk or cycle to school, while improving traffic safety and creating child-friendly streets.	●—●—○
Sub-neighbourhood scale	A.3	**Living streets** Create car-free streets where children can play safely, residents can meet, and people feel ownership of their street. This public space should feel like an extension of their houses. These streets still accommodate emergency vehicles, moving vehicles, and accessibility needs for disabled residents.	●—●—●
	A.4	**Elderly housing** Provide housing options that allow elderly residents to stay in the neighbourhood as their needs change: • Apartments For Life: Fully adaptable homes supporting independent living while allowing care as needs increase. • Knarrenhof: Small, community-focused housing clusters where older adults live independently and support each other socially and practically. • Residential care home: Facilities providing basic daily support and social services while allowing independent living.	●—●—○
	A.5	**Community houses** A place in the sub-neighbourhood for social activities such as weekly bingo, checker tournaments, or other events to strengthen social cohesion.	●—●—○
	A.6	**Diverse playgrounds** Offer a variety of playgrounds for different age groups and preferences.	●—○—○
	A.7	**Sports for elderly** Encourage physical activity among older residents through: • Outdoor fitness equipment for simple exercises • Jeu de boules	●—○—○
	A.8	**Safe crossings** Provide enough crosswalks to ensure safe pedestrian movement.	●—○—○
	A.9	**Shortcuts** Create pedestrian shortcuts, including bridges and pedestrian-only zones, to shorten travel distances.	●—●—○

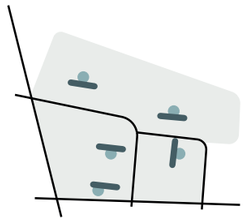
From young to old

The inclusive neighbourhood

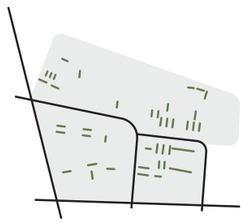
Neighbourhood scale



Local centres



School streets



Car-free living streets

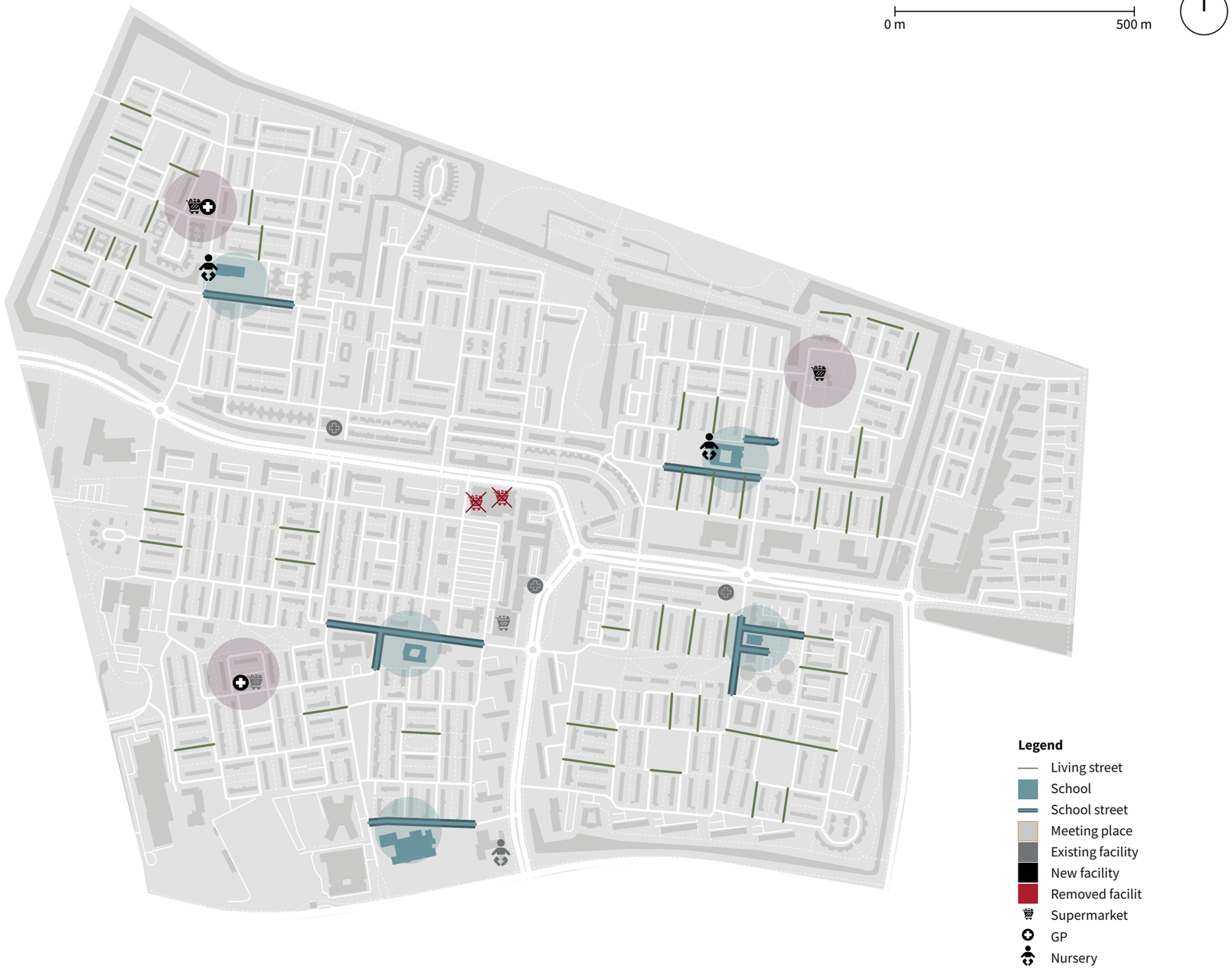


Figure 76: Scenario map *From young to old* for Hoge Vucht

Street scale

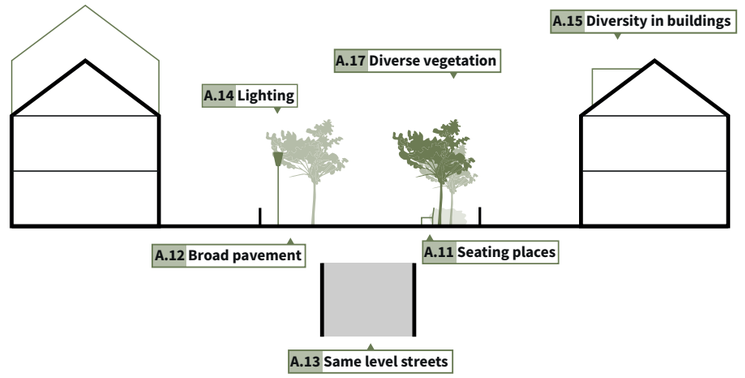
Number	Title	Time frame
A.10	**Meeting opportunities in the street** Improving social interaction and preventing loneliness by providing places in residential streets where neighbours can meet, such as picnic tables, a checker table and a place to barbecue.	●—○—○
A.11	**Seating places** Having enough seating places makes walking more comfortable and accessible for elderly residents and those who need rest. It also provides a place where people can meet and have a chat.	●—○—○
A.12	**Broad pavements** Widen pavements to accommodate walking, jogging, and seating comfortably.	●—●—○
A.13	**Same level streets** Design streets at the same level to prioritise pedestrians and create a more comfortable environment for wheelchair users, strollers, and walkers.	●—●—○
A.14	**Lighting** Providing enough lighting to make streets safe and inviting during evenings and nights.	●—○—○
A.15	**Diversity in buildings** Encourage variation in building height, materials, and forms to make walking more interesting and visually stimulating.	●—●—●
A.16	**Climate resilient measures** Create comfortable streets under extreme weather conditions: • Wadis, green strips, and permeable pavements for heavy rainfall • Shade and shelter from sun, wind, and rain through trees and structures	●—●—○
A.17	**Diverse vegetation** Include varied vegetation to enhance visual interest and encourage walking through streets.	●—○—○

From young to old

The inclusive neighbourhood

Street scale

Residential street



Living street

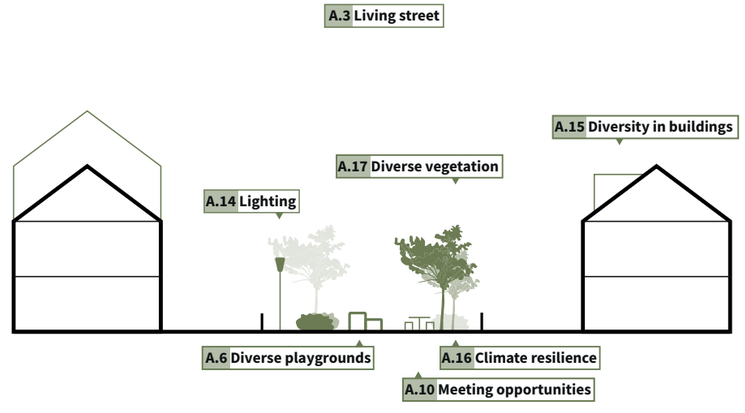
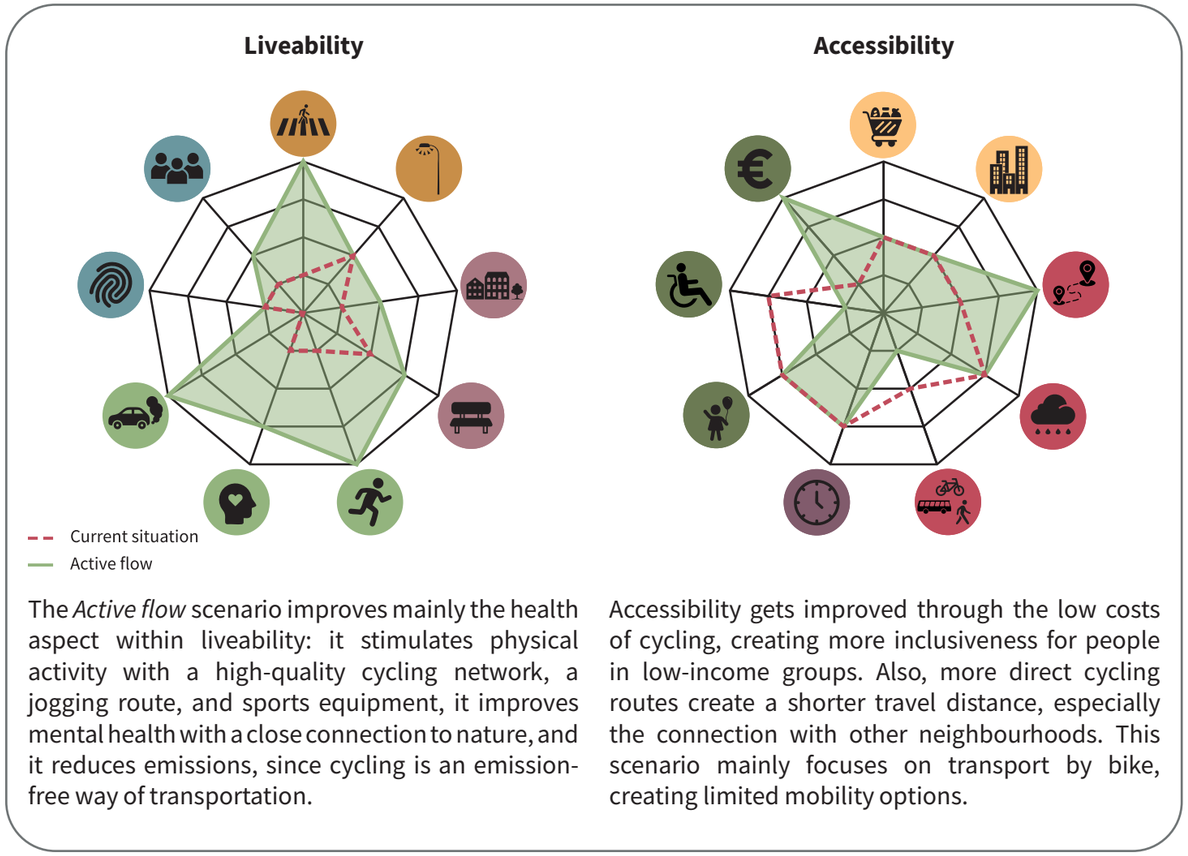


Figure 77: Diagrams of the steet in *From young to old* scenario

6.3 Variant B: Active flow

This scenario focuses on creating a healthy neighbourhood — one that supports physical well-being, mental health, and a sustainable living environment. Cycling will be promoted with direct routes and bicycle parking (both indoor and outdoor), as it is an active and emission-free mode of transport. All the important facilities will be connected to this high-quality cycling network. Cycling can be used for short distances, but also for longer distances, especially with e-bikes. Opportunities for sport will be enhanced by providing fitness equipment in public parks and playgrounds. Paths through nature areas will encourage jogging and walking in nature, contributing to both physical and mental health. Maintaining a healthy ecological system by connecting ditches and biodiverse nature will support a healthy living environment for all residents.



The *Active flow* scenario improves mainly the health aspect within liveability: it stimulates physical activity with a high-quality cycling network, a jogging route, and sports equipment, it improves mental health with a close connection to nature, and it reduces emissions, since cycling is an emission-free way of transportation.

Accessibility gets improved through the low costs of cycling, creating more inclusiveness for people in low-income groups. Also, more direct cycling routes create a shorter travel distance, especially the connection with other neighbourhoods. This scenario mainly focuses on transport by bike, creating limited mobility options.

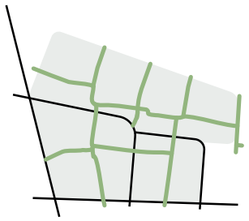
Neighbourhood implementations

	Number	Title	Time frame
City scale	**B.1**	**Fast bike routes** Direct and comfortable bike routes will connect Hoge Vucht with the rest of Breda and link the sub-neighbourhoods with each other. These routes will be asphalted, wide enough that different speeds of cyclists (speed pedelecs, e-bikes, regular bikes) can easily pass each other, and given priority on crossings. These bike routes will overlap and strengthen the original green structure in Hoge Vucht.	●—●—○
Neighbourhood scale	**B.2**	**Jogging routes** ntroducing two marked jogging routes, from 2,6km and 4,7 km, to stimulate people to go jogging. The longer jogging route connects with the existing paths in Hoge Vucht Park. Both routes will receive priority over car traffic on crossings, have water taps, benches and fitness equipment.	●—●—○
	B.3	**Recreational bike routes** Bicycle connections from Hoge Vucht to the Vuchtpolder for recreational and leisure cycling in a green setting.	●—●—○
	B.4	**Ecological connections** Strengthen the ecological and water system by linking ditches and small nature areas promoting biodiversity and a healthy ecosystem.	●—●—○
	B.5	**Urban sports park:** Built a big urban sports park as a central place for outdoor exercise and sport. The urban sports park is located next to the bigger jogging route.	●—○—○
	B.6	**Skate park** A skate park will stimulate skateboarding, skating and cycling mainly for youth and young adolescents.	●—○—○
Sub-neighbourhood scale	**B.7**	**Shortcuts cyclists** Add cycling shortcuts and slow-mobility bridges to reduce travel distances and make cycling the fastest and most convenient mode for local trips.	●—●—○
	B.8	**Fitness equipment** Installing fitness equipment along the jogging route and in local playgrounds ensures easy access to exercise opportunities close to home.	●—○—○
	B.9	**Local sport fields** Small sport fields for football, basketball and other activities create a place to train, play and meet.	●—○—○

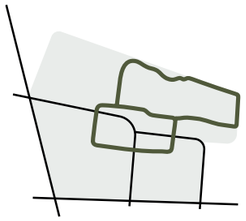
Active flow

The healthy neighbourhood

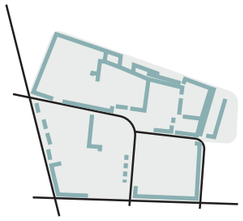
Neighbourhood scale



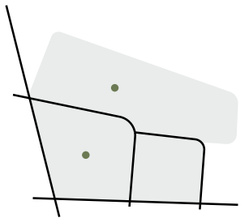
Fast bike routes



Jogging routes



Ecological connections



Urban sports park and skate park

Figure 78: Scenario map *Active flow* for Hoge Vucht

Street scale

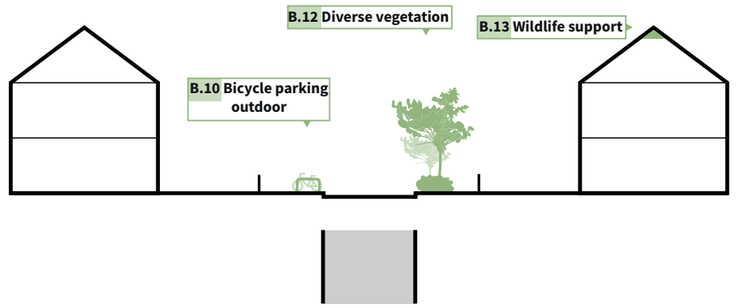
Number	Title	Time frame
B.10	**Bicycle parking in public space** Ensure sufficient bicycle stands and racks near destinations, designed for easy and secure parking, including the possibility of using a second lock.	●—○—○
B.11	**Bicycle parking in buildings** Integrate safe and easily accessible bicycle storage on the ground floors of apartment buildings and facilities. Accessibility should be enhanced through practical design features such as wide doors, automatic door opening, and step-free access. Security can be ensured through cameras, resident-only access, or manned supervision.	●—●—○
B.12	**Diverse vegetation** Planting a rich mix of trees, shrubs and grasses supports a biodiverse and resilient ecosystem and a peaceful and interesting environment for people.	●—○—○
B.13	**Wildlife support** Encourage urban biodiversity with small-scale interventions such as bee hotels, birdhouses, and bat boxes to protect and attract local fauna.	●—○—○

Active flow

The healthy neighbourhood

Street scale

Residential street



Access street

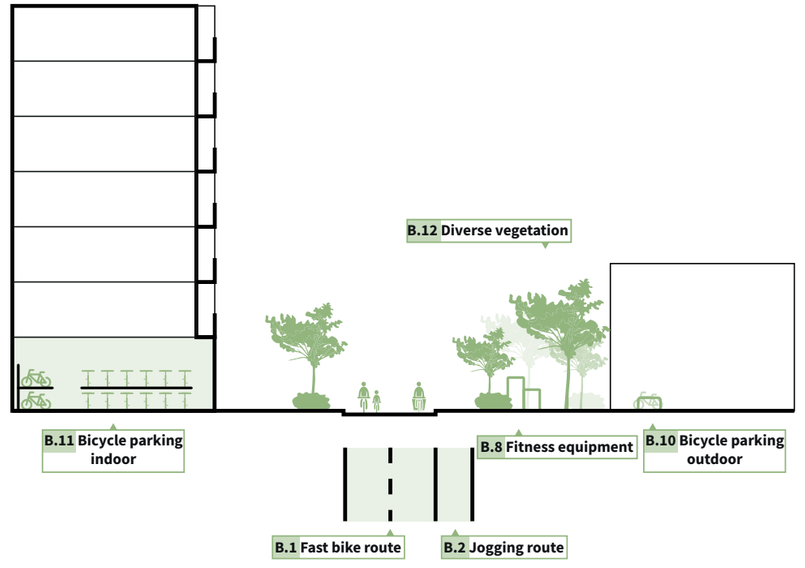


Figure 79: Diagrams of the steet in *Active flow* scenario

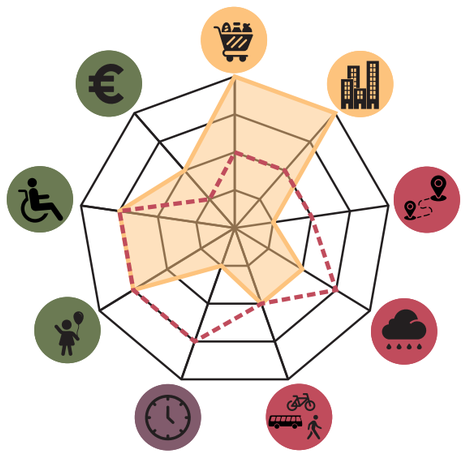
6.4 Variant C: Urban life

This scenario focuses on developing a more urban, diverse and vibrant neighbourhood. Many new houses will be built, particularly smaller appartments for students, elderly and single-person households, addressing the growing demand for this type of housing and contribute to a more varied housing stock in Hoge Vucht. These new houses will mainly be concentrated around public transport stops. New facilities like shops, educational institutions and work opportunities will enhance the local liveliness. High quality public transport will ensure a good connection to the rest of Breda with short-term improvemetns to the bus network, and in the long term, the potential introduction of a tram line. The public square next to the shopping centre will become a central and lively place for terraces, gatherings and community events in Hoge Vucht.

Liveability

This scenario mainly improves liveability in spatial quality of the buildings. Buildings and the functions in buildings get more diverse, making it more interesting.

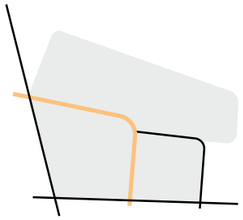
Accessibility



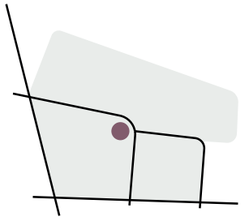
Within accessibility the proximity component significantly increases, with new facilities and a large densification in Hoge Vucht. However, due to the main focus on public transport the average travel time and travel comfort decline compared to the current car-centric situation. Public transport also has more time restrictions, due to the dependency of the schedule in evenings, nights and weekends.

Neighbourhood implementations

	Number	Title	Time frame
City scale	C.1	**Tramline** A new tramline will connect Hoge Vucht with high-quality public transport to the train station, the theatre, HBO education and the hospital in Breda.	●—●—●
Sub-neighbourhood scale	C.2	**Densification along central axis** Creating a vibrant, urban corridor axis by adding housing and functions to the central axis. The focus will be on smaller apartments for students, elderly and one-person households that frequently use public transport. • Facilities on the ground floor create eyes on the street and a connection between the buildings and the public space • New apartment buildings • Top-ups on existing buildings	●—●—●
	C.3	**Central square** Creating a central square next to the shopping centre as a central place for community life. The square will host events, markets, and pavement cafés, becoming a welcoming place for social interaction and public life.	●—●—○
	C.4	**Densification around public transport stops** An example of Transit Oriented Development by building apartments around bus stops and tram stops to promote public transport use.	●—●—○
	C.5	**Transformation of private garages** Replace the large number of private garages at the ends of row houses into small apartment blocks. This will lead to an evenly distributed densification throughout Hoge Vucht, creating a diverse housing stock on a very local scale.	●—●—○
	C.6	**Housing in local green fields** Introduce new housing along the dead edges of local green fields. These new houses will activate the edges, create a stronger sense of ownership and enclose the local green fields.	●—●—○
	C.7	**Diversity in housing** Create diverse housing types to accommodate different household types, income levels and life stages.	●—●—○

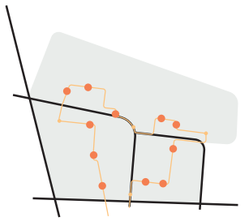


Tram line

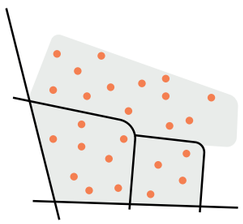


Central square

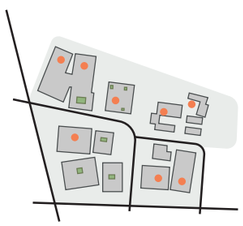
Densification along central axis



Densification around public transport stops



Transformation of private garages



Housing in local green fields

Urban life

The diverse urban neighbourhood

Neighbourhood scale

0 m

500 m

Figure 80: Scenario map *Urban life* for Hoge Vucht

Street implementations

	Number	Title	Time frame
Street scale	C.8	**Quality of public transport stops** Improving the quality of public transport stops with shelter for wind, rain and sun, comfortable seating, digital information boards, bicycle parking, and inclusive design for all users.	●—○—○
	C.9	**Bus lock** A shortcut for the bus will improve travel time in the bus network.	●—○—○
	C.10	**Pavement cafés** Introduce small-scale pavement cafés to activate public life.	●—○—○
	C.11	**Active ground floor** Stimulate active ground floors by placing functions such as cafés, small shops, community spaces, workspaces and shared facilities at street level. This creates continuous “eyes on the street”, and enhances vibrancy of the street.	●—●—○

Urban life

The diverse urban neighbourhood

Street scale

Parkway

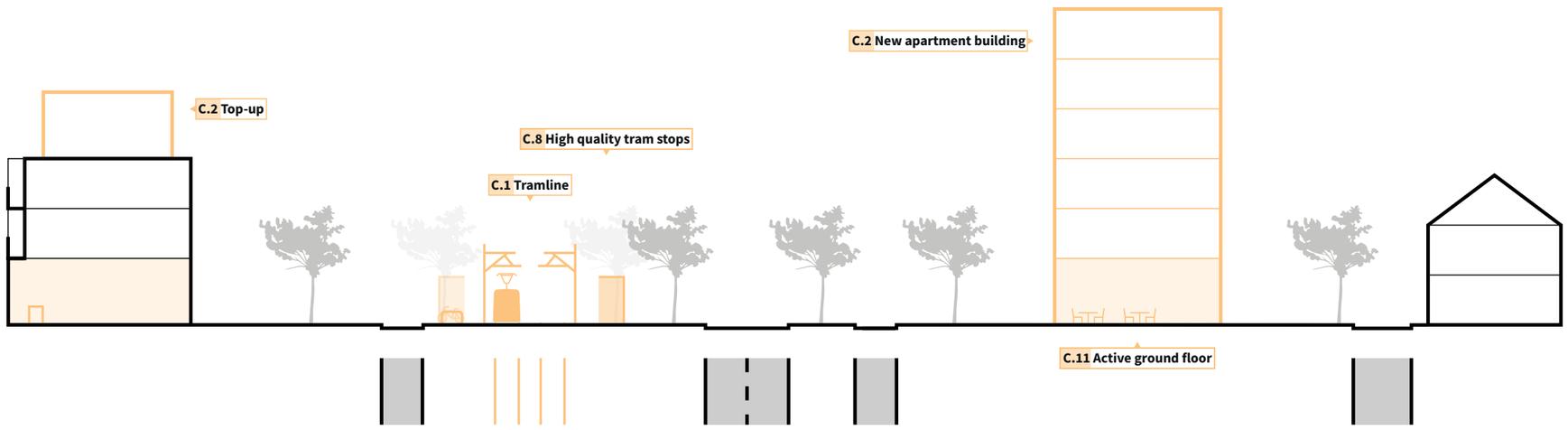


Figure 81: Diagram of the steet in *Urban life* scenario

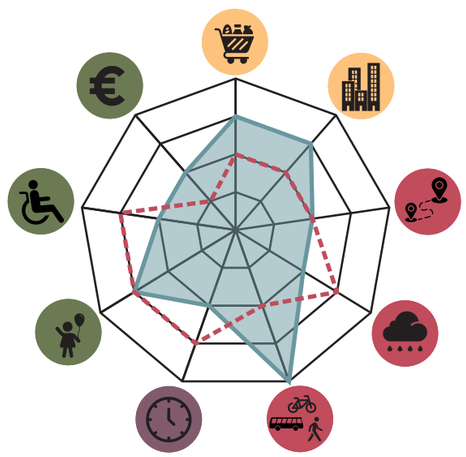
6.5 Variant D: Shared roots

This scenario will focus on creating local communities and enhancing the neighbourhood identity. The aim is to create a sense of connection among residents by sharing mobility and sharing facilities. Also meeting places in the neighbourhood play an important role in facilitating this social cohesion. Living communities will be created with shared gardens, and even a new way of living with shared kitchens, a living room and a guest room. Meeting places and living communities will be combined with mobility hubs of medium scale. Central in Hoge Vucht will be an XL mobility hub, and in residential streets, shared cars will be provided. An improved connection of the private houses to shared small public spaces, such as small grass fields, will enhance a feeling of ownership and prevent these places from becoming anonymous or unused spaces. In addition to an improved connection to their surroundings, this shared sense of responsibility will also enhance the connection to one another.

Liveability

The liveability in this scenario improves most on the social cohesion, with more outdoor meeting opportunities, more indoor meeting opportunities and more sense of ownership to the street.

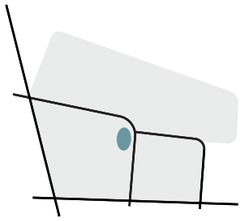
Accessibility



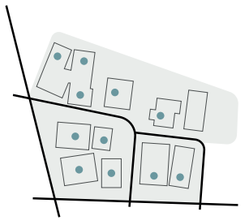
With many new mobility hubs the accessibility shows some changes. There are many different options available: even when you do not own a car, a trailer or a (cargo) (e-)bike, it is possible to make use of it. However, this is limited to the availability and maybe not always possible during peak hours.

Neighbourhood implementations

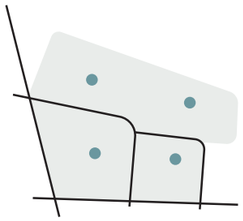
	Number	Title	Time frame
Neighbourhood scale	D.1	**XL mobility hub** Develop a large multi-storey mobility hub near the shopping centre offering a wide range of shared mobility options such as shared bikes, mopeds, cars, vans and small trailers. Shared bikes are located on the ground floor for easy access, while upper floors can also provide private car parking.	●—●—○
Sub-neighbourhood scale	D.2	**Living communities** Create living communities where residents share facilities with each other and with the wider block. New apartments and studios include shared amenities such as a communal dining room, living room, guest room and roof garden. “Friends houses” share kitchens and bathrooms. Additional shared ground-floor functions, such as flexible study spaces, a laundry café, tools library, repair café, a community garden or a small shared mobility hub, are accessible to the entire block.	●—●—○
	D.3	**Meeting place** Provide at least one central meeting place per sub-neighbourhood, offering space for various activities and social interactions. The location also includes package pickup points and shared mobility (cars and bikes).	●—●—○
	D.4	**Small shared mobility hub** • Shared bikes at public transport stops for convenient last-mile connections • Shared cars and shared bikes at large apartment buildings	●—○—○
	D.5	**Courtyard garden** Transform a cluster of existing row houses into a shared courtyard garden to encourage interaction between neighbours. Private back gardens are replaced with one generous communal outdoor space.	●—●—○
	D.6	**Small shared fields** Create small-scale shared public spaces serving one or two streets. Low fences between private gardens and the shared field improve visual and social connection, enhancing the sense of ownership and helping neighbours get to know each other.	●—●—○



XL mobility hub

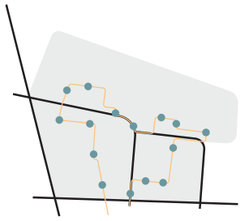


Living communities



Meeting place

Small shared mobility hub
at apartment buildings



Small shared mobility hub
at bus stops

Shared roots

The community neighbourhood

Neighbourhood scale

Figure 82: Scenario map *Shared roots* for Hoge Vucht

Street scale

Number	Title	Time frame
D.7	**Shared car parking** Provide nearby, clearly designated parking spaces for shared cars close to where residents live.	●—○—○
D.8	**Bike share station** Install shared (e-)bike stations throughout the city, ensuring that shared bikes are widely available and easy to use for short and medium trips.	●—○—○
D.9	**Parking for free-floating shared mobility** Designate parking areas for free-floating shared e-mopeds, e-scooters and similar modes. This prevents these vehicles from blocking pavements and reduces irritation among pedestrians.	●—○—○
D.10	**Meeting places on the street** Strengthen the community feeling on residential streets by providing places where neighbours can gather, such as picnic tables, benches and planting strips, checker table and small play elements. This offers opportunities to sit in the sun, chat or have a shared barbecue.	●—●—○
D.11	**Active ground floor** Promote active ground-floor uses to create safer, more welcoming streets and reinforce the connection between buildings and public space. • A central common room on the ground floor of apartment buildings where residents can meet, read, play, study or take part in activities • Ground-floor spaces for shops, services and local facilities	●—●—○

Shared roots

The community neighbourhood

Street scale

Residential street

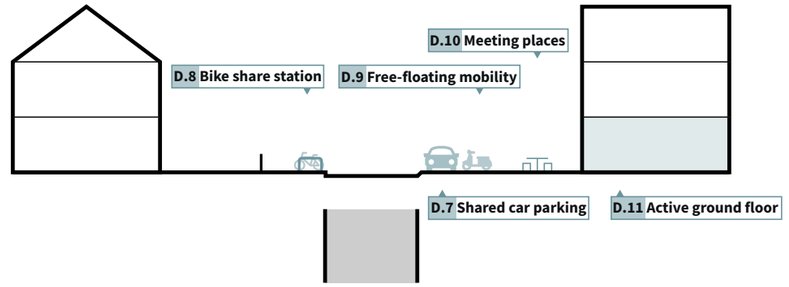
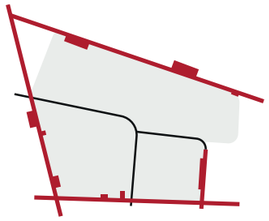


Figure 83: Diagram of the steet in *Shared roots* scenario

6.6 Private cars

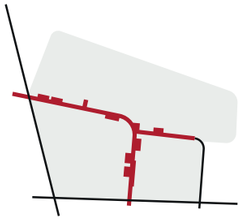
In all four scenarios, there is space needed in the street. There is more than enough space in Hoge Vucht, however, most of it is used for car traffic and parking. This means we need a redistribution of the space that is now used for cars and car parking. This applies to reducing both car use and private car parking. There are different spatial strategies for this reduction, like concentrating parking either on the edges or centrally in the sub-neighbourhoods. This increases the distance between the residence and the car parking, which also discourages car usage.

Also, the materialisation of streets and parking spaces can already create safer and more climate-resilient streets. Raised and semi-paved parking places, and brick pavers in the street are examples of implementations that improve water retention or slow down car traffic.



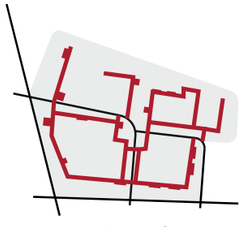
Around edges

The most extreme option is to bring parking around the edges. By doing so, Hoge Vucht can be completely car-free.



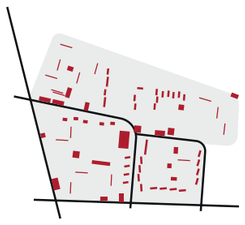
Around central axis

When concentrating parking around the central axis, the distances to parking will be just as big as when concentrating parking around the edges, but the parkways will get a very car-oriented feel.



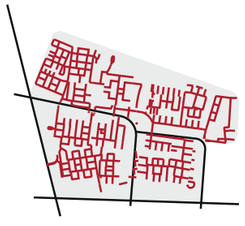
Edges of sub-neighbourhoods

When parking is moved to the edges of sub-neighbourhoods, most streets in the sub-neighbourhoods can be car-free.



Widespread parking lots

With widespread parking lots, parking will be close by but removed from the street because it is concentrated. Parking can also be concentrated in parking garages.



Parking in residential streets

Currently, there is parking on all residential streets. This makes car parking very close to the residences, but all streets are very car-oriented.

Figure 84: Diagrams of private parking options for Hoge Vucht

Private car

Neighbourhood implementations

	Number	Title	Time frame
Neighb. scale	**E.1**	**Parking garages** Place (temporary or permanent) parking garages along main access roads to concentrate car traffic at the edges of sub-neighbourhoods, freeing up inner streets for people-oriented activities.	●—●—○
Sub-neighbourhood scale	**E.2**	**Increase distance to parking** Position parking further from residences to encourage walking and cycling over car use, creating more space in the streets for social interaction and shared activities.	●—○—○
	E.3	**Parking at the backside** Relocate parking to the backside of buildings to free up the front side for a more attractive and welcoming street on the frontside.	●—●—○
	E.4	**Dead-end streets** Introduce dead-end streets to eliminate through traffic within residential areas. Streets are still accessible, but less busy.	●—●—○

Street scale

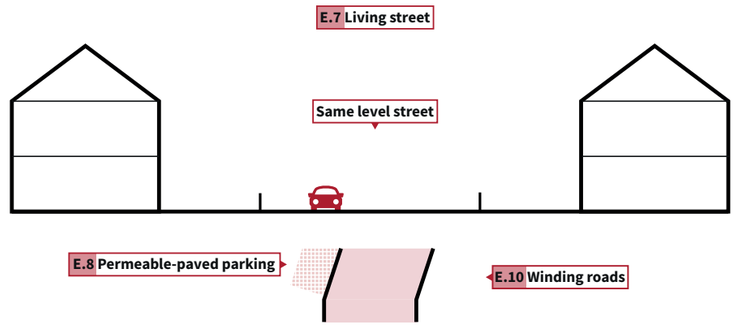
Number	Title	Time frame
E.7	**Living streets** Implement living streets where pedestrians, cyclists and cars share the same street space at one level, with a maximum speed of 15 km/h. Cars are guests and parking is only allowed in designated spaces.	●—●—○
E.8	**Permeable paved parking spaces** Use semi-permeable paving for parking areas to improve rainwater infiltration and contribute to climate-resilient streets.	●—●—○
E.9	**Raised parking places** Create slightly elevated parking places at the level of the sidewalk to visually narrow streets, which naturally slows traffic and increases safety.	●—●—○
E.10	**Winding roads** Avoid long, straight roads to reduce vehicle speeds and promote a calmer, pedestrian-friendly environment.	●—●—○

Private cars

The inclusive neighbourhood

Street scale

Living street



Access street

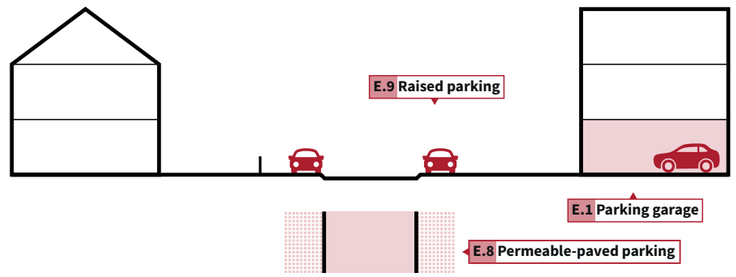


Figure 85: Diagrams of the steet to reduce private car use

6.7 Conflicts

The four different scenarios all have their own qualities, and all focus on a different component within liveability and accessibility. To combine all these qualities, it is not simply possible to overlay all scenarios. When doing this, different spatial and structural conflicts arise. For example, *Urban life* is a very centralised scenario (all facilities to the central axis), while *From young to old, Active Flow* and *Shared roots* are all more decentralised and focus more on proximity within the sub-neighbourhoods.

Other examples of these conflicts that occur when combining the four different scenarios are:

- A spatial overlap between the bus route and the car-free school streets (A.2) and fast bike routes (B.1)
- Improving the ecological structure (B.4) or removing the ditches and densifying around the central axis (C.2)
- Shared cars in the street (D.7) can not be combined with car-free living streets (A.3).

Appendix E shows a sketch of these spatial conflicts.

6.8 Overlaps

Combining the four different scenarios also creates fruitful combinations that strengthen each other. Examples of implementations that strengthen each other are:

- Car-free school streets (A.2) and car-free fast bike routes (B.1). This connects the schools to the bike network.
- Densifying with new buildings (C.2, C.4, C.5, C.6) can be combined with adding living communities with shared facilities and shared mobility (D.2)
- Elderly housing through a knarrenhof (A.4) uses is almost the same as creating a community through a courtyard garden (D.5). Knarrenhofjes are specifically for the elderly, while the courtyard gardens do not have a specific target group.
- Connecting ditches to improve the ecological connecting (B.4) can be combined with bridges for active mobility creating shortcuts and a more interesting route for pedestrians and cyclists (A.9, B.7)
- The parking place next to the shopping centre can get a complete new goal when parking is placed in the XL mobility hub (D.1), creating space for new buildings (C.2) and a square for events, markets and pavement cafes (C.3).
- An urban sports park (B.5) and skate park (B.6) are examples to create more diverse playgrounds for all ages (A.6)
- A central place in each sub-neighbourhood with an active ground floor (D.11) with local facilities (A.1), central meeting places with shared mobility (D.3), local pavement cafés (C.10) can be combined with apartments on top floors and a bus stop (C.4).
- New apartments around bus stops (C.4) can be combined with shared bikes around bus stops (D.4)

Appendix E shows a sketch with all spatial overlaps.

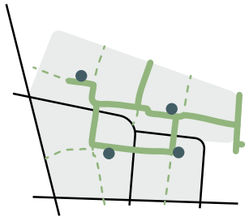
6.9 Spatial vision: Hoge Vucht for the people!

Combining the qualities of the four scenarios and improving liveability and accessibility in multiple categories results in this design for Hoge Vucht in 2050. A neighbourhood that is not designed for the car, but for the people!

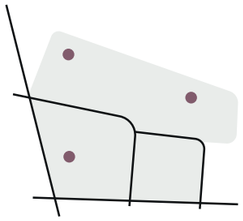
This combined design brings together the principles of all four scenarios into a holistic vision for Hoge Vucht. It envisions a neighbourhood where mobility and liveability reinforce one another: streets are designed for people rather than cars, everyday destinations are within walking or cycling distance, high-quality public space ensures a good connection to the rest of Breda and the region, and shared mobility reduces the need for private car ownership. A healthier urban environment emerges through green, active, and ecological public spaces that invite movement and social interaction. The neighbourhood becomes inclusive by ensuring proximity to facilities and creating spaces that support children and elderly. Shared gardens, living communities, and local meeting places strengthen social cohesion and a sense of belonging. By reorganising parking and reducing car dominance, valuable space is reclaimed for housing, greenery, and community life. This creates a resilient, sustainable, and vibrant urban district for all residents.

Figure 86: Visualisations of the spatial vision *Hoge Vucht for the people!*

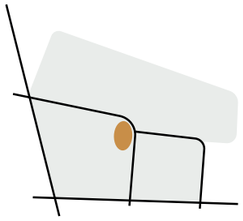
Street hieracy



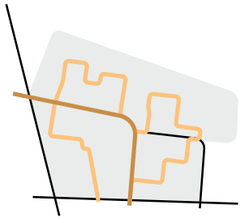
Cycling network



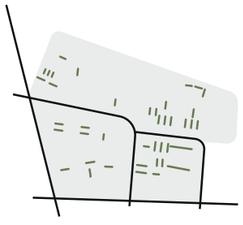
Local centres



Central square



Public transport



Car-free living streets

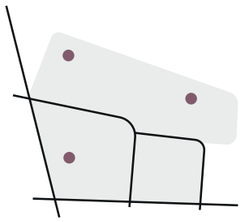
Spatial vision: Hoge Vucht for the people!

The sustainable and liveable neighbourhood

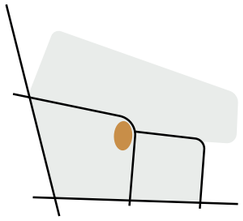
Figure 87: Spatial vision map *Hoge Vucht for the people!*

Facilities

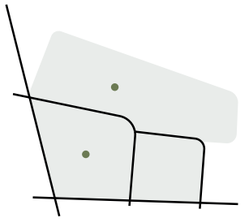
In the spatial vision, Hoge Vucht for the people walking is prioritised as the most important mode of mobility. For this, more proximity to facilities is created, therefore Hoge Vucht has a decentralised neighbourhood structure with more focus on the sub-neighbourhoods. Each sub-neighbourhood gains a local centre, with a supermarket, a mobility hub, a package point and other local facilities. Next to the shopping centre, the parking lot is transformed into a central square for pavement cafés and social events. An urban sports park and a skate park stimulate physical exercise and social interaction.



Local centres



Central square



Urban sports park and skate park

Spatial vision: facilities

The sustainable and liveable neighbourhood

Figure 88: Active mobility map for spatial vision *Hoge Vucht for the people!*

Local centres
Each sub-neighbourhood has a local centre, with a supermarket, a mobility hub, a package point and other local facilities such as a GP, bike repair, flex study spaces, an ice cream shop or a local community house. These functions also activate the outdoor public spaces. These local centres also provide housing on the upper floors, supporting local activity. Around these local centres, apartment buildings introduce a higher residential density, supporting local activity and creating a more diverse housing stock in Hoge Vucht. The local centres are connected to the high-quality cycling network, with separate bike paths, and have a bus stop. In this zoom-in the existing community garden, the hedge is lowered to create more visual connection to the community garden, making it a more inviting place.

Figure 89: Visualisation of a local centre in the spatial vision *Hoge Vucht for the people!*

New city centre
Next to the shopping centre, the big parking lot gets transformed into a public square at the heart of Hoge Vucht, with pavement cafes and space for social events like the weekly market, or a Christmas evening. The new tram line makes the shopping centre and the square well accessible for people outside of Hoge Vucht. Private parking will be relocated to the top floors of the XL mobility hub. The centre of Hoge Vucht is densified with some higher towers, because of the proximity to many facilities and the tramline.

Local green fields
The existing small-scale green spaces are activated and defined as more enclosed areas by adding new housing along the edges, replacing the current inactive or "dead" boundaries. These spaces become more diverse, offering a variety of playgrounds, sports fields, and recreational zones that are connected through play elements integrated into residential and living streets. Examples include an urban sports field, skate park, water play area, ping pong and checker tables, and a mini traffic square for children with go-karts and bicycles.

New city centre

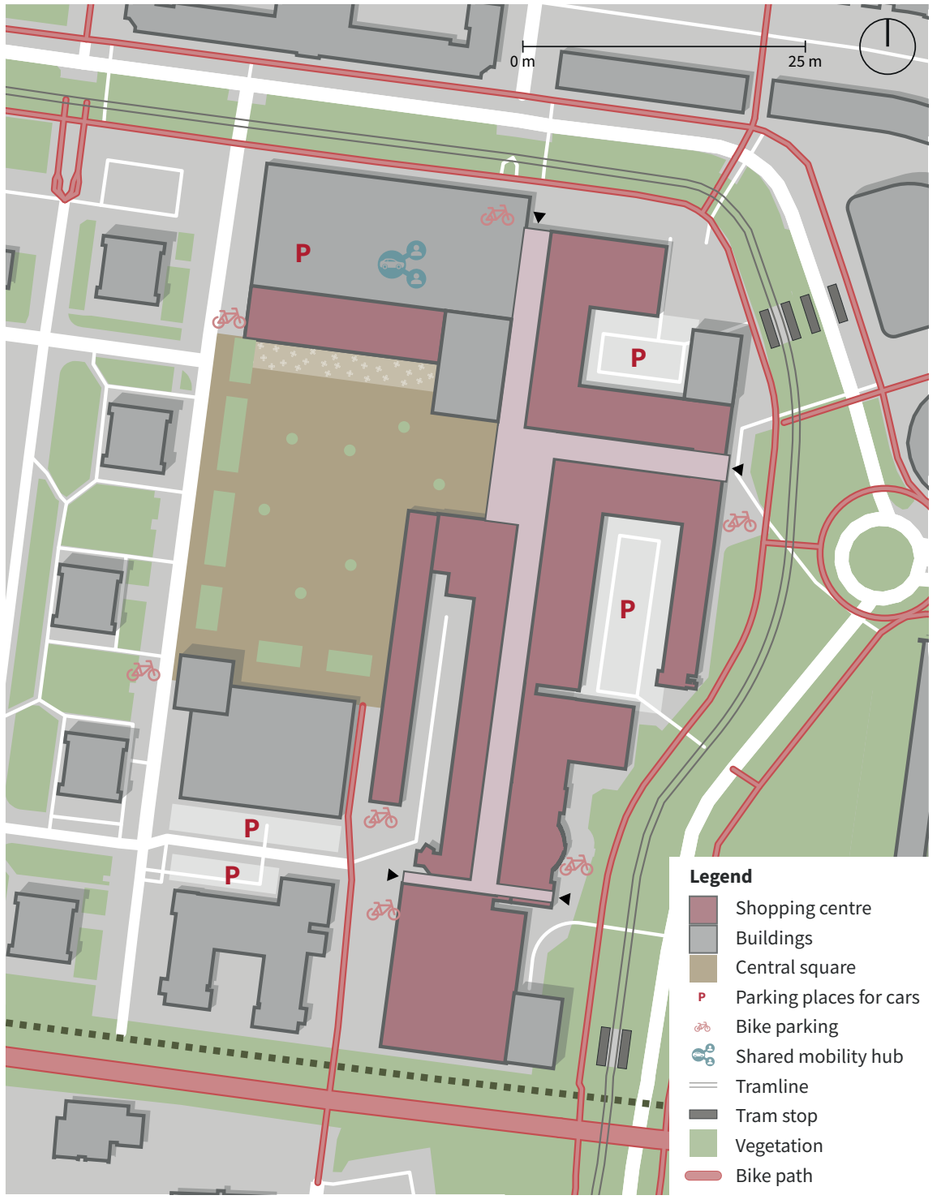
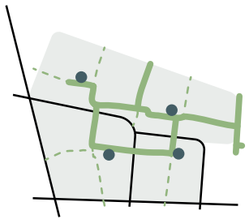


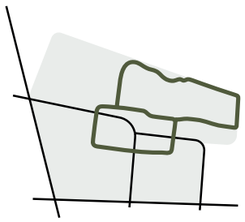
Figure 90: Zoom-in on city centre in the spatial vision *Hoge Vucht for the people!*

Cycling network

In the spatial vision for Hoge Vucht, cycling becomes one of the most important alternatives for the car. A car-free green cycling loop and a jogging path follow the original green structure of Hoge Vucht, With car traffic removed, more space becomes available to restore the green character and create an attractive bike path, with diverse nature, different colours and smells. This cycling route passes by the four primary schools, ensuring safe routes to school, and connects seamlessly to the surrounding neighbourhoods. Additionally, other roads have more separate bike paths that connect all key facilities in the neighbourhood, providing high-quality cycling infrastructure.



Cycling network



Jogging routes

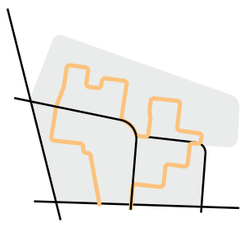
Spatial vision: active mobility

The sustainable and liveable neighbourhood

Figure 91: Active mobility map for spatial vision *Hoge Vucht for the people!*

Public transport
The spatial vision for Hoge Vucht has a high-quality public transport system. A tram line connects Hoge Vucht quickly and reliably to the train station and important destinations in Breda. The bus line runs through the sub-neighbourhoods, with bus stops at the new local centres. The new route of the bus line extends further into the sub-neighbourhoods than the current line, resulting in more people living within 200 metres of a bus stop. Around the bus and tram stops, density is increased, with apartment buildings, so more people live in such a favourable location in proximity to public transport.

Tramline



Busline

Spatial vision: public transport

The sustainable and liveable neighbourhood

Figure 92: Public transport map for spatial vision *Hoge Vucht for the people!*

Spatial vision: public transport

The sustainable and liveable neighbourhood

City scale

The tram line connects key functions in Breda, such as the hospital, theatre, applied universities, and the city centre. Both train stations Breda and Prinsenbeek are connected to the tramline, for well-connected transfers.

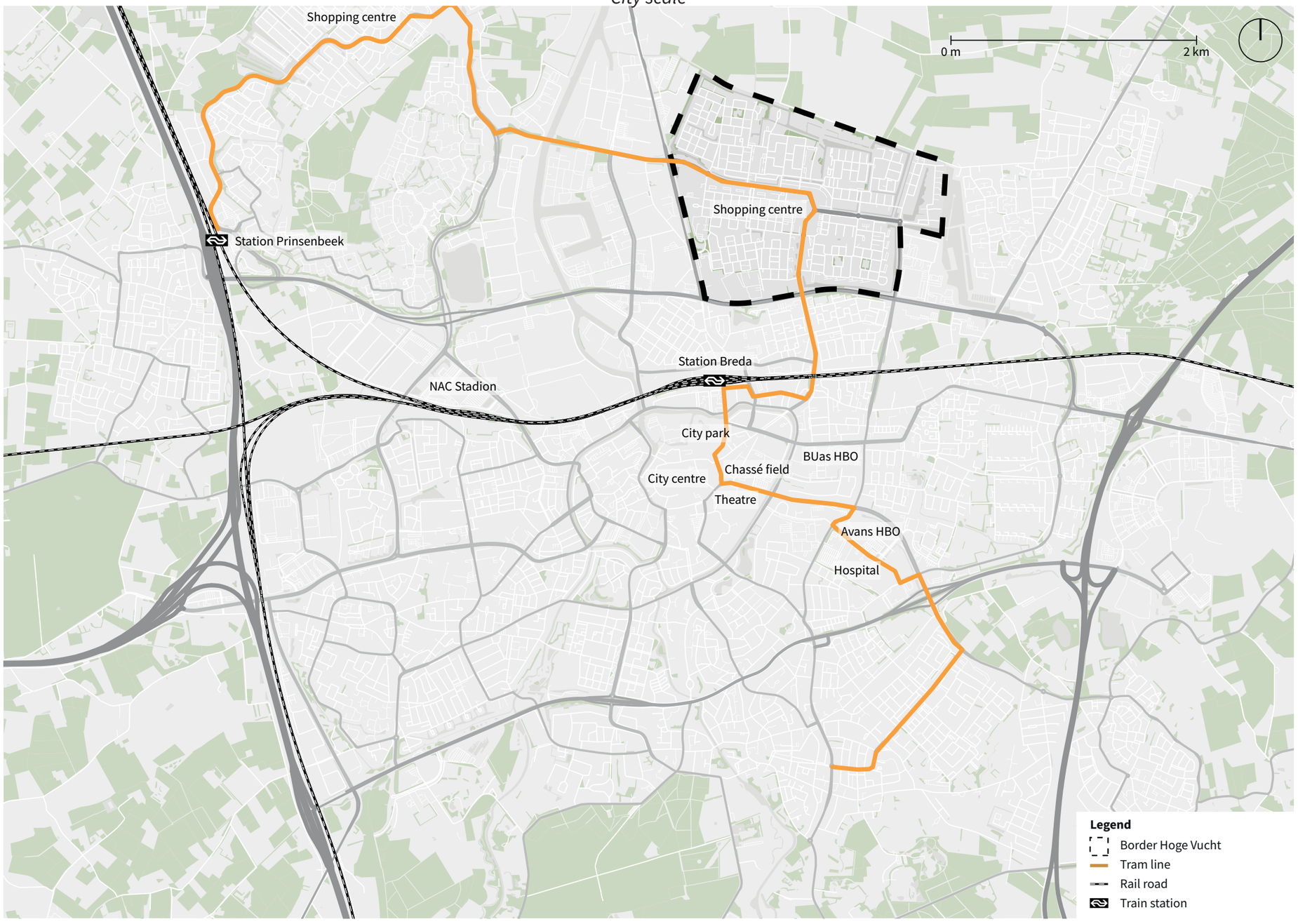
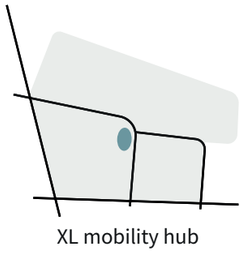
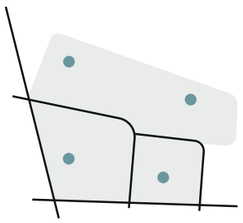


Figure 93: Tram route in Spatial vision *Hoge Vucht for the people* in Breda

Shared mobility
Shared mobility is widespread in Hoge Vucht and forms an important part of the neighbourhood's accessibility system. At the heart of the neighbourhood, next to the shopping centre, is an XL mobility hub, providing access to a wide range of shared vehicles, including small vans, cars, trailers, e-mopeds and cargo bikes. The new local centres all have a mobility hub for the neighbourhood, combined with a package point. Additionally, existing community buildings and high-rise apartment buildings serve as mobility hubs. In residential streets further away from a hub, shared cars are placed directly in the street. Around public transport stops are shared bikes, to support the "last mile" connection to the final destination.

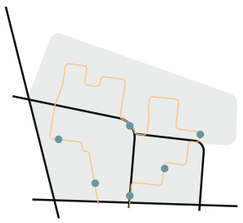


XL mobility hub

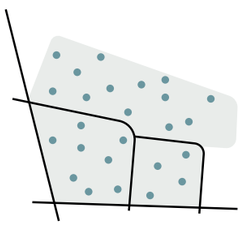


Sub-neighbourhood mobility hub

Small shared mobility hub at apartment building



Shared bikes at bus stops



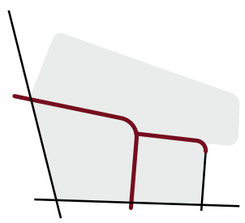
Shared car in residential street

Spatial vision: shared mobility

The sustainable and liveable neighbourhood

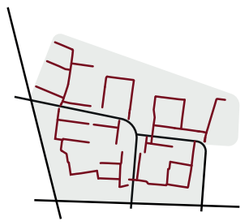
Figure 94: Shared mobility map for spatial vision *Hoge Vucht for the people!*

Street hierarchy
To create car-free living streets and a reduction in parking spaces in residential streets, a new street hierarchy is introduced in the sub-neighbourhoods. Parking is relocated to Access streets along the edges of the sub-neighbourhoods. In these streets, parking is concentrated. Also, the bus line runs through these streets. (Temporary) parking garages provide more parking places. By moving parking and car traffic to the edges of the sub-neighbourhoods, space can be reclaimed by people in the residential streets, living streets, and the green cycling loop.

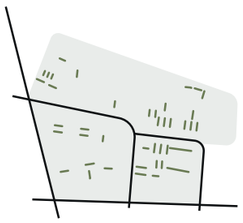


Parkways

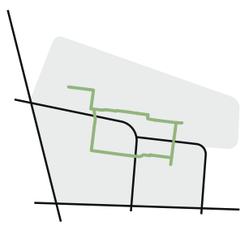
Residential streets



Local access streets



Car-free living streets



Green cycling loop

Spatial vision: street hierarchy

The sustainable and liveable neighbourhood

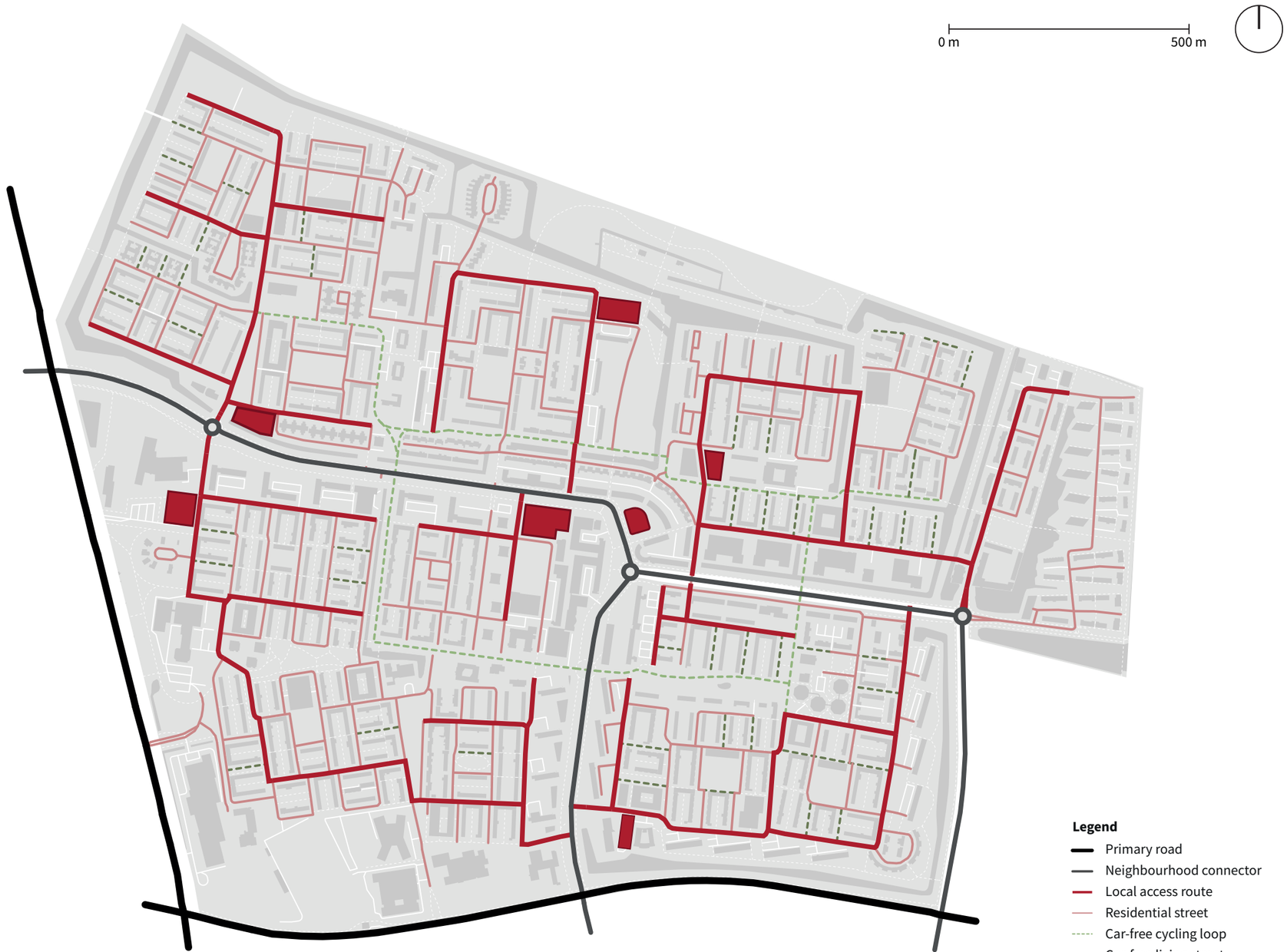
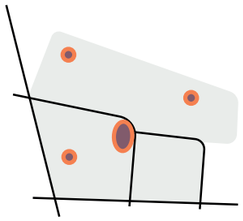


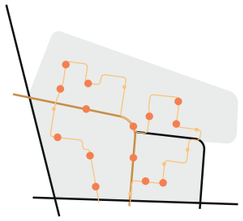
Figure 95: Street hierarchy map for spatial vision *Hoge Vucht for the people!*

Densification

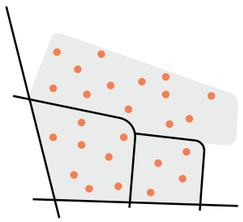
In the spatial vision Hoge Vucht for the people, the neighbourhood is densified, primarily through the addition of small apartments. Currently, in Hoge Vucht, there are primarily large and medium-sized row houses and apartments, which introduces a new housing type. These small apartments are suitable for the ageing population, the growth of one-person households and bringing students into the neighbourhood. Densification occurs throughout the neighbourhood, but especially around facilities and public transport stops.



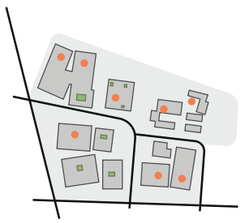
Densification around facilities



Densification around public transport stops



Transformation of private garages



Housing in local green fields

Spatial vision: densification

The sustainable and liveable neighbourhood

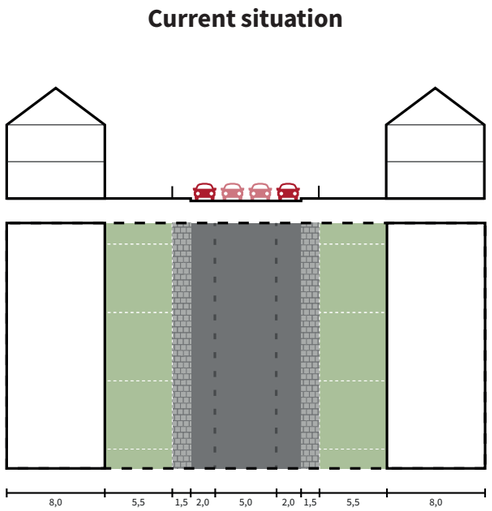
Figure 96: Densification map for spatial vision *Hoge Vucht for the people!*

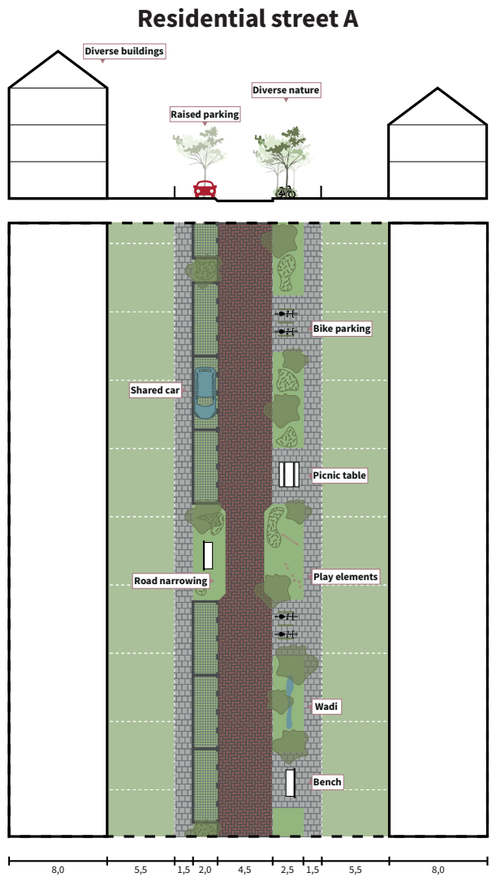
Residential street

In a residential post-war neighbourhood, there are many typical residential streets. These streets should be green places, where kids can safely play and where neighbours can meet each other. There are many variables in how this residential street could look, and to what extent space for the car gets reduced.

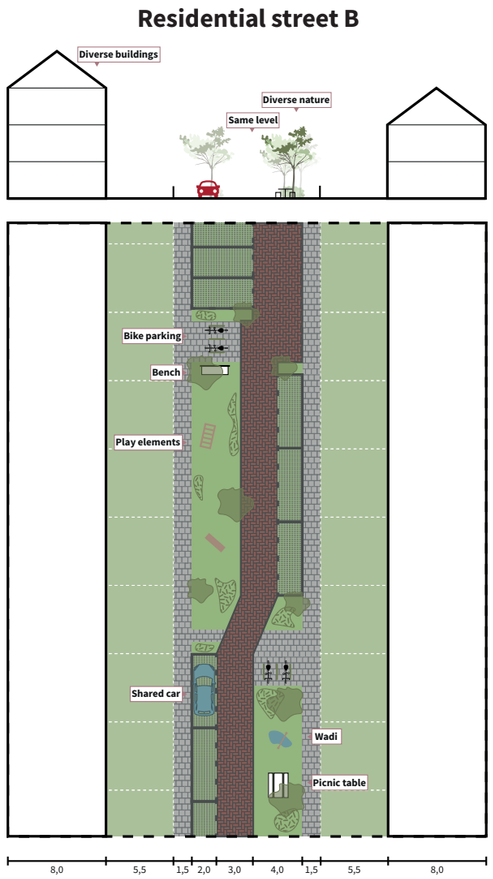
All four examples of a residential street show some reduction in private car parking. In all streets are either small curves or street narrows to slow down car traffic. The streets are materialised with brick pavers, and parking spaces have a semi-paved surface for better water infiltration. In all streets, benches, bike parking, vegetation and play elements are added. Because of the wide street profile, building height could be higher, and the buildings could be more diverse, to create a more interesting street.

The three examples have a decrease in the amount of space for the private car. There are many more ways to vary with these types of streets.

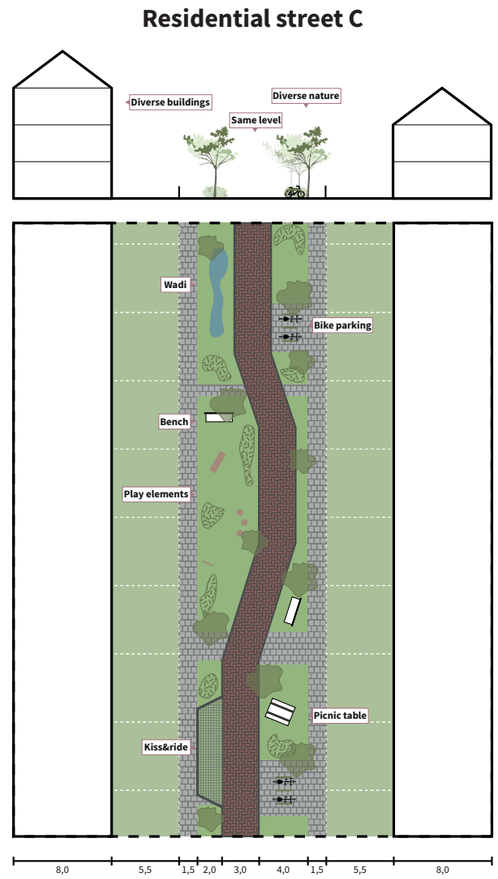




This first example shows a two-way street with parking on one side. Parking places are interrupted by small planters with trees to create a visual interruption of the parked cars and to bring vegetation to both sides of the streets. Traffic is slowed down by the road narrowing and the raised parking spaces, which visually narrow down the street. A shared car reduces the need for a private car.



The second example of a residential street is a one-way, same-level shared street, with several parking spaces. There is lots of space for vegetation and people. A shared car reduces the need for a private car.



The third example of a residential street is a one-way street without car parking. The car is a guest in the street full of play, meetings and vegetation. A kiss-and-ride parking place can be used to pick up or drop off someone, or to (un)load a car.

Figure 97: Typical residential street in Hoge Vucht

Figure 98: Residential streets in the spatial vision *Hoge Vucht for the people!*

Living street
The living street is a car-free variant of a residential street. It is a shared living space, focused on social interaction, play and ecology. The street is one level and one pavement. A 3-meter-wide path is reserved for emergency vehicles or can be used while moving. Wadis, semi-paved surfaces and diverse vegetation improve the water infiltration in the street. Variation in vegetation in grasses, bushes, trees with different heights, colours and structures improves ecology and creates an interesting street. Benches and picnic tables overlooking the play elements provide places to meet, play games or have lunch. Each living street can be unique, with different play elements and different vegetation.

Figure 99: Visualisation of a living street in the spatial vision *Hoge Vucht for the people!*

Current situation: residential street

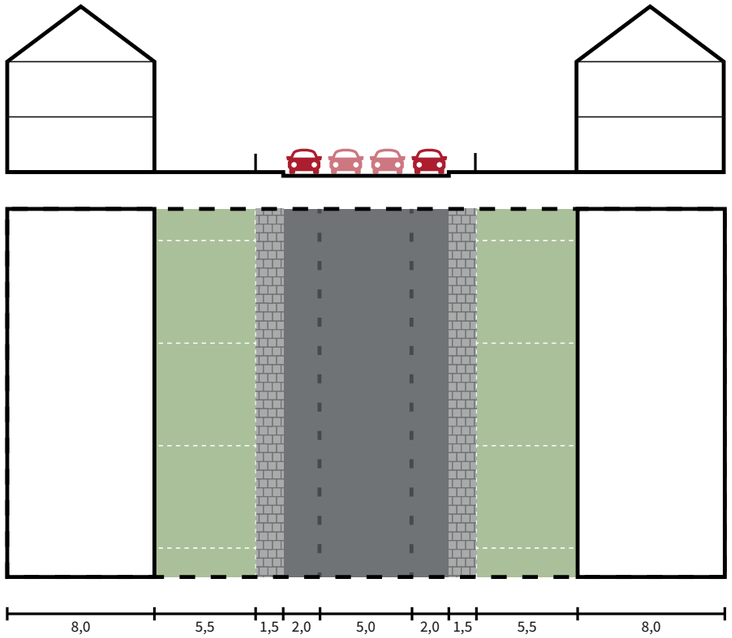
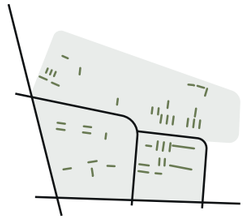


Figure 100: Typical residential street in Hoge Vucht

New situation: living street



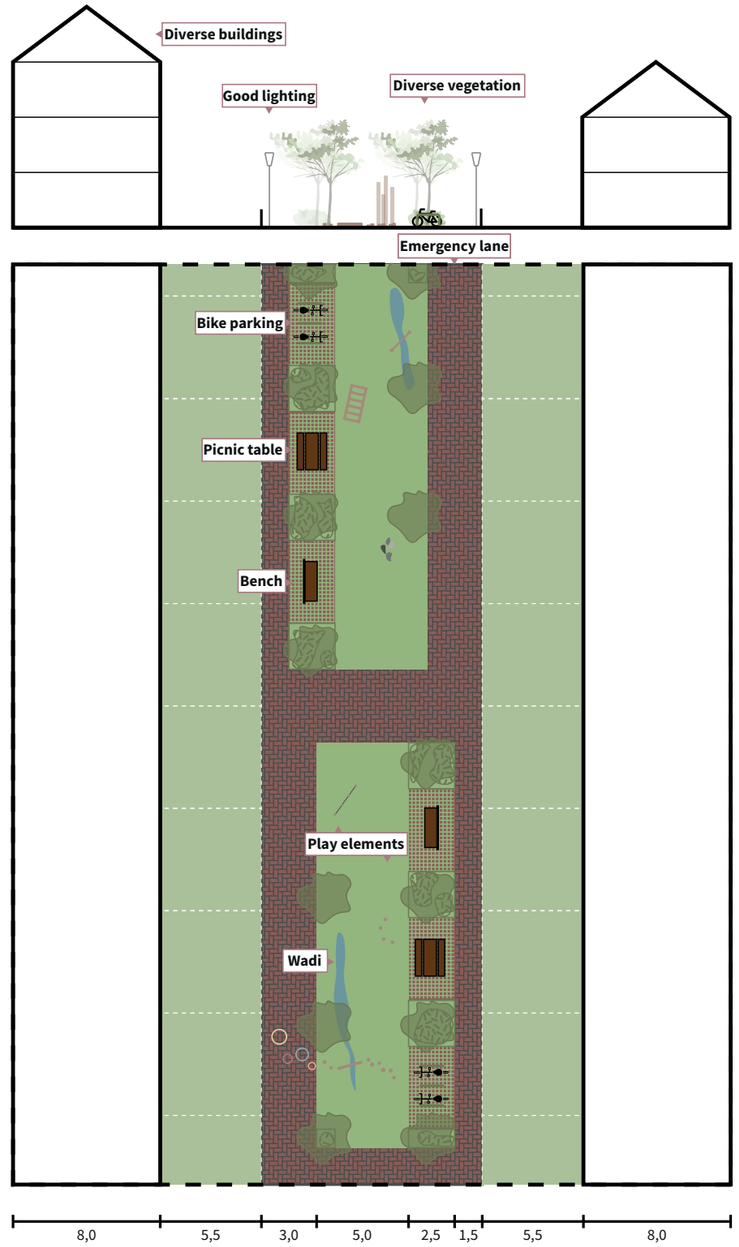


Figure 101: Living street in the spatial vision *Hoge Vucht for the people!*

Green cycling loop
The green cycling loop is a car-free cycling path in Hoge Vucht. This cycling path is extra wide (5 meters), allowing cyclists of different speeds to pass each other easily. It has priority over car traffic at all crossings, creating direct routes without interruptions, and features good lighting for safety during the evening and night. The houses provide social control on these streets. These bike paths connect to all four primary schools in the neighbourhood, so all kids are encouraged to cycle to school safely.

The cycling loop overlaps with the original secondary green structure in Hoge Vucht, and in the new street, this green character is brought back. A wide variation in trees, bushes, grasses and flowers with different heights, colours and smells, makes the street an interesting place to walk, cycle or jog and enhances biodiversity in the neighbourhood. There is also a jogging path that is part of two jogging routes through Hoge Vucht, with benches, water taps and fitness equipment along the route.

Figure 102: Visualisation of the green cycling loop in the spatial vision *Hoge Vucht for the people!*

Current situation: school street

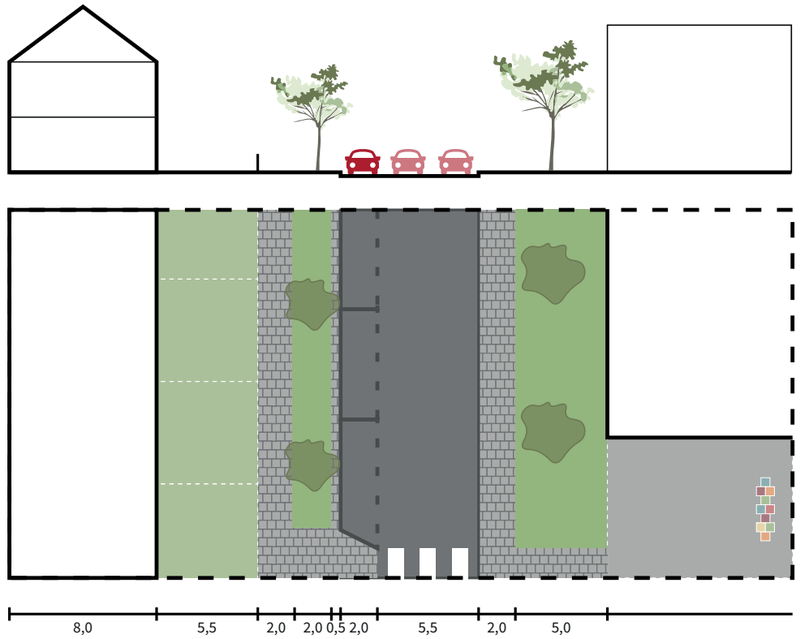
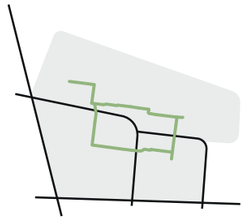


Figure 103: School street in Hoge Vucht

New situation: green cycling loop



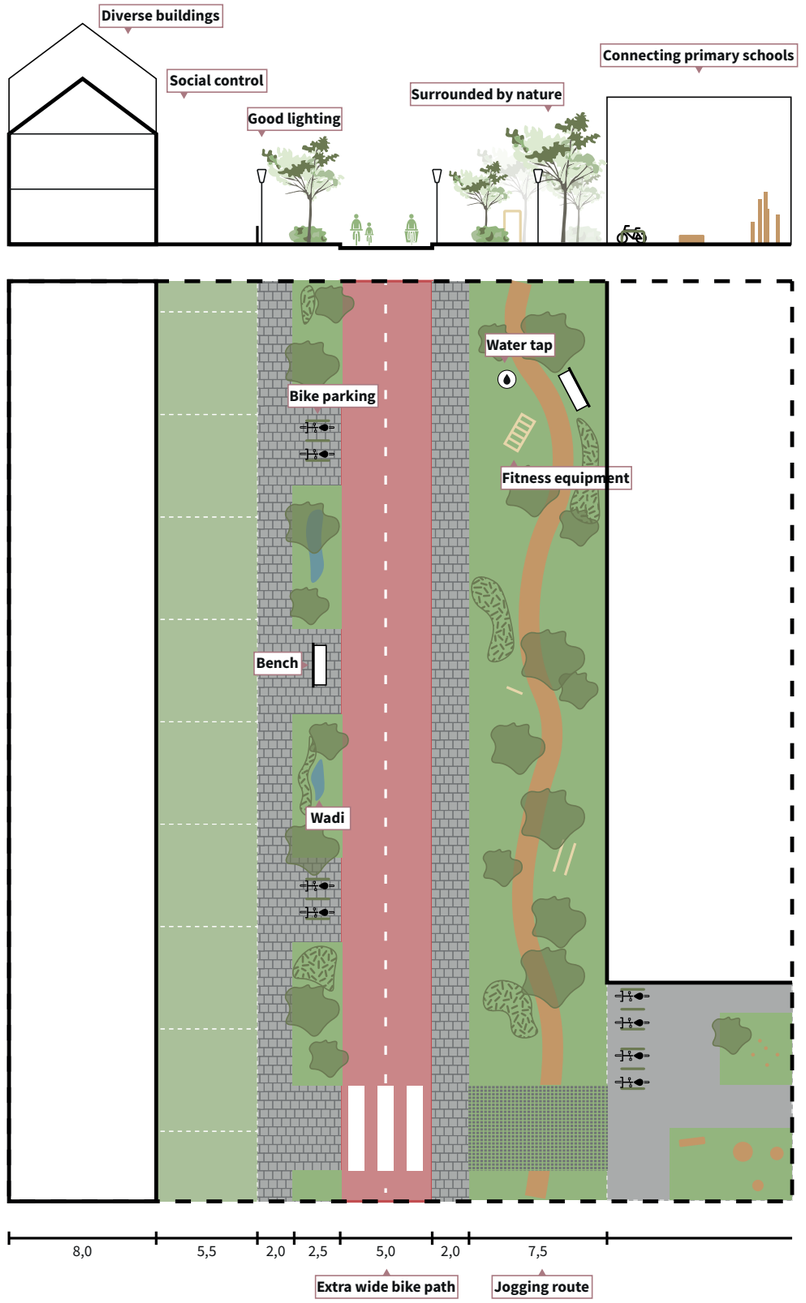


Figure 104: Green cycling loop in the spatial vision *Hoge Vucht for the people!*

Local Access Street

The local access streets are the primary entry points into the sub-neighbourhood. They play a logistical role. In these streets, on-street car parking increases in order to compensate for the reduced amount of private parking within the residential streets. With brick pavers on the street, semi-paved parking spaces and trees interrupting the parking spaces, a more pleasant and human-scaled environment is created.

Shared cars reduce the need for a private car, and are therefore located closer to the entrance of apartment buildings than private parking spaces.

Local access streets also accommodate bus traffic. On the ground floor of apartment buildings, bike storage encourages cycling, and communal living rooms enhance community feeling in the building.

Close to the bus stops, row houses get replaced with higher-density apartment buildings, providing more people to live close to public transport stops, and creating a more diverse housing stock in the sub-neighbourhoods.

These combined functions transform the local access street into an active, well-used street.

Current situation: edge street

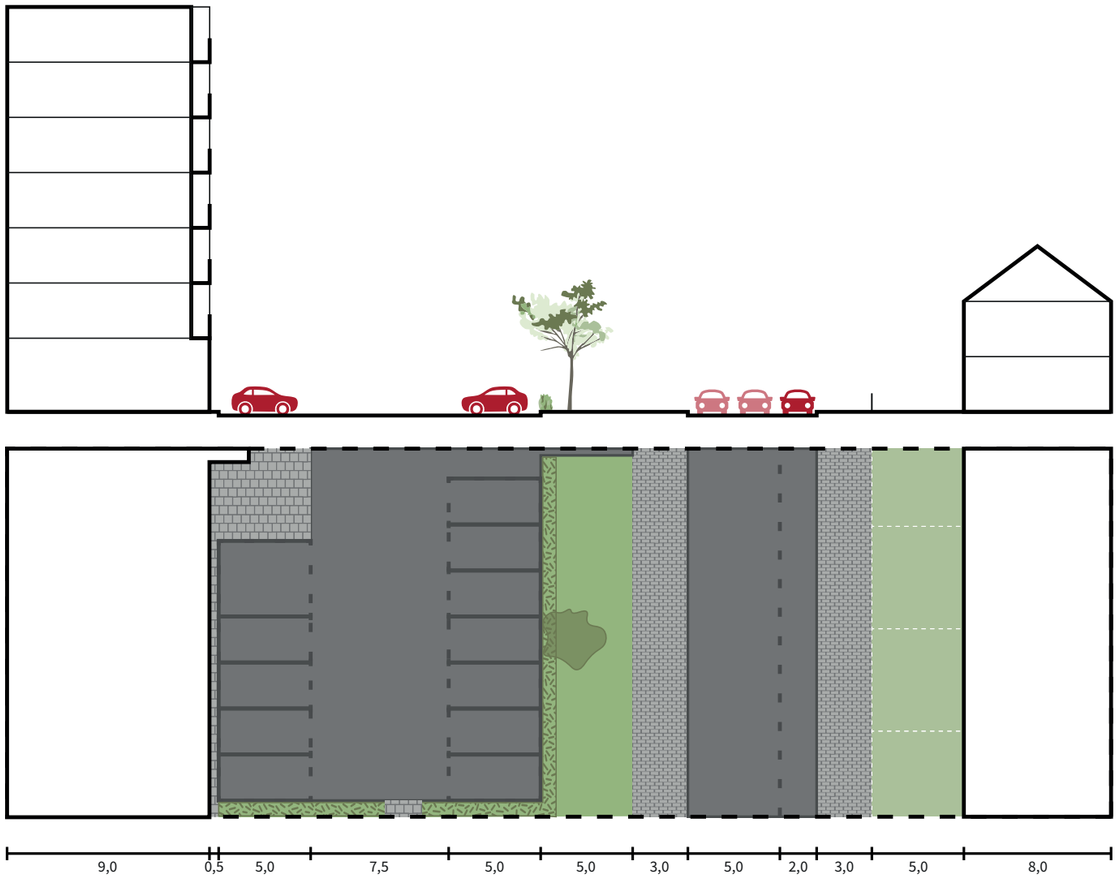


Figure 105: Edge street in Hoge Vucht

New situation: local access street

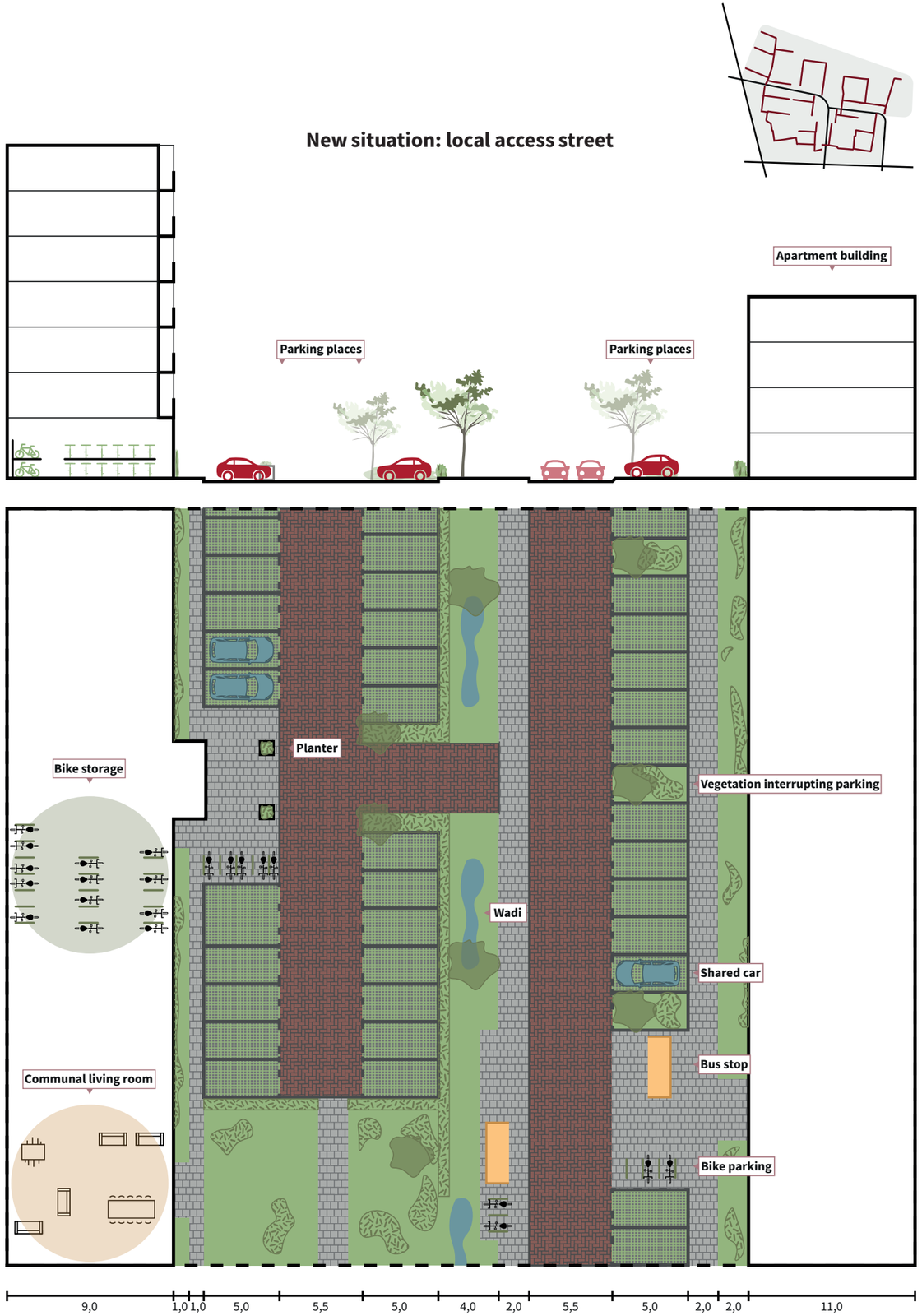


Figure 106: Local access street in the spatial vision *Hoge Vucht for the people!*

Parkway

The parkways are the three access streets to get into Hoge Vucht. These parkways are surrounded by high buildings and have a wide profile. The parkways are used by many types of mobility. A tramline connects Hoge Vucht to the rest of Breda with a high-quality public transport connection. The tram line replaces one of the car roads. At the tram stops, bike parking is accommodated. The parkways have two-way bike paths on both sides of the street, so it is not necessary to cross the street. Bridges for slow traffic create shortcuts for pedestrians and cyclists, and together with more crossings for these modalities, the barrier effect of the parkways gets reduced. Also, cars can still use the parkways, but their speed is slowed down to 30 km/h.

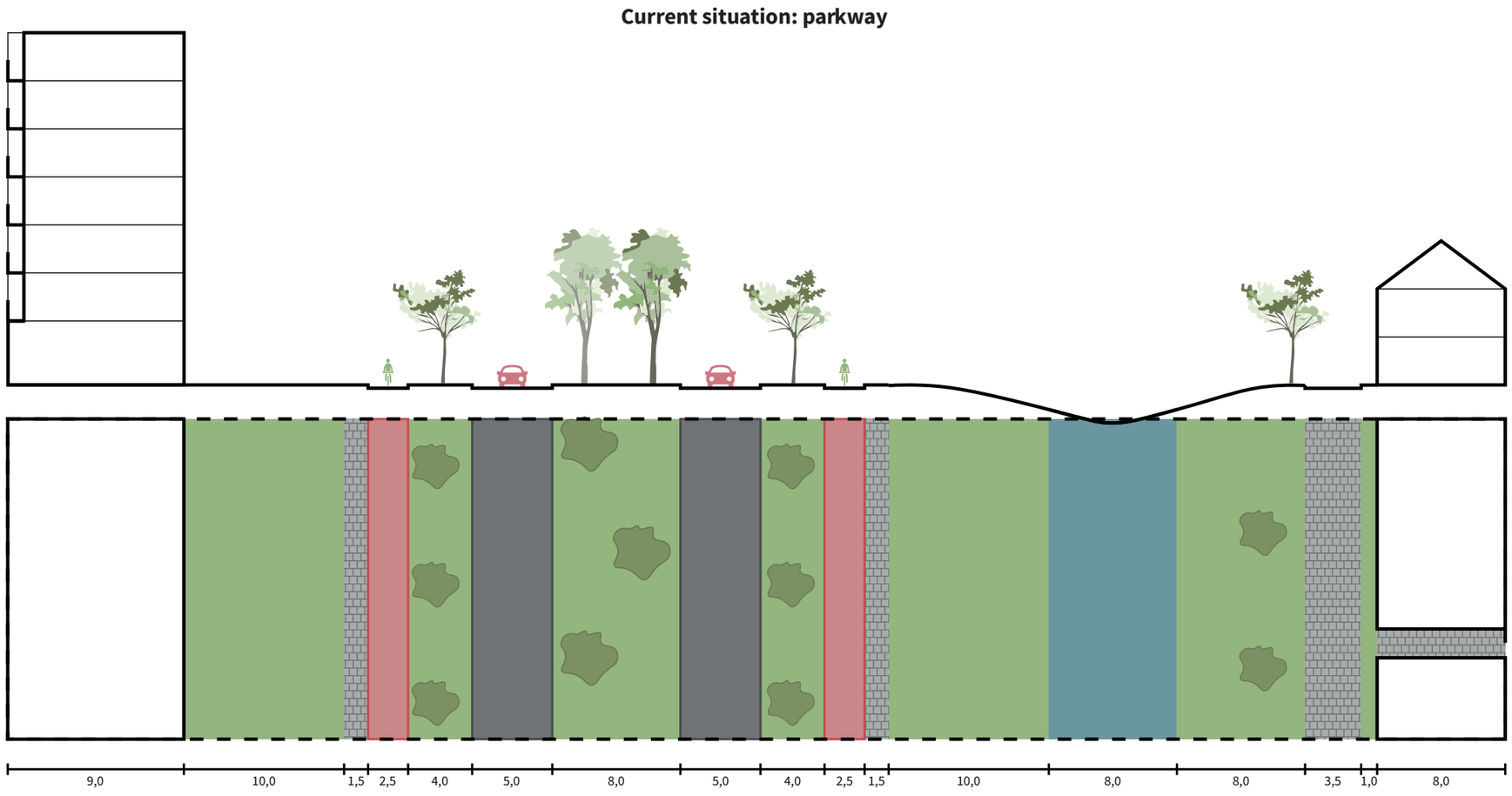
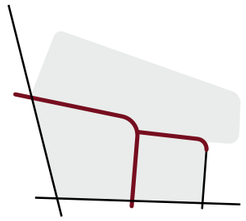


Figure 107: Parkway in Hoge Vucht



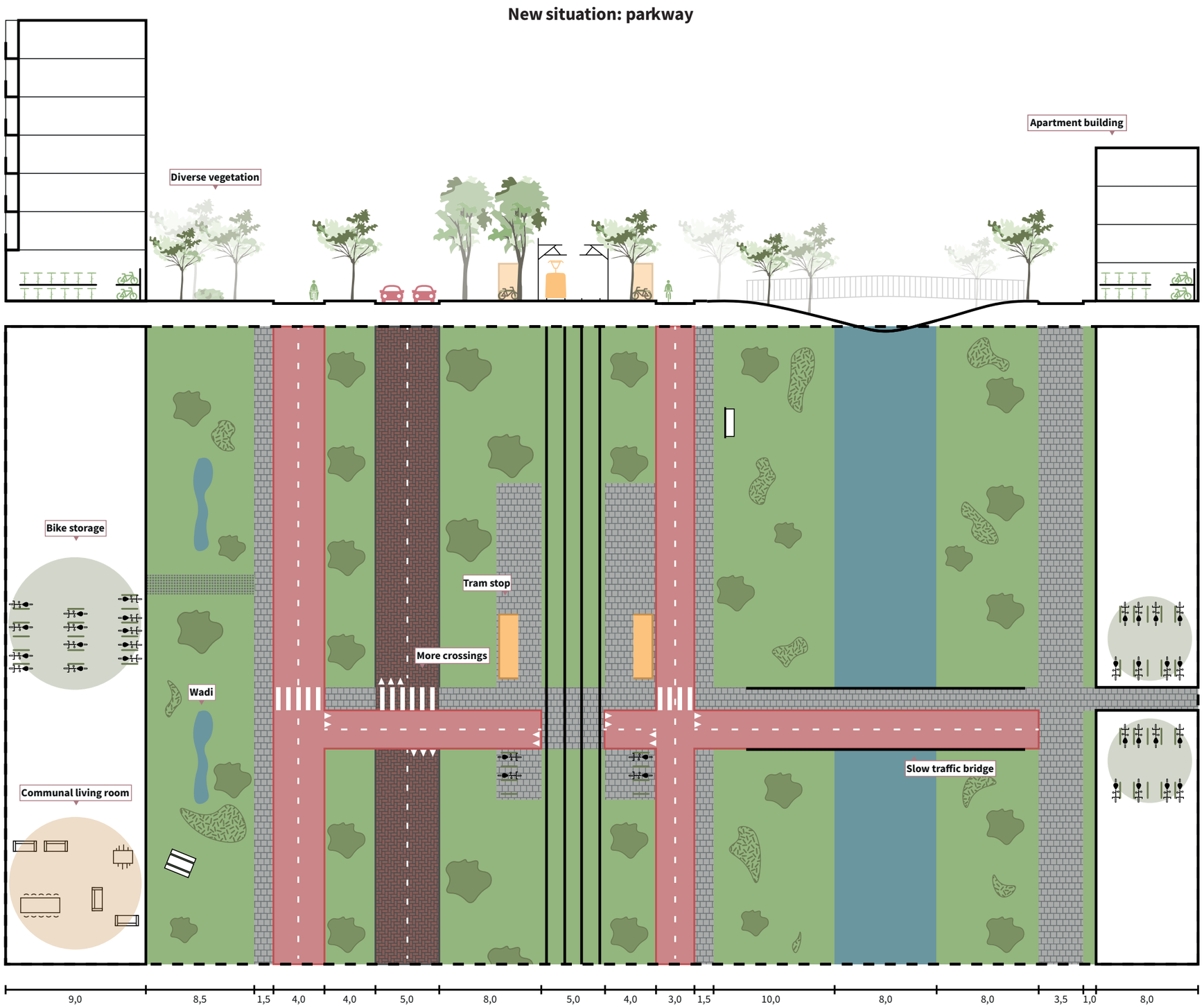


Figure 108: Parkway in the spatial vision *Hoge Vucht for the people!*

Liveability

Applying sustainable mobility strategies to a spatial design for Hoge Vucht shows an overall strong increase in almost all aspects of liveability. All forms of sustainable mobility use less space compared to cars, creating more space for social interaction, physical exercise and vegetation.

Physical safety improves considerably. Pedestrians and cyclists are given clear priority throughout the neighbourhood through wider sidewalks, continuous cycling routes and priority at crossings. Living streets and the car-free cycling loop remove conflicts with motorised traffic. All primary schools are directly connected by this car-free cycling loop, ensuring safe routes to school. Where cars remain, measures such as brick paving, narrower streets and curved street profiles reduce speeds and improve safety.

Social safety is enhanced through good lighting and increased “eyes on the street”. Ground floors of apartment buildings are activated with communal living rooms and shared facilities, strengthening the relationship between buildings and public space. New buildings in local green fields activate edges that currently exist of dead walls. The various benches and picnic tables encourage people to stay in the public space, creating more eyes on the street.

Diverse buildings, through the construction of new apartment buildings and renovation of existing houses, and diverse vegetation, with different heights, colours and structures and the presence of animals, other people or playing children make the streets a more **interesting** place.

Comfort is improved by climate-resilient design measures such as wadi systems, semi-permeable paving for water infiltration, tree planting for shade and vegetation that contributes to cooling during heat stress. New buildings in local green fields create a better enclosure in these places. More benches and picnic tables provide rest places.

The design strongly promotes **physical exercise** by integrating play elements into streets, establishing a high-quality cycling network, providing nearby daily facilities to stimulate walking, and introducing sports facilities such as fitness equipment, an urban sports park and a skate park.

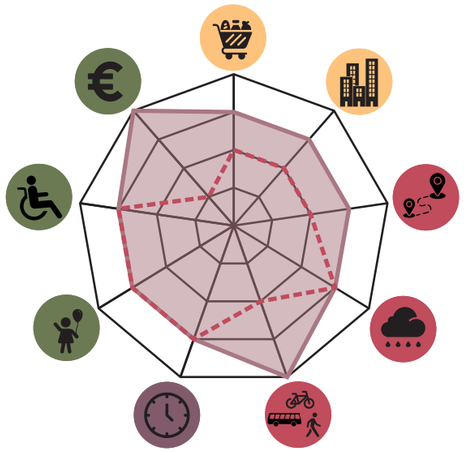
Positive effects on **mental health** arise from the strengthened connection to nature and the presence of greenery throughout all streets.

A **healthier environment** is created through reduced emissions, improving air quality, and the development of a more diverse and connected ecological system

With more diversity between the streets, the streets and sub-neighbourhoods get more **identity**.

Social cohesion benefits from the creation of numerous meeting places: living streets, picnic tables, playgrounds, benches and shared indoor spaces. These elements encourage informal encounters, increase residents’ sense of ownership of the street and strengthen community bonds. Community houses at the sub-neighbourhood level and a central square and shopping area at the neighbourhood level serve as places for social events.

Accessibility



While reducing car dominance can introduce challenges in certain situations, overall accessibility for Hoge Vucht is strengthened by a diverse, well-integrated mobility system. Providing a wide variety of high-quality alternatives compensates for the decline in accessibility by car. Because each mobility mode has certain strengths and weaknesses, there is no single answer to what this alternative should be, but a variety of mobility options is needed for different groups of people and different types of travel. For short distances, walking and cycling are great alternatives, and for longer distances, public transport and shared mobility are good alternatives.

Accessibility to daily **facilities** is improved. New local centres within the sub-neighbourhoods provide a supermarket, combined with a general practitioner, community facilities or flexible work and study spaces. This reduces the need for long-distance travel and supports daily life at the neighbourhood scale.

The neighbourhood is **densified**, primarily through the addition of small apartments. These dwelling types are currently underrepresented in Hoge Vucht, which is dominated by larger apartments and row houses. The introduction of smaller units responds to expected social trends, including population ageing, the growth of one-person households and the possibility for student housing in Hoge Vucht. This diversification of housing types supports social inclusion, and the increased density makes local facilities more viable.

With shortcuts and bridges for slow mobility, walking and cycling routes are more direct, and therefore **travel distance and travel time** are shorter. Also, with bringing facilities closer, travel distances get shorter. Compared to the private car, walking, cycling, and public transport usually have a slightly longer travel time.

Travel comfort is different for each modality. Pedestrian routes are continuous, with wide sidewalks and enough crossings. The cycling network is well-connected, asphalted and has good lighting. Stops for public transport have seating, digital information boards, and a shelter for rain, wind and sun. Shared mobility is concentrated in indoor hubs. Compared to the private car, that is flexible and fast overall travel comfort stays the same.

Residents have access to **mixed options** in mobility modes. Even without owning it, residents can use a car, trailer, moped or a (cargo) (e)-bike, these options remain available through shared mobility systems. This flexibility allows residents to adapt their travel behaviour to different trip purposes and life situations.

Walking and cycling are available at all times without **time restrictions**. Public transport depends on timetables, and shared mobility can be limited by availability, especially during peak hours or holidays. However, the overall system remains robust due to the variety of alternatives.

The design improves inclusivity for both children and the elderly. Safe play areas close to home, reduced walking distances to facilities and frequent resting places make daily mobility more accessible for all **age groups**.

For people with **disabilities**, proximity to facilities can bring more independence to their lives. For people that can not drive a car, the improved public transport also offers more transport options. However, a reduction in accessibility by car can also cause problems for people with certain disabilities.

Walking and cycling remain the most affordable travel options. Although public transport and shared mobility involve costs, the reduced need for car ownership significantly lowers overall mobility expenses, benefiting **lower-income** households.

07
TIME FRAME

Moving from a car-centred neighbourhood to a more sustainable mobility system and a more liveable, accessible neighbourhood does not happen overnight. This is a transition that takes time. Old habits need to make way for new standards. In Hoge Vucht, this transition moves through five phases: from the current car-oriented situation, to small and experimental implementations, a chaotic transition phase of behavioural and infrastructural change, to an early establishment of sustainable mobility in 2050 and finally a fully car-free neighbourhood where public space is reclaimed for people and nature.

Playground surrounded by blind walls Hoge Vucht, Breda (Author's image, 2025)

7.1 X-curve

Moving towards a more sustainable mobility system and a more liveable, accessible neighbourhood does not happen overnight. This is a transition that takes time. Old habits need to make way for new standards. One way to describe how a transition goes is with the X-curve. The X-curve describes how old systems (such as car dependency) get phased out, while new systems (such as a sustainable, liveable and accessible society) get built up (Silvestri et al., n.d.).

The old system starts in an optimised state. When external pressure grows (such as climate change or digitalisation), destabilisation gradually develops. This can be the start of a time of chaos: a decline of the old system through political interventions, the collapse of companies or a crisis. This will eventually lead to a breakdown and phase out of the old system (Silvestri et al., n.d.).

At the same time, a new alternative system is built up. This starts with radical, alternative ideas and experiments. Over time, these alternatives become better understood, cheaper and more visible. This accelerates and enables the emergence of the new system. This new system gets institutionalised, and this ends in a stabilisation of the new system (Silvestri et al., n.d.).

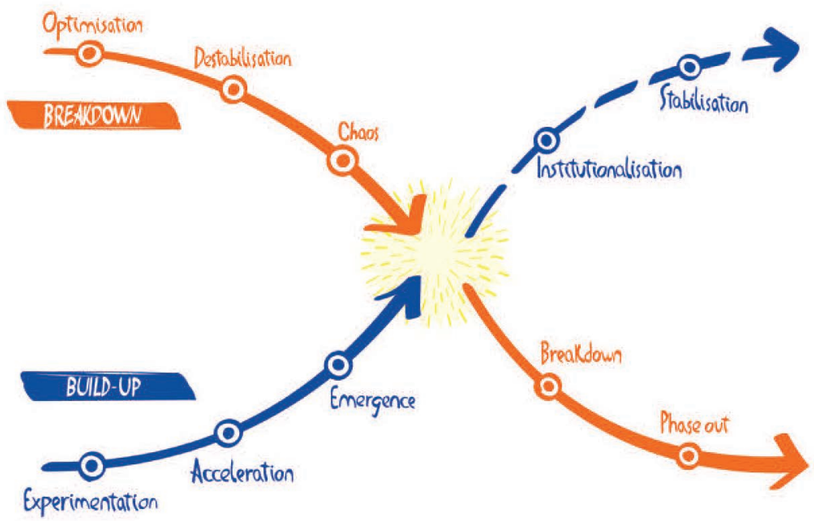


Figure 109: X-curve transition model (Silvestri et al., n.d., p.6)

In Hoge Vucht, the transition moves from a car-dependent neighbourhood toward one that is sustainable, liveable, and accessible. Based on the X-curve model, five phases can be identified: starting with the current car-oriented situation, followed by small experimental measures that promote sustainable mobility. A chaotic transition phase brings temporary tension as travel behaviour and infrastructure begin to change. This phase is particularly critical, as travel behaviour is strongly shaped by habits, routines and social norms, which makes behavioural change a slow and complex process. Even when physical conditions improve, it often takes time before new mobility patterns are adopted and stabilised. Over time, public space becomes people-oriented rather than car-oriented. This is the situation reflected in the final design of Hoge Vucht in the previous chapter. In the long term, private cars could disappear almost entirely, resulting in a neighbourhood defined by sustainable mobility and high-quality public space.

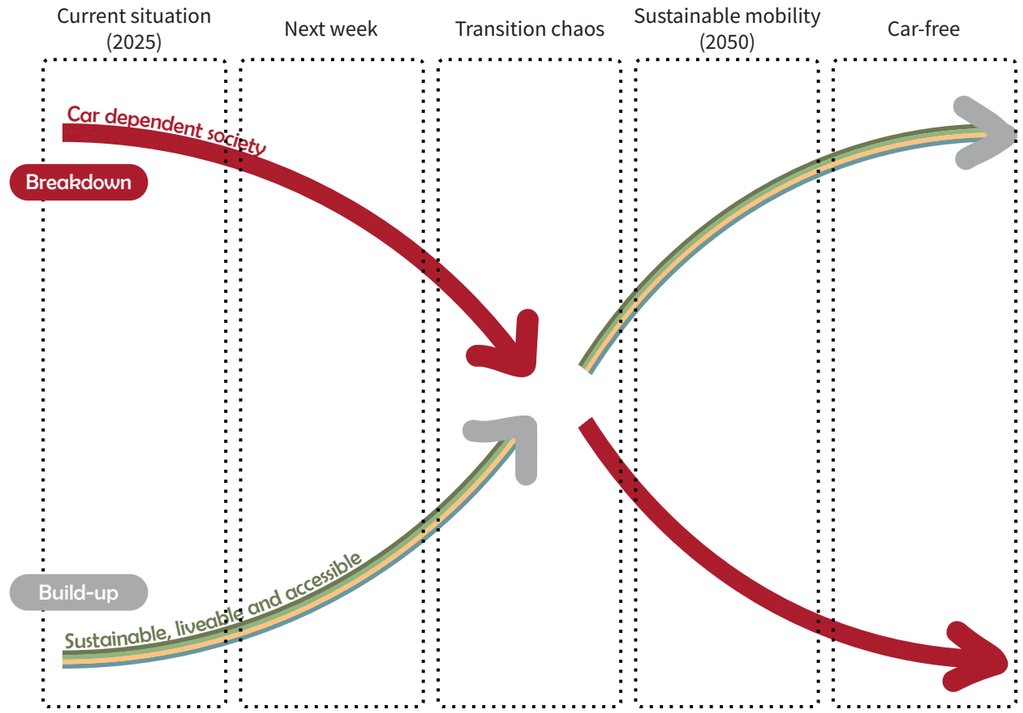


Figure 110: Transition from a car-dependent society towards a sustainable, liveable and accessible neighbourhood

7.2 Phased implementation

This transition from a car-dependent mobility system to a sustainable, liveable and accessible neighbourhood will be explained through the case study area Hoge Vucht.

Current situation

1. Current situation: car dependency
In the current situation, the car dominates space and travel behaviour is Hoge Vucht. Infrastructure is designed and optimised for the car with wide street profiles and parking everywhere. Public transport, cycling and walking are all secondary. Shared mobility is not implemented at all. Hoge Vucht is a monofunctional neighbourhood, with mainly housing and one central shopping centre.

Next week

2. Next week
The second phase consists of small and experimental implementations to promote sustainable mobility and liveability that could be implemented next week. This could be narrowing streets with (temporary) planters, car restrictions around school streets, improved lighting at night, the first shared cars and more crossings and priority on traffic lights for pedestrians and cyclists. Also, pilots with car-free living streets can start to get people used to improvements in liveability and the first destabilisation of car dependency. These are the first steps to reclaiming public space for the people.

Transition chaos

3. Transition chaos
The third phase is a chaotic phase in which residents are still adjusting to a new travel behaviour, while the first infrastructure projects are implemented, prioritising sustainable mobility over the private car. This is seen in a reduction in parking spaces in residential streets and an improved cycling infrastructure with a network of car-free bike streets. The transformation of private garage boxes in apartment buildings, the construction of new buildings next to bus stops, and the construction of high-rises along the parkways bring densification across the whole neighbourhood. This higher density allows for more facilities in proximity. Shared mobility hubs are located in central places within the sub-neighbourhood, reducing the need for private cars. The public space and mobility culture are being rebalanced.

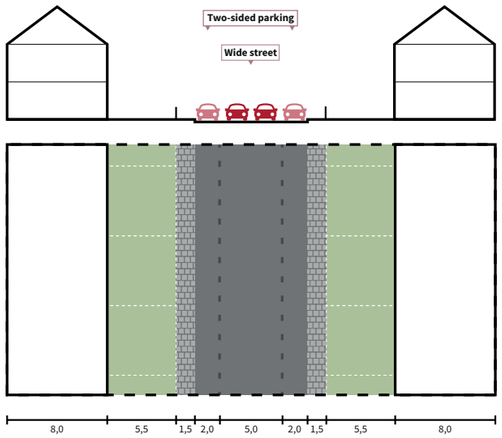
Sustainable mobility

4. Sustainable mobility: 2050
The fourth phase is the phase where the public space is primarily designed for the people and not for cars. Cars are still present but have a low priority. Parking is moved to the edges of the (sub-)neighbourhood(s) with parking spaces in the street and (temporary) parking garages. A high-quality public transport network ensures connectivity from Hoge Vucht to the rest of Breda and to the train station. This is the situation that is described in the previous scenarios and the spatial vision. In this phase, the goal for a 90% reduction in CO2-related emissions from mobility by 2050 is finally achieved (European Commission, 2019). Centrally in the sub-neighbourhoods, facilities such as a GP, supermarket and community house increase proximity to important facilities and enhance social cohesion. The neighbourhood becomes accessible, green, and human-scaled.

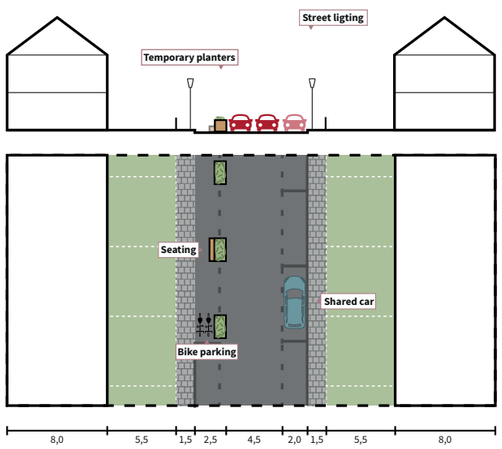
Car free

5. Car-free
If the transition continues even further, the private car could totally leave Hoge Vucht, creating a neighbourhood with only sustainable mobility and a very liveable and accessible public space. No private parking in the neighbourhood, only some kiss-and-ride places for pick-ups with (self-driving) cars. Public space has been reclaimed for social life and nature.

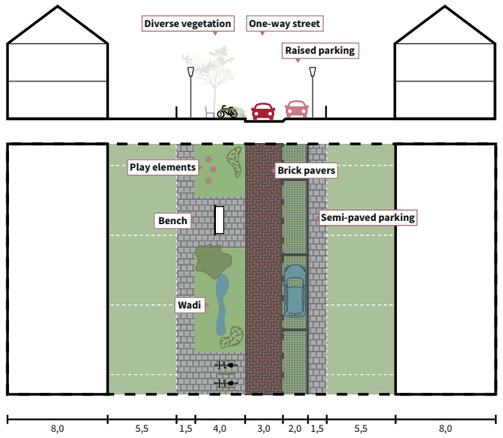
The transition from a car-dependent mobility system to a sustainable and liveable neighbourhood can also be illustrated through the example of a single street, to make this transition more tangible in everyday public space. In this example, a typical residential street in Hoge Vucht undergoes transformation across different time periods.



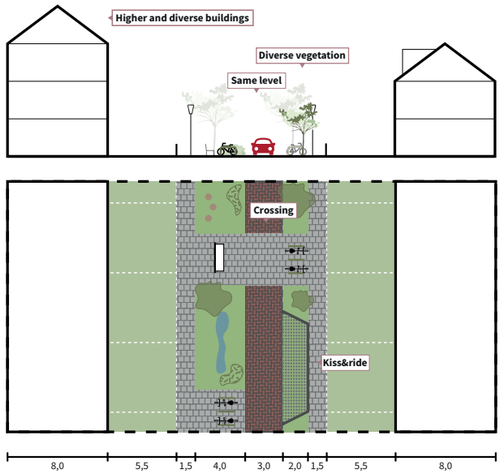
1. Current situation: car dominance
Currently, this typical residential street provides ample space for cars. The street is wide, with parking on both sides. A small sidewalk on both sides is the only place where people can walk, meet and play.



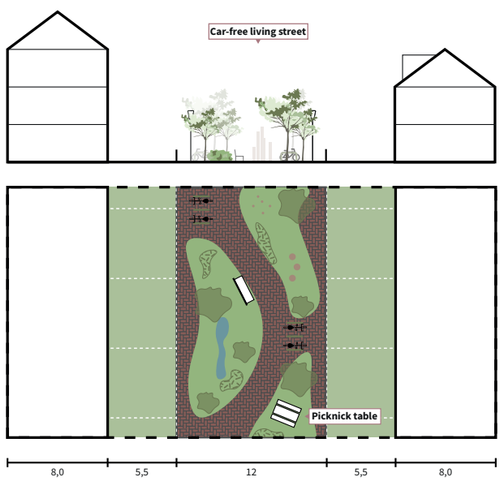
2. Next week
In the second phase, the street shows simple implementations that could be implemented next week. Temporary planters create space on some parking spaces for children to play, people to sit, and bicycles to be parked. The planters also bring more vegetation to the street. More street lanterns improve evening and nighttime lighting, making it safer and more comfortable to be outside at night. A shared car reduces the need for a private car. These interventions already change how residents experience the street, making it more social, safer and less car-dominated.



3. Transition chaos
In the third phase, bigger infrastructural measures are taken. The street transforms from an asphalted two-way street to a brick-paved one-way street. One side of the parking is transformed into a stroke with diverse vegetation, benches, bike parking and play elements. On the other side, the parking area is raised to create a smaller, safer street, and the surface is semi-paved with brick to improve water infiltration. During this phase, residents must adapt to new travel habits and new uses of the street, which can initially cause friction and uncertainty but also open opportunities for new forms of street life.



4. Sustainable mobility
In a residential street where sustainable mobility is the dominant mobility mode, parking is no longer accommodated. The street is at the same level as the pavement, and there is a kiss-and-ride area for picking up and dropping off people and goods. A crossing with a different pavement indicates a clear area where pedestrians have priority, thereby connecting the two sides of the street. To create a more interesting street, buildings are transformed into more diverse forms and materialisations. To support more local facilities and public transport, the density should be added to the street. People are stimulated to walk or bike to their destination by having a safe, interesting and comfortable street. For longer trips, people can use public transport and shared mobility to reach their destination.



5. Car-free: living street
In a car-free living street, there are no cars anymore. Central in the street are places to play and meet, surrounded by diverse vegetation. The entire street is at the same elevation and has the same pavement. There is flexibility in how this street could look and in the types of play elements, seating, or vegetation that can be used. It is still possible to reach the houses with an emergency vehicle or when moving. The street becomes a shared living space where social interaction, play and ecology define its character rather than traffic efficiency.

08
CONCLUSION

The conclusion chapter summarises the main findings of this research and answers the main research question and sub-questions. In the discussion, limitations of this research and recommendations for future research are mentioned.

Pedestrian bridge in Hoge Vucht, Breda (Author's image, 2025)

8.1 Conclusion

This thesis explored how sustainable mobility can be spatially implemented to enhance both liveability and accessibility in post-war neighbourhoods. To do so, three sub-questions were proposed.

Chapter 4 answered the first sub-question: *What spatial conditions influence liveability and accessibility in post-war neighbourhoods, and how can they be assessed?* In the literature, numerous frameworks exist, each with its own definition. Different domains focus on different aspects, scales and indicators of liveability. However, no framework applied to the combination of public space and mobility. Accessibility is usually part of liveability frameworks. For this research, a separate framework for accessibility is developed, as accessibility is a key goal of mobility. These two frameworks connect to both public space and mobility. Figures 41 and 47 show the frameworks. Liveability can be categorised in *safety, spatial quality, health, community* and *accessibility*. Accessibility can then be sub-categorised in *proximity, mobility options, time restrictions* and *inclusiveness*.

The second sub-question is answered in chapter 6: *How can strategies to stimulate sustainable mobility be designed and what are their effects on liveability and accessibility in post-war neighbourhoods?* To answer this, a collection of design implementations on various scales is created, which all have some connection to mobility. Sometimes there is a strong relation between mobility and liveability, for example, the car-free school streets or meeting places with package pickup and shared mobility. However, sometimes there is only a small effect on liveability or accessibility, for example, a shortcut for cyclists or a parking space for a shared car. Other implementations have minimal connection to mobility and a greater impact on liveability or accessibility. Examples include an active ground floor and diverse vegetation.

In general, sustainable mobility and liveability really strengthen each other. All forms of sustainable mobility use less space compared to cars, creating more space for liveability. A decline in car use improves safety, spatial quality, health, and community. A downside is that when car access declines, it can create challenges for some people or in certain situations. Alternative transport options should prevent overall accessibility from declining. There is not one answer to what this alternative should be, but a variety of mobility options is needed for different groups of people and different types of travel. In a car-independent neighbourhood, residents might walk to the supermarket, cycle to school, take the tram to the train station to go to work or take a shared car to visit grandma. Providing a wide variety of high-quality alternatives compensates for this decline in accessibility by car.

Finally, the third sub-question incorporates the aspect of time: *How can a sustainable mobility design be implemented in a post-war neighbourhood in the time frame between now and 2050?* To make the transition from a car-centric neighbourhood to a sustainable and liveable place takes time and needs to start with small steps. Travel behaviour is based on habits, so changing travel behaviour needs time. Also, big infrastructural projects take time, and not everything can improve at the same time. However, there are small steps that could already improve liveability next week! These should show how liveability will increase when less space is allocated to the car.

Together, these sub-questions answer the main research question: How can sustainable mobility improve liveability and accessibility in post-war neighbourhoods through spatial design, both now and in the future? In conclusion, going from car-centred public spaces that are now widespread in post-war neighbourhoods to more sustainable forms of mobility frees up space for kids to play, meetings between neighbours and nature in the street. This improves safety, spatial quality, health and community in the neighbourhood! Reducing private car use does not automatically improve accessibility, but carefully designed sustainable mobility options help maintain and even enhance it. Improved proximity and high-quality walking and cycling paths ensure accessibility within the neighbourhood, while a well-connected cycling network, frequent and fast public transport, and a wide range of shared mobility ensure accessibility for longer distances. This needs to start with small implementations next week, continued by bigger shifts in the long term. When doing so, a transition can be made from functional car-oriented streets to valuable public spaces focused on people and nature!

8.2 Discussion

The discussion describes the limitations of this research and recommendations for future research.

This research focuses on a general definition of neighbourhood liveability. However, little attention is given to the context of the post-war neighbourhood. Characteristics such as the large share of people with a migration background, the large share of social housing and the low average income (CBS Statline, 2024a) are not given attention in this research. Future research could dive deeper into more context-specific values for residents of post-war neighbourhoods. This could be done by looking into literature about these specific demographic groups or by asking residents what they perceive as important values impacting their liveability.

This research also only focuses on the overall score of the liveability of the neighbourhood, while individual liveability is not researched. Overall, liveability could show an increase, while on an individual level, there might be a decrease.

The way this research was conducted also has some limitations. The assessments of the liveability and accessibility are all presumed. The actual results are unknown, since these are predictions of the future (van Dorst, 2012). All assumptions are based on literature and examples of other projects, but results could be different in a different context. Results are also dependent on the extent to which residents change their behaviour. For example, sports equipment can only improve health and well-being when residents use it.

The way the implementations were evaluated in this research also makes it impossible to compare the relevance of the single interventions. The implementations are all combined in four different scenarios. The scenarios as a whole are evaluated on liveability and accessibility. This way, there is no data on the effects single implementations have, or to compare which implementations are most or least valuable. Future research could prioritise which measures most effectively improve liveability. This could be valuable knowledge when, for example, due to limited costs or limited time, only a few implementations can be implemented.

It would be interesting to have a longitudinal study that holds a recurring evaluation during this transformation, where both objective indicators (traffic accidents, air quality, etc.) and perceived liveability of residents (feelings of safety, stress, community feeling, etc.) are measured to provide evidence-based validation of the presumed liveability. It can be researched how residents actually respond to the implementations. This is only possible when this project gets built, and it is very context-specific.

09
REFLECTION

In this chapter, the research process is reviewed, and what could be done differently next time is considered.

Residential street in Hoge Vucht, Breda (Author's image, 2025)

9.1 Reflection

In seven questions is reflected on this research process and what could be done differently next time. The first five questions are from the graduation manual and are obligatory to answer.

1. What is the relation between your graduation project topic, your master track (A, U, BT, LA, MBE), and your master programme (MSc AUBS)?
The *Design of the Urban Fabric* (DUF) studio deals with the interplay between physical urban elements and socio-cultural processes that encourage sustainable and liveable places, with a focus on the neighbourhood scale. This research did this by looking through the lens of mobility. This thesis researched what design implementations stimulate sustainable mobility and how this can improve liveability and accessibility in post-war neighbourhoods.

Within the urbanism track, this research relates to creating sustainable urban landscapes by making spatial designs in the urban environment that can influence societal changes. Within this research, this is done with design implementations on the neighbourhood and street level through the lens of sustainable mobility, with the goal to improve liveability and accessibility.

This aligns with the master's approach of integrating research and design to address complex spatial and societal challenges, contributing to a sustainable and liveable future.

2. How did your research influence your design/ recommendations and how did the design/ recommendations influence your research?
In this project, the research and design processes were closely interconnected. The literature research provided a theoretical understanding of liveability, accessibility and sustainable mobility. While designing the scenarios, each scenario was based on a mobility mode and a liveability value, based on the literature research. The sustainable mobility hierarchy (SHARE-North, 2021) from the research has been guiding when spatial challenges arose when combining the four scenarios in the final design phase. Spatial analysis of mobility interventions and the context of the case study area had a direct influence on the design.

At the same time, the design process also influenced my research. While making the design, new questions arose, asking for new analysis. The design really helped answer the spatial aspects of this research. Spatial conflicts became visible, showing the need to make choices and the importance of the context.

This interaction between research and design was an iterative process, as described in The Delft Approach (Dijkstra et al., 2021). This loop of analysis, design and presentation helped the design to evolve and refine.

3. How do you assess the value of your way of working (your approach, your used methods, used methodology)?
The use of frameworks for liveability and accessibility structured the research and allowed for a systematic evaluation of the design scenarios. Applying these frameworks to the context of public space and mobility increased their relevance to this study but also introduced a potential bias. When evaluating the final design, liveability appeared to improve in most aspects; however, factors such as crime rates, educational quality, and political stability also influence liveability but fall outside the scope of this framework. As a result, residents might still perceive liveability as low, even when, according to the framework, liveability has improved.

The research-by-design approach, combined with a case study, proved valuable for analysing a typical post-war neighbourhood and exploring its spatial challenges. The use of the Maximisation Method, in which separate "lenses" were first designed individually and later combined, allowed for in-depth exploration of different perspectives. However, a limitation of this method is the difficulty of integrating these lenses into a coherent final design. I experienced this challenge myself. It was difficult to identify the main story in the final design because it is partly the sum of the stories from the four scenarios. While it is valuable to combine the qualities of all four scenarios, it also weakens the clarity and coherence of the overarching story of the neighbourhood design.

4. How do you assess the academic and societal value, scope and implication of your graduation project, including ethical aspects?
Within the academic field, this project contributes to the application of liveability and accessibility in the field of public space and mobility, creating two new frameworks for this. It expands the discourse on the sustainable mobility transition through a spatial liveability lens applied to the context of post-war neighbourhoods.

Societally, this work addresses the urgent need to reduce car dependency to move to more sustainable and liveable neighbourhoods. This is needed to achieve the mobility climate goals from the EU Green Deal (European Commission, 2019). The case study of Hoge Vucht in Breda illustrates how this shift can be spatially implemented and offers inspiration for similar neighbourhoods across the Netherlands.

Ethically, this thesis recognises the importance of inclusiveness. Design proposals aim to improve liveability and accessibility for all residents, regardless of age, income, or ability.

5. How do you assess the value of the transferability of your project results?
The transformation to more sustainable mobility and more liveable places is relevant to cities worldwide. The frameworks for liveability and accessibility provide general values that are widely applicable to situations that connect liveability and accessibility with mobility in the context of public space.

The implementations are most transferable to other post-war neighbourhoods in a Dutch context. Some implementations make use of the typical wide street profiles these neighbourhoods have, or are specific to the gallery flats. Implementations regarding facilities might need a minimum amount of density, and since cycling is already embedded in Dutch culture, promoting cycling might need different implementations in an international context. However, the transition to more sustainable mobility and more liveable places is relevant to cities all over the world, and many implementations can also be applied to neighbourhoods worldwide.

6. What is the role of policy in ensuring that spatial design interventions effectively support a sustainable mobility transition?
A spatial design alone cannot achieve a full transition to a sustainable mobility system. To stimulate the use of sustainable mobility, it is necessary that hardware, orgware and software all work together.

Public space design provides *hardware*: the physical and experiential setting needed for change. Policy ensures *orgware*: behavioural and economic feasibility. Policy instruments, such as parking and fuel pricing, car taxation, public transport subsidies, secured bicycle parking and pedestrian zones are essential to influence travel behaviour and make sustainable modes more attractive. The *software* consists of campaigns, education and app platforms, such as MaaS (KiM, 2015). Campaigns could promote the health benefits of cycling and walking, and primary schools could provide cycling lessons.

While the design demonstrates the spatial potential of reallocating car-dominated space toward people-oriented public space, its effectiveness depends on supportive policy measures that discourage car use and promote active and shared mobility. Without such financial and regulatory alignment, residents may continue to prioritise private car ownership, limiting the long-term impact of design interventions. Together they can accelerate the transition toward sustainable, liveable, and accessible neighbourhoods.

7. How could liveability and accessibility be measured more objectively?
In this research, liveability and accessibility are measured based on 18 values in two different frameworks. In the design scenario, I ranked each value based on sub-values on five scales (--, -, 0, +, ++).

To measure this in a less biased way, experts could be asked to evaluate how the different scenarios score on these values. There could even be a comparison between how experts from different fields evaluate the scenarios.

Another option is to ask residents how they perceive their neighbourhood now and how they expect that the designs will change the way they perceive their liveability. Residents tend to have conservative opinions (Leidelmeijer & van Kamp, 2003), but it does make the evaluation more context-related.

Certain aspects of accessibility can also be calculated in digital models, such as a digital twin of the mobility system. Improvements in travel distance, travel time and congestion in peak hours can be calculated beforehand.

10
REFERENCES

This chapter lists all the references used in this research.

Garage boxes in Hoge Vucht, Breda (Author's image, 2025)

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11
APPENDICES

In this chapter, the appendices provide additional material that supports the main body of the thesis. These include calculations, tables, and detailed analyses that complement the findings discussed in the earlier chapters.

Residential street in Hoge Vucht, Breda (Author's image, 2025)

Appendix A: 90% reduction of CO2 in mobility

Under the EU Green Deal, the objective is to achieve a 90% reduction in CO2 emissions from mobility by 2050. This thought experiment investigates the extent to which we need to change our travel behaviours to reach this 90% reduction in passenger mobility. For these calculations, the CO2 emissions per passenger-kilometre from Milieu Centraal (n.d.) and the travel kilometres of CBS Statline (2024b) are used.

This thought experiment compares four mobility scenarios to assess their impact on CO2 emissions.

- The first scenario reflects **current travel patterns** as they exist today.
- The second scenario maintains the **same model split and travel kilometres** but assumes that all modes of transport are fully **electric**. This results in a **CO2 reduction of 61%**.
- The third scenario explores an **80% reduction in CO2 emissions** while keeping the total number of kilometres travelled constant. To achieve this, all modes of transport are fully electric, the **travel kilometres by car need a big reduction**, and the train, bus, bike and walking need an increase.
- The fourth and most ambitious scenario examines the implications of a **90% reduction in CO2 emissions**. To achieve this, a change in the transport modes alone is not enough, also a reduction of the total travel kilometres is needed. The car has an even bigger reduction compared to the third scenario

Although these calculations are very rough, they show how the reduction of CO2 by mobility is not only dependent on the electrification of vehicles, but also a change in the modalities we use and the total amount of travel kilometres.

	1: Current situation	3: 80% reduction		4: 90% reduction	
Private car (driver)	16,12 km	-70%	4,836 km	-85%	2,418 km
Private car (passenger)	6,04 km	-60%	2,416 km	-80%	1,208 km
Train	3,26 km	+200%	9,78 km	+50%	4,89 km
Bus/tram/metro	0,83 km	+100%	1,66 km	+50%	1,245 km
Bycicle	2,92 km	+200%	8,76 km	+200%	8,76 km
Walking	1,14 km	+150%	2,85 km	+150%	2,85 km
Other	1,67 km	=	1,67 km	=	1,67 km
Total	31,98 km	=	31,972 km	-28%	23,041 km

Figure 111: Table of travel kilometres in the different scenarios

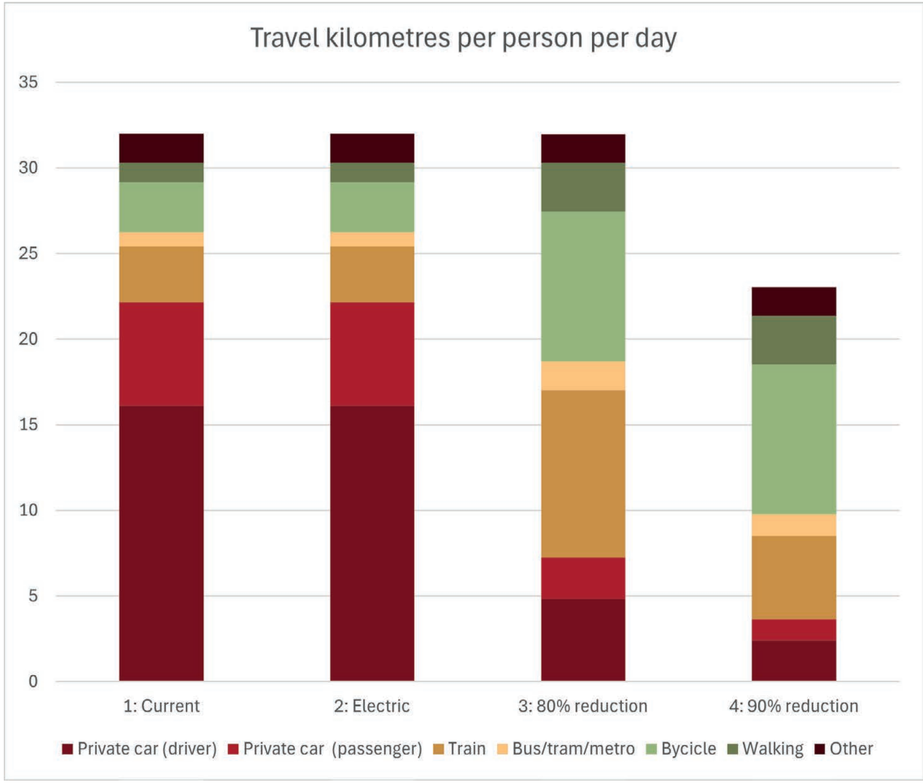

Figure 112: Travel kilometres per person per day

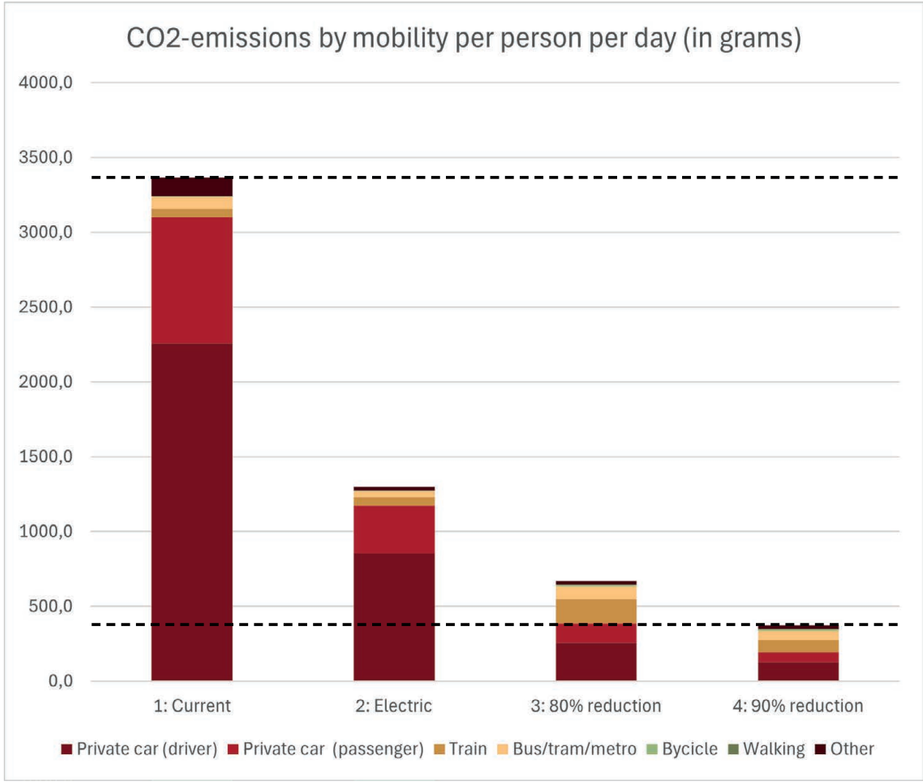

Figure 113: CO2 emissions by mobility per person per day (in grams)

Appendix B: History of mobility

Understanding today's mobility system requires a look into the past. The way people have moved through cities and across regions has changed dramatically over the centuries, influencing how streets and cities are shaped. This historical overview provides insight into how these transformations have led to the urban environments and mobility patterns we know today.

18th century (1700 – 1799)
For the history of mobility in Dutch cities, an interesting place to start is the transport revolution that took place in the 19th century in Europe and the United States. Before this transport revolution, people mainly moved on foot. Richer people used horses with carriages and boats pulled by wind, horses or men. Transport was expensive and labour-intensive. Since many streets were unpaved, boats were the cheapest and usually fastest option for both people and goods. The waterways were narrow, so boat transport was on a small scale. Within cities, people mainly walked, despite poor and dirty street conditions (Filarski & Mom, 2008).

19th century (1800 – 1899)
The Industrial Revolution sparked new forms of transport, beginning in the UK in the late 18th century with better roads and canals, followed by steamships and trains in the early 19th century. The transport revolution gradually spread from Britain to Western Europe in the early 19th century.

In The Netherlands some important developments were the construction of national streets, canals and later railways connecting major cities. In the second half of the 19th century the Spoorwegwet-Van Hall (1960) led to the creation of a national railway network. Trams—first horse-drawn, then steam and electric—also appeared in Dutch cities. At the end of the 19th century some important canals were constructed, like the Nieuwe Waterweg, the Noordzeekanaal and the Merwedekanaal (Filarski & Mom, 2008).

This Industrial Revolution brought rapid urbanisation, especially in industrial regions, driven by economic growth and increasing scale. Cities expanded, small towns grew into urban centres, and old city cores were reconstructed. Cities like Paris and Vienna were restructured with grand boulevards and ring roads, such as Haussmann's redesign of Paris (1854–1870) and the construction of Vienna's Ringstraße (from 1857) (Baggen & van Ham, 2019).

Figure 114: River in Holland in the middle of the 19th century (Filarski & Mom, 2008, p.12)

Figure 115: Mobility at the end of the 19th century, Apeldoorn around 1895 (Filarski & Mom, 2008, p.15)

Start of the 20th century (1900 – 1940)
Because of the industrial revolution The Netherlands changed from an agricultural to an industrial country. This created bigger companies, new jobs and a bigger middle class from industrial workers. Working-class neighbourhoods were built around the industry at the edges of the city in working-class neighbourhoods. Urban transport became cheaper, making it possible to live further away from the factories. The Netherlands also changed into a welfare state in this period. In this new welfare state people had more spare time for recreation and vacation leading to a change in consumption and new travel patterns, initially by train and tram, then also by bike. In housing, the Woningwet from 1901 had a big impact on the improved quality of housing.

The Garden City Movement was a reaction to the poor living environment in cities. It combines the urban buildings in a rural environment with a decentralised satellite city connected by railways. A different response came from the CIAM movement, founded in 1928 by Berlage, Le Corbusier, and May, which promoted the idea of the functional city. Urban functions such as living, working, and recreation were spatially separated but connected through transportation. Roads were classified by speed and function, and residential areas were shielded from major traffic routes using green belts. An example of this approach is Amsterdam's Algemeen Uitbreidingsplan (1935), with its finger-like urban extensions separated by green space (Baggen & van Ham, 2019).

Between 1900 and 1914, the tram experienced its golden age. The introduction of the electric tram led to a sharp increase in passenger numbers, reduced ticket prices, and a wider area could be covered. Many of the new passengers came from social groups that previously travelled rarely or not at all. Even in rural areas, the tram network continued to expand, though less extensively than in urban centres.

The bicycle, at that time, was seen as an adventure: racing allowed people to experience speed on their own terms, and touring the countryside opened up a new sense of freedom—unlike the train, you could change direction whenever you wished. The bicycle evolved into a fast touring model that also became a practical and affordable means of transportation in cities.

The automobile was introduced in the Netherlands in 1896 and developed through three phases. The first was experimental, with diverse, often unreliable designs that resembled racing machines. Around 1901–1902, after racing was banned, cars became faster touring vehicles owned mostly by wealthy pioneers and used for leisure, usually with chauffeurs. Driving was seen as a sport requiring skill and offered an escape from city life. However, this period also saw strong social resistance to the car. From 1907, foreign manufacturers produced practical city cars for everyday use, driven without chauffeurs and used for work, holidays, and leisure. This shift required regulations, fuel supply, and repair services. The rise of the automobile greatly increased private mobility and lessened the need for close access to amenities, changing urban development after World War I.

Figure 116: City traffic at the end of the 1920s at Hofplein in Rotterdam (Mom & Filarski, 2008)

Figure 117: Crowded streets in city centres, De Leidsestraat in Amsterdam in 1959 (Mom & Filarski, 2008)

By 1920, intercity travel was dominated by the train, while regional travel was roughly equally divided between bicycles and trams. In cities, however, pedestrians were predominant. The number of tram passengers was many times higher than the number of train passengers. This should not be confused with the number of kilometres travelled per person; this was higher for the train. Buses were negligible.

After World War I, tram use declined due to limited supplies and rising labour and coal costs, while motorisation became widespread. The tram got competition from emerging transport modes, like buses, private cars and even aviation, intensified. The Netherlands saw limited new railway construction and even tram line closures, while road infrastructure grew rapidly. Key developments included the 1920 Dutch Road Congress, the 1927 Rijkswegenplan (National Road Plan), and the 1936 motorway plan, which introduced modern road design. Despite government support, by the late 1920s two-thirds of regional tram companies were unprofitable, and within a decade, buses had overtaken trams in regional transport (Mom & Filarski, 2008).

WWII (1940-1945)

During World War II, private car and motorcycle use was banned in 1940, followed by a ban on taxis and rental cars in 1941. As a result, bicycle and cargo bike use initially increased, along with horse-drawn carts and even hand- and dog-carts returning to the streets. Bus travel declined sharply, with overcrowded vehicles, while train and tram usage rose significantly. In fact, tram companies reopened 400 km of steam tram lines for passenger transport during the war. From 1944 onwards, German forces deliberately destroyed transport infrastructure, and during the Hunger Winter, city residents tore up asphalt from the streets to use as fuel (Mom & Filarski, 2008).

Figure 118: Collapsed bridge during the Second World War (Mom & Filarski, 2008)

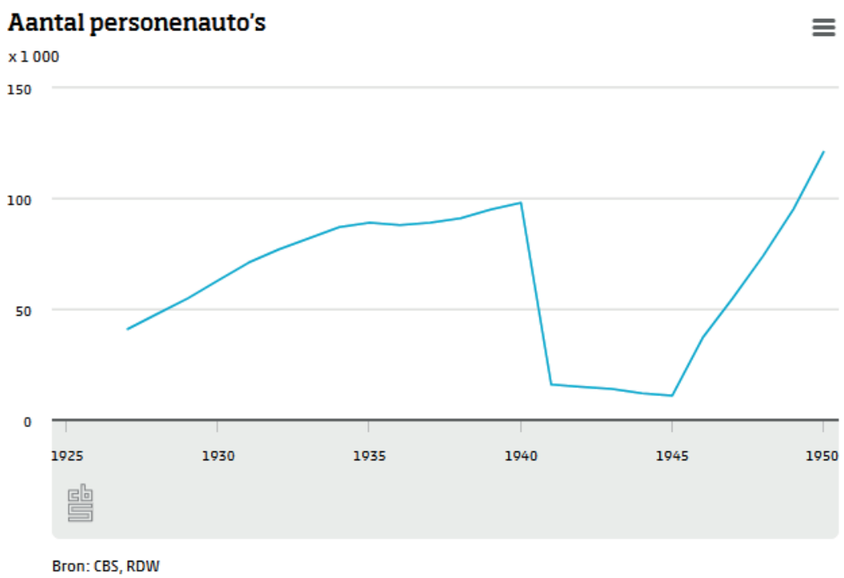

Figure 119: Number of passenger cars in The Netherlands (CBS, 2025)

Reconstruction period (1945-1999)

Between 1945 and 1980, the Netherlands experienced a mobility explosion, with personal transport increasingly dominated by privately owned vehicles: first the moped, then the car. While bicycles, walking, buses, and trams remained common in cities, and buses and trains connected regions, car ownership rapidly expanded into lower-middle and working-class households. The 1960s saw the rise of a consumer society with growing prosperity, and more leisure and foreign holiday travel. Inspired by American ideals of freedom and modernity, car culture flourished, leading to congestions and roadside picnicking. The moped gained popularity from 1947, peaking in the 1960s as a key commuter vehicle before being overtaken by the car. Road design was focused on motor vehicles with an increase in asphalt roads and urban ring roads. In the 1970s concerns about this car-centric planning began to rise (CBS, 2025; Mom & Filarski, 2008).

Figure 120: Mopeds in the 50s and 60s, Schiedam around 1965 (Mom & Filarski, 2008)

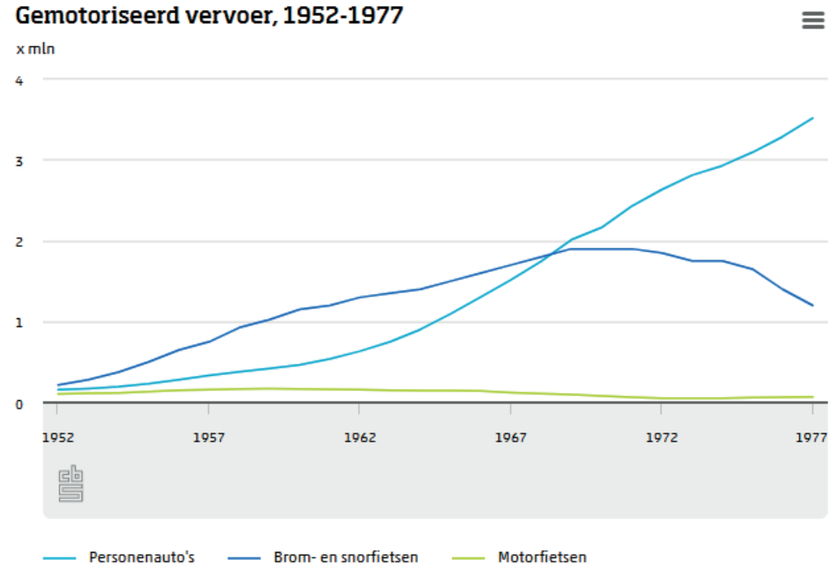

Figure 121: Number of motorised traffic in The Netherlands (CBS, 2025)

Simultaneously, the urgent need for housing after WWII led to large suburban expansions. Post-war neighbourhoods were planned with an emphasis on light, air and space. The previous model of closed urban blocks was replaced by spacious, more open structures of repeating clusters surrounded by green and infrastructure. Reflecting the growing importance of the private car, roads and parking were integrated in the design, giving car traffic a central place in these neighbourhoods. This functionalist planning ideology, rooted in the modernism of the 1920s, reflects the desire to improve living conditions in the city (Urhahn, 2025).

Between 1980 and 2005, the Netherlands saw major shifts shaped by decentralisation, globalisation, and digitalisation. While infrastructure was not significantly expanded, existing networks were improved and maintained to increase efficiency. Automobility resumed its growth in the early 1980s, though at a slower pace. Women increasingly participated in car use, while traffic safety improved due to stronger regulations. From 1995 onwards, walking and cycling began to decline. Public transport saw renewed attention, with big infrastructural projects and the introduction of the student public transport pass. By the early 2000s, car ownership had become widespread, and the car remained dominant in Dutch mobility (CBS, 2025; Mom & Filarski, 2008).

Figure 122: Post-war neighbourhood Hoge Vucht, Breda (van Gurp, 1987)

21th century (2000 – 2025)

In the early 21st century, passenger mobility in the Netherlands stabilised, both in total travel kilometres and in modal share. Attention increasingly shifted towards sustainable and smart mobility. This transition began with the introduction of particulate filters and cleaner engines, followed by rapid growth in innovations and subsidies for electric vehicles. By 2025, many Dutch cities had introduced zero-emission zones, where freight and delivery vehicles are required to operate without emissions.

During the COVID-19 pandemic, mobility patterns changed drastically due to lockdowns and government restrictions. People began working from home, education moved online, and many shops and restaurants temporarily closed. In March 2020, total mobility declined sharply due to the first national lockdown, reaching its lowest point in April 2020. Between 2020 and 2022, mobility fluctuated with the tightening and relaxation of COVID-19 restrictions. Images of empty streets, trains, and airplanes became symbols of this period, while walking and cycling gained popularity as alternative forms of activity and transport.

By 2023, total travel kilometres had almost returned to pre-pandemic levels. Travel by car and public transport remained slightly lower than in 2019, while bicycle travel had returned to pre-crisis levels. Walking became more deeply embedded in daily routines surpassing pre-pandemic levels in terms of kilometres travelled. An interesting long-term effect of the pandemic is the persistence of remote working, which means that the total number of commuting kilometres remains below 2019 levels (CBS, 2025).

Overall, the history of mobility in the Netherlands shows how transport and urban planning have shaped each other over time. From walking and waterways, to trains, bicycles, and cars. The 21st century has seen a stabilisation of travel, a shift towards sustainable and smart mobility, and remote work reshaping daily routines and commuting patterns. These historical and recent trends underline that mobility is deeply intertwined with societal needs, technological opportunities, and urban form.

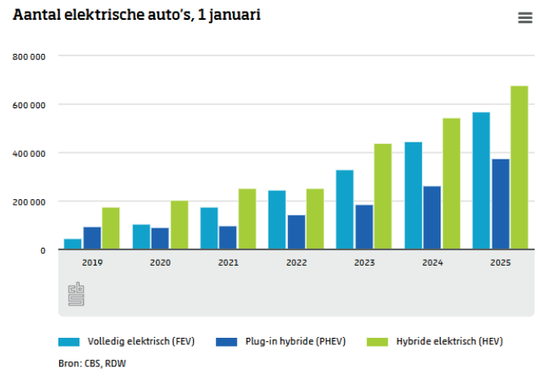

Figure 123: Number of electric cars (CBS, 2025)

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Figure 124: Empty roads during COVID-19 (CBS, 2025)

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Figure 125: Quiet trains during COVID-19 (CBS, 2025)

Appendix C: Values of liveability in literature

Figure X shows different values from eleven different sources describing liveability. The numbers in yellow are values that are mentioned in four or more sources. The values shown in blue are values that are applied in the frameworks from this research.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	
The community of people (social environment),												
Community	x			x	x	x		x	x		x	7
Culture & environment			x									1
Health			x		x	x	x			x	x	6
Neighbours				x								1
Control					x				x			2
Well-being						x						1
Experience							x					1
Public space (accessibile, meeting spaces)							x					1
Identity							x	x	x			3
The environment (physical surroundings)												
Physcial & social safety	x	x		x	x	x	x		x	x		8
Satisfaction with apartment/housing	x	x		x		x						4
Litter (overall environmental quality)	x			x				x				3
Environmental quality	x	x				x			x	x	x	6
Noise	x											1
Traffic	x											1
Infrastructure & facilities		x	x				x	x				4
Stability			x									1
Green/ nature					x		x	x				3
Aestetics						x						1
Accessibility for all							x			x	x	3
Climate-adaptive							x					1
Wildlife								x			x	2
The economy (jobs, income, transfer of goods)												
Accessibility (access to jobs and services)	x			x								2
Services & facilities	x			x		x		x				4
Job opportunities/ availability		x		x		x		x	x			5
Education			x									1
Street as an economic driver							x					1
Recreation								x	x			2

1. (Howley et al., 2009)
2. (European Commission, 2016)
3. (The Economist Intelligence Unit, 2020)
4. (Kennedy & Buys, 2010)
5. (van Dorst, 2012)
6. (Leefbarometer, 2023)
7. (van Driessche et al., 2021)
8. (Shafer et al., 2000)
9. (Cardoso et al., 2022)
10. (Vonk Noordegraaf et al., 2021)
11. (Goudappel, n.d.)

Figure 126: Table with values of liveability from eleven different sources

Appendix D: References for the four scenarios


1.


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14.


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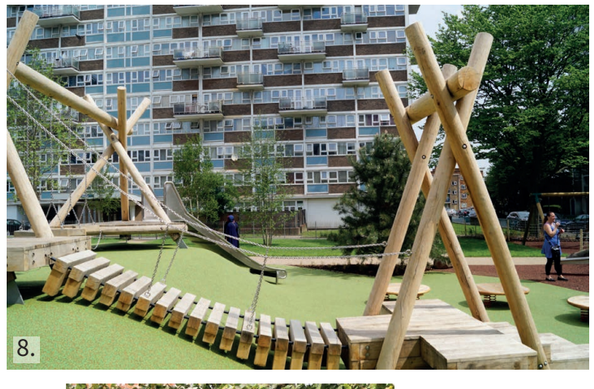
13.


2.

From young to old

The inclusive neighbourhood


8.


9.


10.


12.


7.


11.

1. (Hoevel, n.d.)
2. (Sluijsmans, 2022)
3. (Urban Mobility Explained, n.d.)
4. (Mol, 2018)
5. (Leer in het Verkeer, n.d.)
6. (Verbeke, n.d.)
7. (Bijenhotel kopen, n.d.)
8. (Duncan and Grove, n.d.)
9. (Stradus, n.d.)
10. (Hof van Zeeland, n.d.)
11. (Knarrenhof, 2025)
12. (Pinterest, n.d.)
13. (Rodriguez, 2019)
14. (Sluijsmans, 2017)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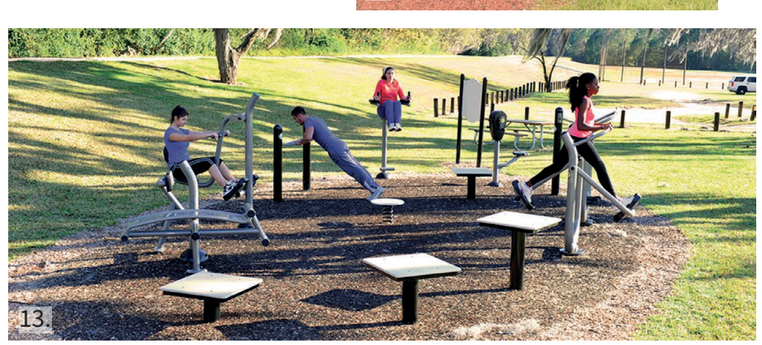
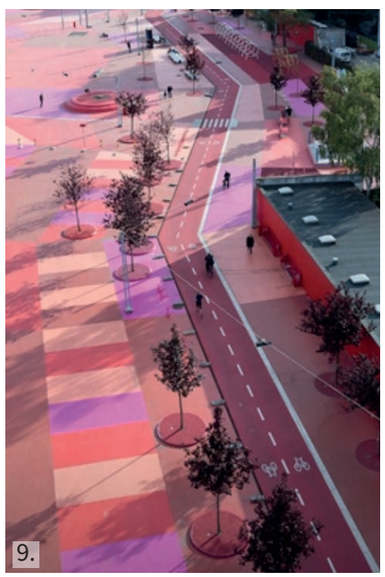
Active flow

The healthy neighbourhood


13.

8.


9.

10.

12.


11.

1. (Hartog, 2015)
2. (Rotterdam Architectuurprijs, 2016)
3. (ipv Delft, n.d.)
4. (Delfland, n.d.)
5. (MASU Planning, 2015)
6. (Brünen, 2020)
7. (LAP Landscape & Urban Design, n.d.)
8. (Jesse, n.d.)
9. (Baan, 2012)
10. (Devpost, n.d.)
11. (Lappset, 2020)
12. (Pretwerk, 2015)
13. (Zoom Recreation, n.d.)

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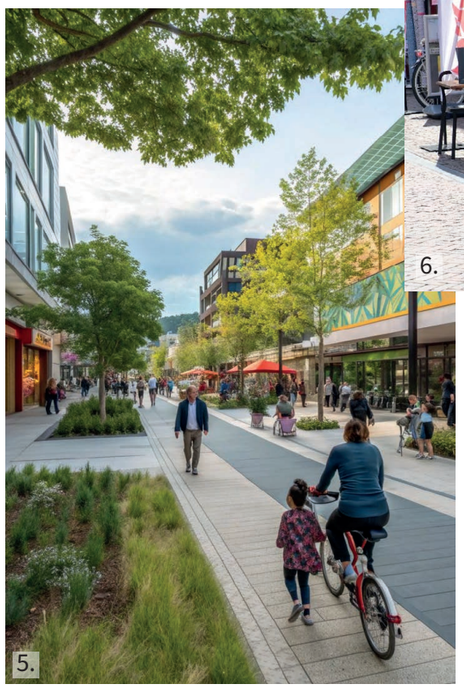

5.

Urban life

The diverse urban neighbourhood

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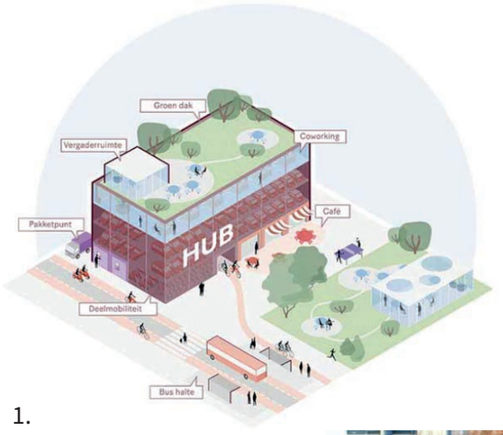
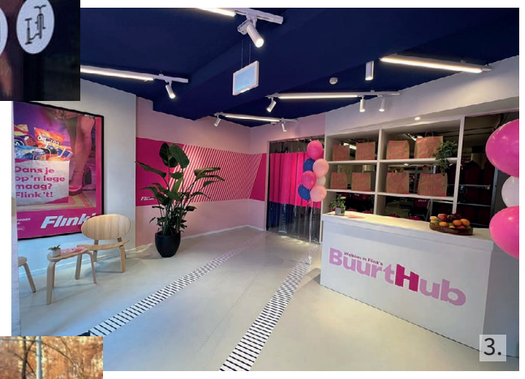
12.

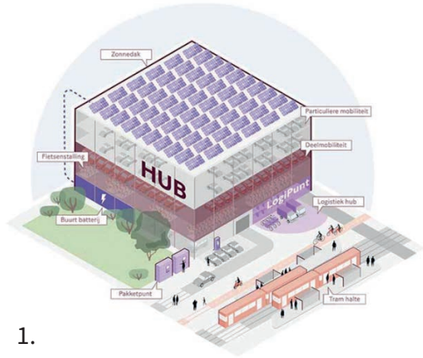
1. (Vorm Vastgoed, n.d.)
2. (BetonInfra, n.d.)
3. (Buesa, n.d.)
4. (Moen, 2021)
5. (Dream Cloud, n.d.)
6. (Hulsbosch, 2017)
7. (Archidat Architectuur, n.d.)
8. (Gerritsma, 2023)
9. (Hobhouse, 2019)
10. (indebuurt Dordrecht, 2024)
11. (Dogterom, 2024)
12. (Hilldale, n.d.)



1.



3.



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Shared roots

The community neighbourhood

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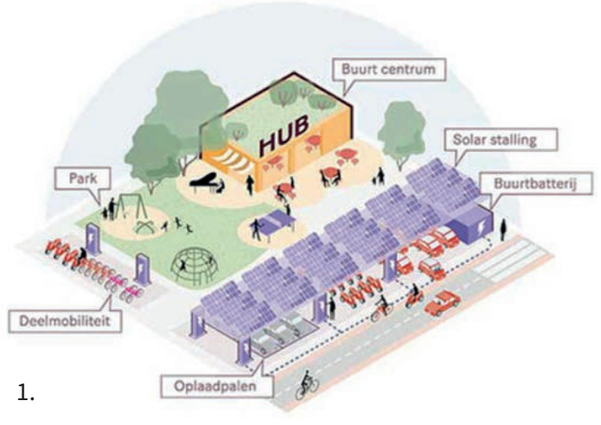


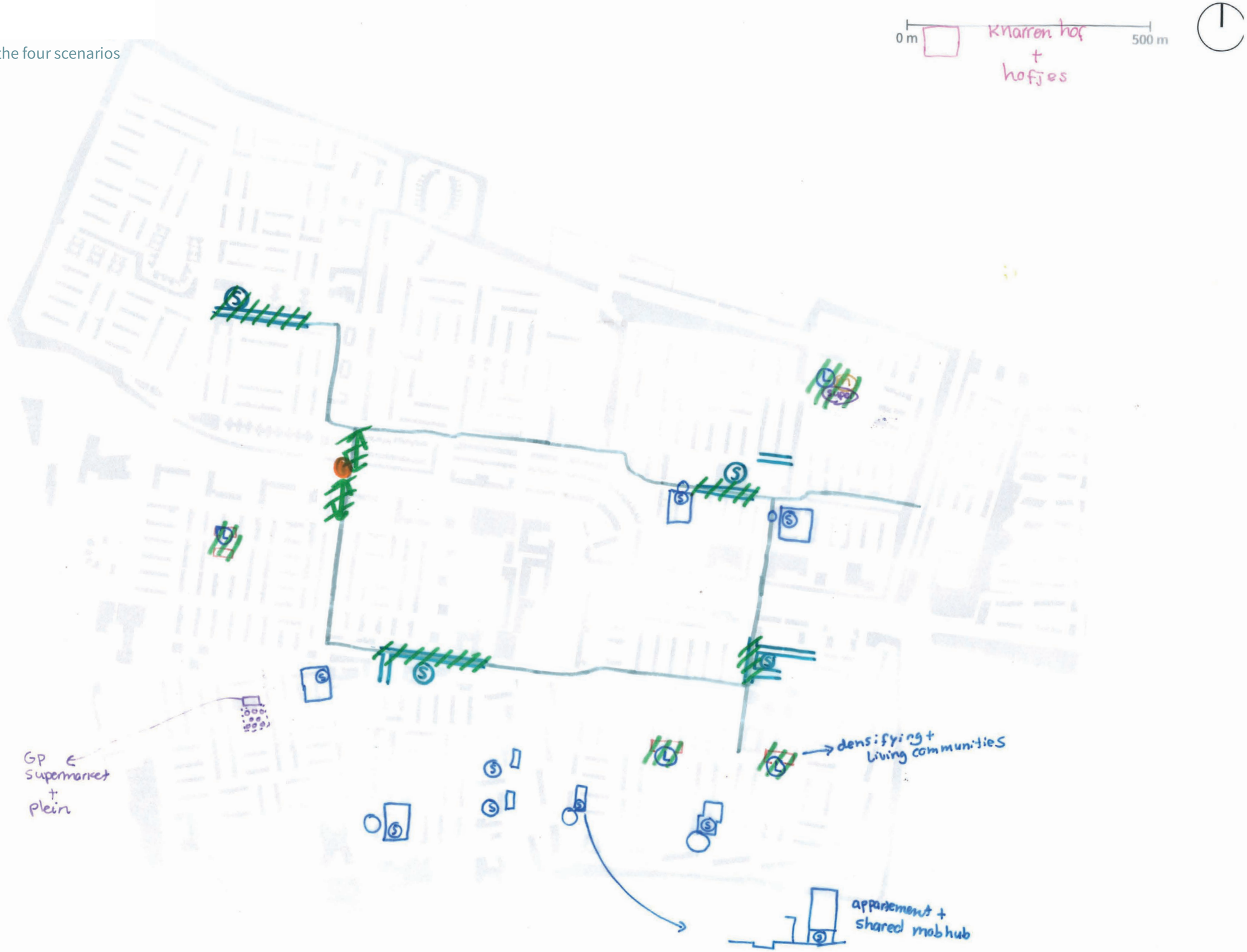
1.

1. (Zwikker et al., 2021)
2. (Marsia, 2014)
3. (Maxtension, n.d.)
4. (Sun, n.d.)
5. (Peters, 2017)
6. (Pol, 2024)
7. (kawarthaNOW, 2022)
8. (Marineterrein Amsterdam, n.d.)
9. (Onze stad Nijmegen, 2025)
10. (DUIC Redactie, 2020)
11. (Knarrenhof, 2025)
12. (Home Garden Era, n.d.)

Appendix E: Conflicts and overlaps between the four scenarios

Conflicts between the four scenarios

Overlaps between the four scenarios



Appendix F: Measuring liveability and accessibility

To assess the different scenario designs for the case study area Hoge Vucht, each value from the liveability and accessibility frameworks is subdivided into sub-components. Each of these components is assessed on a scale from -- (lowest score), -, 0, + to ++ (highest score). The average score from these components results in the score for the liveability and accessibility assessment in the spider web diagrams.

Liveability	Current situation	From young to old	Active flow	Urban life	Shared roots	Final design
Physical safety	-	+	++	0	-	++
Safe crossings for active mobility	0	++	++	0	0	++
Low speed traffic	-	0	+	+	-	++
Seperated routes slow traffic	-	+	++	-	-	+
Social safety	0	+	0	+	+	+
Active ground floor	--	-	-	+	++	+
Lighting	0	++	0	0	0	+
Wayfinding	0	+	+	0	+	+
Active public space	-	+	+	++	++	++
Clear sightlines	+	+	+	+	+	+
Interesting	-	0	0	+	0	+
Building diversity	--	+	-	++	+	+
Landmarks	--	--	0	0	-	-
Sightlines	+	+	+	0	+	+
Diversity in vegetation	--	++	++	-	--	++
Diversity in function	--	-	-	++	+	+
Comfortable	0	+	+	0	0	+
Climate resilient	-	++	++	--	-	+
Enclosure	-	0	0	+	0	+
Support facilities (benches, toilets)	0	++	+	+	+	+
Physical exercise	-	++	++	0	0	++
Stimulating walking	--	++	+	0	-	+
Stimulating cycling	-	+	++	-	-	++
Sports opportunities	0	++	++	0	0	++
Mental health	-	+	+	-	+	+
Relaxation	-	+	+	--	0	0
Social interaction	-	+	+	+	++	+
Connection with nature	-	+	++	-	-	++
Healthy environment	--	+	++	-	-	+
Little emissions	--	++	++	+	-	+
Biodiversity	--	++	++	-	-	+
Connected ecology	-	0	+	--	0	+
Identity	-	-	-	0	0	0
Local landmarks	0	0	0	+	+	+
Monuments	--	--	--	--	--	--
Social cohesion	-	+	0	0	++	+
Outdoor meeting opportunities	-	++	+	+	++	++
Indoor meeting opportunities	-	-	-	++	++	+
Sense of ownership of the street	--	++	0	--	++	+

Figure 127: Assessment table liveability

Accessibility	Current situation	From young to old	Active flow	Urban life	Shared roots	Final design
Facilities	0	+	0	++	+	+
Variety of facilities in sub-neighbourhoods	--	++	--	+	++	++
Variety of facilities in neighbourhood	+	0	+	++	0	0
Density	0	0	0	++	+	+
Density in neighbourhood	+	+	+	++	+	+
Density around facilities	0	0	0	++	++	++
Travel time and distance	0	+	++	-	0	+
Direct routes	0	-	++	--	0	+
Shortcuts	0	++	++	0	0	+
Priority on crossings	+	++	++	+	0	+
Travel comfort	+	+	+	0	0	+
High path quality	0	+	++	0	0	++
Continuity of routes	0	0	++	-	0	+
Shelter for rain, sun and wind	+	-	--	++	+	+
Flexibility	++	++	++	-	0	+
Mixed options	0	--	-	0	++	++
Variety of travel modes	0	--	-	0	++	++
Time restrictions	+	++	+	-	0	+
Restrictions in evenings	0	0	0	--	+	+
Restrictions in weekends	+	++	++	-	++	+
Restrictions in off-peak hours	+	++	++	-	++	+
Restrictions in peak-hours	-	++	+	-	--	+
Reliability	+	++	++	--	-	+
Age groups	+	++	+	+	+	+
Including childeren	-	++	++	-	0	+
Including youth	+	++	++	0	0	+
Including adults	++	++	++	++	++	++
Including elderly	+	++	-	+	+	+
Disabled	+	+	-	+	0	+
Wheelchair inclusive	+	+	-	++	0	+
Guidance for visually impaired	+	+	--	++	0	+
Wayfinding (easy to understand)	+	++	+	--	-	0
Income	-	++	++	0	0	++
Affordable trip price	-	++	++	-	-	+
Affordable fixed costs	-	++	+	+	+	++

Figure 128: Assessment table accessibility

Park in Hoge Vucht, Breda (Author's image, 2025)