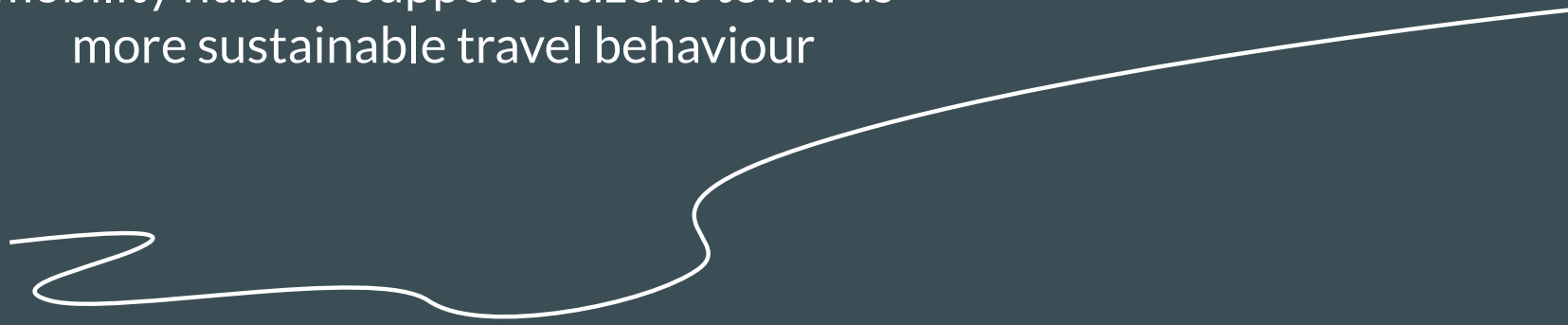
Master thesis, May 2022
Seamless Personal Mobility Lab

Gaby Ghusen

A roadmap for the implementation of mobility hubs to support citizens towards more sustainable travel behaviour



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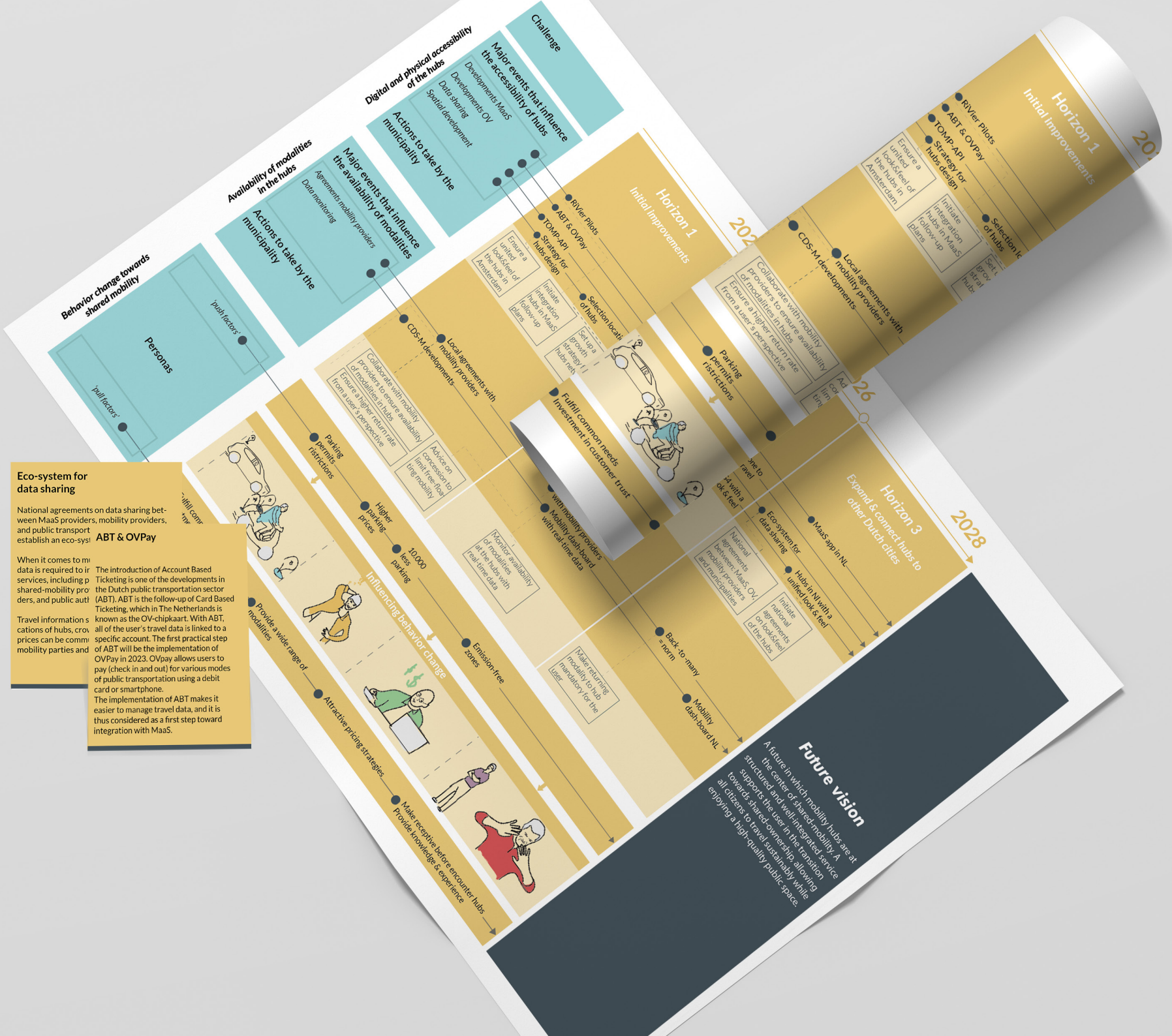
Challenge
Digital and physical accessibility of the hubs
Major events that influence the accessibility of hubs
Developments MaaS
Developments OV
Data sharing
Spatial development
Actions to take by the municipality
Availability of modalities in the hubs
Major events that influence the availability of modalities
Agreements mobility providers
Data monitoring
Actions to take by the municipality
Behavior change towards shared mobility
Personas
'push factors'
'pull factors'
Horizon 1
Initial improvements
RiVier Pilots
ABT & OVPay
TOMP-API
Strategy for hubs design
Selection locati
Ensure a united look&feel of the hubs in Amsterdam
Initiate integration hubs in MaaS follow-up plans
CDS-M developments
Local agreements with mobility providers
Collaborate with mobility providers to ensure availability of modalities in hubs
Ensure a higher return rate from a user's perspective
Parking permits restrictions
Fulfill common needs investment in customer trust
Horizon 3
Expand & connect hubs to other Dutch cities
Eco-system for data sharing
MaaS app in NL
Hubs in NL with a unified look & feel
National agreements between MaaS, OV, mobility providers and municipalities
Initiate national agreements on look&feel of the hubs
Monitor availability of modalities at the hubs with real time data
Mobility dash-board with real-time data
Higher parking prices
10.000 less parking
Emission-free zones
Back-to-many = norm
Mobility dash-board NL
Make returning modality to hub mandatory for the user
Influencing behavior change
Provide a wide range of modalities
Attractive pricing strategies
Make receptive before encounter hubs
Provide knowledge & experience
2028
Future vision
A future in which mobility hubs are at the center of shared-mobility. A structured and well-integrated service supports the user in the transition towards shared-ownership, allowing all citizens to travel sustainably while enjoying a high-quality public space.
Eco-system for data sharing
National agreements on data sharing between MaaS providers, mobility providers, and public transport
establish an eco-syst
When it comes to m
data is required to ir
services, including p
shared-mobility pro
ders, and public auth
Travel information s
cations of hubs, crov
prices can be comm
mobility parties and
ABT & OVPay
The introduction of Account Based Ticketing is one of the developments in the Dutch public transportation sector (ABT). ABT is the follow-up of Card Based Ticketing, which in The Netherlands is known as the OV-chipkaart. With ABT, all of the user's travel data is linked to a specific account. The first practical step of ABT will be the implementation of OVPay in 2023. OVpay allows users to pay (check in and out) for various modes of public transportation using a debit card or smartphone.
The implementation of ABT makes it easier to manage travel data, and it is thus considered as a first step toward integration with MaaS.

Executive summary

As more than half of the world's population now lives in cities, our cities are becoming increasingly crowded. This comes with an increase in mobility in these areas. The increased mobility causes an increase in air- and spatial pollution, which is primarily caused by private cars.
Multimodal travel, which includes public transportation and shared mobility, offers an alternative to private cars. This multimodal travel is supported by mobility hubs. They serve as physical locations that provide a variety of shared modalities, as well as a network of nodes connecting various mobility modes.

Buurthubs are a type of mobility hubs introduced in Amsterdam as part of the eHUBS European project. Buurthubs is a pilot project led by the Amsterdam municipality's Buurthubs team. As the end of this pilot approaches, the municipality wants to determine the next steps for implementing these hubs in the future.

During the discover phase of this thesis, Buurthubs and the challenges they face, as well as their broader context, were discovered. This was accomplished through literature research and a series of meetings with the Buurthubs team. A user research was conducted to understand the users' needs regarding the use of shared modalities.

Next, during the define phase, the three following challenges were chosen to narrow the scope of this thesis: the accessibility of the hubs, both physically and digitally, the availability of modalities in the hubs, and user behavior change toward shared mobility.

These challenges serve as the foundation for the roadmap, which is the thesis's design goal and end result. This roadmap was created and validated in collaboration with the Buurhubs team. The roadmap outlines a future vision as well as the various steps, actions, and developments required to achieve that vision.

The roadmap is delivered in an interactive format to increase its usability and readability for future municipal team members who will work on the hubs' implementation. In addition, a card set was created for a physical implementation of the interactive component.
The roadmap's goal is to aid in the future implementation of mobility hubs in order to achieve more sustainable travel.

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1. Introduction

1.1 Project background

Our cities are getting more crowded and that has an impact on the health and the quality of life of the citizens. To maintain these, it is crucial to promote sustainability and accessibility in transport within cities. In the face of this difficult and challenging task, electric mobility sources like e-Mobility hubs (eHUBS) might be the best future solution (Interreg, North-West Europe, 2019). eHUBS, are dedicated street locations where shared modalities are provided. These are sustainable and electric shared mobility means of which the user can choose from. The ultimate goal of these hubs is to dissuade the user from using/owning a private car, which should result in cleaner and more liveable cities.

The project eHUBS is a European project introduced in 2019 and there are 10 pilot cities from six different countries that are taking part in this project. Each of these cities has its own approach on the implementation of these hubs, according to the different needs of the representative city.

The city of Amsterdam is one of the six pilot cities taking part in this eHUBs project. Their own approach on this eHUBS project is named Buurthubs, this Buurthubs pilot will be the focus of this thesis and it is further to be referred to as 'the project'.

1.2 Project stakeholder: Amsterdam

This thesis is formulated with the Smart Mobility Team, which is part of the Chief Technology Office (CTO) of the municipality of Amsterdam. The Buurthubs team is part of the Smart Mobility Team, which is part of the Chief Technology Office (CTO) of the municipality of Amsterdam. The Buurthubs project is part of the 6-year Smart Mobility Programme introduced in 2019. With this programme, Amsterdam hopes to develop, together with its citizens, visitors, public and private parties, the new mobility system of the future. Their vision is a cleaner, more connected and less crowded city. This is why they are researching new alternatives for transportation that are in line with this vision. Buurthubs are one of these mobility alternatives, which will hopefully contribute to a more sustainable city. The kick-off of the Buurthubs project took place in 2019 and by 2022 the Buurthubs team was able to realize 14 Buurthubs in Amsterdam. A more elaborated description and analysis of Buurthubs will follow in chapter 2.3.3. As the Buurthubs project will be finalized in 2022, a new team within the Amsterdam municipality is being formed. In the near future, this team will work on mobility hubs and will continue the Buurthubs project. For this team, it is important to know what future steps are to take this project from a pilot to a successful network of mobility hubs in Amsterdam.

1.3 Thesis assignment

The assignment of this thesis is formulated together with the Buurthubs team as follows:

“To design scalable solutions for the Buurthubs in Amsterdam, that contribute to the mobility transition towards shared ownership.”

This assignment forms the starting point of this thesis. During the project, this assignment was adjusted and given a more specific direction in chapter 3.3.

As the pilot project of Buurthubs is nearly to its end, the team is interested in the next steps. The potential of these mobility hubs is being recognised and with the pilot of Buurthubs, many aspects have been tested. This means that a lot of lessons have been learned and these lessons are essential to scale up the hubs. There are also a lot of challenges that the team is facing with the current approach to set up the hubs. The focus of this thesis is to identify these challenges and translate these into future opportunities for a successful implementation of the hubs.

A more detailed description of this initial project brief is to be found in appendix 8.1 .

1.4 Project approach

The overall structure of the design process of this thesis is set up according to the Double Diamond approach (British Design Council, 2004). This approach was chosen due to the complexity of this project, as it gives the possibility to discover a project on a broad scale, while it also allows to converge and focus on certain elements of it. The focus of the first diamond is to find the right problem, while the focus of the second diamond is to solve the right problem.

Following this approach, this thesis is divided into four phases, which also forms the following 4 chapters of this thesis:

Chapter 2, Discover:
This phase is meant for thinking broadly and considering different angles of the project. In this phase mobility hubs in general and the broader context of multimodal travel are explored. Buurthubs, their role in multimodal travel and the challenges they face are also discovered. Additionally, user research was performed which resulted in defining user needs when it comes to the use of shared mobility.

Chapter 3, Define:
The knowledge gained during the discover phase was synthesized during this phase. Here, the project’s more specific focus is defined by selecting three major challenges to focus on that were identified during the discover phase. The design brief is created, and the design goal is set to design a roadmap for future implementation of Buurthubs.

Chapter 4, Develop:
In the develop phase, the future vision was defined as a starting point for the roadmap, followed by the different horizons of the roadmap. The final roadmap focuses on the 3 major challenges that are

defined in the define phase.

Chapter 5, Deliver:
The roadmap was converted into an interactive roadmap during this phase to make it self-explanatory. A card set is also introduced for a physical form of roadmap implementation.

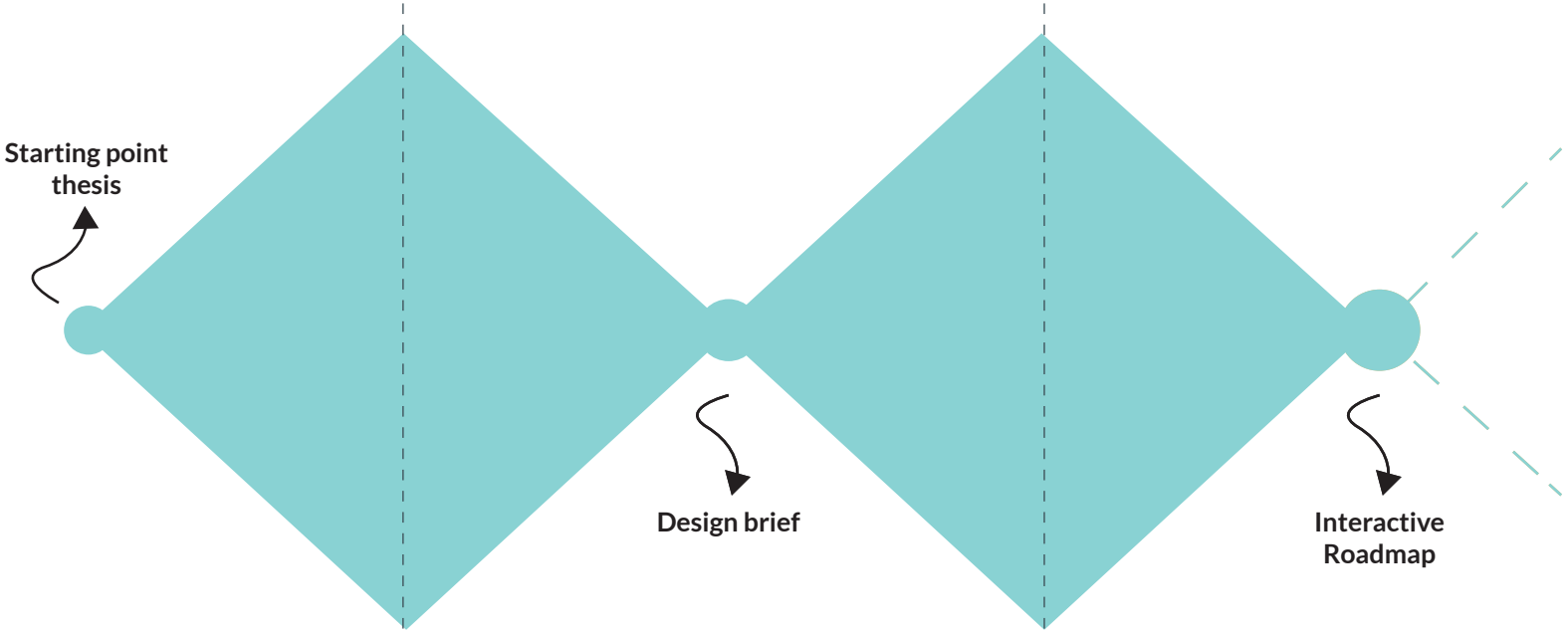


Figure1. Double Diamond approach of this thesis

2. Discover phase

This chapter starts with a look at mobility in Amsterdam. Then, as part of the multimodal travel, a desktop research on mobility hubs was conducted. More specifically, Buurthubs and their developments are discovered, as well as the challenges they face. User research was carried out in order to comprehend the user's role and define their needs.

2.1 Introduction discover phase

To be able to design for the future of Buurthubs, as mentioned in Chapter 1.3, it is necessary to understand how these hubs operate, what their added value is, what challenges exist, and how these can be transformed into future opportunities. Not only must the hubs be understood, but also their context factors must be discovered. Mobility hubs are not an end goal in themselves, but rather a means to achieve more sustainable travel. The next chapter will begin by exploring mobility in Amsterdam to learn about the various aspects of the hub's context.

2.2 Mobility in Amsterdam

2.2.1 Urbanization and private cars

Our cities are getting more crowded every year. More than 4 billion people, which is more than half of the world's population, now live in urban area's. This shift of population towards urban areas happened in the last few decades. With this transition we changed the way we live, work and travel (Ritchie & Roser 2018).
Amsterdam is one of these growing urban areas. With all the opportunities that this city offers, more and more people decide to move there. According to a recent demographic project of the province Noord Holland, more than 1 million people will live in the municipality of Amsterdam by 2040. The number of houses in the city will increase by 100.000 between 2019 and 2040. This growth is accompanied by an increase of mobility. The daily movements to, in and towards Amsterdam will increase by 20-39% between 2030 and 2015 (Mobiliteitsverkenning voor een groeiend Amsterdam, 2017). This growth in mobility comes with a cost. Emission and occupation of public space.

Emission

The increase in mobility results in an increase in CO2 emissions, nitrogen oxides, and particulate matter. As a result, the air quality suffers. At the moment, one of the most serious health risks in Amsterdam is poor air quality. Amsterdam's air pollution reduces the average citizen's lifespan by one year (Smart Mobility Programme, 2019)

Public space

Owning and driving a private car contributes not only to air pollution but also to spatial pollution. Even when they are not in use, the millions of cars we own take up a lot of space. In fact, according to the UN Habitat III (2016), private vehicles remain parked about 95% of the time.

The municipality of Amsterdam is trying to improve the public space through different approaches. These approaches are officially stated in Agenda Amsterdam Autoluw in the form of 27 measures that the city wants to take. The focus is put towards the private cars, because of their spatial impact. One of these measures is reducing car parking spaces in the cities. The ambition is 7.000 to 10.000 less parking spaces by 2025. The created free space is used for multiple sustainable purposes, such as greening the streets, more walking space and also reserving spots for shared mobility (Agenda Amsterdam autoluw, 2022).

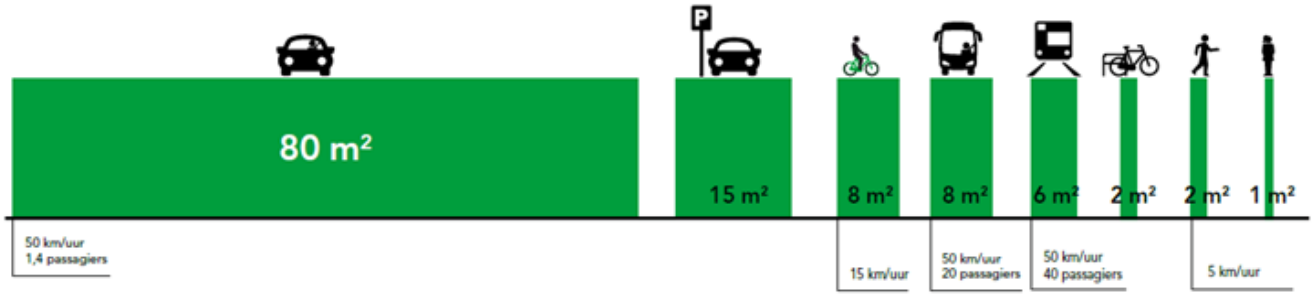


Figure2. (Occupied space per transportation mode)

Figure3. Ambition regarding car parking spots 2025, municipality of Amsterdam)

The increased mobility in cities, as well as its negative effects on our environment and public space, has prompted us to think about alternative modes of transportation. The policies governing private cars in the Netherlands' major cities have been changing in favor of more sustainable travel alternatives. This means fewer parking spaces and more stringent parking permit requirements (Mobiliteitsplan2040 Utrecht, 2021).

Figure4. Inspiration car free, Herengracht Amsterdam between 1867 and 2022)

2.2.2 Shared mobility

In the last decade, the concept of a sharing economy emerged as a new paradigm that enables access to goods and services beyond ownership. This can be seen in the rising popularity of short-term rental services of vehicles, housing and work spaces (Machado et al., 2018). In the mobility sector, lots of companies and start-ups launched their (e)cars on the streets, supported by technology to ease the use of these modalities. Examples of car sharing companies in The Netherlands are Greenwheels, ShareNow and Amber.

Another form of shared mobility are shared micro mobility services that include e-bikes, mopeds, and scooters. The 3 main operators of shared mopeds that we see a lot on the streets in The Netherlands are Fleyx, Go Sharing and Check. There are 8.000 shared mopeds to be found in The Netherlands (Mopedsharing, 2021).

This rapidly growing concept of shared mobility has promising environmental consequences, as it contributes to decreasing the amount of owned private cars per family (Machado et al., 2018).

Shared mobility has the potential to reduce the use of private cars and to complement the mobility services of public transportation (Gemeente Amsterdam, 2021). Multimodal travel, which combines various modes of transportation to get from one location to another, has the potential to compete with the flexibility and comfort of private cars (Miramontes et al., 2017). In the following chapter, multimodal travel and its different elements are discovered further.

Key insights 2.2

- The shift of urbanization towards urban areas results in a growth of mobility in these areas. The daily movements to, in and towards Amsterdam will increase by 20-39% between 2030 and 2015.

- Private cars contribute to air pollution due to their emission and to space pollution as they occupy a lot of free space on the streets.

- The municipality of Amsterdam is introducing measurements to reduce the use of private cars. One of these measures is to reduce the number of car parking spaces in the city. The ambition is 7.000 to 10.000 less parking spaces by 2025.

- Shared mobility could help reduce the number of privately used cars and therefore has promising environmental consequences.

2.3 Mobility hubs as part of multimodal travel

Within this section, research was done on mobility hubs using the following sub-questions:

- What is multimodal travel and what role do mobility hubs play in it?
- What is the vision on mobility hubs in Amsterdam
- What are Buurthubs? What are the developments and challenges concerning these hubs?
- What are the developments on mobility hubs in other cities participating in the eHUBS project?

2.3.1 Multimodal travel and mobility hubs

To understand the role of mobility hubs, it is necessary to understand the concept of multimodal travel. Multimodal travel refers to using different modes of transportation to get from point A to point B. This combines walking, cycling, making use of public transportation and shared modalities, such as shared bikes, mopeds and cars.

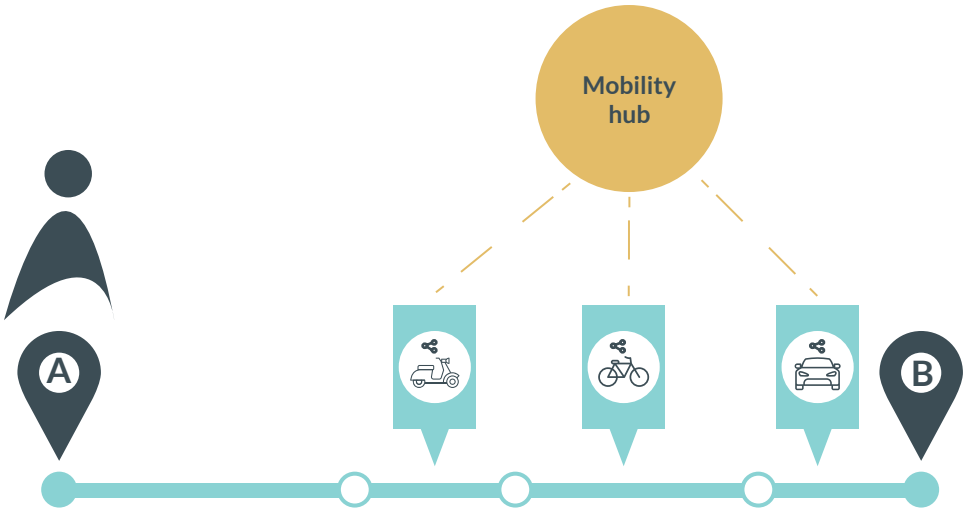


Figure5. (Illustration of a multimodal trip)

Mobility hubs are physical locations that offer a variety of shared modalities. Hubs ensure that users can use the modalities in a simple and convenient manner. The hubs have a variety of forms and goals, but the hubs in residential areas serve as a replenishment/ replacement for private cars (Goossens, 2021). A hub's size can range from an entire station area to a small hub with only a few modalities. In the Netherlands, the potential of these hubs is being recognized as in the last two years, more than 150 mobility hubs have been established.

Sustainable travel

Mobility hubs address the need for multimodality as a means of achieving sustainable mobility solutions (Rise, 2020). In practice, a network of mobility hubs is thought to create a smarter, more sustainable mobility lifestyle, potentially resulting in less car use (Liu, 2021). In comparison to private cars, the modalities provided in these hubs are low-emission shared modalities that ensure more sustainable travel. According to Ciari and Becker (2017) simulations, a combination of shared e-bikes and e-cars could replace the majority of short (<5 km) trips currently made by private car. Because users do not have to worry about the high purchase costs of electric cars, shared electric cars are expected to accelerate the process of replacing fossil-fuel-powered cars (Liao et al., 2017).

Public space

Mobility hubs are a way to structure shared modalities in the cities, as they provide an alternative for the free-floating concept of shared mobility (Smart Mobility Programme, 2019). Reducing space occupied by mobilities could also be achieved by the efficient space use of shared mobility hubs (Snel, 2020). Although it is difficult to estimate how many private cars can be replaced by one shared car, it is estimated that one shared car can replace four private cars (CROW-KpVV, Going Dutch, 2014). The extra space could be used for more walking or cycling space, green infrastructure, or other sustainable and eco - friendly purposes.

Social benefits
Aside from the mobility options that these hubs provide, mobility hubs can also provide social value to neighborhoods. Additional services provided in these hubs, such as shops, catering services, a children's playground, a package collection point, and so on, will help to improve the livability and social cohesion of neighborhoods (Koedood, 2019). These hubs have the potential to become the "hearts of the neighborhoods (Snel, 2020)
Increasing accessibility in the rural areas:

Connection with public transportation
Public transportation in rural areas is frequently limited in terms of accessibility, resulting in long waits and travel times. New travel routes that include transfers at multimodal mobility hubs may allow for better mobility connections, thereby strengthening public transportation (Frank et al., 2021).

2.3.2 Vision on mobility hubs in Amsterdam

The potential of mobility hubs is being recognized in Amsterdam. Aside from Buurthubs being a pilot project, an overall vision on mobility hubs (Hubsvisie Amsterdam) is introduced in 2021. The role of mobility hubs in urban development is discussed in this document and Buurthubs are a component of this future mobility vision.
"Hubs appear to be an important element in developing a pleasant and liveable city"- Egbert de Vries (Wethouder Verkeer en Vervoer, Water en Luchtkwaliteit)

According to the Hubsvisie, the ambition is to create a network of hubs with a variety of types and locations. There are 4 types of mobility hubs defined (Hubsvisie, 2021):
- **Buurthubs:** A Buurthub is a physical location where emission-free electric shared modalities are provided for the neighborhood.

- **Wijkhubs:** A Wijkhub is a location where multiple modes of transportation meet. Aside from providing shared modes of transportation, a Wijkhub also serves as a parking facility for private vehicles. Existing parking garages are examples of places where such a hub could be established.

- **Stadshubs:** A Stadshub is a public transportation hub where passengers can switch between national/regional and local public transportation. The primary goal of these hubs is to improve public transportation accessibility by providing other modes of transportation, including shared modalities.

- **Regiohubs:** A Regiohub is a location where people can switch from public transportation to private cars or shared modalities. It connects national and regional roads and is directly connected to the public transportation network. Regiohubs include existing P+R locations. Regiohubs are similar to Stadhubs, but their locations are carefully chosen further away from the city center.

The various types of hubs mentioned in this vision are still theoretical. It remains to be seen whether these hub scale levels will become a reality.
However, Buurthubs (part of the eHUBS project) have been set up on the streets of Amsterdam by the municipality's Buurthubs team, as mentioned in chapter 1.2. The scope of this thesis will be focused on Buurthubs, with the understanding that a larger network of hubs of varying size and location is required for multimodal travel to be an alternative to private cars.

2.3.3 Buurthubs in Amsterdam

Buurthubs are defined as follows (Hubsvisie, 2021):
A small hub located in a residential area with a maximum of 5 modalities, including e-bikes, mopeds, cargo bikes, and e-cars (max 2 cars). A charging station is installed at the hubs where e-cars are available. These hubs help to reduce the use of private cars by providing a diverse range of shared modalities. Cargo bikes, for example, can be used to help move large items, whereas mopeds and e-bikes provide first- and last-mile solutions for city tips.

Buurthubs are a component of the European eHUBS project. Each city involved in the eHUBS project has its own strategy for putting the hubs in place.

The term 'Buurthubs' refers to Amsterdam's approach.
Aside from the name, the team decided on a participation procedure for the hubs. Using this procedure, residents of the respective area are asked to vote for the location of the hub, the modalities provided in the hub, and the providers of the modalities.

Figure6. (First Buurthub in Amsterdam-West, 2021)

Figure7. (Buurthub Boelenlaan, between Zuid amd Rai)

Figure8. (Buurthub Watergraafsmeer)

Figure9. (Buurthub Boelenlaan, Zuidas)

Figure10. (Buurthub Parnassusweg)

Figure11. (Buurthub Sciencepark)

Buurthubs are primarily intended to replace private car parking spaces (figure 6-11). It is difficult to calculate how much parking space can be freed by one Buurthub. More specific studies are expected in the coming years, but the Buurthubs team predicts that clustering the modalities provided in the hub will result in a gain in free space.

In Amsterdam, there are now 14 Buurthubs established. Figure 12 shows the locations of these hubs. Commercial mobility providers such as Felyx, Cargoroo, and Amber now provide the modalities in these hubs. To be able to use the modalities, the user can use the app of the representative provider. Each of these providers have their own app, which the user can use to plan, book and pay for the trip.

Figure12. (Locations of Buurthubs, May, 2022)

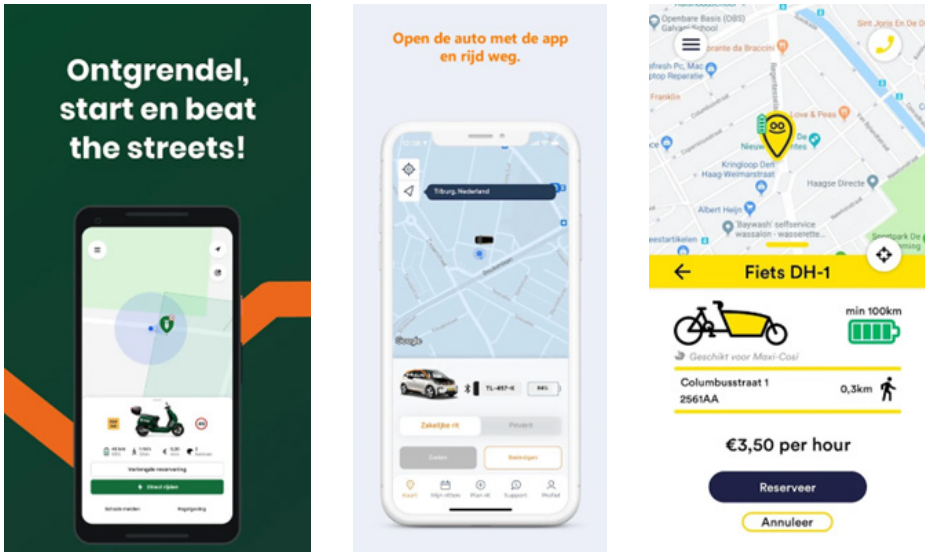


Figure13. (Examples apps of shared mobility providers, from left to right: Felyx, Amber, Cargoroo)

Challenges of Buurthubs

To be able to design for the future of Buurthubs, it is critical to understand the challenges that are out there and try to translate these into opportunities. The following overview consists of challenges that are either identified by the Buurthub team and are discovered during a series of meetings held within the municipality.

Participatory procedure of Buurthubs
Buurthubs are now set up in cooperation with the neighborhoods. Which makes these hubs modular, as they are modified according to the needs of the neighborhood. Yet, according to the team this participatory procedure makes the implementation of hubs highly expensive and thus difficult to scale up. It is an assumption taken by the Buurthub team that when the citizens participate in this procedure, their involvement with Buurthubs will increase. This should at the end lead to increase of use of these hubs. Aside from the high

costs, there are numerous complications associated with this setup. For example, if the neighborhood votes for a mobility provider and the partnership with that provider fails, another provider must be selected. Voters may become dissatisfied as a result of this. Another issue that the team also mentioned was that the number of people who voted/participated was relatively low. According to the team, this approach will not be used by the next team, primarily due to the high costs associated with it. As a result, it was suggested that this approach not be investigated further during this thesis.

User adoption to Buurthubs

The goal of the Buurthubs is to facilitate shared mobility for the user to finally reduce the use of private cars. Yet, the comfort, flexibility and the availability of the private car makes it hard for the user to consider other mobility options. Also, the user's association with cars as a place for me-time, makes them hard to replace. To make considering shared modalities even possible, the user must be offered a worthy alternative. As explained in chapter 3.2, although people are getting more familiar with the concept of shared mobility, a real behavior change is hard to achieve. A survey carried out by Psychology for Sustainable Cities shows that 70% of car owners in Amsterdam (n=554) see no need for trying out shared modes as they already have a vehicle. This leads to low user adoption to Buurthubs.

Agreements with mobility providers

Commercial companies provide the modalities in Buurthubs. Most of these businesses operate on a free-floating model, which means that modalities can be parked 'anywhere.' The free-floating concept is the most convenient for users because they have almost complete control over where they pick up and park their rides. For the providers this is an easy way to launch their services as there is no physical infrastructure needed across the city.

There are 3 main challenges with mobility providers:

- The availability of the modalities in Buurthubs: The fact that the user is not required to return the modality to the hub after use, results in a (partially) empty hub. For now, the Buurthubs team has made 'soft arrangements' with these mobility providers to return the modalities to Buurthubs. There are nog official agreements made to ensure constant availability.
- The digital accessibility of modalities: To be able to make use of the modalities provided in Buurthubs, the user needs to make use of the app of the provider. In the case of multi-modal travel, the user needs to make use of different modes and therefore they now need to use multiple apps.
- Another issue is the physical accessibility of modalities in the suburb. The city of Amsterdam is most densely populated in its center, which makes it the most interesting for mobility providers, as their modalities there are most commonly used. This contradicts the concept of Buurthubs of inclusivity and accessibility, which should be especially applicable in the suburbs where public transportation is often insufficiently connected.

The missing network of Buurthubs

In Amsterdam, only 14 Buurthubs have been realized. In essence, the concept of mobility hubs only works when there are enough hubs to form a network that covers the entire city. As previously stated, there are now 14 Buurthubs in operation, which is of course insufficient to cover all neighborhoods. This makes optimal operation of the hubs nearly impossible.
The Buurthubs team indicates a 5 minutes walk as the maximum distance users are prepared to walk before reaching the hubs. Only when a network of these hubs is created, will the physical accessibility be realized.

The financial side of Buurthubs

When it comes to shared mobility, users, particularly private car users, frequently make insufficient or incorrect financial comparisons. According to research, these users may be less sensitive to the

long-term costs of vehicle ownership than to the operating costs of a car sharing subscription (KiM, 2018). There are costs that users are unaware of, such as car insurance, road tax, and maintenance. When comparing prices, many users usually only consider petrol costs against the costs of shared rides.

Look & Feel of Buurthubs

Buurthubs as they are set up currently still lack unity. This is mainly caused by the regulations that limit the team on what they can set up in public spaces. The lack of adequate 'look and feel' elements in the hubs, makes them unrecognizable, which is especially necessary in a phase where the use of these hubs need to be promoted. However, there are serious initiatives from the municipality to create a united identity for the hubs. One of these initiatives is the agreement of the G4 (Grote 4 steden, refers to the 4 big cities in NL: Amsterdam, Rotterdam, The Hague and Utrecht) to create a unified identity for the hubs in these 4 cities. The assignment is being executed by Mijksenaar in 2022.

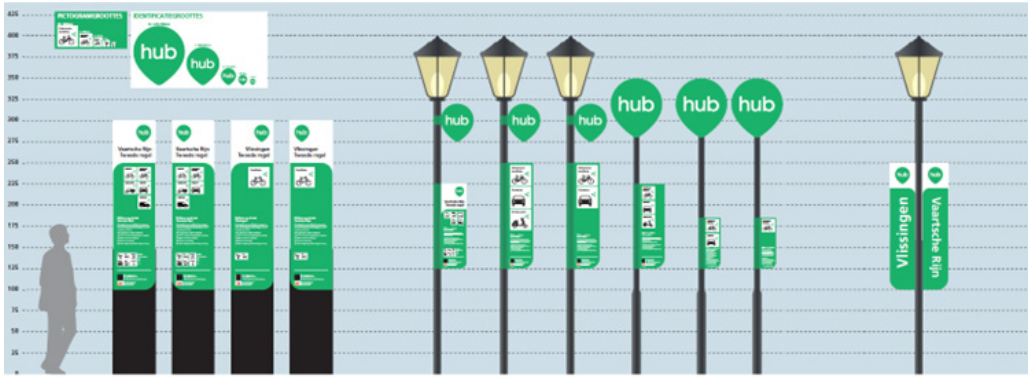


Figure14. (Identiteit Hubs, Mijksenaar, Introduced identity design of the hubs)

Different pilots will be executed to test this concept in different locations. Such plans show a good sign of willingness of municipalities for cooperation regarding mobility hubs.

Charging of electric vehicles at Buurthubs

Regarding charging there are 2 main challenges to discuss. At each Buurthub, there is a charging point for shared e-cars. The parking spot at the hub is dedicated exclusively to the shared vehicle. This means that only this vehicle can make use of the charging point, which is financially unattractive to the charging points provider (in this case; Total Energy). The second challenge here is that these charging points are seen as objects that clutter the public spaces.

2.3.4 Mobility hubs in other cities

To be able to understand and compare the progress of other cities participating at the eHUBS project, more cities are explored:

Nijmegen Arnhem
Nijmegen and Arnhem are the other two cities in the Netherlands taking part in the eHUBS project, in addition to Amsterdam. As stated before, each of these cities has its own strategy and approach on mobility hubs. The mobility hubs in Nijmegen and Arnhem are defined as ehubs. For these hubs, both cities use the same branding. The hubs all have the same name, logo, and color scheme. Furthermore, the websites for both cities are identical.
The mobility providers are comparable to those in Amsterdam. By 2022, there are 11 eHUBS operational in Nijmegen and 3 eHUBS in Arnhem (ehubnijmegen, ehubarnhem, 2022).
Whereas Amsterdam takes a more subtle approach to materialization and signage, Nijmegen and Arnhem take a more visible approach. On the one hand, Amsterdam's decision is based on public authorities' restrictions on what can be set up on the streets. On the other hand, they consider the cluttering of public space. When the number of these hubs grows, too many eye-catching elements of the hub will crowd the public space.

Figure15. (eHUBS in Nijmegen and Arnhem with similar identity)

Leuven
Leuven in Belgium is another city that is joining the eHUBS project. At first, they called a hub Mobipunt. However, these hubs are now called Hoppinpunten. The name Hoppin is the official name that relates to the national policy introduced by the government in Belgium. This new mobility brand combines various travel modes, with public transportation included. The same name and corporate identity is given to these different mobility modes, to make them well recognisable by the user.

The MobX, which is the information column located at the hub, is an interesting component of Hoppin hub. The interactive screen provides the user with real-time information on bus and train travel times. It also enables the user to make use of various mobility apps of mobi-

lity providers, in order to use their modalities offered in the hub. To combine these services, an app and a website are being developed, where users can plan and pay for their trip (Hoppin, 2022).

Figure16. (The MobX of a Hoppin hub)

Key insights 2.3

- Multimodal travel refers to using different modes of transportation to get from point A to point B. This combines walking, cycling, making use of public transportation and shared modalities, such as shared bikes, mopeds and cars.

- Mobility hubs provide a variety of shared modalities with the goal to replace the use of private cars. They play an important role in multi-modal travel, as they act as nodes between different mobility modes.

- Amsterdam aims to set up a network of hubs of various types and locations. This vision includes four types of mobility hubs: Buurthubs, Wijkhubs, Stadhubs, and Regiohubs. Parallel to this vision, Buurthubs are the Amsterdam approach to the eHUBS European project.

- Buurthubs are small mobility hubs located in residential areas in Amsterdam. Where modalities are offered for the neighborhood. Modalities included in these hubs are e-bikes, scooters, cargo bikes, and e-cars (max 2 cars). These modalities are provided by commercial mobility providers such as Amber, Felyx and Cargoroo.

- Buurthubs' challenges are identified through a series of meetings with the Buurthubs team and are listed in this chapter.

- Other cities taking part in the eHUBS project have different approaches on their hubs. In Nijmegen and Arnhem, the hubs are called ehub and they have identical branding in both cities.

- In Leuven, Belgium, the government is taking a more central approach by introducing a national mobility policy called Hoppin.

2.4 Broader context of multimodal travel

To be able to design for mobility hubs, a deeper understanding of their context is required and therefore a literature review was conducted. To complete the ecosystem of multimodal travel, the different components that it consists of and are within the scope of this thesis, are defined. This includes the user that needs to travel from point A to point B, modes of transportation to travel with and digital services that allow for this travel. During the discover phase, it became clear that MaaS is unmissable when it comes to multimodal travel. Therefore, the concept of MaaS and its (future) developments are discovered in the following section, through desktop research and an expert interview.

2.4.1 MaaS and data sharing

Mobility as a Service (MaaS) is a new mobility concept that combines existing and new mobility services into a single digital platform, allowing for customized door-to-door travel as well as personalized trip planning and payment options (KiM, 2018). MaaS enables various (commercial) mobility providers to offer their services on a MaaS plattform, which brings all of the different parties together. By providing digital solutions to integrate these different parties, MaaS facilitates the multimodal trips for the user.

Next to Buurthubs, MaaS is one of the projects of the Amsterdam municipality's Smart Mobility Programme. In the Netherlands there are 8 MaaS-apps developed/ in development, which are part of 7 national pilots initiated by the Ministry of Infrastructure (Ministerie van Infrastructuur (IenW), 2019).

The MaaS pilot in Zuidas, Amsterdam is called Amaze.

The Amaze app is a live example of how MaaS could be implemented in practice. On this app, various modalities can be viewed and booked. It provides an overview of the available modes at a given location, as well as how much they cost and how long the trip would take.

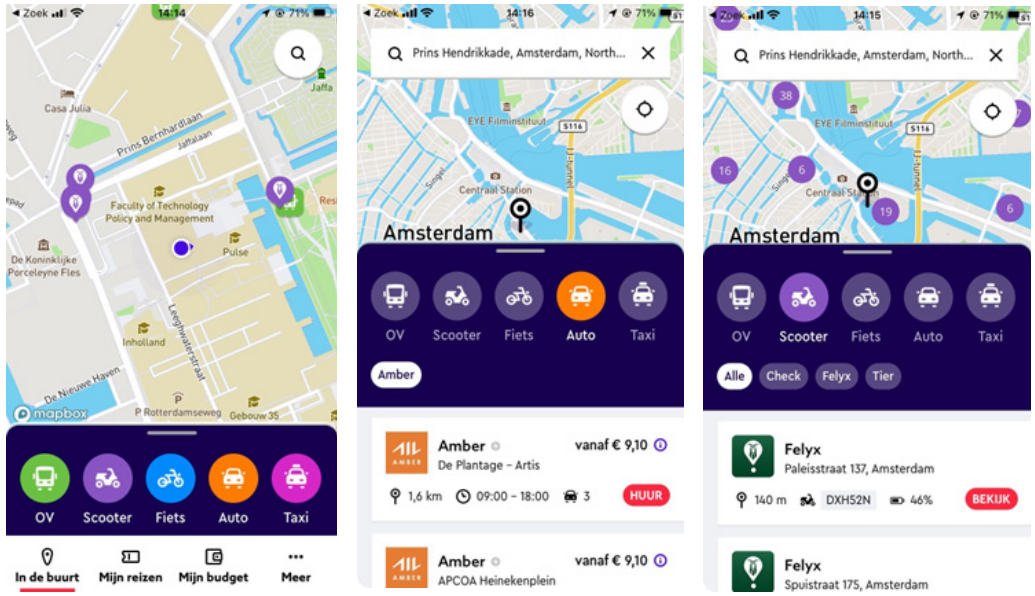


Figure17. (Interface of the Amaze application)

Buurthubs are now places that physically bundle shared modalities. However, digital integration of these modalities is missing. When different mobility services are integrated into a MaaS app, it is expected that using shared mobility will become more convenient. MaaS providers can inform users about various travel options and prices to get from point A to point B using real-time data. To have a deeper understanding of the developments of MaaS, the following expert interview is conducted.

MaaS Expert interview

Throughout the project it became clear that MaaS is a crucial element when it comes to the future of mobility hubs and the use of shared mobility. To have more in depth insights on MaaS developments now and in the future, an expert is interviewed. The three themes discussed during this interview are: future plans of MaaS pilots in Amsterdam, expert's expectation of future MaaS developments and the integration of public transportation (OV) in MaaS.

According to the expert, there are still no official plans developed for MaaS pilots in Amsterdam. The running 7 pilots in NL are expected to be wrapped up in 2022. The expert's opinion is that a less fragmented approach on MaaS is needed for further development: "The 7 MaaS pilots provided us with a lot of knowledge and lessons, but they also exposed the fact that a regional/fragmented approach on MaaS does not help". According to him, a national or at least regional approach is needed. For such an approach, the Rivier model is a promising development. This model is an initiative from the 3 big OV-parties: NS, HTM, RET to create a national approach on MaaS called Rivier. Initially, GVB was also a partner in this project, but later they stepped back. Rivier will act as the central point that all MaaS apps and the different mobility providers can connect to (Rivier, 2021). Such a centralized approach will provide overview and convenience for the user. The expert's concern about this model is that there will still be multiple MaaS providers connected to Rivier: "My concern is still about the different MaaS apps that are connected to Rivier, which the user will be faced with ''.
Another outcome could be a governmental national approach on MaaS, which could erase the hassle of having multiple MaaS providers. However, the expert is less optimistic about this approach, as The Netherlands trusts its market and does not want to take a position in it. "To be honest, this is a less plausible scenario".

The integration of OV in MaaS differs a lot from the integration of other mobility providers. According to the expert, when it comes to OV, the governance in The Netherlands is hard to deal with. There are MaaS worthy concessions formulated for OV-parties about the commercialized products they offer, which is leading to a slow progression towards MaaS-integration. However, pricing is still a big hassle when it comes to this integration.

Data sharing:

According to Eric Mink, Programme manager MaaS at IenW, the data generated from MaaS apps can be effectively used to stimulate the travel behavior of users.
This data can lead to new policy agreements regarding the liveability and the sustainability of our cities. Therefore, cooperation is needed between MaaS providers, mobility providers and governments. "Hereby it is important to have standardization, coordination and game rules."
There are 2 important standardizations of data sharing within the mobility system currently ongoing:

TOMP-API
It is critical to have a common ground for digital integration between MaaS providers and mobility providers. TOMP-API(Transport Operator to Mobility Provider-Application Programming Interface), a standardized technical interface, on European level, has been developed to accomplish this cooperation. The rules for what data must be shared between MaaS providers and mobility providers are defined in this interface. This information could be about the availability of a particular modality at a given time, for example.
In Amsterdam, all mobility providers working together with the municipality to provide their modalities in Buurthubs, must agree to the TOMP-API.

CDS-M
City Data Standard Mobility (CDS-M) is being developed to create a uniform standard for exchanging data on mobility between mobility

providers and public authorities. CDS-M provides a better understanding of the use of shared mobility and the possible effects on public spaces. With the gathered data from mobility providers, the municipality can monitor and manage public spaces.
The long term aim is to work towards a single European data standard for mobility. For now, a prototype has been developed, which still needs to be applied, tested and developed before it becomes a national standard (Gemeente Amsterdam, 2021).

2.4.1 Public transportation

Public transportation (OV) is an important component of multimodal travel. After walking and cycling, the most sustainable mode of transportation in the Netherlands is OV, which includes trains, buses, trams, and metros (Waterstaat, 2021). From 2017 all trains in The Netherlands run on green energy and from 2025 onwards, all buses will ride on renewable energy. (Waterstaat, 2021). Although public transportation will not be further investigated in this thesis to limit the complexity of the project, light will be shed towards the integration between MaaS and OV as a part of the multimodal trip.

One of the developments in OV that can be directly linked to this integration is the introduction of Account Based Ticketing (ABT). ABT is the follower of Card Based Ticketing, which in The Netherlands is known as the OV-chipkaart. With ABT, all travel information is transferred from the traditional OV-chipkaart to the back-office (Cooperatieovbedrijven, n.d). This allows the user to have access to their travel data at all times. The implementation of OVPay in 2023 in the public transportation sector in The Netherlands is the first practical step of ABT (OVpay, 2022). With OVpay the user will be able to pay (check in and out) for various public transport modes using the debit card or smartphone.

By linking all the data from the user to one account, it would be much easier to manage a multimodal trip. ABT opens new doors for the users, but also voor MaaS providers, as it is seen as the first step towards an integration with MaaS apps.

2.4.3 User and behavior change

As concluded in chapter 2.2, the increased mobility in urban areas is causing municipalities to develop policies that will allow for changes towards a more sustainable mobility system. Because of the massive spatial and air pollution that private cars cause, they have become the focal point of this change. Shared mobility seems a promising, though partial, solution as emission-free driving leads to cleaner air in the city, car sharers own cars less often and drive fewer kilometers, and shared mobility leads to fewer cars on the street (Gent et al., 2019). Research shows that people who live in urban areas, who are young and highly educated, are more likely to participate in car sharing (KiM, 2015). The group of users that can be seen as early adaptors are 'flexible car-lovers' who do rely on the convenience of private cars, but are still open to other mobility options (Bösehans et al., 2021). Yet, because shared mobility is relatively a new concept and the user is not used to it, the area of behavior change is essential to understand.

Behavior change

Research shows that when it comes to travel behavior, we tend to keep it unchanged. This behavioral state is called inertia and it is characterized by certain thresholds that need to be crossed before changing routine behavior (Bovy and Stern, 1990). Travelers often prefer the 'status quo' in their travel behavior (Ho et al., 2017). In our societies, the car has become dominant, as it provides clear advantages over other transport options in comfort, flexibility and availability (Martinez et al., 2017) .

Windows of opportunity and push-factors

Even though we tend to keep our travel behavior unchanged, recent studies have shown that we are more open to change our travel patterns when big events occur in our life. These events are called 'windows of opportunity', they are key events that trigger changes in travel behavior (Schäfer et al., 2012). Examples of these events are to move to another city or to start a new job. According to Chatterjee et al, (2013), the conceptual model for changing travel behavior looks as follows:

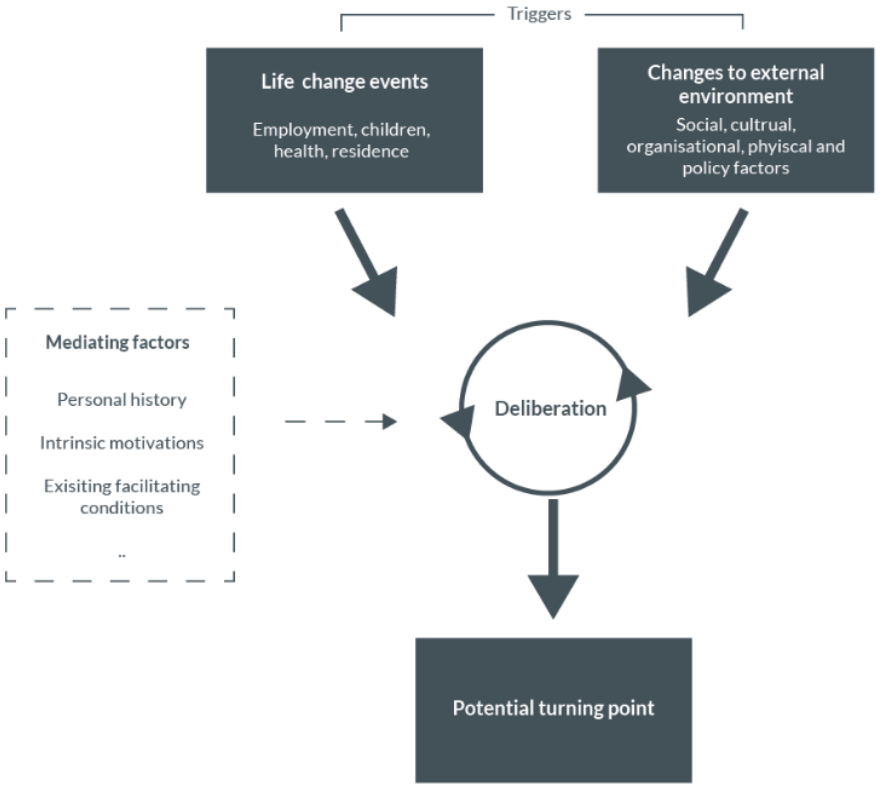


Figure19. (The conceptual model for changing travel behavior by Chatterjee et al., 2013)

The model explains that a life change event or a change to the external environment of a person can be seen as triggers that lead to a potential turning point. Along the way, there are also mediating factors that could help reach this turning point.

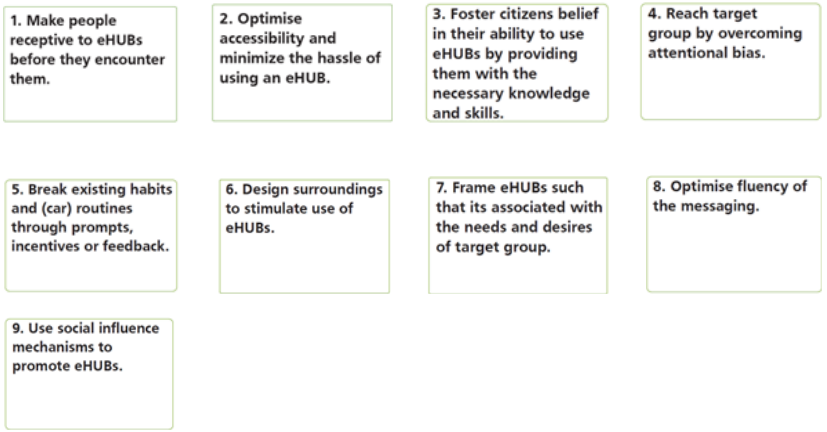
As a result of what has been explained above, it may be difficult to persuade users, particularly car owners, to change their travel habits. In the case of shared mobility, it is a fundamental change in their travel pattern

However, the conceptual model for turning points in travel behavior makes it possible for us to intervene. These life change events or the changes in the external environment could be used as triggers to change a user's travel pattern.
Getting a new job or moving to another city are examples of events where the user may re-evaluate his/her travel routine. But, these triggers on their own may still be not enough to achieve the turning point. A qualitative study from the University of Utrecht (de Graaf, 2019) shows that the chosen mobility option for home-work travel stays unchanged after moving.

The mediating factors illustrated in figure 19 could be crucial in convincing the user to change their travel pattern. Government policies, such as limiting parking spaces/permits for car owners, could be used as push-factors to reduce the use of private cars. When a car owner relocates to a new city, the car is the first mode of transportation considered. However, if this user is unable to obtain a parking permit at this new location, or if the parking prices are prohibitively expensive, he or she will reconsider the chosen option and compare it to others.

Behaviour change towards Buurthubs

A more specific study on behavior change regarding the use of Buurthubs is the study conducted by the research group Psychology For Sustainable Cities, (2020). The study shows how applying psychological concepts could assist the uptake of eHUBS. There are 10 psychological concepts presented to increase the chances of success of the Buurthubs.



However, the study also mentions that these steps could only guarantee small success. For a real behavior change, the persuasion is more complex. The ultimate goal of mobility hubs is to reduce the usage and possession of private cars, which is where the complexity is. Next to the fact that the convenience of private cars is one of the hardest challenges for mobility hubs, the psychology behind possessing a private car plays a huge role. An important element of having a private car is its association with me-time. For a lot of users it is hard to replace the car, because they regard it as a place for me-time and a place to zone out (Kent, 2015).

Setting course for further user research:

It is clear that user involvement in using shared mobility is a big hassle for mobility hubs. The use of private cars is one of the main reasons why people would not consider other mobility options. However, as mentioned before, the use of shared mobility is still getting more and more popular. The concept of mobility hubs is quite new and Buurthubs have only been a pilot project. This is why the focus of further user research will be put towards the users of shared mobility in general. As more in-depth knowledge is needed about this target group, user research will be conducted in next sections to identify specific user needs.

Key insights 2.4:

- Mobility as a Service (MaaS) combines various mobility services into 1 app. This allows for customized door-to-door travel as well as personalized trip planning and payment options.

- There are 7 national MaaS pilots initiated by the Ministry of Infrastructure (Ministerie van Infrastructuur in NL. The Amaze app is the pilot of Amsterdam, which allows users to view and book available modes of transportation at a specific location and time.

- To be able to share data with different parties within the mobility system, including MaaS providers, mobility providers and the government, more data standardization is needed. These standradizations are emerging with examples such as TOMP-API and CDS-M.

- Rivier is one of the developments concerning MaaS, which refers to a national approach led by the 3 big OV parties in the Netherlands (NS,HTM,RET). The aim is to create a centralized point that all MaaS apps and the different mobility providers can connect to

- From a user perspective, behavior change is hard to achieve when it comes to the use of shared mobility compared to private cars. However, there are triggers that, when combined with push- and pull factors, can persuade the user to change their travel patterns.

2.5 User research

As discussed in chapter 2.4.3, behavior change is a bottleneck for mobility hubs because it prevents people, particularly car users, from changing their travel habits. However, the concept of shared mobility is becoming more popular, which means that many people are already using it. It is critical to understand what these people consider essential for using shared mobility. When their requirements are discovered and understood, these could then be used to persuade non-users to make use of shared mobility. Of course, this should be done from the perspective of mobility hubs.

2.5.1 Survey for initial insights

To get a general impression on how people look at shared mobility, whether they use it or not and for what purposes, a survey was sent out to a group of people using Instagram stories (24 hour). This group of participants consisted mostly of young people (students - starters) and the survey resulted in 36 respondents.
The questions were asked as follows:
Have you ever/do you make use of shared modalities (an overview of what these modalities are was included)?
For what purposes do you make use of it?
If you have used it once, would you use it again? If not, why haven't you?

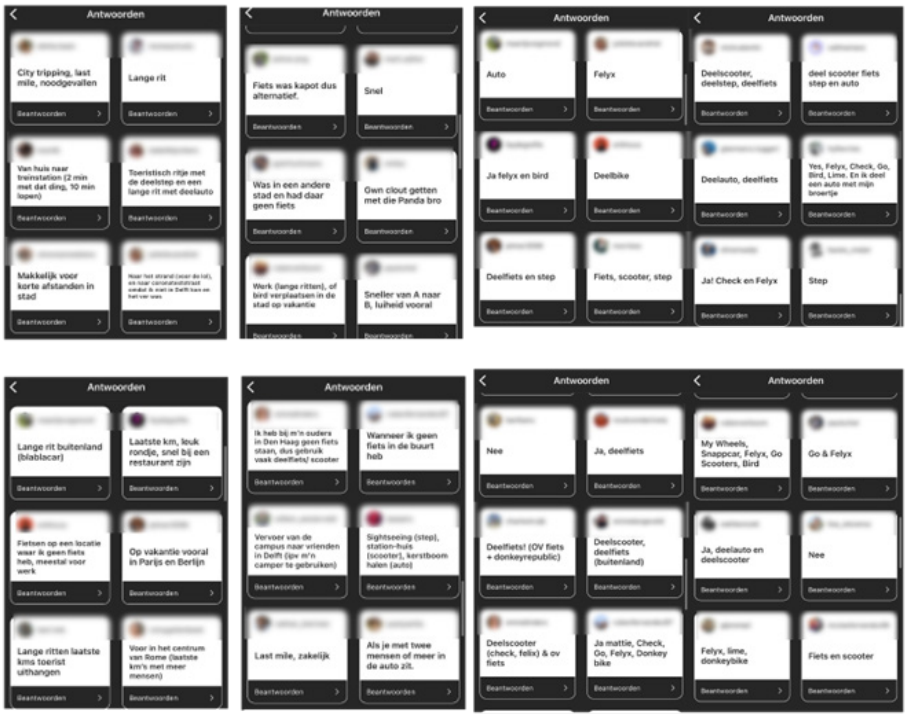


Figure20. (Impression of the conducted survey)

Initial insights on the use of shared mobility

- Shared mopeds were used the most, compared to shared cars, steps and bikes.

- Main reasons to make use of shared modalities are:
To quickly get from A to B: The main reason given for the use of shared scooters is to save time and quickly get from one place to another. "To get quickly to a restaurant appointment"

For fun: A remarkable outcome is that many people made use of shared modalities for the fun of it. The use of shared steps, mainly while on vacation, could clarify the association with the fun aspect, as these

are not allowed in The Netherlands.

Last mile: Shared modalities are used for last-mile trips. “ When I go to my parents, it
is like 2 minutes with the Felyx, instead of 10 minutes walking”

- Another interesting finding is the disparity in opinions about the cost of shared mobility. This could be clarified by the comparisons they make between various modes of transportation. Using a shared scooter, for example, can be quite expensive when compared to walking or cycling.

This survey’s findings are used as a jumping-off point for the next phase of research. Interviews are conducted in the following chapter to gain a better understanding of the users and gain a more in-depth understanding of their needs when it comes to shared mobility.

2.5.2 Interviews with users of shared mobility

Interviews with users of shared mobility were conducted in order to define the various (potential) users of Buurthubs and better understand their needs. Because of COVID restrictions and the low number of Buurthubs (and Buurthub users), the interviews were conducted with users who use shared mobility in general. The participants were recruited either through the municipality, as follow- up interviews of the conducted Instagram survey or through personal connections. For a broad perspective, both car owners and non-owners were interviewed, as well as people living in The Netherlands and abroad. 7 participants were interviewed in total.

Interviewees:

Participant	Gender	Age	Currently living in (City)
P1	Female	21-25	Rotterdam, NL
P2	Male	21-25	Gothenburg, Sweden
P3	Male	21-25	Delft, NL
P4	Male	25-30	Amsterdam, NL
P5	Female	25-30	Amsterdam,NL
P6	Male	21-25	Delft, NL
P7	Male	30-35	Amsterdam, NL

Figure21. Table with information of interview participants

The interviews are semi-structured and focused on the users' experiences and needs when using shared modalities. The goal of the interviews is to gain insights into the needs of the users so that they can be mapped and used to create need-based personas. Because of the broadness of the subject, the semi-structured method was chosen, as it allows for an emphasis on (and gives the freedom to ask further questions about) what the interviewee says. At the same time, it provides the necessary structure for comparing insights from various interviews.

Interviewees were asked about their experiences with shared mobility, how frequently they use it and for what purposes. During the interviews users were gradually asked to prioritize the needs they mentioned. To document the findings, quotes from the interviews are translated and used to express the user's needs.

Insights from interviews:

Frequency:
Most of the interviewees (5 out of 7) made use of shared mobility at least once in two weeks. Even users who had a private car, still made use of shared scooters/bikes on a regular basis. "I do have a car, but I still use shared scooters every week" -P1 (female, 20-25, NL)

Convenience on the go:
There is some planning needed when users make use of public transportation. Especially when headed towards a new destination. Shared mopeds are in this case used to skip the planning part. 5 out of 7 interviewees mentioned using mopeds for their convenience and to save time while traveling.

"For me it is like convenience on the go and you don't lose time doing it. I do not want to figure out how to get there using public transportation." -P1

Fun element
Mopeds are mostly used to get quickly from A to B. Yet, the fun element of shared modes is mentioned as an additional reason to make use of it. "I use shared cars for short trips in Amsterdam, sometimes it is just for fun." -P7 (male, 30-35, NL)

Ov-fiets:
The Ov-fiets is mentioned repeatedly during the interviews (5 out of 7 interviewees). Reasons why they choose the Ov-fiets are that it is always available and that it provides freedom regarding rental-period and parking spots.
"OV-fiets is cheap. They are always available and you can bring them in late at night." -p5 (Female, 25-30, NL)

Transport:
It is mentioned by different users (3 out of 7) that they make use of shared scooters when they need to carry heavy bags. It is seen as more convenient compared to cycling or walking. "I use it when my bike is broken or when I need to carry heavy luggage" P4 (Male, 21-25, NL).

User needs

Besides the insights from the interviews listed above, an overview of the user's needs is created.

Needs	Times mentioned
Accessibility of modalities	6
Availability of the modalities	4
Quality modality	3
Hygiene	3
Parking possibility	2
Financial advantage	2
Sustainability	1

Figure22. (Overview of user needs indentified during interviews)

Accessibility was mentioned by most interviewees as their number 1 priority when it comes to shared mobility. Many of them indicate a 5 min walk as the maximum distance they are prepared to walk to get to a modality. The availability of modality was brought up as an important requirement for the use of shared mobility. The quality of the modality and its hygiene were also essential to the users, as they were mentioned by almost half of the interviewees (3 out of 7).

2.5.3 Validation of user's needs

To validate the needs of the users gathered from the interviews more quantitative data is needed. Therefore a small workshop is held during the Master Research Day (MRD), at the faculty of Industrial Design Engineering. 32 students participated in the workshop.

Participant were asked to write down their main requirements, when it comes to the use of shared mobility

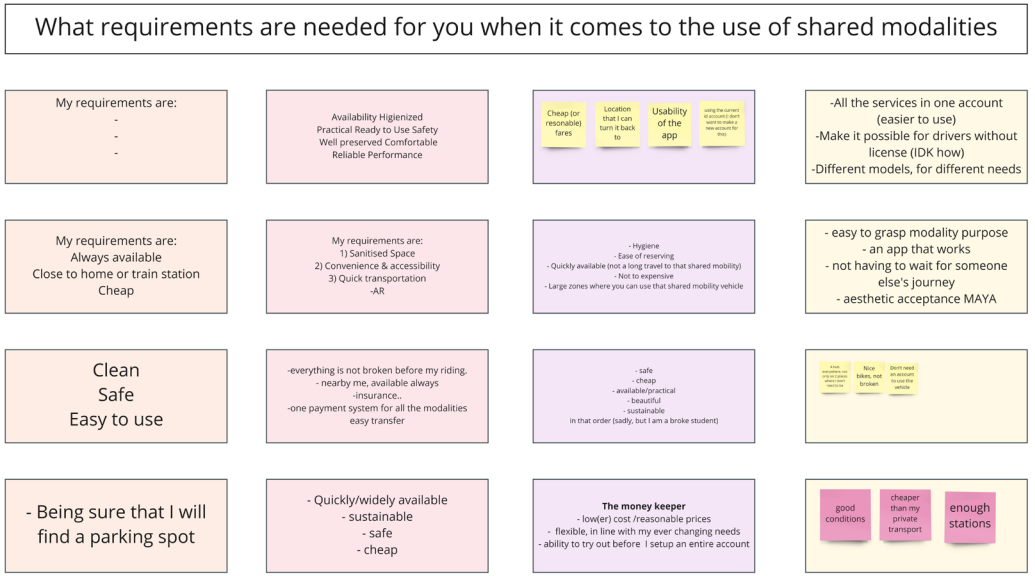


Figure23. (Impression some results of MRD)

The needs gathered from this session are list in the following table:

Needs of participants (n=32)	Times mentioned
Physical accessibility of modalities	17
Digital accessibility of modalities	13
Availability of the modalities	11
Financial advantage	8
Quality modality	7
Hygiene	7
Parking possibility	5
Safety	4
Sustainability	2
Variety of modalities	2
Aesthetic of modality	1

Figure24. (Overview of user needs identified during MRD)

To avoid confusion, the accessibility was now divided into physical and digital accessibility. These two are mentioned the most by participants, along with the availability of modalities. The financial advantage was also frequently mentioned. This could be explained by the participants' relatively low budgets, as they were all students.

These needs will be the common thread through the coming phases of the thesis. In the following section, different personas are created with the insights gathered during the user research phase.

2.5.4 Need-based personas:

There is a limited amount of existing literature conducted on specifically users of mobility hubs, as these hubs are still relatively new. With the gathered insights from the discover phase, including literature studies, the conducted survey and interviews, an overview of (potential) users of shared mobility is created in the form of personas.

As a result, 6 need-based personas were identified following the method of Koos Service Design (Koos Service Design, n.d.). These personas are created based on their shared needs. Demographics such as age, gender, and occupation are not taken into account. To validate the results, the personas were tested with the students during the Master Research Day.

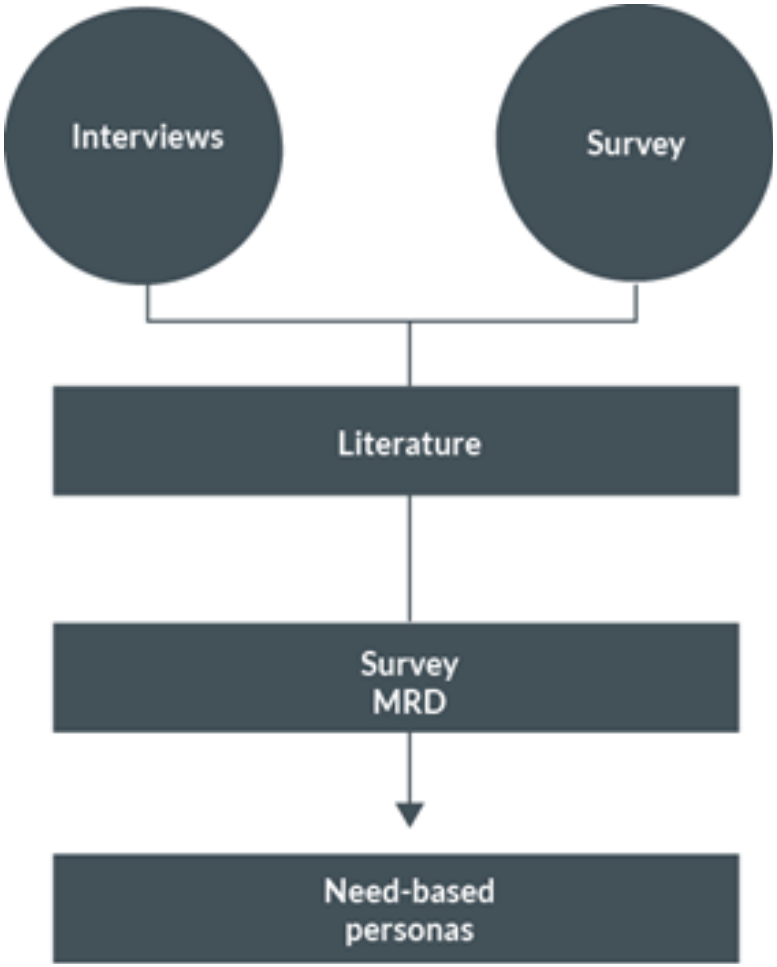
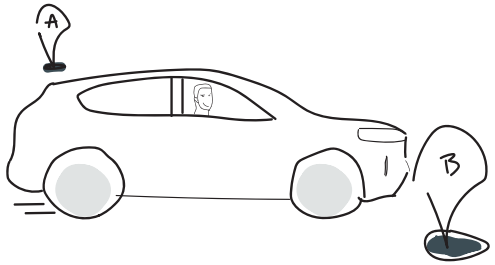


Figure25. (Steps taken to define need-based personas)



The car share'er

A car focussed user. Uses shared mobility and relies on the convenience of a car. Concerned about the modalities' quality, safety, and hygiene.

Quality convenience

Likely to use shared mobility

◉◉◉◉

"I use shared cars for short trips in Amsterdam, sometimes it is just for fun."

The multimodal A to B'er

A multi-modal user frequently makes use of shared mobility, for daily commuting, shopping trips, or just for fun. Is most concerned with getting from point A to point B as quickly as possible.

Quick & easy transition

Likely to use shared mobility

◉◉◉◉

"The closets by, accesability is for me the most important. Doesn't matter whether it's a Felyx or Check."

The money keeper

Makes use of shared mobility for it's finacial advantages. Needs to be provided with an overview of travel expenses to compare prices and select the most profitable option.

Financial advantage

Likely to use shared mobility

◉◉◉○

"It depends on the intensity of use how expensive shared mobility can get, but for us it is a perfect option"

The one in need

Only uses shared mobility when 'out-of-the-ordinary events' occur. Unless external factors force him to use shared modalities, he prefers to use his own/public transportation modes.

Tailored convenience

Likely to use shared mobility

◉◉○○

"I would only change my current mobility pattern if the requirements change"

The holder

Open to the idea of shared mobility, but has never tried it. Satisfied with the current mobility options (bicycle, own car or public transportation). In need to take the first step towards shared mobility

Knowlegde & experience

Likely to use shared mobility

◉○○○

The refuser

Satisfied with his/her regular trip and prefers to use existing mobility options (own car, public transportation, bicycle). Shows very low intention to use shared vehicles.

Convencing

Likely to use shared mobility

○○○○

KEY INSIGHTS 2.5

- In this chapter, 7 interviews with users of shared mobility were conducted, generating many insights about the use of shared mobility, such as the frequency with which users use it and the reasons for doing so. An overview of user needs has been created, which presents the user's most important requirements for shared mobility.

- A workshop was organized during the Master Research Day (MRD) at the faculty of Industrial Design Engineering to collect more data on these requirements. Data from 32 participants was used to create a list of requirements, the top three of which were physical accessibility of modalities, digital accessibility of modalities, and availability of modalities.

- Based on the insights gathered during the user research, 6 need-personas are created, including users and non-users of shared mobilit

2.6 Conclusion

Multimodal travel, as discovered in this phase, can provide an alternative to private cars, which pollute the air and take up a lot of public space. Within multimodal travel, shared modalities complement public transportation services. However, when compared to private cars, multimodal travel faces a number of challenges. According to the findings of the conducted literature research, one of the most difficult challenges to overcome is behavior change. Private cars alternatives must compete on comfort, flexibility, and availability. Other psychological factors, such as the association of the private car with me-time, make it difficult for the user to replace. Other specific Buurthub challenges identified during this phase include:

- Participatory procedure of Buurthubs
- User adoption to Buurthubs
- Agreements with mobility providers
- The missing network of Buurthubs
- The financial side of Buurthubs
- Look & feel of Buurthubs
- Charging of electric vehicles at Buurthubs

Based on the conducted user research, it was determined that physical and digital accessibility of modalities, as well as modality availability, are the most important needs for the user when it comes to the use of shared mobility. These requirements overlap with the challenges identified concerning Buurthubs. When it comes to agreements with mobility providers, the main issues are the availability of modalities in the hubs and their accessibility in relation to their locations in the city.

The foundation for user adoption to Buurthubs is found in behavior change towards alternatives for private cars. For this change to take place, there are multiple factors to focus on. These factors can be divided into pull- and push factors. Pull factors in this case are concerned with making the alternatives to private cars appealing to the user. While push factors discourage the use of a private vehicle.

These challenges and identified user needs, as well as the various elements of the broader context of multimodal travel, will guide the next chapter of this thesis.

3. Define phase

This chapter selects three major challenges to be addressed in the subsequent phases of this thesis. The design brief is formulated, and a roadmap is selected as the thesis's design goal.

3.1 Introduction define phase

To be able to find a good direction for this thesis, a decision on which challenges concerning Buurthubs to focus on must be made.
The challenges described in chapter 2.3.3 are the result of information gathered over a longer period of time by the Buurthubs team. As explained in chapter 3.2, some of these challenges overlap with user needs found in chapter 2.5. Aside from this overlap with user needs being a good reason to focus on these specific challenges, a creative session with the Buurthubs team is organized to review and reflect on these challenges.

3.2 Defining the right challenges

To find a more specific focus within this project, it was decided to narrow down the scope of the project to the 3 most important challenges concerning Buurthubs.

The 3 main challenges:

To have the Buurthubs team's opinion on defined challenges in chapter 2.3.3, a creative session was organized. The goal of the session was to define and reflect on the main challenges the team is facing with the Buurthubs hubs. This excluded the procedural challenges within the municipality, as that is not the focus of this thesis.

The question was then asked, "Why is this a challenge?" for each of these challenges. The responses revealed that some of the challenges mentioned before were intertwined or needed to be redefined.

The team was then asked to prioritize the top 3 challenges that have the greatest impact on the success of Buurthubs according to them .
The main three challenges were the following ones:
The accessibility of the hubs, both physically and digitally
The availability of the modalities in the hubs
Behavior change towards shared mobility

The three main challenges identified by the Buurthubs team during this session, correspond to the three main challenges identified in the discover phase. As a result, these challenges will be the primary focus and starting point for the design brief introduced in the following section.

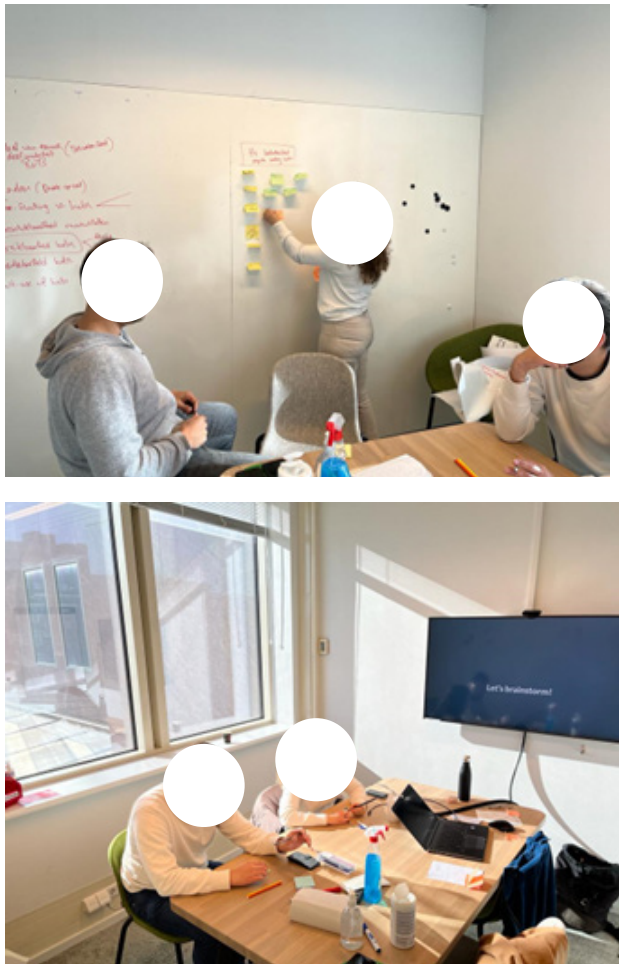


Figure26. (Impression of the creative session with Buurthubs team)

3.3 Design brief

Following the approach of the Double Diamond introduced in chapter 1.4, A design brief is (re)formulated to steer this project in the direction of 'solving the right problem', which is the goal of the second diamond. Therefore, the focus of the design brief is put towards the challenges defined in the previous section. These are the accessibility of the hubs, both physically and digitally, the availability of the modalities in Buurthubs and behavior change of users towards shared mobility.

My vision
A world where shared mobility allows for more sustainable travel, by reducing the need for private cars in the city.

My mission
I want my design to contribute to the future implementation of Buurthubs, by overcoming the challenges defined above.

Design goal
To design a **user-centric roadmap** for the implementation of Buurthubs to reduce the use of private cars, in order to support citizens towards more **sustainable travel behavior** and to **rearrange the urban public space.**

The goal of this thesis is to design for the future of Buurthubs so they can be successfully implemented in Amsterdam. The design will consist of short- and long-term developments that will ensure this success. These developments will be mapped on a timeline in the form of a roadmap. Knowledge from the pilot Buurthubs project, from the literature research and from the conducted user research will form the basis to achieve this design goal.

The Buurthubs project is a pilot project that will be finalized in 2022. The Buurthubs team of the municipality is nearing the end of the project and working on the deliverables for the eHUBS. Within the municipality of Amsterdam, a new team is being formed that will work on mobility hubs in the near future. As a result, the roadmap and its various elements will center on the next innovation team that will take over the project in Amsterdam. This will be the target audience for the next phases of the thesis. The starting point for the roadmap is where this next innovation team will pick up the project.

3.4 Conclusion

The goal of this chapter's design brief is to result in the creation of a roadmap for the implementation of Buurthubs. The roadmap will focus on the challenges of hub accessibility, both physically and digitally, the availability of modalities in Buurthubs, and user behavior change toward shared mobility. These three major challenges were chosen to narrow the scope of the project and provide a clear roadmap. The roadmap's goal is to present short- and long-term developments to Buurthubs and their larger context in order to ensure successful implementation.

4. Develop phase

This chapter contains the future vision, as well as the various horizons of the roadmap that form the steps toward that vision. To visualize these horizons, a visual map is created. As a result, in this chapter, the final roadmap is created.

4.1 Introduction develop phase

Earlier stages of this thesis discovered the negative impact of private cars on air quality and space occupation. Following the design brief, a roadmap will be developed to ensure mobility hubs' contribution to the future of multimodal travel.

To be able to imagine this future, according to Simonse (2017)'s roadmapping method, a future vision must be created, towards which the roadmap will lead. Following that, the various steps for achieving this future vision must be defined.

4.2 Future vision

The design goal of this thesis is a user-centric roadmap for the implementation of Buurthubs. To be able to create this roadmap, a future vision must be defined first.

Future visioning is about imagining desired values that are actionable and within reach of the participating innovation professionals (Simonse, 2017). A future vision is determined by four core elements (Simonse, 2017):

Clarity: the vision expression enables immediate understanding of what it would be like to experience the future innovation in the explicitly expressed desired end state
Value drivers: drivers capture the compelling benefits of value wishes: wherein the specific value fulfills an unmet need or solves a dilemma of a user target group in the future
Artifact: materialize the imagined value wishes with images in 2D or 3D-dimensions.
Magnetism: involves the desirability and attractiveness of the vision – 'the thing' the vision creators are truly passionate about in such a way that it potentially energizes others to direct their actions towards it.

This means that the created future vision will give clarity about the role of Buurthubs within the future mobility system. It also contains the value drivers that meet the needs of both users and the municipality of Amsterdam when it comes to sustainable mobility and public space. An artifact of this future vision has been extended to a visual roadmap, for a more complete expression of the desired future (Figure: 27). The following future vision has been developed with input gathered throughout different stages of this project.

Future vision:

A future in which **mobility hubs are at the center of shared-mobility**. A **structured** and **well-integrated** service supports the user in the **transition towards shared-ownership**, allowing all citizens to **travel sustainably** while enjoying a **high-quality public space.**

4.3 Horizons roadmap

To achieve the defined future vision, the steps required to get there must be defined. As a result, three horizons are created, which form the timeline of the roadmap to the future of Buurthubs. Horizon 0 is added to explain the current status of the hubs, as a starting point for the roadmap.

Horizon 0: 2022 status quo

Horizon 0 is about the current state of Buurthubs. The pilot project has been in operation for over three and a half years. Despite all of the challenges, the team was able to establish 14 Buurthubs by 2022. Many challenges with these hubs are described in the chapter 2.3.3. The roadmap is built around the three main challenges that have been identified in chapter 3.2. To ensure a clearer overview, this horizon will not be shown further in the final roadmap.

Horizon 1: 2024 Initial improvements

After the Buurthubs pilot project ends, the municipality of Amsterdam already has plans to take mobility hubs to the next level. The number of hubs in Amsterdam will gradually increase over this time horizon, contributing to the hubs' accessibility. More people will become familiar with shared mobility and its benefits.

Agreements between various stakeholders in the mobility system will lay the groundwork for a multimodal travel system, of which mobility hubs are a component. Multiple MaaS providers will be operating in Amsterdam within this system. Some, but not all, modes of transportation are integrated into these apps. Mobility hubs are included in MaaS apps as locations where shared modalities are available, as a part of the multimodal travel.

Horizon 2: 2026 hubs network Amsterdam

The goal of this horizon is to set up a greater network of mobility hubs in Amsterdam. These hubs vary in size and location. Where Buurthubs cover residential areas and provide first- and last mile solutions, larger hubs must be set up for the user to complete the multimodal travel. Mobility hubs placed near to public transportation stations act as nodes where the user can switch between public- and other transportation modes.

Further MaaS development will result in fully integrated services that include all modality combinations. All shared modalities available in mobility hubs are included in one or more MaaS app(s). The user can use this app to plan, book, and pay for all modes of transportation, including shared modalities and public transportation.

Horizon 3: 2028 expand and connect to other Dutch cities

The user can travel between cities in the Netherlands using a large network of mobility hubs in this horizon. These hubs will be part of a multimodal travel ecosystem established in accordance with national agreements. 1 or more (the largest) MaaS player(s) will remain in the Netherlands to facilitate multimodal travel between different Dutch cities through a fully integrated service for planning, booking, and paying for both shared mobility services and public transportation.

The following map was created to visually represent the various horizons.

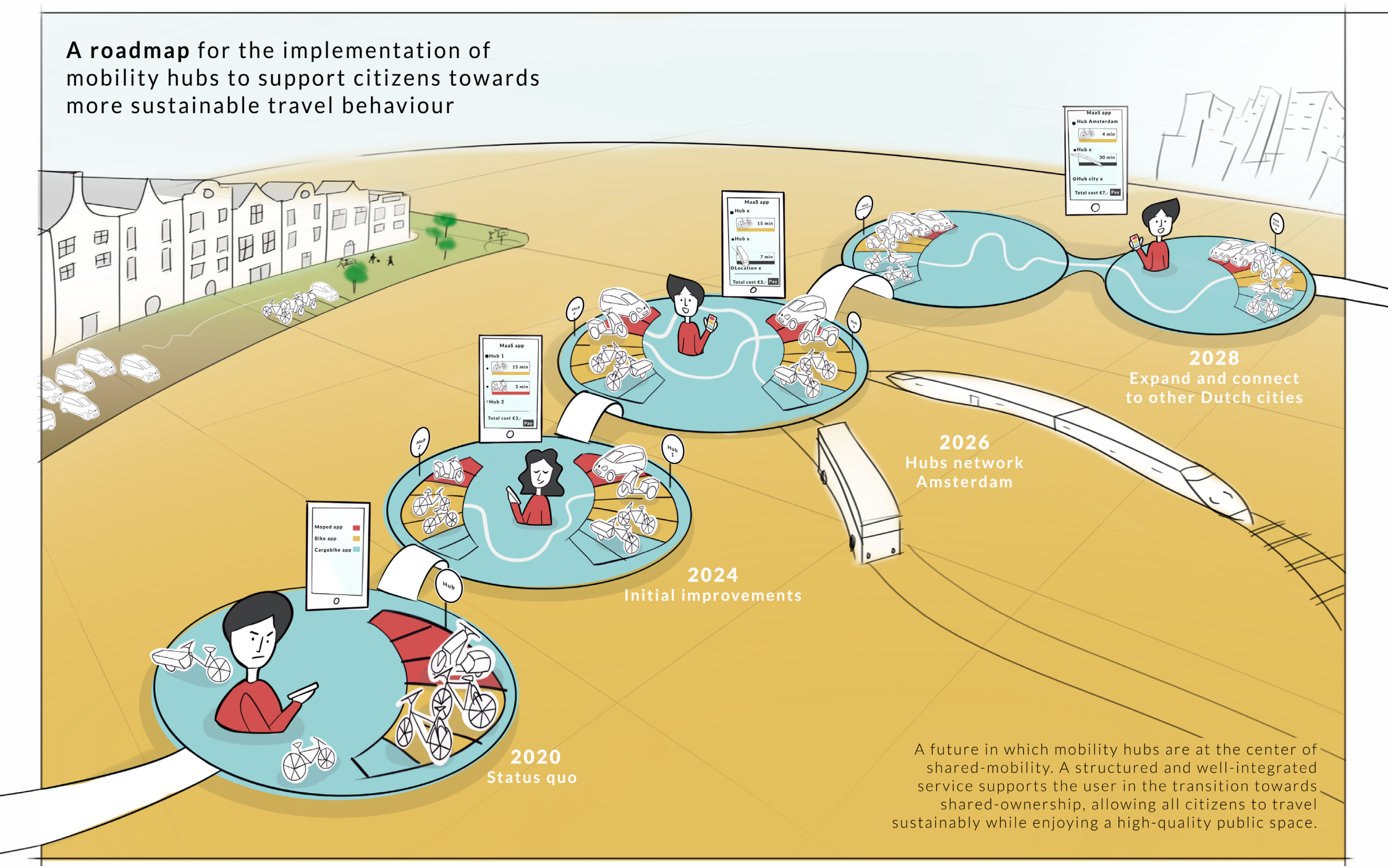


Figure27. (Visual map of the defined horizons| Digitally illustrated in collaboration with Roos van 't Klooster)

4.5 Final roadmap

The three main challenges defined in chapter 3.2, are used as the foundation for the final roadmap. These are the accessibility of the hubs, both physically and digitally, the availability of the modalities in Buurthubs and behavior change of users towards shared mobility. The roadmap's goal is to arrive at the defined future vision.

Co-creation sessions with the municipality's Buurthubs team have been organized to aid in the development of the roadmap. A presentation on the future vision and horizons was given during these two sessions with three members of the Buurthubs team. A brief description of the personas was also provided to the team.

An initial roadmap was created and its content was discussed, evaluated, and finally adjusted together with the team. The outcomes of these sessions were considered positive by the team members. A selection of questions and comments are listed and discussed in appendix 8.2 to demonstrate some of the outcomes of these sessions.

The final roadmap and its components are presented step by step in the following section.

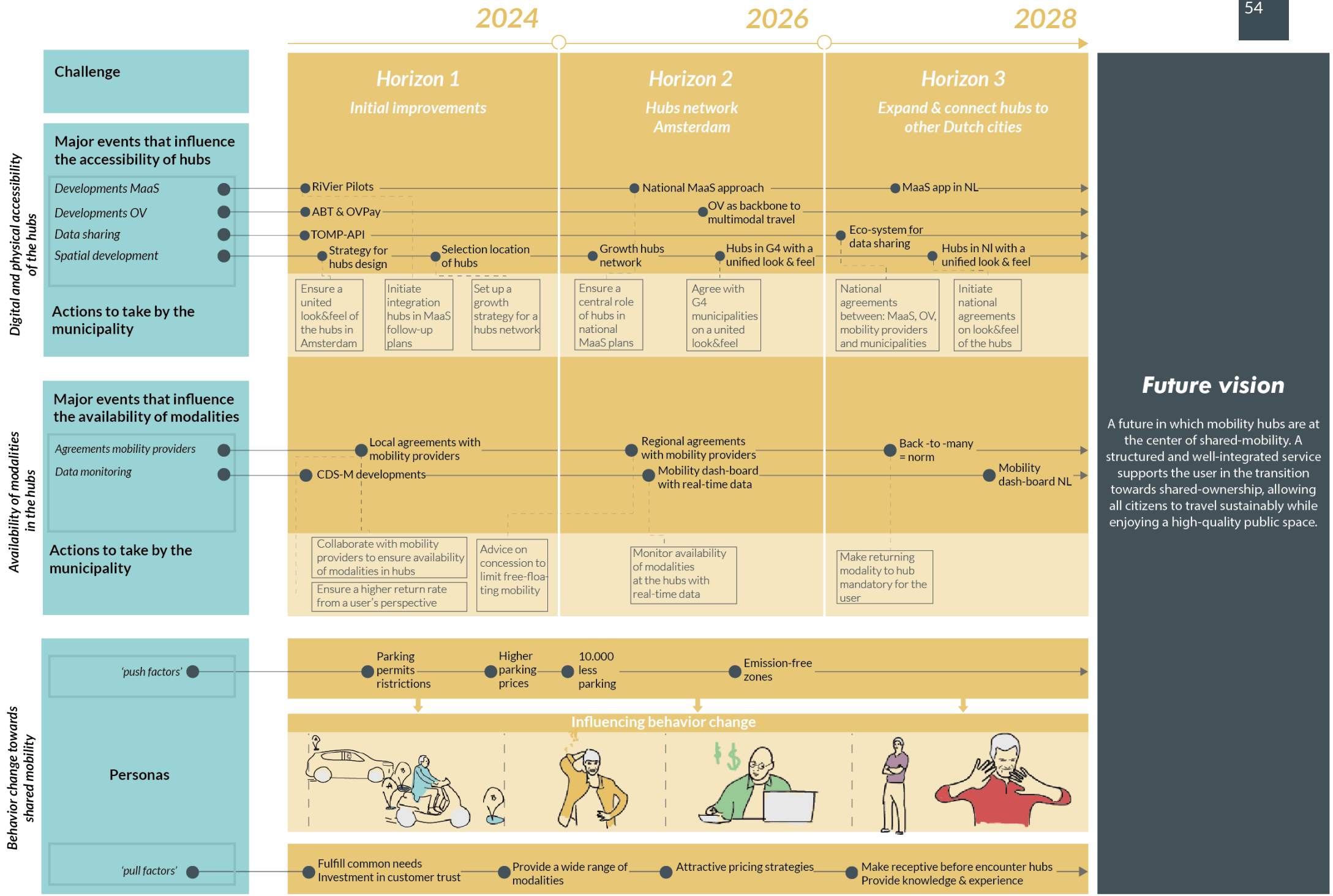
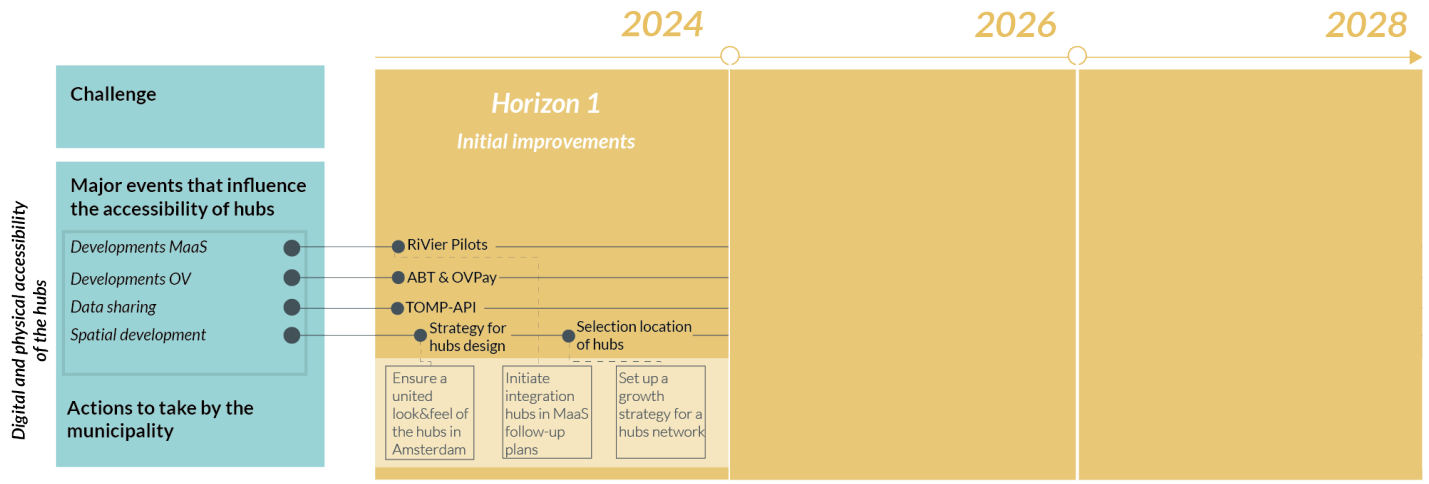


Figure28. (The final roadmap)

Challenge 1: Digital and physical accessibility of the hubs

Horizon 1:

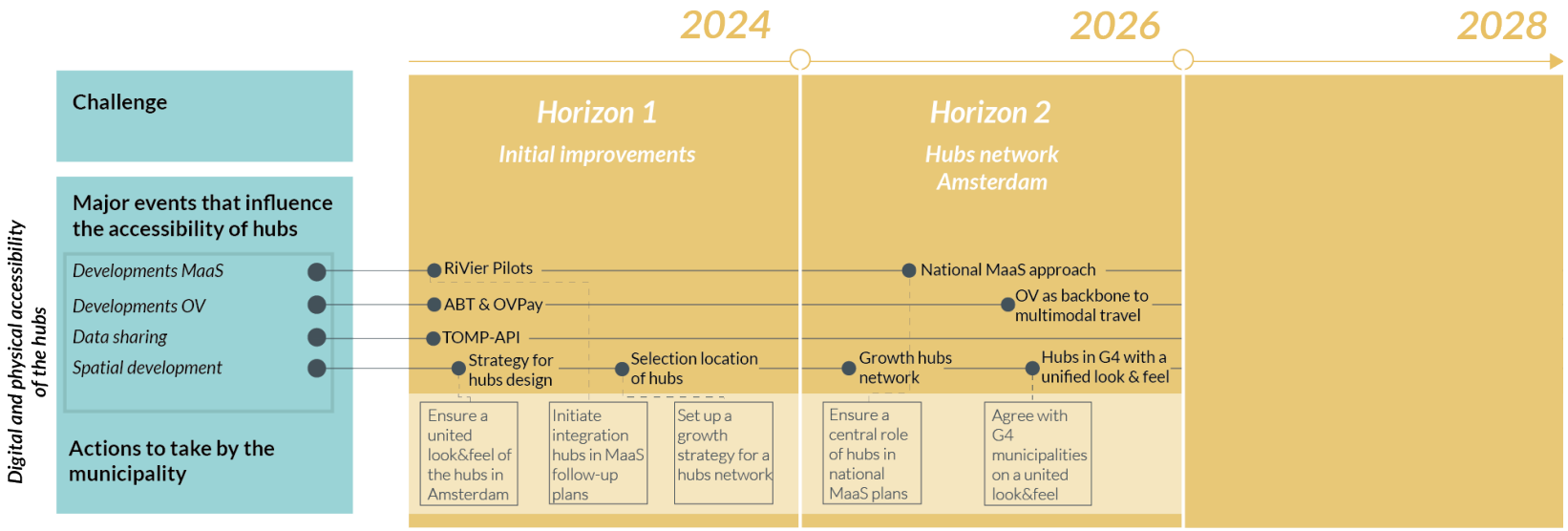


The MaaS pilots launched in the Netherlands have laid the groundwork for the digital integration of various mobility parties. Despite the fact that there are no official follow-up plans for the MaaS pilot in Amsterdam, there are promising initiatives and plans for further MaaS development. Less fragmented and more national approaches, such as Rivier, should be addressed by the Buurthubs follow-up team. Integrating Buurthubs into such pilot projects from the start is critical to their success.

Introducing TOMP-API (chapter 2.4.1) describes the need for unity and standardizations within the mobility system. It is a first step towards a mobility ecosystem, where data must be shared between MaaS providers and mobility providers. This data can be used to analyze users' travel patterns to better understand their needs. The municipality can as a result act upon this data by introducing new policy agreements regarding the liveability and the sustainability of her cities from a mobility perspective.

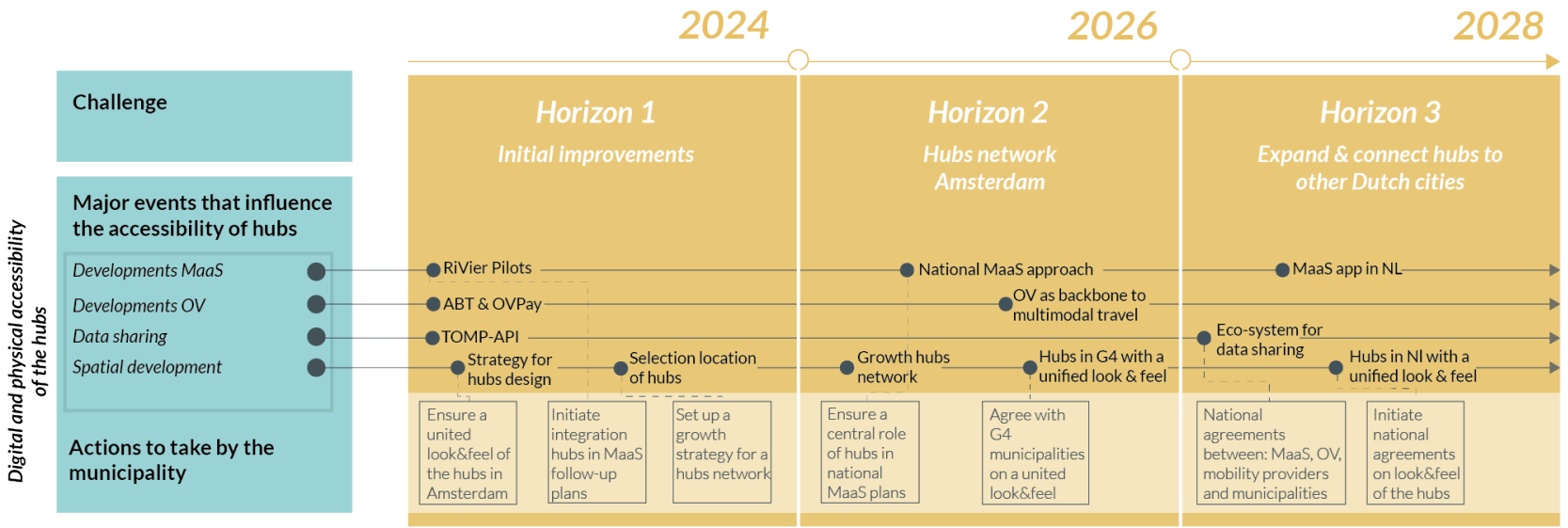
After the Buurthubs pilot project of 3 and half years, a lot of knowledge is gained on how to practically develop these hubs. There are already plans initiated within the municipality on the design of hubs and their physical implementation on the streets. To ensure a thorough spatial developments, the follow-up team must ensure a united look&feel of the Buurthubs in Amsterdam to make them recognisable for the user. A detailed plan for the locations of the new Buurthubs must be set up to improve their physical accessibility for the user.

The implementation of OVPay in the public transportation sector in The Netherlands is the first practical step of Account Based Ticketing (ABT). ABT opens new doors towards the integration of OV in MaaS apps.



Horizon 2:

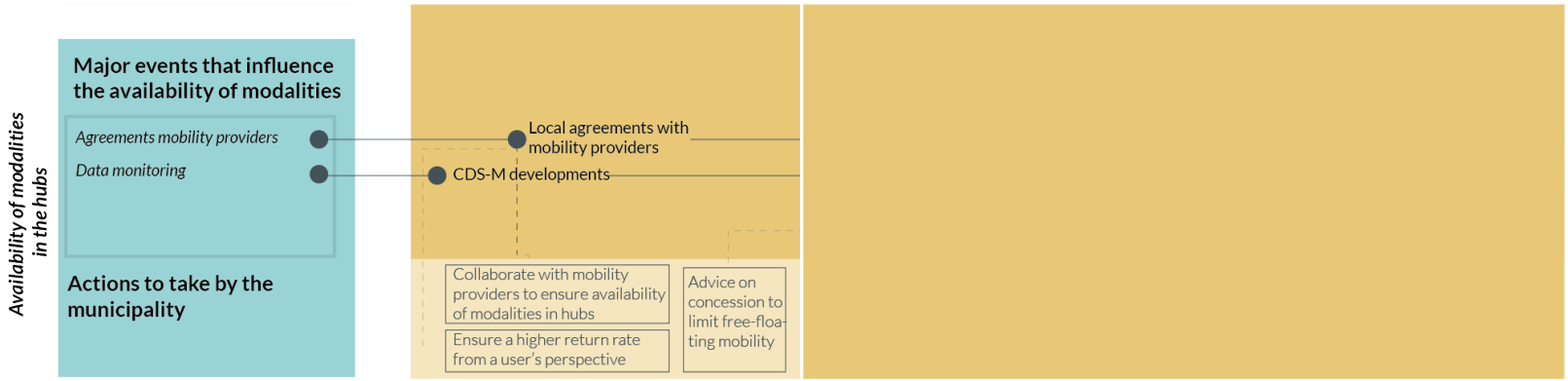
When it comes to MaaS development, there are numerous future scenarios that are difficult to predict. However, a national approach is desired and should be advocated for by the municipality. The technical functionality of MaaS apps has already been achieved, as there are MaaS apps that are operational to a certain level in 2022. Whether through a governmental or commercial approach, it is expected that further developments will be promising for the future of multimodal travel. The desired digital outcome is a functioning MaaS app with Buurthubs integrated in it, where the user can see, plan, book and pay for the available modalities offered in the hubs. This MaaS app must also integrate OV services to make the multimodal travel complete.
Within this horizon the network of Buurthubs will grow, as hundreds of Buurthubs are expected to be set up in Amsterdam by then. Outcomes of the pilots for the G4 cities on the identity of the hubs will be completed, which should lead to clear arrangements on how to unify the hubs between these 4 cities.



Horizon 3:

The third horizon focuses on expanding Buurthubs and connecting them to other cities in the Netherlands. This means that more hubs will be established in Amsterdam in order to create a fully functional network that covers the entire city. Other cities in the Netherlands, including the G4 cities, are expected to develop a network of hubs as well. Connecting these hubs is a complex step that the resources in this horizon will enable. To achieve this, agreements on different topics must reach a national level. Such a national approach requires a more complete ecosystem for data sharing between the different mobility parties. Looking at the current developments regarding mobility data sharing, this ecosystem is expected to be available in the future. This ecosystem must also include data from public transportation as well, for the OV to act as the backbone of multimodal travel. More cities will follow after the G4 cities have united their hubs, especially if national agreements are reached. This will result in a network of hubs with a single identity that connect cities and allow for multimodal travel between them.

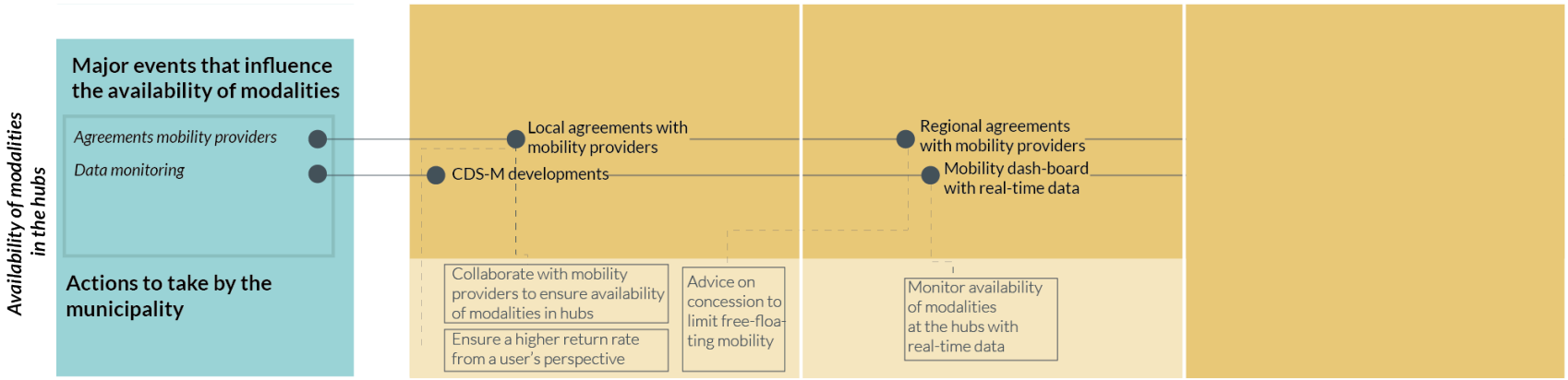
Challenge 2: availability of modalities in the hubs



Horizon 1:

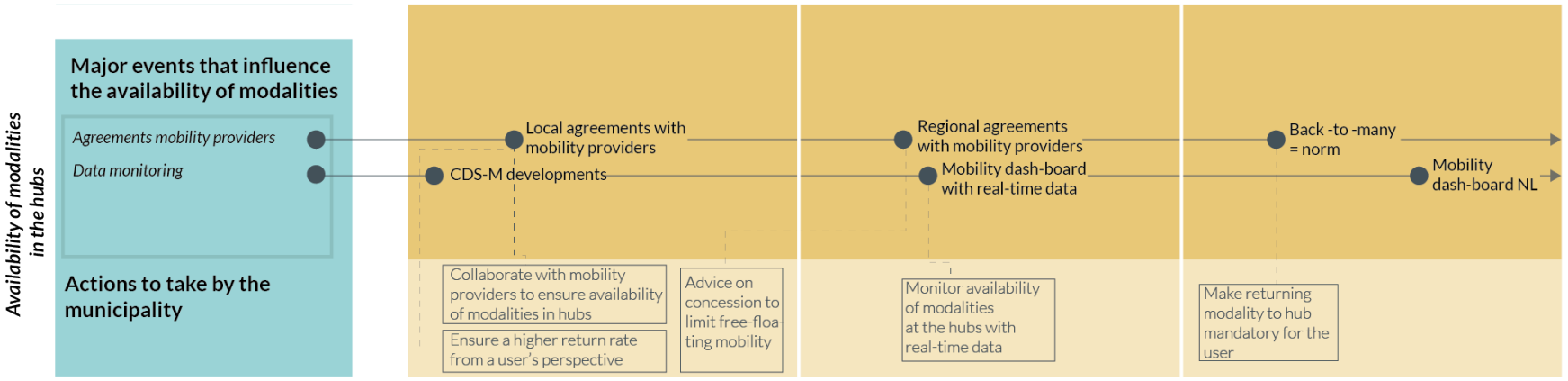
Within this horizon, the main focus is put towards the agreements with mobility providers. In 2024 it is expected that most mobility providers will still operate according to the free-floating concept. These commercial providers now offer their modalities in Buurthubs. From the perspective of Buurthubs these modalities need to be returned to the hubs after use. Up until now the Buurthubs team has been working with various mobility providers on the terms of 'soft agreements', for the providers to return the modalities to Buurthubs. The municipality must introduce local agreements that obligues the providers to ensure availability of modalities in Buurthubs.
On the user's side, a lot still can be done to encourage the user to return the modalities to the hubs after use. Rewarding systems that some mobility providers are already working with, could stimulate the user to return the modalities. While standardization such as TOMP-API allows for data sharing between MaaS and mobility providers, standardization like CDS-M form a standard for exchanging data on mobility between mobility providers and public authorities.

This will allow the municipality to have a grip on data monitoring. Using this data, the municipality could monitor the modalities offered in Buurthubs, their use and availability.



Horizon 2:

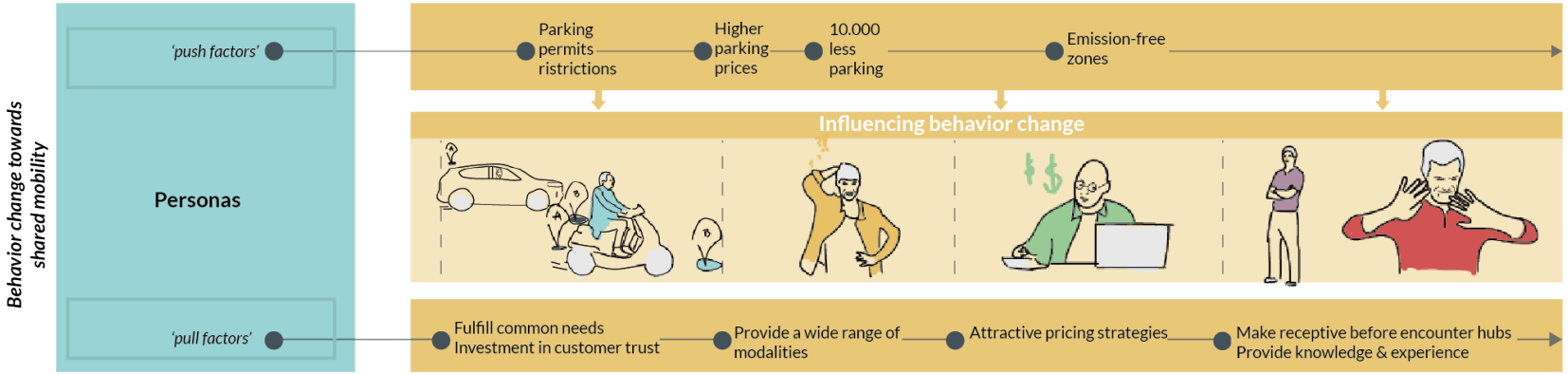
Agreements with mobility providers, like the development of MaaS, must be handled with a national approach in the end. However, because the development of these agreements is still highly unpredictable, various scenarios can be expected. The most likely are a fully back-to-many system or a hybrid system that combines back-to-many and free-floating.
The first implies that mobility providers are not permitted to work with free-floating concepts. Buurthubs' functionality is best served by a back-to-many system, as modalities used at one Buurthub must be returned to the same or a different Buurthub. However, a possible outcome is a hybrid system. This could mean that an alternation of back-to-many and free-floating is used between the city center and the outskirts of the city. In all possible scenarios, for Buurthubs to function the free-floating concept must be limited to a certain level. Combining data sharing between mobility providers, MaaS providers, public transportation and public authorities will create a data ecosystem where real-time data will be very valuable for multimodal travel. Real-time data provided in a MaaS app could assure the user of modalities availability at Buurthubs at a certain moment. A real-time data dashboard will provide real-time mobility data to the municipality. The municipality can use this data to take a more dynamic approach to hub locations as well as the variety and intensity of modalities offered in these hubs. There are already platforms that provide such data to cities in order to help them improve their mobility. The upcoming data standardization is promising for such platforms because it will make more data available for sharing.



Horizon 3:

When a (partially) back-to-many system is agreed upon, users will be required to return the modalities to the hubs. The growing number of Buurthubs, on the other hand, will make it easier to return these modalities.
Horizon 2's dashboard will have access to more (real-time) data.
A platform like this has the potential to spread across the country, allowing cities to exchange and connect their data. Connecting such a platform with real-time data to MaaS providers will have significant advantages on multimodal trips (between different cities). Travel time changes or delays, as well as the availability of a modality in a Buurthub at a specific time, are all combined and can therefore be communicated to the user.

Challenge 3: Behavior change towards shared mobility



The third challenge focuses on changing user behavior towards shared mobility. The challenge is divided into push and pull factors to accomplish this. The city of Amsterdam is already attempting to accomplish this through the implementation of a car-free agenda. Parking spaces for private cars are already being removed in Amsterdam, and car- and emission free zones are emerging. Private cars will remain difficult to tackle unless users are encouraged to consider other sustainable mobility options.
On the roadmap, the personas defined in earlier stages of this project are mapped. The personas are mapped over the horizons from left to right based on how likely they are to use Buurthubs. Personas that are least likely to share are, however, crucial for achieving high impact. However, given the immature state of Buurthubs in the earlier horizons, it is unlikely that we will be able to persuade these people to use the hubs. Buurthubs are more likely to be used by users who are more open to shared mobility in the coming years. Their multimodal mind must still be stimulated, and their needs must be met. When the core needs which form the first two challenges of the roadmap are met, they will already stimulate the users. The increased use of shared mobility in cities will undoubtedly have an impact on pricing, which should result in more appealing pricing for the user.
Aside from addressing the two main challenges outlined in this roadmap. To target the presented personas, specific steps must be taken. Already, studies are being conducted on ' nudging' to encourage users to use shared mobility. This study's findings must be further used to develop more specific pull factors that fit within the context of each horizon.

4.6 Conclusion

The co-creative sessions held in this section with the current Buurthubs team went remarkably well, generating numerous insights that aided in the creation of the final roadmap's content. A roadmap demonstrates a future vision as well as specific steps to achieve that vision. However, there is no one way to create such a roadmap (Simonse, 2017). It is up to the designer to decide how the roadmap should look and how many layers it should have and what content it should present. Choosing the three challenges as the roadmap's foundation has helped to narrow its focus while maintaining a clear overview of the context. This was confirmed during the co-creative sessions and the overall reaction was quite positive.

However, further validation of the final roadmap with the follow-up team is required. This validation will be more concerned with the roadmap's implementation.

5. Deliver phase

The implementation of the roadmap is the focus of this phase. A validation session was held with a member of the follow-up team. As a result of this phase, the roadmap was transformed into an interactive roadmap, and a card set was created to assist in its implementation.

5.1 Introduction deliver phase

It is critical to find a way to make the created roadmap usable for future teams in the municipality that will be working on hub implementation. Because the follow-up team has not yet been fully formed, the roadmap should be presented in a way that the majority of team members can use. This means that even without the thesis report, the roadmap should be understandable. In the following section, a validation session will be performed with a member of the follow-up team, to validate the roadmap and discuss its usability.

5.2 Implementation in organization

5.2.1 Validation session follow-up team

This validation session had a similar approach to the previous sessions introduced in chapter 4.1. However, during this session additional focus was put on the readability and usability of the roadmap. This team member, as explained in chapter 3.3, is together with future members, the final user of this roadmap. The main feedback from this session was essentially quite positive. According to the team member the roadmap provided a clear and complete overview. There were two major points raised in terms of content:

The first is about the physical implementation of the hubs in practice. A large number of hubs will be required in the future: “Perhaps we’ll need 2000 hubs in Amsterdam.” It is certain that several hundred hubs will be established.” The practical side of the process on how to establish a Buurthub is still undiscovered in the roadmap.

The second point concerns the agreements with mobility providers. “We prefer to make a single citywide agreement with shared mobility providers, whether their vehicles are offered in a hub or as free-floating.” According to the team member this could be seen as one scenario, which was the one explained in the roadmap as well. However, there are multiple scenarios to be expected. One of the scenarios could be a hybrid solution. An example of such an approach is to provide back-to-many in the city center and free-floating in the outskirts. According to a team member, more emphasis could be placed on national agreements in horizon 3. “More regional or even national agreements must be reached in order to expand and connect to other cities.” When such agreements are reached with mobility providers, it will be easier for municipalities to connect with each other.

During the session, it was necessary to validate whether all of the roadmap’s content was understandable to the follow-up team. According to the team member, the presented content is clear and understandable. As for the usability of the roadmap, an interactive form was suggested to help understand the different elements of the roadmap.

5.2.2 Interactive roadmap and cardset

The roadmap was converted into an interactive roadmap to improve its usability. Each element on the roadmap is made clickable for the reader. When readers click on the element, an explanation card appears. This card includes the element's title and text to explain the element. If necessary, additional sources are added to the card, which are also made clickable. These are either links to online documents and websites that help explain the subject at hand, or links to literature studies that provide a more in-depth understanding of the subject. An example of an explanation card is shown in figure 29.

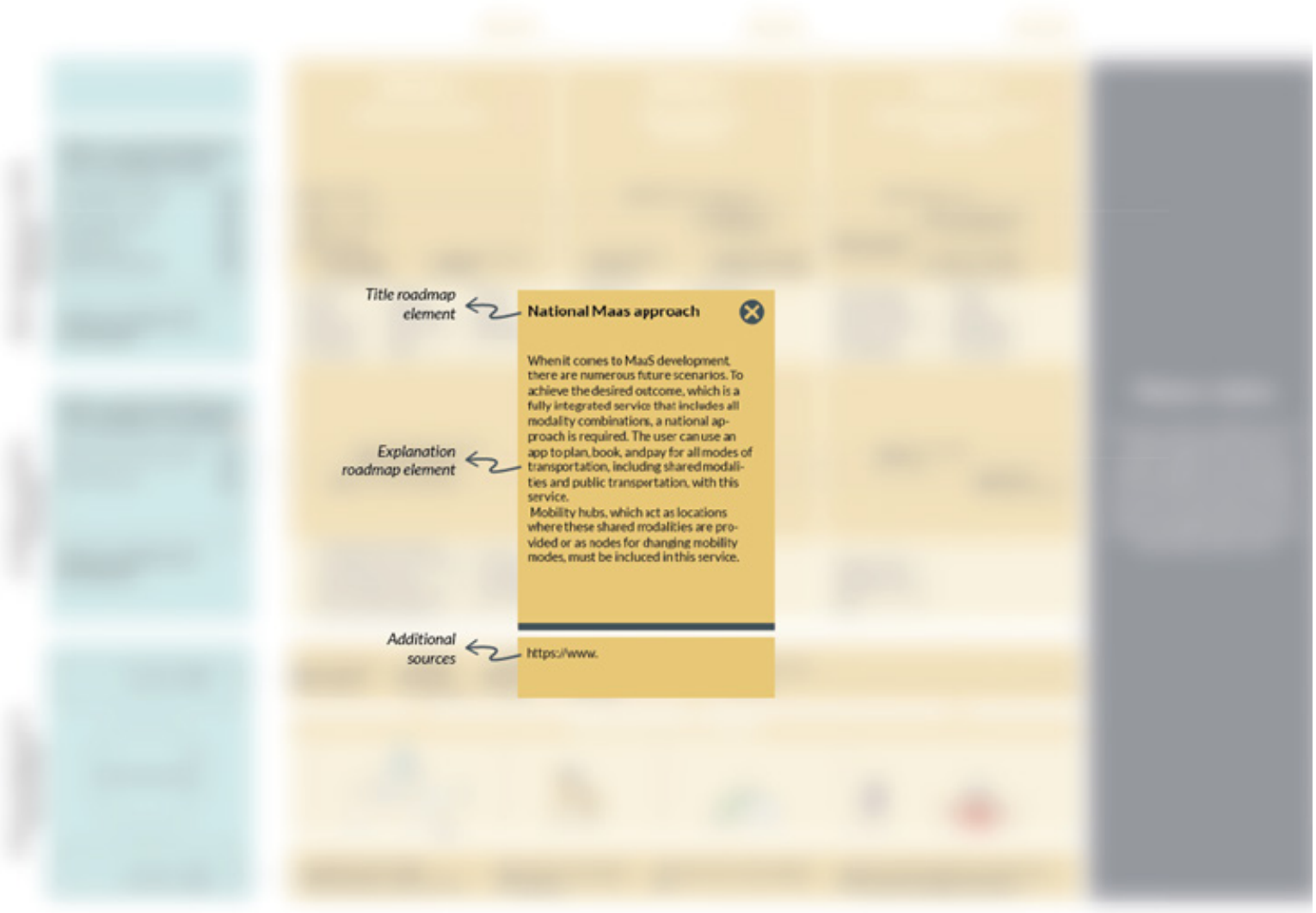


Figure29. (Layout of a clickable roadmap element)

A card set was created in addition to the interactive roadmap to help explain the roadmap in a physical form. This is similar to the interactive roadmap in that the physical card set contains the same cards as the clickable roadmap elements. The cards in the card set differ slightly in that each one represents a number that corresponds to the number of the corresponding roadmap element. Six more cards are created to explain each of the personas depicted on the roadmap. The results are shown in figure 30.

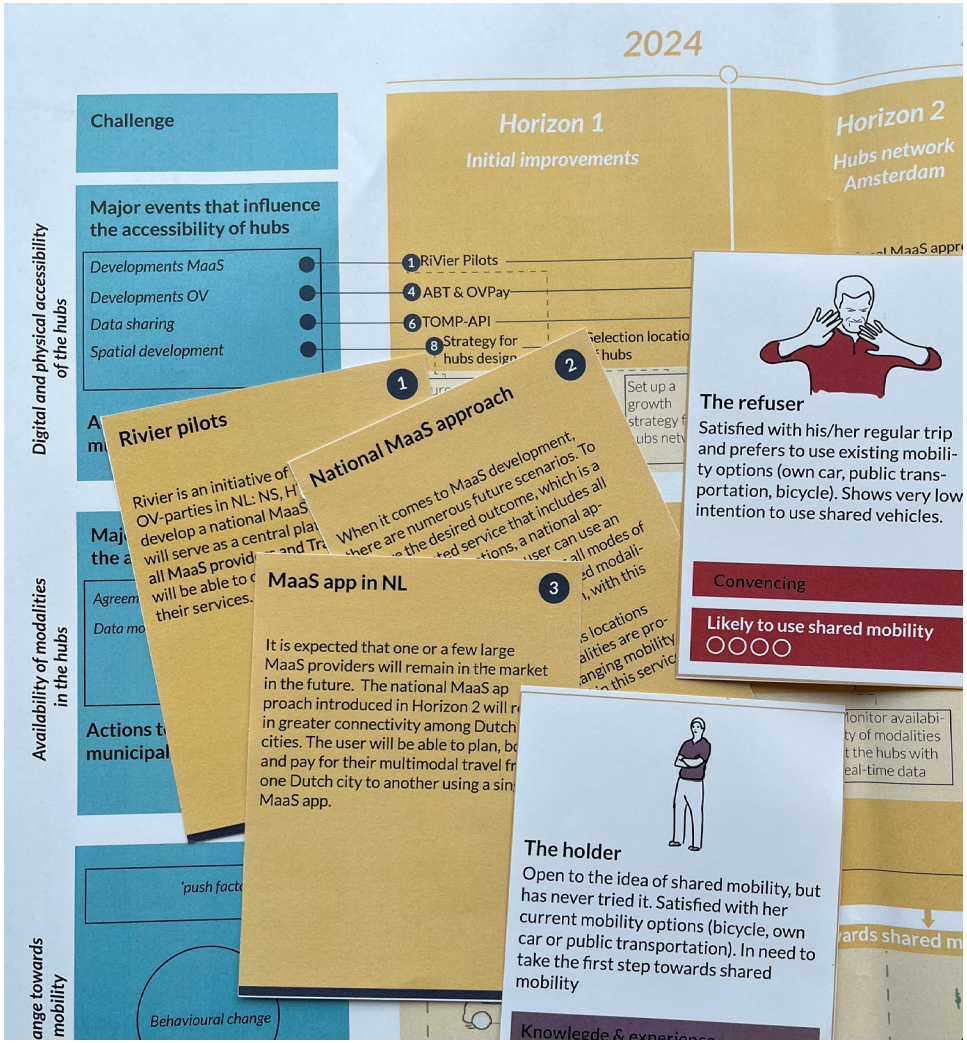


Figure30. (Physical card set of roadmap elements)

5.3 Conclusion

The roadmap was transformed into an interactive roadmap as a result of the deliver phase to make it self-explanatory for the reader. This was also suggested during the co-creation sessions with the Buurthubs team and the validation session with the follow-up team member. Because of the uncertainty about how future team members will interact with the roadmap, a card set that could be physically used in combination with the roadmap was introduced as well. The digital and physical forms of the roadmap and card set are the end results of this thesis, which are both discussed with the current Buurthubs team. The roadmap was created collaboratively with the Buurthubs team and was later evaluated on. However, due to the thesis's deadline, the interactive part and card set will not be tested with future team members.

6. Discussion & final conlusion

6.1 Discussion

Three major challenges to the success of Buurthubs have been identified: the accessibility of hubs, both physically and digitally, the availability of modalities in Buurthubs, and user behavior change toward shared mobility. These difficulties are the result of the research conducted in this thesis on Buurthubs and their broader context, and they also overlap with user needs identified in the user research. The roadmap mainly focuses on these challenges. However, as the roadmap presents the major developments of different elements of multimodal travel, the challenges are placed in a broader context. This is due to the fact that Buurthubs are not an end in themselves, but rather a means to enable and sustain multimodal travel. The active involvement of the Buurthubs team was used to gain as much practical knowledge on the subject as possible.

The self-explanatory approach to the roadmap improves its readability and usability by future teams working on mobility hubs within the municipality. Furthermore, for the same purpose, both digital and physical forms are covered.

Limitations

Although the focus of this thesis has been on Buurthubs, their broader context includes a variety of other very important elements. Public transportation for instance is critical to sustainable multimodal travel, but it receives little attention in this thesis due to its broadness. In addition, for Buurthubs to be successful a network including bigger hubs is needed. These hubs are not analyzed in this thesis for 2 reasons. One is to narrow down the focus of the thesis and the second is that these hubs have not been developed yet by the municipality of Amsterdam.

The Buurthubs team played an important role throughout this thesis. Many discussions and conversations have resulted in the knowledge used in this thesis. However, as stated in this thesis, this Buurthubs team has been working on the Buurthubs pilot, which is scheduled to conclude in 2022. The municipality's follow-up team remains undiscovered in this thesis because it was not fully formed at the time this thesis was completed.

The created roadmap focuses on a broader perspective, which means that much detail, such as the specific design of the hubs and the financial side of it, is left out. In addition to the three challenges highlighted in the roadmap, other challenges identified in this thesis must be overcome for Buurthubs to be successfully implemented.

Recommendations

The Buurthubs pilot has been running for 3,5 years, while for the bigger hubs such as Stadshubs and Regiohubs there are no detailed plans yet to run pilots. These pilots are needed to gain a similar amount of knowledge and experience on the different types of hubs. Only then, the ability to create a network of these hubs will be realistic.

The broader perspective of the roadmap results in many elements that need further detailing. An example is the agreements with shared mobility providers. More information on how to reach such agreements, whether at the local, regional, or national levels, is required.

Mobility hubs are a relatively new concept. There has been very little literature research done specifically on the users of these hubs. However, as the Buurthubs team has stated, there are ongoing research studies on these users, and more will be conducted in the near future. The findings of these studies, combined with the personas created, can be used to develop more detailed push and pull factors that ena-

ble multimodal travel.
Future graduation projects could concentrate on different aspects of the multimodal travel context in order to conduct more in-depth research on each of them. An example could be the digital implementation of hubs in MaaS developments, or the integration of public transportation and mobility hubs. These projects could be carried out in collaboration with future municipal teams working on the development of mobility hubs.

6.2 Final conclusion

The final results of this project are the interactive roadmap towards the implementation of Buurthubs and the explanation cards provided with the roadmap. The foundation for this roadmap are the future vision and the 3 challenges presented including the accessibility of hubs, both physically and digitally, the availability of modalities in Buurthubs, and user behavior change toward shared mobility. The three challenges are defined in the discovery phase, mainly through discussions with the current Buurthubs team. These challenges overlap with the user needs defined throughout the conducted user research. The future vision forms the ultimate goal of which the roadmap leads to, following the steps presented on the map.

The end results adres the design goal which was to design a user-centric roadmap for the implementation of Buurthubs to reduce the use of private cars, in order to support citizens towards more sustainable travel behavior and to rearrange the urban public space.

To conclude, the self-explanatory roadmap could either be used digitally or physically by future team members in the municipality that will be working on implementing mobility hubs. The hope is that these hubs will have a remarkable contribution to multimodal travel and shared mobility, in order to reduce the use of private cars.

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8. Appendix

8.1 Initial project brief

Personal Project Brief - IDE Master Graduation

TUDelft

BuurtHubs and their effect on mobility transition to shared ownership — project title

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

start date 08 - 12 - 2021 — 18 - 05 - 2022 end date

INTRODUCTION **

Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

The city of Amsterdam is getting more crowded, with lots of cars parked still alongside the streets. For the municipality, the vision is a cleaner, more connected and less crowded city. This is why the municipality is researching new alternatives for transportation that are in line with this vision, thus smarter and cleaner mobility. These alternatives go hand in hand with data and digitalisation. Therefore, the Smart Mobility programme 2019-2025 was introduced, which contributes to the vision of this future city. With this programme, Amsterdam develops together with the residents, visitors, public and private parties the new mobility system of the future.

One of the projects of the Smart Mobility Programme, initiated by the municipality, is the BuurtHubs. A BuurtHub is a physical place, where shared electric means of transportation are offered (e-bikes, e-cargo bikes, e-scooters and/or e-cars). These BuurtHubs are set up according to a participatory procedure with the neighbourhoods. Therefore, these Hubs can vary in size, type of location and type of offer. The project is part of a European project called the eHUBs, in which the muncipality is collaborating with partners from countries like Belgium, Germany, France and the UK. Each city has an own approach on the Hubs, each will differ according to the size and needs of the resepective cities.

The eHUBS project kick-off took place in 2019 and there are already 5 BuurtHubs realized in Amsterdam (10 by the end of this year). These Hubs are set up with the goal to provide a more sustainable way of transportation. The aim is that shared mobility will replace/reduce the use of private cars and therefore save public space and reduce CO2 emissions.

On a practical note:
This graduation topic was formulated in cooperation with Diederik Basta from the Smart Mobility Programme. Diederik is a project manager at the CTO (Chief Technology Office), currently working on the European HUBS project/ BuurtHubs. Diederik will be the supervisor from the municipalities' side. My Mentor is Sylvia Mooij and she will be providing the strategic perspective to the project. My Chair is Suzanne Hiemstra, director of the Seamless Personal Mobility Lab and she has a lot of expertise on mobility.

space available for images / figures on next page

Personal Project Brief - IDE Master Graduation

TUDelft

PROBLEM DEFINITION **

Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

There are already a couple of BuurtHubs in use in Amsterdam. The 'Amsterdamse Aanpak' (Amsterdam Approach), consists of 3 elements, of which the first is to start small and then scale up to the whole city. This means they test their concepts on a small scale, they monitor their results and lessons learned and then they use these results to scale up. The same goes for the BuurtHubs. As the end of the European pilot project is near, the question remains how to scale up the BuurtHubs in such a way, to achieve their maximum potential to sustainable mobility.

Besides the technical issues such as costs and logistics, there are user related matters that need to be addressed: Who were actually the target group of this project? Who did the BuurtHubs attract at the end? What is the effect of the hubs on user's behaviour? Will people who enjoy having a private car use the Hubs? If not, how can the Buurthubs seduce these people to use the hubs?

Although these challenges are to be further determined in my research phase, they can already be summed up in 2 categories, which will form the structure of my project: 1) What are the lessons learned from the current Hubs? And 2) What changes need to be made on the current Buurthub set-up to make it scalable?

ASSIGNMENT **

State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, ... In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

Designing scalable solutions for the BuurtHubs in Amsterdam, that contribute to the mobility transition to shared ownership

The first part will involve doing research on the current BuurtHubs. This means gathering data and information on the project. There are universities researching different aspects of the Hubs, such as a research conducted by a team from HvA (Hogeschool van Amsterdam) measuring the actual effect of these Hubs on the behavioural change of the users. During this phase, I will be talking to /interviewing these different parties, connecting the dots and drawing up concrete conclusions on which challenges we are facing with the Buurthubs and maybe already touching upon solution spaces.
Possible outcomes of this phase could be: process and shareholder analyses, customer journey map, coherent vision for the future Hubs, overview of the challenges of the current hubs..

The second part will start by exploring the solution space and designing solutions that are scalable and that will contribute to the Buurthubs to make them more attractive than using private cars. A lot of focus will be put into the social impact of the Buurthubs and the behavioural change of the users.

Personal Project Brief - IDE Master Graduation

TU Delft

MOTIVATION AND PERSONAL AMBITIONS

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, ... Stick to no more than five ambitions.

WHY?:
To design for the sake of living sustainable has been a thread through my study career. All project I have done in the past years, involves various parts of sustainability. The Smart Mobility programme in general focusses on traveling more sustainable, which fits my personal interests. In addition, the aim of the BuurtHubs is to reduce the use of private cars, which in essence relies on the basis of Shared Economy, which I admire (and use) a lot.

This summer, I was in Berlin for the first time. Such a wonderful city. But yet, there I witnessed the negative side of this Shared Economy. Thousands of shared (electric) bikes, steps and cars stacked on the streets and are barley being used.

Since I was a kid, I was always fascinated by streets where cars were not allowed. Where I, as a kid, could run over the broad streets without caring about the cars. One trip to Brussels a while ago reminded me of this fascination. As cars were not allowed on the streets on that day, I think it was a Sunday morning, the streets were extremely quiet, calm and clean.

PRACTICE:
On a more practical note, I chose to do this project for the municipality, as I wanted to get into practice as much as possible. This project involves a lot of different stakeholders and there is where I think an SPD student is needed the most. To connect these different parties with a fresh perspective. I do think that the bureaucratic approach of the municipality is going to be a challenge. Yet, I think the communication skills I have developed and the holistic approach I have will get me quite far.

NEAR-FUTURE ORIENTED
What I find very interesting about this project is the fact that there are already BuurtHubs realized in Amsterdam. This pushes the project away from being just 'theoretical'. I hope that what a I design will be (partly) achieved and is to be seen on the streets of Amsterdam within a short period of time.

BEHAVIOURAL CHANGE
Even though I don't want this project to get very psychological, I do not want to ignore it when it comes to behavioural change. Understanding people and their needs lies at the core of my studies, but making them change their behaviour if needed, is highly complicated. It is something I need to address and I hope that the results of the HvA study will be beneficial for my project.

JOYFUL
Graduation always freaks people out. This will happen to me as well, but I still want to enjoy working on MY project, push myself to the limits and be proud of what I deliver.

FINAL COMMENTS

In case your project brief needs final comments, please add any information you think is relevant.

8.2 Co-creation session

During the 2 co-creation sessions, a presentation was given on the future vision, the horizons, the roadmap and its different elements. Additionally, the team was provided with a short description of the personas. The sessions had a co-creative take, as the content of the roadmap was discussed, evaluated and finally adjusted.

The results of the sessions were perceived by the team members as positive. To show the results of these sessions, a selection of questions and comments is listed and discussed about the content of the roadmap:

“The push factors are a very important element. We as municipality have the role and the ability to anticipate on these factors” -team member 1
The push factors mentioned in the roadmap were perceived as very useful as they are within the power of the municipality and some of them are already being achieved.

“Emission-free zones must be added to the push factors” -team member 3
One important push factor was missing and that is the implementation of emission-free zones in Amsterdam. Vehicles with combustion engines are no longer allowed in these zones. This is seen as a serious push factor for people owning a petrol car.

“Behavior change is usually underexposed in the world of mobility, I would love to see it more in your roadmap” team member 2
The actual take of the third challenge was behavior change. This was titled as ‘user involvement in using the hubs’, which was quite confusing for the team. The way to increase user involvement in using Buurthubs is to achieve the desired behavior change. Changing the title to ‘behavior change towards shared mobility’ makes much more sense. However, the link between push- and pull factors and their effect on the users was not clear yet. The next question was asked by team member 2: “What is needed to reach each persona within the different horizons?”

“Ensuring a higher return rate of modalities must be more the responsibility of mobility providers” team member 2
The examples given were some providers of shared electric cars when connected to a charging point, the user is rewarded. Also Check is working with rewarding systems for the user when the modalities are parked correctly.

“Chose one abstraction level for the actions presented in the roadmap”-team member 3
The actions shown in the roadmap did not have the same abstraction level as they differed from very task-specific to general actions that needed to be taken by the municipality. Actions such as ‘evaluate on..’ are left out.

One of the bottlenecks mentioned during the session is the spatial occupation of these hubs, which becomes especially apparent as the number of hubs increases. One of the arguments against establishing the hubs, from a free-floating standpoint, is that it will clog the public space. The municipality will have far greater control over their spatial development than when modalities are free to roam the streets. However, this spatial development still necessitates considerable thought, planning, and execution. One factor that could aid in this development is the multifunctionality that the hubs can provide. Activities from our everyday lives can be incorporated into the hubs. Using the hubs as a package delivery point is one example. The multi-functionality of (un)occupied space in the hubs remains a challenge.

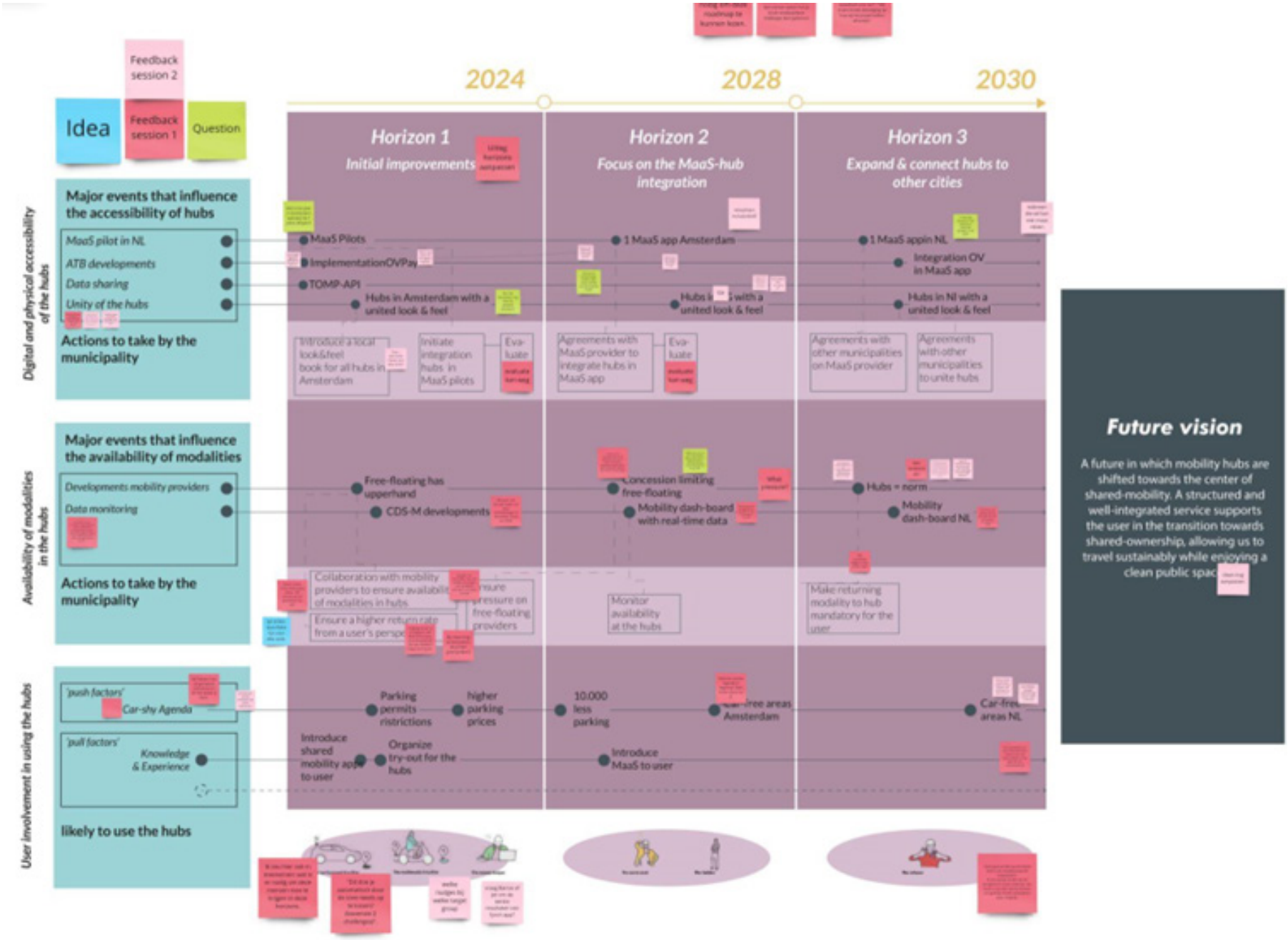

Figure31. (Impression of results validation sessions with Buurthubs team)