A design approach to determine the locations in combination with amenities for neighbourhood hubs, based on user profiles

Qualitatively researching the users, amenities, and locations for neighbourhood hubs

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Qualitatively researching the users, amenities, and locations for neighbourhood hubs

by

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Preface

This thesis, "A design approach to determine the locations in combination with amenities for neighbourhood hubs, based on user profiles", is the final product to complete the master's programme TIL (Transport, Infrastructure & Logistics) at the TU Delft. It represents the work I have done during the foregoing seven months in cooperation with the TU Delft and Advier.

I have already been following the world around mobility hubs since I started with my master's programme. Mobility hubs combine many interesting domains, such as mobility (obviously), urban development, social cohesion, and many others. That's why I wanted to do more research into mobility hubs. When I first came across Advier, it was immediately clear that they are one of the most prominent companies in the Netherlands regarding mobility hubs and shared mobility. A good match! Their question focused specifically on the allocation of amenities to a grid of neighbourhood hubs. When I started at Advier, it became clear very quickly that there are a lot of unknowns regarding neighbourhood hubs. Obviously, in the early stages of my graduation trajectory I wanted to do way too much, which resulted in a very extensive research proposal. I think this is the most common issue among graduation students. As the thesis progresses, you realize that you cannot answer all questions related to neighbourhood hubs over the course of a few months… scoping, scoping, and scoping - that's the motto. Fast-forwarding to today, I am grateful that I have been able to contribute to the domain of neighbourhood hubs in both a practical and scientific way.

I feel very fortunate that I have been given to opportunity to spend my last time as a student at Advier. Despite a large part of my graduation trajectory fell right within the Corona pandemic, my colleagues at Advier did everything to involve me into the activities of the company as well as possible. I would like to express my gratitude to my supervisors from Advier, Riëtte Zonnenberg, Jordi Spruit, and Minze Walvius, and all my other colleagues for their help and positive support. Moreover, I would like to thank my daily supervisors from the TU Delft, Jan Anne Annema and Niels van Oort for their valuable guidance, feedback, and time. I was even given the chance to promote my work on TV. It is great that students get such opportunities. I am also very grateful that Bert van Wee was willing to chair my committee, and provide such detailed feedback during the official supervision meetings. Finally, I would like to express my heartfelt thanks to the support I received from family, friends, and fellow students during my thesis. I really enjoyed all the good conversations and fun times!

And of course, I will keep following the developments around hubs, and I am very curious for what the future holds!

Vianen, J.C. (Jarco)

Rijnsburg, April 2022

Summary

Context

Cities and regions are dealing with increased levels of urbanization due to population and economic growth, demanding for more urban densification. It requires space to realize the development projects. Moreover, the addition and/or expansion of functions is often accompanied with a higher mobility demand. Infrastructure allowing for growing mobility flows also occupies space. At the same time, goals such as liveability, sustainability, health, and social equity are becoming increasingly important for cities. All of the above demands for mobility solutions to use urban space more efficiently while maintaining and improving accessibility.

According to Advier, a grid of mobility hubs could contribute to a better use of space dominated by inefficiently used private vehicles. A mobility hub is a recognizable place which integrates a range of transport modes and shared services. These hubs occur in different sizes, varying from larger hubs like train stations, to neighbourhood hubs which serve the needs of people on a local level. Through clustering of different amenities, mobility hubs can organize them in a more efficient way. This could potentially lead to less required infrastructure, connect different amenities with each other, and increase the attractiveness and recognizability of shared mobility alternatives. Furthermore, according to Coenegrachts et al. (2021) and CoMoUK (2019), a grid of mobility hubs in combination with shared mobility could lower the car-dependency, subsequently lowering the required number of parking spaces.

Problem definition

A grid of mobility hubs can only contribute to a better use of space if the amenities at these hubs are actually used by people. While this seems obvious, it can be observed in practice that authorities and consultancy agencies lack knowledge about users, amenities, and locations of mobility hubs. Moreover, there is a growing need for a practical tool to determine the most preferrable locations and amenities for hubs. Advier has already developed a tool to determine a grid of mobility hub locations, by using existing transport nodes. For this thesis, Advier has expressed the need to expand this tool by also considering non-mobility related nodes, and determining the amenities for each mobility hub location.

Meanwhile, scientific literature on the locations and amenities of mobility hubs is scarce. In available literature three main scientific gaps can be identified: (1) studies focusing specifically on locations of mobility hubs mainly consider larger scale mobility hubs, (2) none of the existing literature has researched which shared services and transport modes should be allocated over a grid of hubs, and (3) the influence of users on hub locations and offered amenities at each hub location remains unknown.

Research objective & Research question

Based on the problem definition, the following research objective is formulated:

To develop a design approach which is able to determine the most preferred locations in combination with amenities for neighbourhood hubs. Knowledge about users, amenities, and locations is gathered and translated into the design approach, aiming to determine the locations and amenities for neighbourhood hubs in such a way, that people are more likely to use them.

The design approach provides a step sequence to determine the most preferred locations in combination with amenities for neighbourhood hubs, based on users, and provides suggestions to interpret and possibly implement the step sequence results. The step sequence should be practical and effectively applicable by consultancy agencies (e.g. Advier) to advise their clients (e.g. authorities) about neighbourhood hubs. It is therefore not practical to consider all people individually – users are in this thesis classified into user profiles.

Following the research objective, the main research question has been formulated as follows:

"What is a suitable design approach to determine the most preferred locations in combination with amenities for neighbourhood hubs, based on user profiles?"

The design approach is referred to as the Neighbourhood Hub Design Approach (or in short, Design Approach).

Methodology

The author has chosen to only use qualitative methods for this thesis, because it considers user profiles in an existing urban environment. And when you consider user profiles, you consider people. People have a numerous characteristics and exhibit different types of behaviour – this is very hard to express quantitatively. Therefore, the author believes that a qualitative approach is most suitable to capture the needs of people into the Neighbourhood Hub Design Approach.

Different methods were used in this thesis to answer main research question. A **Literature review** was used for different purposes, such as exploring the state-of-the-art, formulating key policy objectives, providing theoretical background for the Design Approach, indicating hub locations, amenities, catchment areas of hub amenities, and research the influence of user on amenities and locations of hubs. During the **Step sequence conceptualization**, the existing Advier tool was expanded to iteratively obtain the step sequence. User profiles were based on the **Whize segmentation**, an existing classification of Dutch households into 11 segments. A personification of these user profiles was made to efficiently explain them to experts during **Focus groups**. These focus groups play an important role to obtain an expert perspective on the probability that a user profile will use hubs, and amenities for each user profile. A **Case study** in the municipality of Almere was used to assess the Design Approach. A reflection session was held with the municipality of Almere and Advier to determine the usability of the Design Approach, and how the step sequence results could be interpreted and implemented.

Findings

Key policy objectives related to neighbourhood hubs

Before applying the Neighbourhood Hub Design Approach, it is important that authorities know which objectives they want to achieve with the development of neighbourhood hubs. This research has shown that, especially Dutch policy documents, do not explicitly link policy objectives with neighbourhood hubs (or mobility hubs in general). Furthermore, it can be observed that mobility hubs are solely related to mobility-related functions while they could contribute to wider societal benefits.

Input from the SUMP, 5E framework and Advier has been utilized to propose a set of key policy objectives:

- ***Social inclusiveness****: enable all people to access all key destinations and services;*
- ***Healthy people & environment****: offer sustainable transport alternatives to stimulate physical exercise among people, and reduce pollution and emissions;*
- ***Efficient & attractive use of space****: decrease parking space for private vehicles to use those areas for greenery and other functions;*
- ***Improve social cohesion****: create a place for local residents to meet and stimulate interaction;*
- ***Stimulate local economies****: placing neighbourhood hubs near local shops and other facilities creates synergy effects as people will be stimulated to do their shopping and groceries locally.*

The proposed key policy objectives provide a guidance for policymakers to define goals they would like to achieve with developing neighbourhood hubs.

Neighbourhood Hub Design Approach

Incorporating user profiles into the Neighbourhood Hub Design Approach can be theoretically underpinned with the Fogg Behaviour Model. According to this model, it requires a combination of motivation, ability, and triggers for someone to show behaviour. The incorporation of user profiles can be related to the motivation part of the model. For example, if shared mobility is offered at a hub, users can anticipate on using this for their trips. Moreover, placing hubs within walking distance of residents lowers the physical effort and thus increases someone's ability to use hubs.

The step sequence of the Neighbourhood Hub Design Approach is presented in figure 1. In essence, the step sequence can be divided into three parts. The first part, *I. Hub locations*, aims to determine the most preferred hub locations by using anchor points. The second part, *II. Hub amenities*, aims to determine which amenities should be considered, and subsequently what are existing locations of these amenities and what are the search areas for new locations. User profiles are used to determine the preferred amenities in each district. Finally, the third part, *III. Amenities per hub location*, combines the results from the first and second part by determining promising hub amenity types for each hub location.

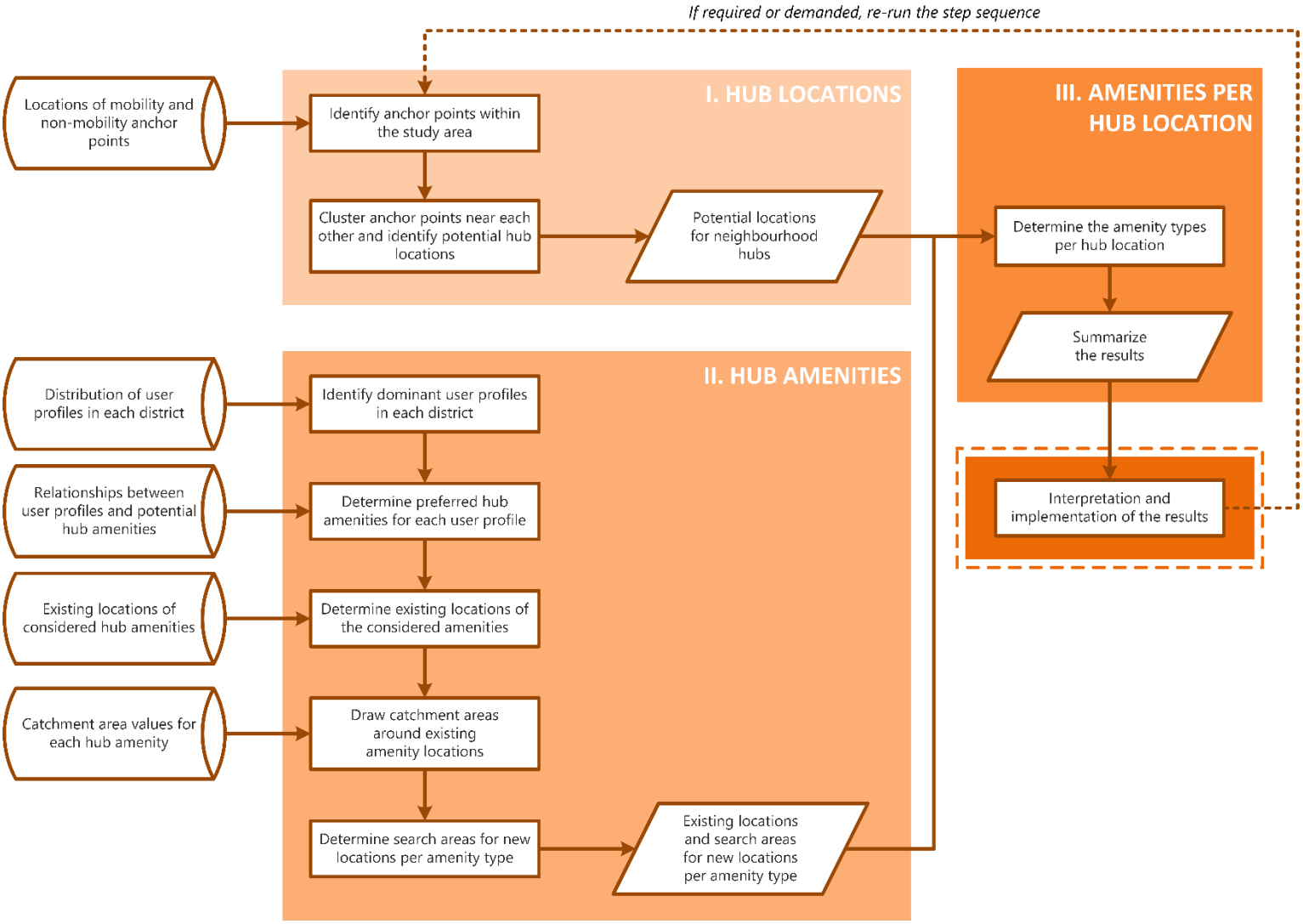


Figure 1 - Neighbourhood Hub Design Approach into conceptualized flow-chart.

The component in the darkest orange coloured box entails the 'Interpretation and implementation of the results'. This means that the Neighbourhood Hub Design Approach does not stop after having obtained the results in part III. The next step is to interpret these results, and make an implementation plan if policymakers would like to develop hubs in their city. A final component of the step sequence that needs to be discussed is the feedback loop, showed by a dotted line. It could be required to run the step sequence multiple times consecutively with different inputs. For example, considering more and more types of anchor points to increase the neighbourhood hub grid density.

During the development of the Neighbourhood Hub Design Approach, it turned out that if one would want to apply the step sequence in a case study for a real city, more research is required for multiple components. The results of these components are addressed in the following.

Locations for neighbourhood hubs

A literature study found a number of potential types of locations (i.e. "anchor points") to place a neighbourhood hub. A neighbourhood hub does not have to be placed at an existing transport node per se, but could also be placed at a non-mobility anchor point. Different criteria and attributes can be used to indicate which anchor points could be promising neighbourhood hub locations. Two indicators are proposed, which were suggested by Advier and could be related to the theory from Bertolini (1999).

The first indicator, number of clustered anchor points, assumes that more anchor points lying close to each other indicate more activities and functions in that area. This could be related to a higher place-value, and subsequently a higher intensity and diversity of potential neighbourhood hub users. The second indicator, network level of each anchor point, assumes that different types of anchor points serve on different hierarchical network levels. A higher network level could indicate a higher potential for passenger and visitors, and a lower movability of the anchor point type. Both indicators can be used to determine the most preferred locations for neighbourhood hubs, and prioritize locations for the rollout of neighbourhood hubs.

Amenities for neighbourhood hubs

The Neighbourhood Hub Design Approach requires a limited set of amenities to be able to consider all of them during the focus groups, and to keep the step sequence practical and efficient. For this step four hub guidelines from SHARE-North partners were reviewed. Therefore, only those shared services that could be a trigger on themselves for people to use neighbourhood hubs are considered. This is because the step sequence actively searches for existing and new locations for each amenity type. Besides, only those amenities that occur two or more times in the four reviewed hub guidelines are considered. This narrows down the list of amenity types to eleven shared services and eleven transport modes. These amenities are used for the remainder of the study.

User profiles method

For this thesis the Whize segmentation was found the most suitable method to define user profiles. Available data of the Whize segmentation distribution in the municipality of Almere shows that there are five dominant user profiles on a four-digit zip code level: "Young & Hopeful", "Working Class", "Average Joes & Janes", "Friendly Emptynesters", and "Planning & Rushing". Thus, these user profiles are considered in the focus groups to determine the most preferred neighbourhood hub amenities, and which user profile has the highest probability to actually use neighbourhood hubs.

Young & Hopeful	Working Class	Average Joes & Janes	Friendly Emptynesters	Planning & Rushing

In order to merge the user profiles into a presentable format, personas were created. Existing templates and expert judgement from Advier were consulted to create a persona for each user profile. These personas are used in the presentation for the experts during the focus groups.

Influence of user profiles on locations and amenities of neighbourhood hubs

Based on the focus groups and a literature review, it could be concluded that people from any user profile can be incentivized to use neighbourhood hubs if they have the right motivations. This aligns with the Fogg Behaviour Model which states that motivations, together with ability and triggers, influence behaviour. Offering those amenities that correspond with the needs of people could convince anyone to use neighbourhood hubs, but motivations can differ among user groups.

Still, some user profiles are more likely to adopt neighbourhood hubs than others. It was found that the user profiles Young & Hopeful and Average Joes & Janes have a relatively high probability to actually use neighbourhood hubs. If it is known for every district which user profile is dominant, the probability distribution can be used to indicate those districts where implementing neighbourhood hubs should be prioritized from an adoption perspective. Moreover, the most preferred amenities are different for each user profile. For example, Young & Hopeful and Average Joes & Janes are the main target groups for shared mobility. Planning & Rushing could be convinced to use shared mobility if it really adds value to what they already possess. The presence of certain user profiles influences the set of most preferred amenities to consider in a district.

Thus, the presence of user profiles influences the prioritization of neighbourhood hub locations through the probability of each user profile to use neighbourhood hubs, and it influences the most preferred amenities for neighbourhood hubs through each user profiles' needs for shared services and transport modes.

Catchment areas of neighbourhood hub amenities

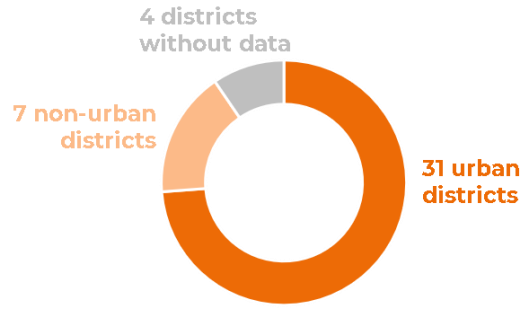
Based on a literature study, assumptions for the catchment area values per amenity are made. The catchment area is defined as the willingness to walk expressed in meter. It is assumed that all amenities for which no specific literature is available have a catchment area of 400 m (i.e. the walking distance). Cycling is another popular access mode in the Netherlands which can increase the catchment area of an amenity, and potentially influence the willingness to walk. For this latter part, no evidence has been found in this study.

Assessment of the Neighbourhood Hub Design Approach in Almere

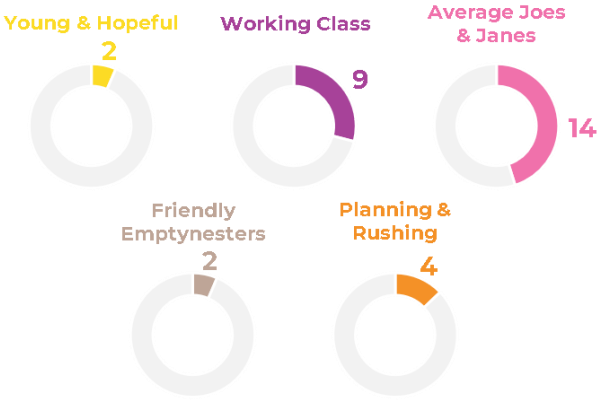
The Neighbourhood Hub Design Approach has been assessed in a case study with the municipality of Almere. Especially the bus stops, community centers, and shopping facilities contribute to a well-spread grid of anchor points throughout Almere. Going through the step sequence results in a grid of 38 most preferred neighbourhood hub locations. These can be used in the first phase of rolling out hubs in Almere. Average Joes & Janes and Working Class are the dominant user profiles in most districts. As a result, the three transport modes with the highest number of new locations at neighbourhood hubs are: shared cars, shared cargo bikes, and trailers. For the shared services these are bicycle parking, bicycle repair stands, and sports equipment. The overall results are summarized in the infographic in figure 2.

INFOGRAPHIC – CASE STUDY RESULTS ALMERE MUNICIPALITY

Number of urban, non-urban, and no data districts



Number of urban districts in which the user profile is dominant



Types and number of anchor points

6 train stations

5 P+R locations

109 bus stops

23 community centers

19 squares

28 shopping facilities

38

Most preferred **neighbourhood hub locations**. These can be used for the first phase of rolling out neighbourhood hubs

9 types of transport modes and **9 types of shared services** are distributed over the 38 most preferred neighbourhood hub locations

For **5** transport mode types and **8** shared service types, there were already **existing locations**

For **8** transport mode types and **8** shared service types, **new locations** should be added

Number of most preferred neighbourhood hub locations at which an amenity is:

already there,
to be added, or
do nothing;

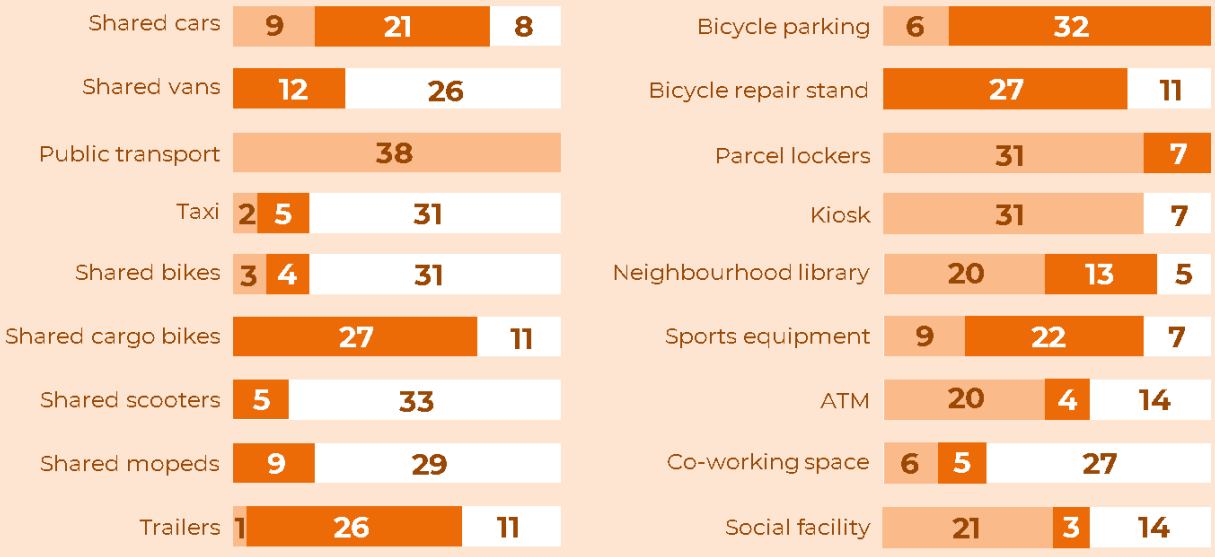


Figure 2 - Case study results summarized in an infographic.

From the reflection it could be concluded that the municipality of Almere thinks that the Design Approach is a suitable tool to consider when implementing neighbourhood hubs. First, in the current situation the municipality has little to no substantiation for determining the locations of neighbourhood hubs. The use of anchor points offers a stepping-stone to come up with logical hub locations. Second, the potential user groups of hubs remain largely unknown for the municipality as of now. Representatives think that incorporating user profiles into the Design Approach provides first insights in the needs of users. Advier also thinks that the Design Approach will be applied in future projects. This is because the tool provides a grid of hub locations and amenities at each hub location, which can be used as a starting point for further neighbourhood hub developments. While the demand from clients is there, such a tool does not exist currently. The addition of residents also provides a first indication for how to tailor hub amenities and locations to residents.

The reflection sessions contributed in another way to the Design Approach through suggestions to prioritize hub locations. Anchor points with a lower movability and hub locations in districts with a high share of Young & Hopeful could be prioritized. Moreover, the reflection sessions provided suggestions to determine hub locations in more detail. If there are multiple anchor points, the anchor points with the lowest movability could be preferred. Also, policy objectives could play an important role in location choice. For example, a supermarket might be preferrable over a public transport stop if social cohesion is a major objective for authorities.

Conclusion

This thesis proposes the Neighbourhood Hub Design Approach which is able to determine the most preferred locations and amenities of neighbourhood hubs in urban areas, based on user profiles. The underlying principle is to determine the locations in combination with amenities in such a way, that people are more likely to use neighbourhood hubs. To the best of the author's knowledge, this is the first study to consider the influence of user profiles on the amenities and locations of hubs. By aligning the locations and amenities of hubs with the needs of people, any user profile could be convinced to use neighbourhood hubs. This thesis has researched which potential locations (anchor points) are suitable for neighbourhood hubs, and how the characteristics of these anchor points and presence of user profile can be used to prioritize neighbourhood hubs locations, and determine each location in more detail from a theoretical perspective. Furthermore, research has shown which types of amenities should be offered at neighbourhood hubs for each user profile.

The Neighbourhood Hub Design Approach provides a step sequence and suggestions for the interpretation and implementation of the step sequence results. The step sequence has brought the existing Advier tool to a next step. It can be used by consultancy agencies, such as Advier, to support decision-making of authorities regarding the most preferred locations and amenities for neighbourhood hubs. Because it incorporates knowledge about the needs from users, these can be considered from the beginning in the development of neighbourhood hubs. Suggestions for the interpretation and implementation of the step sequence results could help authorities to prioritize the rollout of neighbourhood hubs, and determine each neighbourhood hub location in more detail.

Recommendations

This thesis provides a number of recommendations for future research. A first direction to pursue in future studies is to gain more insights into the residents, or users of neighbourhood hubs. User profiles are based on the existing Whize segmentation. To elaborate on this, future studies could empirically classify users into area-specific user profiles. A second direction to gain more insights into users of neighbourhood hubs, is to empirically research what are the needs for amenities from user profiles. A third direction to pursue which is related to the above is to research what are the effects or benefits on the willingness to use or pay by placing certain shared services or transport modes at a neighbourhood hub. Next, more criteria could be used to indicate the most preferred neighbourhood hub locations. This could be done in the form of a Multi-Criteria Analysis, or if possible, a full quantitative analysis. A fifth possibility may well point in the direction of also researching hubs with a destination function.

Finally, a number of recommendations for policymakers are presented. Before using the step sequence results, policymakers should have a clear definition of the 'neighbourhood hub' which looks further than the mobility aspects, and point out the policy objectives to which neighbourhood hubs should contribute. In the end, policy objectives determine how the results from the step sequence are used. Moreover, if authorities would like to develop a neighbourhood hub in a certain area, it is important that they engage the people living in that neighbourhood during the development process. With that, they should also consider the dynamic character of hubs as cities and its residents change over time. Also, it is recommendable that services are clustered at hubs as much as possible if there is sufficient space available. Besides, even if the Neighbourhood Hub Design Approach would be able to perfectly locate neighbourhood hubs and determine the ideal set of amenities at each hub locations, still a trigger is required before people are actually going to use hubs. Finally, besides using neighbourhood hubs as pull factors, push factors are required to make it less attractive to own a private car.

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1. Introduction

1.1 Context

Cities and regions are dealing with increased levels of urbanization due to population and economic growth, demanding for more urban densification (Wang et al., 2019). For example, the Dutch government is planning to build nearly one million houses until 2030, which requires denser cities and regions (Rijksoverheid, 2021). It requires space to realize the development projects, such as housing developments. Moreover, the addition and/or expansion of functions is often accompanied with a higher mobility demand: people have to travel to, from, and between activities. Infrastructure allowing for growing mobility flows also occupies space (roads, parking spaces, loading and unloading areas, etc.). At the same time, goals such as liveability, sustainability, health, and social equity are becoming increasingly important for authorities and the people living, working or visiting the areas (Valcárcel-Aguiar et al., 2018; UNSD, 2020). All of the above demands for more efficient use of urban space and thus mobility solutions to maintain and improve accessibility as well as reducing the spatial impact of corresponding infrastructure (CoMoUK, 2019; KiM, 2021).

Mobility hubs have received attention in a number of recent studies (Bösehans et al., 2021; Coenegrachts et al., 2021; Franken, 2021; Van Gerrevink, 2021; Van Marsbergen et al., 2022). According to Advier, a grid of mobility hubs could contribute to a better use of space dominated by inefficiently used private vehicles. A mobility hub is a recognizable place which integrates a range of transport modes (e.g. car-sharing, bike-sharing, bus, etc.), and shared services (e.g. postal lockers, neighbourhood library, kiosk, etc.). These hubs occur in different sizes, varying from larger hubs like train stations which combine a lot of shared services and transport modes, to neighbourhood hubs which serve the needs of people on a local level. Through clustering of different amenities (shared services and transport modes), mobility hubs can organize them in a more efficient way. This could potentially lead to less required infrastructure, connect different amenities with each other, and increase the attractiveness and recognizability of shared mobility alternatives. Furthermore, according to Coenegrachts et al. (2021) and CoMoUK (2019), a grid of mobility hubs in combination with shared mobility could lower the car-dependency, subsequently lowering the required number of parking spaces in an area. This unlocks more space for greenery, housing, and other developments.

1.2 Problem definition

A grid of mobility hubs can only contribute to a better use of space if the amenities at these hubs are actually used by people. While this seems obvious, it can be observed in practice that authorities and consultancy agencies lack knowledge about users, amenities, and locations of hubs, and how these users influence which amenities should be offered at each hub location. Moreover, there is a growing need for a practical tool to determine the most preferrable locations in combination with amenities for mobility hubs. Advier has already developed a tool to determine a grid of mobility hub locations, by using existing transport nodes. For this thesis, Advier has expressed the need to expand this tool by also considering non-mobility related nodes and determining the amenities for each hub location. Not all amenity types should be offered at every location in the mobility hub grid, as this depends on the catchment areas of amenities and demand from users.

Meanwhile, scientific literature on the locations and amenities of mobility hubs is scarce. In available literature three main scientific gaps can be identified (see chapter 3 for a more comprehensive overview). First of all, it can be observed that studies focusing specifically on locations of mobility hubs mainly consider larger scale mobility hubs, rather than the smaller scale neighbourhood hubs (Blad, 2021; Martinez & Rakha, 2017; Petrović et al., 2019). There are a few studies that explicitly consider neighbourhood hubs (Claasen, 2020; Van Rooij, 2020), but these do not focus on determining preferred

locations of these hubs. Second, none of the existing literature has researched which shared services and transport modes should be allocated over a grid of hubs. Third, while a few studies researched typical users of mobility hubs, the influence of users on hub locations and offered amenities at each hub location remains unknown (Bösehans et al., 2021; Claasen, 2020; Van Rooij, 2020).

By combining the needs from Advier, authorities, and scientific literature, it can be concluded that there is a need for knowledge about users, amenities, and locations of smaller scale mobility hubs (i.e. neighbourhood hubs), and how users could influence the locations and offered amenities of neighbourhood hubs. Moreover, the needs from Advier and authorities could be addressed by translating this knowledge into a design approach to determine the most preferred locations in combination with amenities for neighbourhood hubs, by incorporating users.

1.3 Research objective

As mentioned, the development of neighbourhood hubs can only contribute to goals such as more efficient use of urban space, if the amenities at neighbourhood hubs are actually being used. With this in mind, the following main research objective can be formulated:

To develop a design approach which is able to determine the most preferred locations in combination with amenities for neighbourhood hubs. Knowledge about users, amenities, and locations is gathered and translated into the design approach, aiming to determine the locations and amenities for neighbourhood hubs in such a way, that people are more likely to use them.

The design approach will be referred to as the Neighbourhood Hub Design Approach (or in short, 'Design Approach'), which provides a step sequence to determine the most preferred locations in combination with amenities for neighbourhood hubs, based on users, and provides suggestions to interpret and possibly implement the step sequence results. The existing tool from Advier can be used as a starting point. This tool is aimed at urban areas, so the Neighbourhood Hub Design Approach in this thesis also focuses on urban areas. The step sequence should be practical and effectively applicable by consultancy agencies (e.g. Advier) to advise their clients (e.g. authorities) about neighbourhood hubs. It is therefore not practical to consider all people individually – users are in this thesis classified into user profiles.

1.4 Research questions

Following the research objective, the main research question has been formulated as follows:

"What is a suitable design approach to determine the most preferred locations in combination with amenities for neighbourhood hubs, based on user profiles?"

The design approach is proposed in this thesis. But, to be able to apply the design approach in a real-life city and to address the knowledge gaps from practice and science, research is required into a number of topics. Therefore, the following sub-research questions have been formulated:

1. *"What are the key policy objectives to which neighbourhood hubs in urban areas could contribute?"*
2. *"What are promising types of locations and amenities for neighbourhood hubs in urban areas?"*
3. *"What are the most suitable user profiles to incorporate the influence of users on neighbourhood hub locations and amenities?"*
4. *"What is the influence of user profiles on the most preferred locations and amenities for neighbourhood hubs in urban areas?"*

1.5 Relevance

1.5.1 Scientific relevance

This study contributes to scientific research into the domain of planning neighbourhood hubs, by focusing on smaller scale mobility hubs (i.e. neighbourhood hubs) which serve the needs of communities in neighbourhoods, instead of only considering larger scale mobility hubs. Second, it researches what are the most preferred amenities to offer at each neighbourhood hub location, about which there is little knowledge as of now. Third, it aims to gain knowledge about users of neighbourhood hubs and their influence on the most preferred neighbourhood hub locations and amenities.

1.5.2 Practical relevance

This study contributes to practice as it aims to gain knowledge about users, amenities, and locations of neighbourhood hubs. Moreover, it proposes a Design Approach to determine the most preferred locations in combination with amenities for neighbourhood hubs. The main target groups of the Design Approach are consultancy agencies and authorities who are dealing with the implementation of neighbourhood hubs. The step sequence of the Neighbourhood Hub Design Approach should be practical and easily usable by consultancy agencies, such as Advier, to advise policymakers who want to develop neighbourhood hubs in their cities. Moreover, the Neighbourhood Hub Design Approach aims to provide suggestions how to interpret the step sequence results, so authorities can be advised on how they should implement neighbourhood hubs. Furthermore, because the influence of users is incorporated, policymakers are able to get an impression of user needs at an early stage, so they can consider those from the beginning in their neighbourhood hub planning strategies.

1.6 Scoping

1.6.1 Neighbourhood hubs within mobility hub hierarchy

This thesis focuses on neighbourhood hubs - mobility hubs which locally serve residents of neighbourhoods. Besides neighbourhood hubs there are more types of mobility hubs, each functioning on different levels in the transport network. For cities, a distinction can be made between four levels: (1) interregional/national, (2) regional, (3) local, and (4) neighbourhood. Based on these four levels, we can propose a mobility hub hierarchy (see figure 3).

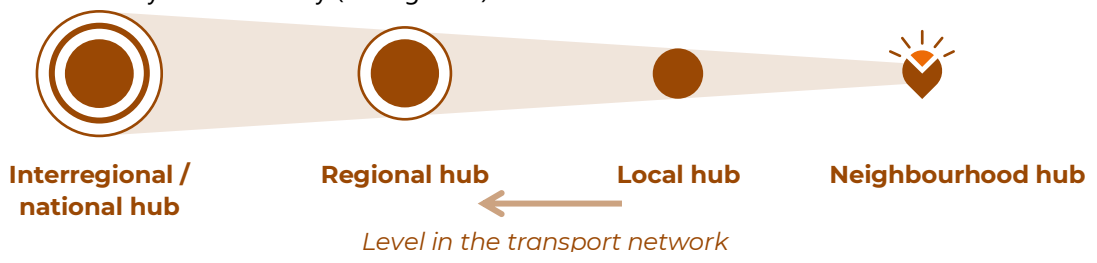

Figure 3 - Mobility hub hierarchy.

It can be seen that neighbourhood hubs are at the far right end of the spectrum, because these serve the needs of residents of the neighbourhood in which they are located. So, in this thesis neighbourhood hubs have an origin function as these are places where residents start their journey. Interregional / national hubs are on the far left end of the spectrum. These are larger scale mobility hubs with big passenger flows to and from functions around the hub, often offering a wide variety of services and transport modes.

Mobility hubs from a higher level can also serve lower levels of the mobility hub hierarchy. Take for example a train station located in the middle of a large city. It functions in the national railway network, but its services could also be used by residents living in neighbourhoods close to the station. Next, if we consider an example city with different types of mobility hubs, the resulting network of mobility hubs could be divided into four layers, according to the mobility hub hierarchy. Figure 4 shows how mobility hubs from a higher level can also serve on lower levels in the hierarchy. Thus, for this thesis we focus on any nodes located next to or within residential areas, with the assumption that they can serve the needs of residents living in surrounding neighbourhoods and communities. This means that the focus will lie on the lowest level in figure 4.

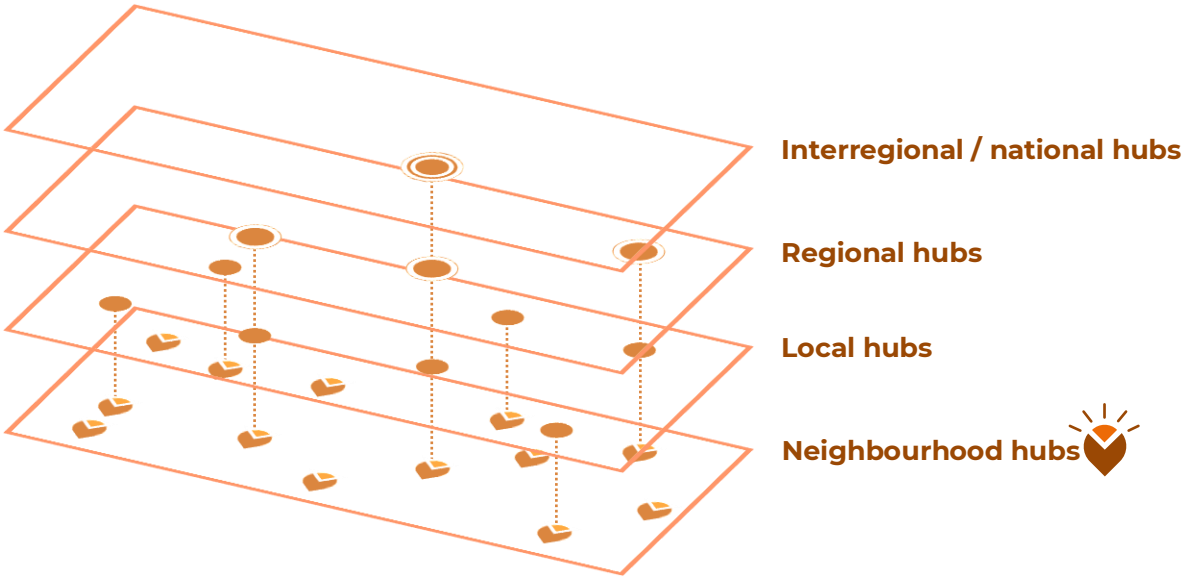

Figure 4 - Mobility hub hierarchy in layers for an example city.

1.6.2 Other scoping points

As stated in the research objective, this thesis focuses on determining the most preferred locations and amenities of neighbourhood hubs. This will be done from a user perspective which is why user profiles are used. Thereby, the main focus will lie on the Dutch context because the majority of Advier's clients is Dutch. Other aspects related to neighbourhood hubs, such as governance, the business case, logistics, and maintenance of services are excluded from the scope. Besides, this thesis focuses on existing urban environments and not on new residential areas developments. Neighbourhood hubs could also be implemented in rural areas, however it is assumed that neighbourhood hubs have a larger impact on efficient space usage in urban environments.

1.7 Thesis structure

This thesis is structured as follows. Chapter 2 provides an overview of the used methods in each chapter, and explains why and how a method is applied. Chapter 3 reviews existing literature about locations, amenities, and user of hubs. Next, chapter 4 proposes a set of key policy objectives to which the development of neighbourhood hubs could contribute. Chapter 5 starts with the most important theoretical underpinnings why incorporating user profiles in the Neighbourhood Hub Design Approach could increase the probability that people will actually use neighbourhood hubs. Next, it proposes the Neighbourhood Hub Design Approach and researches components of the corresponding step sequence. The influence of user profiles on locations and amenities of neighbourhood hubs is considered chapter 6, followed by the assessment of the Neighbourhood Hub Design Approach in chapter 7. Finally, chapter 8 concludes on this thesis by answering the main research question, discussing the findings and methodology, and providing recommendations for practice and future research.

2. Methodology

This chapter discusses the methodology which is used for this study. The author has chosen to only use qualitative methods for this thesis, because it considers user profiles. And when you consider user profiles, you consider people. People have a numerous characteristics and exhibit different types of behaviour – this is very hard to express quantitatively. Therefore, the author believes that a qualitative approach is most suitable to capture the needs of people into the Neighbourhood Hub Design Approach. The incorporation of user profiles in this thesis offer a new perspective on the design and planning of neighbourhood hubs.

Section 2.1 presents a total overview of the methodology. Next, section 2.2 to 2.6 individually discuss the range of used qualitative methods.

2.1 Methodology overview

Figure 5 divides the substantive part of this thesis into four phases, presents which method is applied for each phase, and highlights the corresponding sub-research question.

Phase	What happens in this phase?	Used methods	Related sub-research question
State-of-the-art *(Chapter 3 & 4)*	Locations, amenities , and users of neighbourhood hubs	Literature study	
	Key policy objectives for neighbourhood hubs	Literature study	*"What are the key policy objectives to which neighbourhood hubs in urban areas could contribute?"*
Neighbourhood Hub Design Approach set-up & components *(Chapter 5)*	Theoretical background on considering user profiles in the Neighbourhood Hub Design Approach	Literature study	
	Proposing the step sequence to determine neighbourhood hub locations in combination with amenities, based on user profiles.	Step sequence conceptualization	
	Components		*"What are promising types of locations and amenities for neighbourhood hubs in urban areas?"*
	• Preferred locations for neighbourhood hubs	Literature study	
	• Neighbourhood hub amenities	Literature study	
	• User profiles method	Whize segmentation	*"What are the most suitable user profiles to incorporate the influence of users on neighbourhood hub locations and amenities?"*
	• Catchment areas of neighbourhood hub amenities	Literature study	
Influence of user profiles on locations and amenities *(Chapter 6)*	Using two perspectives to determine for each user profile the probability to adopt neighbourhood hubs, and the most preferred amenities to offer	Focus groups Literature study	*"What is the influence of user profiles on the most preferred locations and amenities for neighbourhood hubs in urban areas?"*
Neighbourhood Hub Design Approach assessment *(Chapter 7)*	Applying the step sequence on the municipality of Almere Reflecting on the application of the step sequence	Case study	*No sub-research question has been formulated for this phase, but the author believes that the assessment step is highly important to answer the main research question*

Answering the main research question: "*What is a suitable design approach to determine the most preferred locations in combination with amenities for neighbourhood hubs, based on user profiles?*"

Figure 5 - Methodology overview.

The first phase, *State-of-the-art*, explores what it known about the locations, amenities, and users of neighbourhood hubs in existing literature. This is done during a literature study to explore which methods have been used, determine what can be learned from existing research, and identity the main scientific gaps. Besides, policy documents are reviewed to research how authorities have incorporated objectives related to neighbourhood hubs in their current policies. In both cases a literature study is used. After this, an answer can be provided to the sub-research question: *"What are the key policy objectives to which neighbourhood hubs in urban areas could contribute?"*

The second phase, *Neighbourhood Hub Design Approach set-up & components*, starts in chapter 5.1 by providing the most important theoretical underpinnings for incorporating user profiles into the Neighbourhood Hub Design Approach. Next, the step sequence is conceptualized based by improving the existing Advier algorithm. Also, it is determined which components require more research in order to apply the Neighbourhood Hub Design Approach. Research into the components mainly uses a literature study, but additionally the Whize segmentation is used as a method to define user profiles. Based on this, an answer can be provided to the second and third sub-research questions: *"What are promising types of locations and amenities for neighbourhood hubs in urban areas?"* and *"What are the most suitable user profiles to incorporate the influence of users on neighbourhood hub locations and amenities?"*

Next, the third phase, *Influence of user profiles on locations and amenities*, aims to determine the probability of each user profiles to use neighbourhood hubs, and also which amenities are most preferrable for each user profile. As stated in the introduction, knowledge about users and their influence on locations and amenities of hubs is one of the main gaps in practice and science. Therefore, two qualitative methods are used: (1) focus groups to take into consideration the opinions from hub experts, and (2) a literature study related to users of neighbourhood hubs and neighbourhood hub amenities. Based on this, an answer can be provided to the sub-research question: *"What is the influence of user profiles on the most preferred locations and amenities for neighbourhood hubs in urban areas?"*

In the final phase, *Neighbourhood Hub Design Approach assessment*, the step sequence is applied on a real-life case study in the municipality of Almere. This has been done to verify if the proposed step sequence indeed delivers desired results. Moreover, a reflection on the Neighbourhood Hub Design Approach by the municipality of Almere and Advier is used to determine whether they think that the Design Approach would be a suitable tool to use in practice, and to provide suggestions how to interpret the results. For this fourth phase no sub-research question has been defined. However, the assessment step of the proposed Neighbourhood Hub Design Approach is very important to answer the main research question.

2.2 Literature study

The literature study is applied as a method for different topics. Scientific literature on these topics is found by searching and screening for studies with the search queries as shown in table 1. The search engines used to find scientific literature (e.g. conference papers, journals, theses) are: Scopus and Google Scholar. Whether literature is found useful for this thesis is assessed by considering the publication year, title, publisher, and abstract. Moreover, if a certain study is found useful for this thesis, references inside that study are also considered. This could result in interesting studies which otherwise would not have been found with the search queries from table 1.

Besides scientific literature, grey literature (e.g. policy documents, guidelines, consultancy reports, blogs) is also used for this thesis. Most documents have been found using the Google Search engine.

Table 1 - Overview of used search queries during the scientific literature study.

Literature study topic	Search queries
Locations, amenities, and users of hubs	"mobility hubs"; "mobility hubs" AND "location"; "mobility hubs" AND "network"; "intermodal terminal" AND "location"; "mobility" AND "network design"; "potential users of neighbourhood hubs"
Key policy objectives related to hubs	"hubs"; "hub" (within the reviewed policy documents)
Theoretical background on incorporating user profiles	"Fogg"; "Fogg Behaviour Model" (recommended by hub and shared mobility experts from Advier)
Preferred locations for neighbourhood hubs	"mobility hubs"; "mobility hubs" AND "location"; "mobility hubs" AND "network"; "intermodal terminal" AND "location"; "mobility" AND "network design"; "SHARE North mobility hubs guideline"; "SHARE North mobility hubs strategy"
Neighbourhood hub amenities	"SHARE North mobility hubs guideline"; "SHARE North mobility hubs strategy"
User profiles method	"user profiles"; "user classes"; "user profiles" AND "transportation"; "user classes AND "transportation"; "user classes" AND "mobility";
Influence of user profiles on locations and amenities	"potential users of neighbourhood hubs"; "shared mobility" AND "user class"; "shared moped" AND "user"; "sharing economy" AND "neighbours"; "car sharing" AND "user groups"; "electric scooter sharing"; "e-scooter" AND "user profiles"; "potential user" AND "hubs"; "potential users of mobility hubs"; "cargo bike sharing"; "e-cargo bike sharing" AND "user groups"; "electric scooter sharing"; "DRT" AND "socio-demographics"; "parcel locker" AND "customer"; "pushchair" AND "users"; "public transport user" AND "Netherlands";
Catchment areas of neighbourhood hub amenities	"walking distance" AND "e-scooter"; "walking distance" AND "train station"; "walking distance" AND "bike-sharing"; "parcel lockers" AND "distance"; "loopafstanden Nederland"; "acceptabele loopafstanden"; "walking distance to e-mopeds"; "walking distance to shared scooters"; "walking distance to work"; "walking distance to a library"; "loopafstand tot speeltuin"'; "walking distance to an atm"; "walking distance to supermarket"; "afstand tot pakketkluisjes";

Important to note is that during the literature study the term 'mobility hub' is often used for searching publications instead of 'neighbourhood hub'. This is done because the term 'mobility hub' is significantly more common in existing literature. The following paragraphs explains the purpose of the literature study for each topic specifically.

Locations, amenities, and users of hubs

The first topic relates to the locations, amenities, and users of neighbourhood hubs. Existing scientific literature and master theses about this topic have been scanned and analysed for multiple reasons. The first is to gather findings about locations, amenities, and users of neighbourhood hubs from existing literature, which can be considered in the remainder of this thesis. Also, it is used to further scope this thesis, and identity the main scientific gaps.

Key policy objectives related to hubs

If the 'neighbourhood hub'- concept is implemented properly and could be used as a means to achieve policy objectives of authorities, there is a reason for policymakers to develop neighbourhood hubs and potentially use the Neighbourhood Hub Design Approach for that. Hence, a literature study is required to find out to what extent authorities have currently formulated policy objectives regarding neighbourhood hubs. The literature study contains multiple Dutch and foreign policy documents. Policy documents from Dutch authorities because the current study will focus primarily on a Dutch urban environment, and foreign policy documents because foreign authorities have more experience with the implementation and design of neighbourhood hubs. Insights from foreign policy documents are also very useful to take into consideration while screening Dutch policy documents.

Theoretical background on incorporating user profiles

It requires a certain behavioural change for people to use services and transport modes at neighbourhood hubs. Taking into consideration the influence of user profiles in the Neighbourhood Hub Design Approach demands for a theory to explain what factors determine behaviour. Therefore, the philosophy from the Fogg Behaviour Model (FBM) is used in section 5.1 as a theoretical underpinning for the incorporation of user profiles in the Design Approach. According to Fogg (2009), it is especially relevant to use the FBM when designing or studying so-called persuasive technologies. These are technologies which attempt to influence people's behaviour. In this thesis, Design Approach can be perceived as the 'persuasive technology', as the locations and amenities should be determined in such a way, that people are more likely to use neighbourhood hubs.

The Fogg Behaviour Model (FBM) is often used by Advier for hub or shared mobility-related studies and projects. In scientific literature, there are only a few mobility related studies in which the FBM has been used (Slavenburg, 2018; Van Gent et al., 2019). However, an important advantage of this model is that it describes behaviour change in a very practical way. Therefore, the author believes that the FBM is a very suitable model to explain how implementing neighbourhood hubs according to the Design Approach could increase the probability that people will actually use them.

Preferred locations for neighbourhood hubs

Determining the preferred locations of neighbourhood hubs is one of the key parts in the main research question. Therefore, it is required to determine what are preferred locations for neighbourhood hubs. This thesis assumes that promising locations of neighbourhood hubs are places which are already embedded in a greater transport network and/or attract a certain amount of visitors / passenger on a daily basis. In the rest of this thesis, these places are referred to as *anchor points*. Some existing scientific research and hub guidelines already consider logical places in a city to locate neighbourhood (or mobility) hubs. Therefore, these are used to identify preferred locations in cities for hubs.

Neighbourhood hub amenities

Determining the most preferred amenities at neighbourhood hubs is also one of the key parts in the main research question. The goal of the literature study is to identify the most occurring shared services and transport modes in existing design guidelines for neighbourhood (or mobility) hubs. Planning and design guidelines from SHARE-North partners are used as literature to identify the most occurring hub amenities. "SHARE-North" is a partnership of public authorities, NGOs, and research institutions from the North Sea Region who cooperate to promote shared mobility, but also support the launch of mobility hubs (Advier is the Dutch partner of SHARE-North) (SHARE-North, n.d.). These parties are considered to have a significant level of experience with the planning and/or implementation of hubs in an existing urban environment.

User profiles method

This thesis considers the influence of user profiles on the locations and amenities of neighbourhood hubs. Therefore, a method is required to determine what is suitable way to define user profiles for this thesis. A literature study is used in section 2.4 to identify multiple methods to define user profiles, and support why the Whize segmentation is selected as the most suitable method. The literature study consists of two types of literature: (1) methods for data gathering and clustering which are used for scientific purposes, and (2) methods which are often applied for commercial purposes. The latter is interesting because the proposed Design Approach aims to be applicable in practice. Moreover, if the Design Approach is applied in real-life city, data is required about where in the city which user profiles live.

Influence of user profiles on locations and amenities

A literature study is one of the two methods used to determine the influence of user profiles on the most preferred amenities, and where hub locations should be prioritized. Currently, no literature is available on this topic, as it is a scientific gap. But, we can consider literature about typical users for neighbourhood hubs in general, and other scientific studies about typical users of each individual amenity. Based on this, it could be determined what are suitable amenities for certain user groups, and which user groups are more likely to use neighbourhood hubs. But, the literature study serves another purpose. The other used method are focus groups (explained in section 2.5). A literature study helps to get a grip on what is currently known about typical users of neighbourhood hubs and the individual hub amenities, in advance of the focus groups. This knowledge can be used to properly design the discussion guide for the focus groups. Literature used for this part of the literature study consists of scientific research and master theses focusing on typical users of neighbourhood hubs, and the individual hub amenities.

Catchment areas of neighbourhood hub amenities

The final literature study topic relates to the catchment areas of amenities. It is required to make an assumption for the catchment area value of each individual hub amenity to apply the Design Approach. A literature study is considered to be a more efficient method to identify catchment areas compared to other methods, like focus groups or semi-structured interviews with the service and transport mode providers. Besides, the author believes that a literature study is sufficient because the catchment areas are not part of this thesis' main research objective. Literature that is considered for this topic are scientific studies focusing on catchment area values of individual transport modes, shared services, and neighbourhood (or mobility) hubs in general.

2.3 Step sequence conceptualization

The step sequence to determine neighbourhood hub locations and amenities based on user profiles is conceptualized into a flow chart. The goal is to propose the step sequence in such a way, that performing all steps sequentially will result in the preferred locations in combination with amenities for neighbourhood hubs in urban areas.

The Advier tool is used as starting point for the step sequence, because this has already been developed and Advier has specifically asked the author to expand the Advier tool (Advier, 2021a). Therefore, first the Advier tool is explained. Next, the improvements for the Advier tool are highlighted. Both the Advier tool and identified improvements are used to formulate the step sequence of the Design Approach. This is done iteratively by repeatedly applying the step sequence on an imaginary city, and using input from supervisors.

2.4 Whize segmentation

2.4.1 Existing methods to define user profiles

Different methods could be used to gather data and subsequently create user profiles. The following briefly goes through a number of these methods. A more comprehensive explanation can be found in Appendix B.

Let's start with methods which are mainly used for scientific purposes. Mobility-related literature that creates user profiles from a sample of people is found by using the search queries from table 1. For data gathering, an often applied method is a survey. This could be a survey which was held separately from the scientific study (Shelat et al., 2018), or a survey which was held specifically for that study (Alonso-González et al., 2020; Bösehans et al., 2021; Winter et al.,2020). Methods to cluster data into user profiles vary from a latent class cluster analysis (Alonso-González et al., 2020; Molin et al., 2016; Shelat et al., 2018) to a nested logit model with latent classes (Winter et al., 2020), to a combination of Ward's method with the k-means clustering procedure (Bösehans et al., 2021). In the end, the goal of all clustering methods is to obtain a set of homogeneous groups.

Besides, this thesis covers two methods which are primarily meant for commercial purposes. These methods also use clustering techniques to create user profiles out of data, but the data itself is usually collected in a less scientific way. The Mentality-model from Motivation BV (2019) classifies the Dutch population into eight classes based on their values and lifestyle. For each class, the Mentality-model provides a brief description of their ambitions, societal, and political perspectives, the role of work, lifestyle, social relationships, and socio-demographics.

The other method is the Whize segmentation model by WHOOZ BV (2019). The Whize segmentation classifies 7.8 million Dutch households into 59 segments, which are subsequently merged into 11 main segments. This classification uses a database which has been collected for over 30 years with over 2,000 user characteristics. The Whize brochure provides an abstract diagram with the 11 segments categorized by age and prosperity (see figure 6). For every segment, Whize distinguishes five categories of characteristics: demographic characteristics, living environment, lifestyle, media, and mentality (see Appendix D).

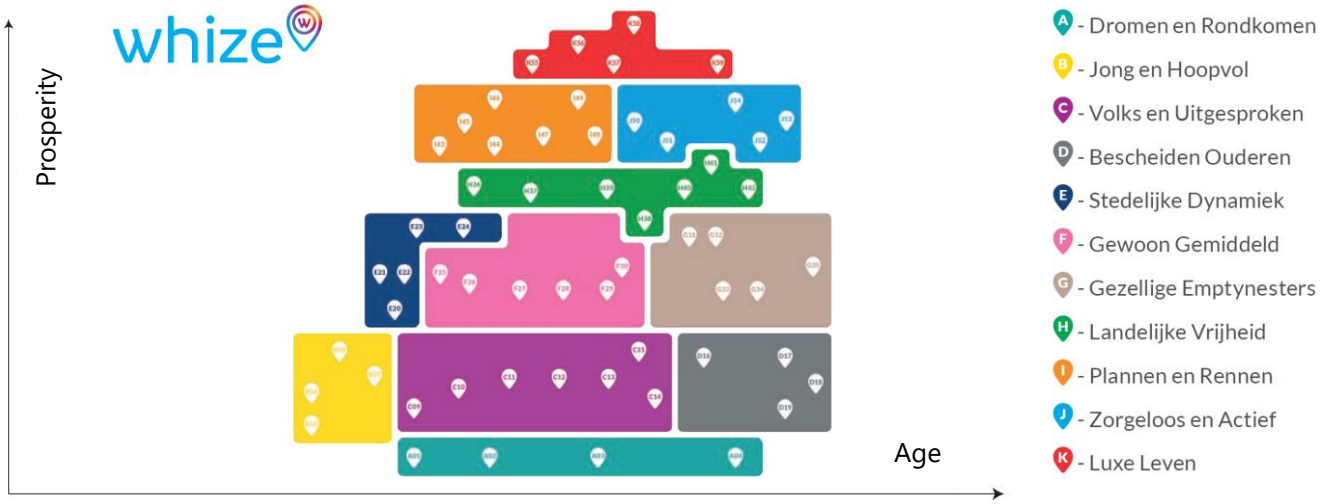

Figure 6 - Overview of Whize segments based on prosperity and age (WHOOZ BV, 2019).

2.4.2 Why the Whize segmentation is selected to define user profiles

The Whize segmentation has been found most suitable to use in this thesis. To be able to properly substantiate why the Whize segmentation model is the most suitable method to create user profiles, Minze Walvius from Advier has been interviewed by the author. He has a wealth of experience in collecting data and using clustering techniques, and has applied the segments from Whize segmentation in practice for different use cases.

First, the Neighbourhood Hub Design Approach demands for a practical and efficient way to distinguish user profiles in existing urban areas. The clustering methods used for scientific purposes could be suitable methods. However, for these methods data should be collected and analysed for every individual application of the Design Approach. Thus in terms of practicality and efficiency, the Whize segmentation has a clear edge over the scientific methods as the Whize segments already have been predefined.

Second, the underlying database of the Whize segmentation model is more extensive compared to databases used by scientific methods to identify user profiles. The Whize segmentation uses a combination of open data sources and commercial data sources. Open data sources are accessible by everyone, while commercial data sources include data for which you have to pay to gain access. WHOOZ BV is especially interested in online consumer behaviour data, which is predominantly commercial data. Consumers agree to share their online data in different ways, for example by accepting the terms and conditions when creating a social media account, or by accepting cookies on a news website. WHOOZ BV has been accumulating different types of online consumer data dependent on availability. An additional advantage of having online data from different sources is that WHOOZ BV is able to filter inconsistencies by combining different data sources for the same household. With all these types of data, WHOOZ BV is able to create user profiles not only based on socio-demographics, living environment and mobility behaviour, but also online consumer behaviour. This is very valuable when targeting certain groups for products, services, and policies. Due to costs it is not possible for this thesis to gain access to the underlying database of the Whize segmentation model. However, the extensiveness of this database gives the segments from the Whize segmentation an edge over data bases which are collected manually.

Third, the Whize segmentation model has been based on clustering techniques using statistical analysis, like the methods used in scientific research. The segments from the Whize segmentation model are in fact based on combinations of data ranges from characteristics. Clustering of households into user profiles can be done based on different characteristics. The 11 segments described by the Whize segmentation model provide a general representation of the Dutch population (WHOOZ BV, 2019), but the data sources from WHOOZ can actually be used to cluster households into user profiles for specific purposes (e.g. determining target groups for housing developments, public transport services, telecom services). How these clustering techniques work exactly is not known in detail by the author because WHOOZ BV is a commercial party so their methods are not publicly available.

Fourth, while user profiles in scientific research are often combinations of data ranges, the Whize segmentation model takes a step further by describing the segments as personas. When targeting certain groups for shared services and transport modes at neighbourhood hubs, it would be convenient that every actor involved in the implementation process, from transport operator to marketeer, has the same perception of who to target. The descriptions of the segments in the Whize segmentation model have been created by experts from WHOOZ BV based on years of experience. Personas are considered useful for this thesis, as during the focus group they help to efficiently explain the Whize segments to the focus group attendees (see section 2.5 on focus groups).

Fifth, the Whize segmentation model has been used in several use cases for e.g. mobility agencies and urban development projects. One example is that developers of residential areas use the segments to determine which housing types and price categories should be considered for development of a new neighbourhood. Another example is that mobility agencies use segments from the Whize segmentation to tailor the type and location for advertisements to the right target groups. As such, the application of Whize segmentation model in practice shows the relevance and could be perceived as a validation.

The aforementioned paragraphs explain why the Whize segmentation model is preferred over making personas with methods used in scientific research with manually collected data. The reason why the Whize segmentation model is preferred over the other commercial method, the Mentality-model from Motivaction, is related to the availability of information on segments. The openly available brochure from Whize segmentation contains information on demographic characteristics, living environment, lifestyle, media, and mentality, while the brochure of the Mentality-model does not. Besides, data is available for the real-life Whize segment distribution on a four-digit zip code level for the municipality of Almere. And this data is considered essential for doing the case study with the Neighbourhood Hub Design Approach in Almere (see 2.6 on the case study method).

The Whize segmentation model certainly has several disadvantages and it is not suggested that it is the very best approach to identify user profiles. However, taking into consideration the aforementioned reasons, this existing data-driven approach is perceived to be the most suitable approach for this thesis.

2.5 Focus groups

2.5.1 Why using focus groups as a method

As this study has a qualitative approach, a qualitative method is required to gain insights in the influence of user profiles on amenities and locations of neighbourhood hubs.

Two prominent methods to gather inputs from experts are *focus groups* and *semi-structured interviews*. Both methods can provide an individual's ideas and thoughts. But, an advantage that focus groups have over semi-structured interviews is that they enable the researcher to capture deeper information in a more economical way. Another major advantage of using focus groups is that it allows for interaction between focus group attendees. This thesis is the first to explore the influence of users on preferred neighbourhood hub amenities and locations, using personas. Therefore, it is assumed that attendees do not have any prior experience with this and probably do not have fully developed perspectives about it. Because focus groups allow for interaction between attendees, they can be influenced by the arguments of others while developing their perspectives (Kitzinger, 1994). Thus focus groups can help to develop perspectives in a more comprehensive way than semi-structured interviews would. Moreover, because attendees have the possibility to interact and discuss with each other, focus groups can give insights in the motivations and extent of agreement or disagreement between the attendees (Morgan, 1996).

A disadvantage of focus groups is that, given the number attendees, there is in most cases not sufficient time to allow every attendee to give their full perspective on each topic. Still, because this is the first research to consider personas, the author believes that it is more insightful to allow for interaction between experts.

2.5.2 Purpose of focus groups in this thesis

Focus groups are used as a second method besides the literature study to determine what are the most suitable neighbourhood hub amenities to consider for each user profile. Besides, focus groups aim to determine which user profiles are most likely to use neighbourhood hubs. This can be used to determine which locations should be prioritized. Before performing the focus groups, literature on *Influence of user profiles on locations and amenities* (see section 2.2) is reviewed to determine what is already known about this topic, and subsequently make a suitable discussion guide.

Results from both the literature study and the focus group are compared to conclude with an indication for the probability that each user profiles will actually use neighbourhood hubs, and most preferred amenities to consider for each user profile.

2.5.3 Focus group methodology

Number and composition of the focus groups

Conducting focus groups enables the researcher to capture expert opinions in an economical way. Moreover, the possibility for internal debates between the experts is considered valuable. To exploit these advantages, focus groups typically consist of 6 to 10 participants, but the ideal number of participants depends on the context of the research design (Morgan, 1996). The sample size should promote discussion and at the same time enable the moderator to keep the group on the task Nagle & Williams (2013). According to Morgan (1996), discussions may flow more smoothly in focus groups with a homogeneous composition, e.g. when they have something in common such as social class. Besides similarities, differences between participants are equally important. It encourages them to re-think their point-of-view, which could enrich the discussion (Kitzinger, 1994).

For this thesis, it was important to include mobility hub experts in the focus groups rather than finding a homogeneous group based on social demographic factors. Still, it could be assumed that all participants have a higher educational level considering their level of expertise. Another aspect in which the participants are homogeneous, is that all participants of the Dutch focus group speak Dutch, and all participants of the foreign focus group speak English. The mobility hub experts included in the focus groups originate from research institutions, companies, and authorities. This heterogeneity in professional background aims to feed the internal debate.

Regarding the number of focus groups, two have been conducted for this thesis to include both the perspective from the Netherlands and other European countries. The Dutch focus group has been held because this thesis focuses on a Dutch urban environment. The foreign focus group is conducted because foreign countries, i.e. SHARE-North partners, are perceived to have greater experience with the design and planning of mobility hubs.

Recruitment of focus group participants

This study has utilized the internal network of Advier to recruit the focus group participants. First, a suitable list of potential Dutch and foreign participants has been created using expert judgement from Advier. The list contains mobility hub experts from a mix of companies, research institutions, and authorities. Next, a request to participate in the focus group has been sent to all potential participants. Based on the responses from the participants, 14 December 2021, 11:00-12:00 has been selected for the Dutch focus group, and 15 December 2021,14:00-15:00 has been selected for the foreign focus group. Following this, an invitation was sent to all participants who were available on these dates. All communication has been executed by e-mail. The Dutch focus group sample consists of 11 participants, while the foreign focus group sample consists of 5 participants (see Appendix G for the attendees list).

Data collection

Before conducting the Dutch and foreign focus groups, the draft scenario design was tested in a pilot session internally at Advier. This pilot session was held at 9 December 2021, 14:30-15:30. In total, five colleagues from Advier participated in the pilot focus group. The goal of the pilot focus group was to gain feedback on three topics: (1) the suitability of the program to obtain answers for the goals of the focus group, (2) determine whether the 'Polls' function in Microsoft Teams works properly, and (3) determine whether it is feasible to go through five user profiles in the available time (~45 min effectively). After the pilot focus group, there was time for the participants to give feedback. Doing the pilot focus group was considered essential by the author and moderator, as significant changes were made to the program and timing of the initial focus group.

The official Dutch focus group has been conducted in Dutch and the foreign focus group has been conducted in English to allow all participants to comfortably give their opinions. Both sessions lasted 60 minutes, including the introduction, substantive part, and ending.

One of this thesis' supervisors from Advier was the moderator of both focus groups, while the author of this study took notes. The moderator is experienced in supervising sessions with different types of stakeholders. Moreover, knowledge about the topic of mobility hubs was perceived essential to adequately moderate the focus groups.

Data analysis

The author of this thesis has transcribed all verbal data from the discussion parts. Non-verbalism statements such as nodding one's head have not been transcribed, as requiring a video camera during the session could have made the participants feel uncomfortable.

The verbal data has been systematically analysed using the content analysis principles as described by Elo & Kyngäs (2008). According to their study, a content analysis can be used to analyse written, verbal, or visual communication messages. This thesis uses an *inductive content analysis approach* to conduct and analyse the focus groups without any a priori theoretical assumptions, because the approach of using personas has never been applied in focus groups before. The inductive content analysis approach was also applied by Krabbenborg et al. (2020) who conducted focus groups as well.

The main findings from the discussion were summarized in bullets, assigned to the five user profiles, and sent to all focus group participants via e-mail. In this way, all participants were given the opportunity to verify the findings and make suggestions for adjustments and/or supplementations if required. As part of analysing the focus group data, the verbal data from the discussion parts has been supplement by the visual results from the 'Polls' function, which were exported and processed in Excel.

2.6 Assessment of the Neighbourhood Hub Design Approach in a case study

This final section of the methodology explains why Almere has been chosen for the case study, and what role the case study plays in this thesis. The case study was performed for the municipality of Almere, because representatives from the municipality of Almere were willing to co-operate with the author to apply the Neighbourhood Hub Design Approach in an existing Dutch urban environment. The municipality of Almere was perceived to be a suitable case study by the author to assess the Neighbourhood Hub Design Approach for a number of reasons (see next page).

- Almere is located in the Netherlands, in accordance with the Whize segmentation model which is based on Dutch households.
- Data for the distribution of Whize segments is available for Almere municipality on a four-digit zip code level.
- Almere is one of the Dutch G10 municipalities, with a total population of 215.000 (January 1st, 2021; CBS).
- The municipality consists for a big part of urban areas.

The representatives from the municipality helped the author to define the study area and were willing to deliver data to go through the step sequence. The municipality was willing to share the following data sources:

- Existing locations of anchor points in the municipality of Almere;
- Existing locations of the considered shared services and transport modes;

The case study is performed digitally as a spatial analysis in a software-tool called QGIS. QGIS is an application for GIS and often applied in a professional context. The software application is a Free and Open Source Software (FOSS) and thus free to use for any person. This was convenient for the author, but also interesting for possible future applications of the Design Approach. There is a large number of external databases (such as CBS data) which can be imported into the software for free.

After having applied the step sequence on the municipality of Almere, the results and step sequence are assessed. This assessment step uses reflection sessions with two parties: one with the municipality of Almere and one with Advier. These two parties were chosen because the Design Approach is mainly meant for authorities (such as the municipality of Almere) and consultancy agencies (such as Advier).

The first session is held with representatives from the municipality of Almere. The municipality is the responsible party for the implementation of neighbourhood hubs, so they use the results and recommendations from the Design Approach to formulate and conduct hub policies. The two goals for this first session are:

1. Determine whether the municipality thinks that the Design Approach is a promising tool to use when researching hub locations and amenities for their city. And if so, why.
2. Provide recommendations for future scientific research and improvements of the Design Approach.

The second session is held with hub experts from Advier. Advier is chosen because it represents a consultancy agency which has to apply the Neighbourhood Hub Design Approach if a client (such as a municipality) demands for that in a project. Moreover, consultancy agencies have to interpret the results, and provide advice for authorities on how to use the results for the implementation of neighbourhood hubs. The three goals for this second session are:

1. Determine whether Advier thinks that the Design Approach is a suitable tool to use in future projects about locations and amenities of neighbourhood hubs. And if so, why.
2. Provide recommendations for future scientific research and improvements of the Design Approach.
3. Determine how the results from the Design Approach could be interpreted to provide advice to authorities. Examples could be advice on how to phase the rollout of hubs, or how to determine the locations of each hub in more detail.

3. Neighbourhood hubs: the state-of-the-art in literature

This chapter performs a literature study on locations, amenities, and users of neighbourhood hubs. Section 3.1 addresses recent scientific literature on the locations, amenities, and users of neighbourhood hubs in cities. Next, section 3.2 concludes with insights from existing literature, which can be considered in the remainder of this thesis.

3.1 Existing literature on locations, amenities, and users of hubs

The following selection of scientific papers and master theses has been found using the search queries from table 1. A paper or thesis is considered if it explicitly researches locations of hubs, amenities for hubs, and/or typical users of hubs in urban context. It is good to mention that many existing literature focused on mobility hubs in general rather than specifically on neighbourhood hubs. Because neighbourhood hubs are within the hierarchy of mobility hubs, studies on mobility hubs are also considered.

Petrović et al. (2019) developed a method to determine the locations of mobility hubs along a railway line. In contrast to the scope of this thesis, they focused on large scale mobility hubs (intermodal terminals). To identify the best locations in their optimization algorithm, they used catchment areas, defined as the number of residents that can reach a location by foot, by bike, or by another transport mode. Catchment areas for neighbourhood hubs will probably differ compared to the large scale mobility hubs considered by Petrović et al. (2019). In terms of amenities, it focused solely on railway transport. Besides, it did not consider the profiles of potential users living in the surrounding area.

A study that researched that locations of mobility hubs in a broader sense is the one from Martinez & Rakha (2017). They developed a framework for establishing a city-wide mobility hub network in 'mid-sized cities'. Part of their study was to research the potential of anchor points to sustain activity – these were used to identify mobility hub locations. Instead of using the number of residents for catchment area like Petrović et al. (2019) did, they took a radius of two miles (~3.2 km) between hubs (resulting in a travel time of 15 minutes to cycle between the hubs). This results in a grid of larger scale mobility hubs across the city. Amenities were not explicitly considered. So both the studies from Petrović et al. (2019) and Martinez & Rakha (2017) focused on the locations of large scale mobility hubs.

Coenegrachts et al. (2021) did look at more transport modes by examining the case of a shared mobility hub. Together with focus groups, including public and private stakeholders, they designed five types of business model blueprints, each belonging to a different hub network typology (first-/ last-mile, clustered, point-of-interest, hybrid, and closed mobility networks). Note that this network typology differs from the one introduced in section 1.6 as it is more related to businesses cases of different hub networks in a city, rather than a city-wide mobility hub hierarchy. What is interesting to see is that each hub network typology from Coenegrachts et al. (2021) resulted in a completely different structure of locations and different offered transport modes, depending on the type of area in a city and existing transport networks.

Similar to this thesis, Blad (2021) tried to find promising locations for mobility hubs. Instead of neighbourhood hubs, he focused on regional mobility hubs. Locations proposed by the MRDH (Metropolitan Region Rotterdam The Hague) were assessed by using a GIS-Multi-Actor Multi-Criteria Analysis to score areas in Rotterdam. The proposed locations were aimed to connect to existing transport networks. Regarding hub amenities, Blad (2021) considered a range of mobility-related and non-mobility-related transport modes and services. He stated that there is no 'one-size-fits-all' solution and that each hub location should be tailored to its specific context. However, it was not determined for each regional hub location which amenity types would be preferrable.

Bösehans et al. (2021) researched what are the potential early and late adopters of shared electric mobility hubs. They used a Categorical Principal Components Analysis to analyse attitudinal statements from a survey, after which a two-step clustering method was applied to define clusters. Interestingly, the study from Bösehans et al. (2021) explicitly assigned each respondents to one of the four adoption categories ('Early adopters', Early majority', 'Late majority', and 'Laggards'), based on the Diffusion of Innovation (DOI) theory from Rogers (1962). While not their main focus, they briefly touched upon the locations of mobility hubs. They highlighted potential locations appear to be important public transport intersections or near activities to facilitate the access or egress trips. In accordance with Coenegrachts et al. (2021), the main focus is on shared transport modes as amenities for mobility hubs. The influence of potential users on the location and amenities of mobility hubs was not considered.

One of the key topics in the study from Claasen (2020) was to research the influence of user characteristics on the intention to use shared mobility at mobility hubs, by using a stated choice experiment. Data on characteristics from residents in existing inner-city neighbourhoods was gathered using a survey. Regarding hub amenities, only shared modes were considered. Interestingly, Claasen (2020) stated that from an adoption perspective it seems opportune to implement mobility hubs in neighbourhoods with a high share of residents with a positive attitude towards shared mobility and other sustainable transport modes. Explicit locations were not considered however.

A final study that focused on the user is the thesis from Van Rooij (2020) which specifically addressed the potential users of neighbourhood hubs. Van Rooij (2020 stated that these central points in neighbourhoods can offer a variety of shared mobility. A literature study, focus groups, and binary logistic regression model were used to determine the characteristics of potential hub users. Potential users are mainly younger persons with a sustainable mindset who are experiencing a certain level of parking pressure. Neighbourhoods with high parking pressure were highlighted as potential locations. Like the two previous studies, no examples of locations were suggested.

To summarize the above, table 2 shows whether a study explicitly considers the location, amenities, and/or users of hubs.

Table 2 - Overview of reviewed literature on locations, amenities, and users.

Author	Considers hub locations	Considers hub amenities (both mobility and non-mobility)	Considers potential users of hubs	Method used to determine hub locations/users
Petrović et al. (2019)	Yes	No	No	Optimization algorithm (using an objective function) for intermodal terminals, based on accessibility (defined as the number of citizens that can reach the location).
Martinez & Rakha (2017)	Yes	No	No	City-wide grid of hub locations using anchor points (based on activity patterns of people) and catchment areas to provide adequate coverage and accessibility.
Coenegrachts et al. (2021)	Yes	No	No	Using anchor points to determine the grid of hub locations. Which types of anchor point are used depends on the hub network typology.
Blad (2021)	Yes	Yes (but not for each hub location)	No	A GIS-Multi-Actor Multi-Criteria Analysis (MCA) was used to identify potential areas for a regional mobility hub. The analysis used different criteria and attributes to end up with a grid of MCA scores in the study area.
Bösehans et al. (2021)	No	No	Yes	A Categorical Principal Components Analysis was used to analyse attitudinal statements from a survey, after which a two-step clustering method was applied to define clusters. Subsequently, survey respondents were assigned to one of the four adopter categories from the DOI theory.
Claasen (2020)	No	No	Yes	A stated choice experiment was applied to research the relationship between user characteristics and the intention to use shared mobility at mobility hubs.
Van Rooij (2020)	No	No	Yes	Literature study, focus groups, and binary logistic regression model were used to determine the characteristics of typical hub users.

3.2 Concluding remarks on existing literature

Based on the literature study, it can be concluded that there are already existing studies that directly or indirectly determine the locations for hubs. However, these studies mainly consider larger scale mobility hubs, rather than neighbourhood hubs which are used in this thesis. Moreover, it can be observed that different methods are applied to determine hub locations, varying from an optimization model (Petrović et al., 2019), to an MCA (Blad, 2021), to the use of anchor points (Martinez & Rakha , 2017; Coenegrachts et al., 2021). To that respect, the location determination part of this thesis is quite similar to the study from Martinez & Rakha (2071) who also worked with anchor points and catchment areas. Because their study focused on larger scale hubs, the catchment areas in this thesis will likely be smaller. Besides, it can be learned that anchor points have to ability to sustain a certain level of activity, largely influenced by the number and variety of functions around a hub location. These functions can be both mobility and non-mobility related, which was also shared by Coenegrachts et al. (2021). While Blad (2021) did not use anchor points, we can learn from his MCA approach that there are multiple criteria and attributes which

can be used to determine the most preferred hub locations. For example, Van Rooij (2020) found that areas with high parking pressure are promising to develop hubs.

Regarding amenities for neighbourhood hubs, existing literature provides a rather uniform picture. The main focus for mobility hubs lies on providing transport alternatives for the private car. Non-mobility-related services are often excluded. One exception is the thesis from Blad (2021). We can learn that there is no 'one-size-fits-all' hub design, and that various mobility and non-mobility related facilities can be considered for a hub. But, these were not further considered to recommend which amenities should be offered at each hub location. To the best of the author's knowledge, none of the considered studies have researched which shared services and transport modes should be offered per hub location.

Finally, there are already multiple studies on users of neighbourhood hubs. While the influence of user profiles on preferred neighbourhood hub locations and amenities remains unknown in existing literature, some interesting insights can be presented. The studies from Bösehans et al. (2021), Claasen (2020), and Van Rooij (2020) provide user characteristics that influence the probability to use hubs. These characteristics can be used for the literature study into users of hubs in chapter 6. Interestingly, one of the conclusions from Van Rooij (2020) was that there is no fixed hub user, which means that hub users do not always have the same user characteristics. This also indirectly follows from the study from Bösehans et al. (2021) as all of their clusters contain a percentage of 'early adopters'. Next, like this thesis, the study from Van Rooij (2020) uses a literature study as well as focus groups, and provides a comparison between the results from both methods. Hence, it is important that chapter 6 critically compares the findings from the literature study and focus groups, especially because results from both methods could differ significantly (which was the case for Van Rooij (2020)).

KEY TAKEAWAYS

- While limited, existing studies about locations of hubs mainly consider larger scale mobility hubs.
- Two previous studies have worked with anchor points to determine hub locations. These places have the ability to sustain a certain level of activity, which is influenced by various mobility and non-mobility related functions around it.
- Multiple criteria and corresponding attributes can be used to determine what are the most preferred hub locations.
- Each hub could have a different range of mobility and non-mobility related amenities – there is no 'one-size-fits-all' solution.
- None of the existing studies have considered the influence of user profiles on hub locations and/or the range of offered amenities at each hub.
- There is no fixed hub user, as there could be adopters in every user group.

4. Key policy objectives related to neighbourhood hubs

Implementing neighbourhood hubs in a city is not a goal in itself, so policymakers should make sure to state why they would want to develop neighbourhood hubs. This chapter aims to come up with a list of key policy objectives to which neighbourhood hubs could contribute. Section 4.1 provides an inventory of policy documents from Dutch and foreign authorities about policy objectives related to hubs. Section 4.2 discusses the findings from the reviewed policy documents. Lastly, section 4.3 provides other perspectives related to mobility or transportations projects, to conclude with a proposed set of key policy objectives which can be used by policymakers if they would like to implement neighbourhood hubs. Sub-question (1) is answered at the end for this chapter.

4.1 Policy objectives in Dutch and foreign policy documents

Dutch policy documents

For the selection of Dutch policy documents, the thesis from Van Gerrevink (2021) is used, and supplemented with other Dutch G10 municipalities by scanning their policy documents with the search query "hub". The list of considered municipalities and related policy documents for this thesis is shown in table 3. Moreover, the third column briefly explains how each document perceives the hub.

Table 3 - Dutch municipalities and related policy documents.

Municipality	Policy document	Role of hubs in the document	Reference
Almere	Mobiliteitsvisie Almere 2020-2030	A transfer node for people from rural areas.	Gemeente Almere (2020)
Amsterdam	Programma Smart Mobility 2019-2025	A means to unlock space by clustering shared mobility alternatives.	Gemeente Amsterdam (2019)
Breda	Mobiliteitsvisie Breda	A node which connects mobility networks on different levels, offers a starting point for trips.	Gemeente Breda (2020)
Delft	Mobiliteitsprogramma Delft 2040	Transfer node between different modalities.	Gemeente Delft (2021)
Den Haag	Smart Mobility Visie Den Haag	A collection point of different types of mobility.	Gemeente Den Haag (2021)
Eindhoven	Agenda Deelmobiliteit	A location for shared mobility which facilitates transfers.	Gemeente Eindhoven (2019)
Groningen	Groningen goed op weg	Place to switch between modalities with additional social / economic functions.	Gemeente Groningen (2021)
Nijmegen	Nijmegen goed op weg	Node with different types of electric mobility.	Gemeente Nijmegen (2019)
Rotterdam	Rotterdamse MobiliteitsAanpak	Unlock space by concentrating car parking and offering other types of mobility.	Gemeente Rotterdam (2020)
Utrecht	Mobiliteitsplan 2040	A means to offer different transport modes and other facilities.	Gemeente Utrecht (2021)

Policy documents from the national government are also considered to obtain a broader perspective than only municipalities. Table 4 shows the three national policy documents that were found using the search query "hub". Each text passage in the policy documents containing the word "hub" is inventoried for policy objectives related to mobility hubs.

Table 4 - Dutch national authorities and related policy documents.

Authority	Policy document	Role of hubs in the document	Reference
Kennisinstituut voor Mobiliteit	Verkenning van het concept mobiliteitshub	Physical nodes for different transport modes which can also function as places for urban development.	KiM (2021)
Rijksoverheid	Toekomstbestendige mobiliteit	Multimodal transport nodes for both passenger and logistic flows.	Rijksoverheid (2020)
Infrastructuur en Waterstaat	Schets Mobiliteit naar 2040: veilig, robuust, duurzaam	Places for transfers between mobility systems where different service are located.	Ministerie van Infrastructuur en Waterstaat (2019)

Foreign policy documents

Besides the Dutch context, this thesis also takes into account policy documents from foreign authorities. The selection of considered foreign policy documents are from the following SHARE-North partners: Bremen, Bergen Kommune, SEStran (South East of Scotland Transport Partnership), and Flanders.

Bremen is considered to be the first-mover and primary example for other SHARE-North partners in implementing mobility hubs. The first mobility hub in Bremen was introduced in 2003, and since then the network of so-called "mobil.punkte" and "mobil.pünktchen" has grown to an amount of 43 hubs (CoMoUK, 2021). A study published by Schreier et al. (2018) showed that on average every shared car in Bremen has replaced 16 private cars (from which seven vehicles no longer owned and nine vehicles not purchased). In total, this resulted in approximately 5,000 fewer vehicles in Bremen's streets. This shows that mobility hubs play a significant role in Bremen's strategy to reduce car ownership and parking demand.

The other SHARE-North partners (Bergen Kommune, SEStran, and Flemish Government) adopted the mobility hub concept from Bremen. SEStran, one of the 7 Regional Transport Partnerships in Scotland, has yet to start with implementing mobility hubs. Bergen Kommune and the Flemish Government have already been implementing mobility hubs for years. Currently, the Flemish Government has plans to roll out 1,000 mobility hubs under the Hoppin-brand in the coming years (OV Magazine, 2021). The table below shows the considered foreign policy documents for the inventory of policy objectives.

Table 5 - Foreign authorities (SHARE-North partners) and related policy documents.

Institute / Authority	Policy document	Role of hubs in the document	Reference
City of Bremen	Mobilpunkt Flyer 2019 Car-Sharing Action Plan for Bremen Mobility Hubs: The Problem-Solving Approach to Congestion and Parking	Offering car-sharing and other modes near residents to decrease car-dependency, emissions, and congestion. Moreover, hubs stimulate the use of sustainable transport modes and help to regain street space.	Freie Hansestadt Bremen (2019) Senate Department for Environment, Construction, Transport, and European Affairs (2009) CoMoUK (2021)
City of Bergen	Mobility Hubs Mobiele punten [website]	A place that integrates different types of sustainable mobility and other services to cater the needs of the community, to decrease private car ownership.	SEStran (2020) Bergen Kommune (2021)
South East of Scotland Transport Partnership	Mobility Hubs	A recognizable and accessible place which integrates different transport modes and services, aimed to encourage more sustainable travel.	SEStran (2020)
Flemish Government	MOBIPUNTEN – beleidsvisie en implementatiekader	A recognizable place with different types of mobility, supplemented with other services, to facilitate transfer between modalities.	Flemish Government (2019)

Unlike the Dutch policy documents, the policy documents from the table above are not screened for the search query "hub". This is because the foreign policy documents are all focused specifically on mobility hubs, thus the policy objectives mentioned in these documents are logically related to mobility hubs.

Key policy objective inventory

Before making an inventory of key policy objectives in the existing policy documents, we should first define categories of objectives. The document from the KiM (2021) is very suitable for this. They distinguished functions of mobility hubs and societal goals. Functions of mobility hubs contribute to achieving the broader societal goals (see figure 7).

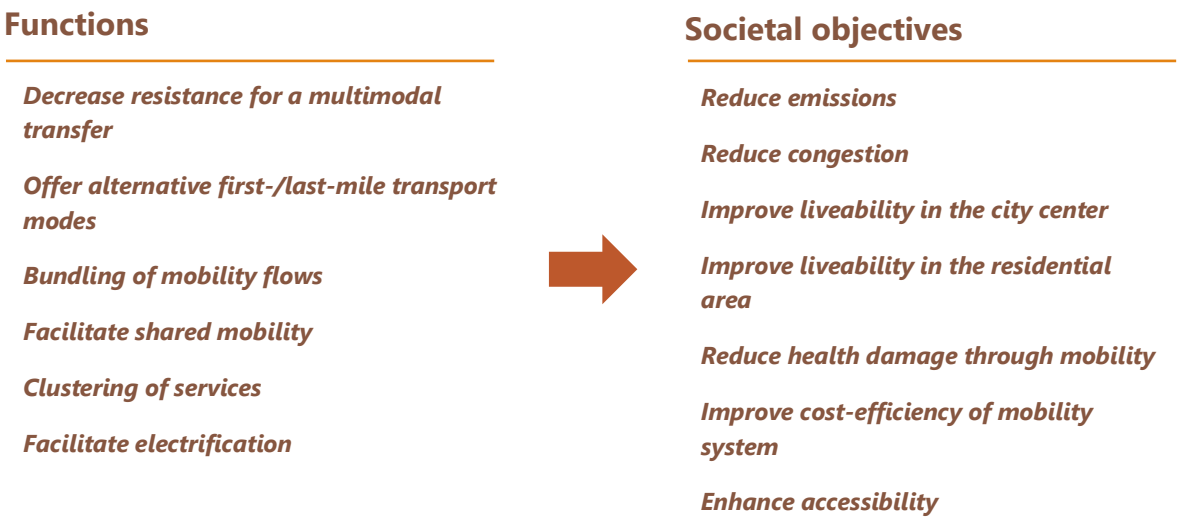

Figure 7 - Mobility hub functions and societal objectives (KiM, 2021).

From the inventory into other policy documents from table 3, 4, and 5 it appeared that the mentioned objectives can be related to these functions and societal objectives from the KiM (2021). Therefore, both the functions and societal objectives as defined by the KiM are considered in the inventory. Besides, the reduction in car use, ownership and parking demand is often mentioned in other policy documents while it does not occur in the functions and societal objectives from the KiM. The reduction in car use/ownership is therefore included as a separate category. Another objective which is not mentioned by the KiM but occurs multiple times in the inventoried policy documents is 'inclusivity'.

Table 6 shows the resulting inventory for each individual policy document. Figure 8 shows a graph, ranging from the most (left) to the least (right) occurring objective/function related to mobility hubs.

The three most occurring functions/objectives are *Decrease resistance for multimodal transfer*, *Offer alternative first/last-mile transport modes*, and *Reduce car use/ownership*. Apparently, most of the inventoried policy documents believe that mobility hubs facilitate transfers between different types of (first/last-mile) mobility. The main objective to which this should contribute is a reduction in use/ownership of private cars. The three least occurring functions/objectives are *Bundling of mobility flows*, *Reduce congestion*, and *Improve cost-efficiency of the mobility system*.

Table 6 - Categorization of functions and societal objectives.

Policy document	Societal objectives (KiM, 2021)						Functions (KiM, 2021)							
	Reduce emissions	Reduce congestion	Improve liveability	Reduce health damage from mobility	Improve cost-efficiency of the mobility system	Enhance accessibility	Decrease resistance for multimodal transfer	Offer alternative first/last-mile transport modes	Bundling of mobility flows	Facilitate shared mobility	Clustering of services	Facilitate electrification	Improve inclusivity	Reduce car use/ownership
Almere							■							
Amsterdam			■			■	■	■		■	■			■
Breda			■			■	■	■						■
Delft							■						■	■
Den Haag								■						
Eindhoven							■	■		■		■		
Groningen							■	■					■	■
Nijmegen								■		■		■	■	
Rotterdam			■				■	■			■	■	■	
Utrecht							■	■					■	■
Rijksoverheid			■			■	■	■	■		■	■		■
Infrastructuur en Waterstaat			■			■	■	■			■			
City of Bremen	■	■	■	■						■	■	■		■
City of Bergen							■					■	■	■
South East of Scotland Transport Partnership	■			■	■	■	■	■		■		■	■	■
Flemish Government	■				■	■	■	■			■			

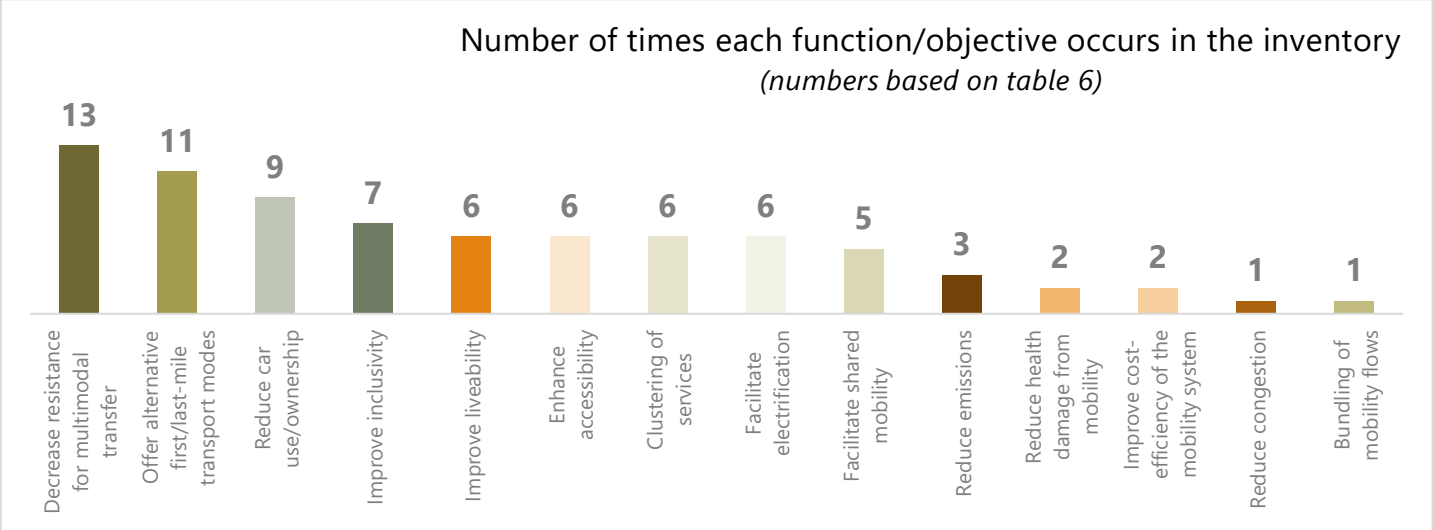

Figure 8 - Overview of number of times each function/objective occurs in the inventory.

4.2 Discussion on policy document inventory

Let's first consider the Dutch policy documents. It can be noticed that most existing Dutch policy documents do not explicitly mention policy objectives for mobility hubs. By screening the documents with the search query "hub", objectives could be identified, however these are mentioned implicitly and predominantly scattered throughout the policy documents. This was also found by Van Gerrevink (2021) who stated that shared mobility (with mobility hubs as an enabler for shared mobility) is perceived as a measure for the mobility transition, but not clearly linked to policy goals. Moreover, she recognized that there is a lack of coherence in the considered municipality documents regarding mobility hub-related objectives. This is also the case for the policy documents from national Dutch authorities considered for this thesis, except for the KiM (2021). In contrast to most Dutch policy documents, foreign policy documents mention their objectives to which mobility hubs could contribute more explicitly. This is probably because these documents specifically focus on mobility hubs.

An interesting observation in table 6, is that the mobility hub functions and objectives in Dutch and foreign policy documents are mainly mobility-related. For example, figure 8 shows that *Decrease resistance for multimodal transfer* and *Offer alternative first/last-mile transport modes* are mentioned most often in relation to hubs. Inclusivity could be interpreted as a non-mobility policy objective, but in the context of the reviewed documents it relates to offering different types of mobility for everyone who needs it. Next, liveability is perceived as a non-mobility component, but this term is in itself very broad and it is the only pure non-mobility component.

This focus on mobility might be explained by how authorities define the hub concept. Table 3 and 4 show that most Dutch authorities see hubs as transfer nodes (or 'vervoersknooppunten' in Dutch). From table 5 it can be observed that foreign authorities consider additional services, but still focus on the hub as a collection point for transport modes. In general it could be concluded that it remains unclear what is exactly the definition of a hub. This was also found by the KiM (2021) and Van Gerrevink (2021) who stated that there are various definitions among different parties. If policymakers would want to implement neighbourhood hubs, a clear definition of the hub concept is required which looks further than solely the mobility-related aspects.

The neighbourhood hub as scoped in this thesis clusters a variety of shared services and transport modes at a recognizable and attractive place. Next, neighbourhood hubs do not only contribute to mobility-related goals, but can also be a means to contribute to wider societal benefits. Policymakers should also point out what are the societal benefits from implementing neighbourhood hubs.

KEY TAKEAWAYS

- Most Dutch policy documents do not explicitly link mobility hubs to policy objectives, and policy objectives are scattered throughout the documents. In contrast, foreign policy documents provide a clearer overview of hub-related objectives.
- Both Dutch and foreign policy documents relate mobility hubs solely to mobility-related functions and objectives. This might be explained by how authorities define the hub concept, and it was also found that mobility hub definitions vary between different policy documents.
- Besides mobility-related goals, the development of neighbourhood hubs can be a means to contribute to wider societal benefits.

4.3 Formulating a broader set of policy objectives

The question is what set of policy objectives would give a more complete representation of societal benefits to which neighbourhood hubs could contribute. The following provides three perspectives.

One perspective could be the SUMP (Sustainable Urban Mobility Plan). A SUMP is a strategic plan that aims to create an urban transport system that meets the mobility needs of people and businesses. While obviously mobility is an important part of the SUMP, it takes a more integral approach by focusing on people, businesses, and their surroundings. Therefore it is considered valuable for this thesis. The minimum objectives for a SUMP as defined by Rupprecht Consult (2013) are:

- O1 - "Ensure all citizens are offered transport options that enable access to key destinations and services";
- O2 - "Improve safety and security";
- O3 - "Reduce air and noise pollution, greenhouse gas emissions and energy consumption";
- O4 - "Improve the efficiency and cost-effectiveness of the transportation of persons and goods";
- O5 - "Contribute to enhancing the attractiveness and quality of the urban environment and urban design for the benefits of citizens, the economy and society as a whole".

Another perspective is the 5E framework which was developed by Van Oort et al. (2017) to assess the full value of public transport. Like for thesis, Van Oort et al. (2017) also tried to take into account the 'wider societal benefits' from mobility systems, in their case public transport. Their proposed methodology to value public transport was summarized in five main aspects (five E's):

- Effective mobility (E1) – "effectiveness of transport and mobility";
- Efficient city (E2) – "suitability of spatial use and spatial/urban (re)development";
- Economy (E3) – "prosperity and wellbeing in/for cities";
- Environment (E4) – "decreasing carbon footprints; sustainable cities";
- Equity (E5) – "socially inclusive cities".

Figure 9 - The 5E framework (Van Oort et al., 2017).

Note that the five objectives from the SUMP and five E's are actually quite similar to the societal objectives as defined by the KiM (2021). However, they are formulated in a broader context incorporating e.g. economic development, social equity, inclusiveness and environmental quality.

A third perspective is provided by Advier which has been developing and researching mobility hubs in both rural and urban contexts. The guideline they proposed for the city of Utrecht highlights a number of objectives, specifically for smaller scale neighbourhood hubs (Advier, 2021a):

- Decrease car-dependency to free up space for other functions and stimulate people to use healthier transport alternative;
- Less parking demand frees up space to improve urban quality;
- Stimulate social inclusiveness of transportation;
- Improve social cohesion: create a place for local residents to meet and stimulate interaction;
- Stimulate local economies: placing neighbourhood hubs near local shops and other facilities creates synergy effects as people will be stimulated to do their shopping and groceries locally.

Combining these three perspectives, a set of key policy objectives can be proposed for neighbourhood hubs:

- ***Social inclusiveness****: enable all people to access all key destinations and services;*
- ***Healthy people & environment****: offer sustainable transport alternatives to stimulate physical exercise among people, and reduce pollution and emissions;*
- ***Efficient & attractive use of space****: decrease parking space for private vehicles to use those areas for greenery and other functions;*
- ***Improve social cohesion****: create a place for local residents to meet and stimulate interaction;*
- ***Stimulate local economies****: placing neighbourhood hubs near local shops and other facilities creates synergy effects as people will be stimulated to do their shopping and groceries locally.*

Sub-research question (1): "*What are the key policy objectives to which neighbourhood hubs in urban areas could contribute?*"

The literature study in this chapter has shown that most Dutch policy documents do not explicitly link policy objectives to mobility (or neighbourhood) hubs. Objectives are predominantly scattered throughout policy documents which results in a lack a coherence. On the other hand, foreign policy documents provide a clearer overview. Furthermore, it can be observed that mobility hubs are solely related to mobility-related functions and objectives in both Dutch and foreign policy documents, while they could contribute to wider societal benefits.

If policymakers would like to implement neighbourhood hubs, they should formulate a clear definition of the 'neighbourhood hub' which looks further than the mobility aspects, and point out in advance what societal goals they want to achieve. Input from the SUMP, 5E framework and Advier has been utilized to propose a set of key policy objectives:

- ***Social inclusiveness****: enable all people to access all key destinations and services;*
- ***Healthy people & environment****: offer sustainable transport alternatives to stimulate physical exercise among people, and reduce pollution and emissions;*
- ***Efficient & attractive use of space****: decrease parking space for private vehicles to use those areas for greenery and other functions;*
- ***Improve social cohesion****: create a place for local residents to meet and stimulate interaction;*
- ***Stimulate local economies****: placing neighbourhood hubs near local shops and other facilities creates synergy effects as people will be stimulated to do their shopping and groceries locally.*

The proposed key policy objectives provide a guidance for policymakers to define goals they would like to achieve with developing neighbourhood hubs.

5. Neighbourhood Hub Design Approach set-up & components

This chapter deals with the set-up and components of the Neighbourhood Hub Design Approach. First, section 5.1 provides theoretical background on how considering user profiles in the Neighbourhood Hub Design Approach could increase the probability that people will use neighbourhood hubs. Section 5.2 deals with the set-up of the Neighbourhood Hub Design Approach by expanding the existing Advier tool. Next, section 5.3 to 5.6 research four components of the Design Approach which are required to apply it in a case study. At the end of the chapter, sub-research question (2) and (3) are answered.

5.1 Theoretical background on incorporating user profiles

5.1.1 The Fogg Behaviour Model

The Fogg Behaviour Model (FBM) consists of three principal factors that control whether people perform a certain behaviour: *motivation*, *ability*, and *triggers* (Fogg, 2009). All three of these factors need to be present for behaviour to occur. Figure 10 shows the FBM with the three factors.

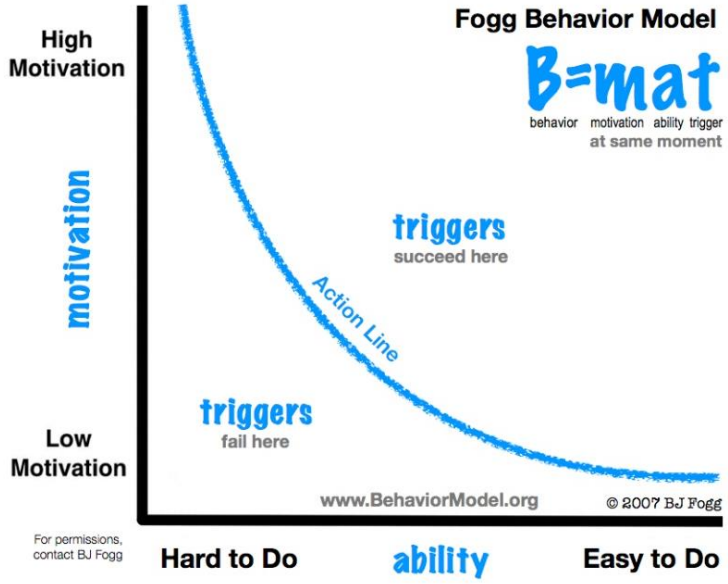

Figure 10 - Fogg Behaviour Model (Fogg, 2007).

The FBM has two axes where the *motivation* has been placed on the vertical axis and *ability* has been placed on the horizontal axis. If someone has a high motivation and a certain action is easy to do, that person is more likely to perform that behaviour. Besides, the blue Action Line can be seen – this is the behaviour activation threshold. The motivation and ability must be at such a level, that the combination of both results in a point above the Action Line. The curved shape of the Action Line shows that there is a trade-off between motivation and ability. This means that is it not required that both are high for someone to perform behaviour. In the context of this thesis, a person could have very low motivation to use shared cars, but if it is very easy, the person could still be willing to use them. This leads to the third factor of the model: the *triggers*. Without a trigger, behaviour will not occur even if both motivation and ability are very high. A trigger could have different forms, such as an alarm, a sound, a slogan, or photo. Note that a trigger also must occur at the right time, so motivation, ability and triggers are all present at the same time.

Fogg (2009) provides sub-factors for each of the three principal factors motivation, ability, and triggers. There are three core motivators that determine the motivation factor, each having two sides: *Pleasure / Pain, Hope / Fear*, and *Social Acceptance / Rejection*. Hope / Fear is often anticipated as it considers the

consequences from behaviour, while Pleasure / Pain is a response on what is happening at the moment itself. Which of the three core motivators are most influential on someone's motivation depends on the specific person and situation.

Next, ability is referred to as 'simplicity' by Fogg (2009). Making things easier or simpler to do increases the probability that someone performs behaviour. Fogg defines six elements of simplicity: *Time, Money, Physical Effort, Brain Cycles*, *Social Deviance,* and *Non-Routine*. Each person has a different simplicity profile. For example, some people may opt for the cheapest transport mode due to financial resources, while others opt for the fastest transport mode due to their busy agendas. Ultimately, simplicity is a function of someone's scarcest resource. Regardless of what the scarcest resource is, we can reduce the barriers to perform a target behaviour.

Finally, Fogg defines three types of triggers: *Sparks, Facilitators*, and *Signals*. Sparks are often designed with a motivational element, for example showing videos to inspire hope. Facilitators are appropriate for users with a high motivation but low ability. Effective facilitators tell people that something is easy to do, for example an advertisement from a car-sharing provider. Lastly, Signals work best if people have both high motivation and ability, as it simply serves as a reminder for people to perform behaviour.

5.1.2 Role of the Fogg Behaviour Model in this thesis

The foregoing shows that there are multiple factors that influence whether someone would use a neighbourhood hub or not, as it requires a combination of motivation, ability, and triggers. The Neighbourhood Hub Design Approach which is proposed in the next section is inspired by the FBM, as it incorporates some of the factors from this model.

First of all, the Design Approach considers user profiles to determine the most preferred locations and amenities of neighbourhood hubs. This incorporation of user profiles can be related to the motivation part of the FBM model. For example, if a user profile is willing to use shared mobility, this could be offered at a hub. Next, users can anticipate on using these transport modes for their trips. So, by addressing the needs of users and aligning the offered amenities at a hub with those needs, it is assumed that people are more likely to use an amenity from a hub. Likewise, offering hubs at places with user profiles who are willing to use neighbourhood hubs could increase the motivation of those user profiles to actually use hubs. The involvement of user profiles could also be related to ability, because each user has a different simplicity profile. However, most elements of simplicity are very person-specific so hard to incorporate into user profiles.

There is one element of simplicity that is addressed in this thesis, because the Design Approach aims to determine the most preferred locations of neighbourhood hubs: *Physical Effort*. Placing neighbourhood hubs closer to people lowers the walking distance to access amenities. In other words, proximity of amenities lowers the physical effort and thus increases someone's ability to use those amenities. Proximity has been recognized as an important factor influencing the use of shared mobility / neighbourhood hubs (Claasen, 2020; Van Gerrevink, 2021; Van Marsbergen et al., 2022). Because neighbourhood hubs have a denser grid compared to other higher level mobility hubs, it is more likely that a hub is located closer to residents.

All in all, the Neighbourhood Hub Design Approach is based on several factors from the FBM, aiming to increase the probability that someone will use a neighbourhood hub. Whether implementing neighbourhood hubs according to the Design Approach actually results in a higher use, is not in the scope of this thesis.

5.2 Neighbourhood Hub Design Approach set-up

5.2.1 Explanation of the Advier tool

First, the Advier tool is explained, because this is used as a starting point for the Design Approach step sequence. Of course, the Advier tool starts with defining the study area. Next, within the study area all existing transport nodes are highlighted. Figure 11 below shows the case of Utrecht where the Advier tool was applied (Advier, 2021a). Within the observed city, all transport nodes are highlighted, in this case the existing P+Rs (blue circles), train stations (burgundy circles), bus stops (yellow, orange, and red circles), and tram stops (lime circles). The next step is to draw a circle with a 1 kilometer radius around each node which gives access to the national transport network – this is the catchment area of train stations and P+R locations in the observed area. The catchment areas of P+Rs and train stations are represented by a blue circle in figure 12. All areas lying within the blue catchment areas are not considered to develop neighbourhood hubs, because it is assumed that people whose origin or destination is located within a 1 kilometer radius from a station will walk or use their bike for the access and/or egress trip leg. The areas outside the blue catchment areas can be considered for mobility hubs: these areas are the so-called "white spot" areas as these are not covered by the P+R's and train station nodes.

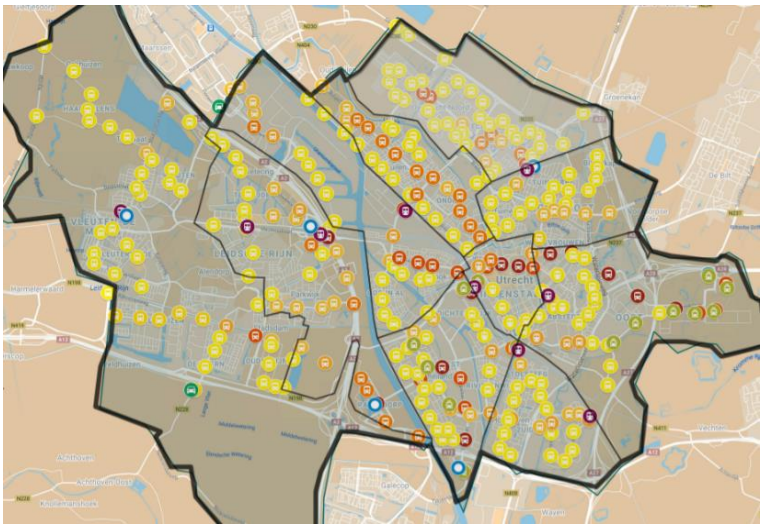

Figure 11 - Existing transport nodes in Utrecht (Advier, 2021a).

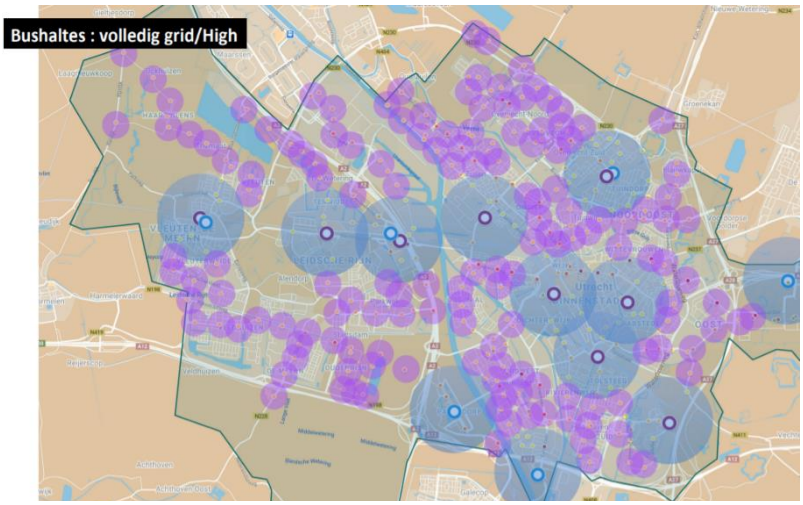

Figure 12 - Example neighbourhood hub grid on bus stops high scenario - (Advier, 2021a).

Within these white spot areas, the existing bus and tram stops act as potential locations for neighbourhood hubs (i.e. 'anchor points'). This is because bus and tram stops already attract a certain amount of people every day, and they are part of a transport system. The catchment area of these locations is assumed to be a circle with a 300 meter radius; these are the purple circles in figure 12. A number of scenarios can be made for the neighbourhood hub grid. Figure 12 shows the 'high' scenario in which a purple circle is drawn around all bus stops. But if there is for example a budget limitation, one could opt for a less dense neighbourhood hub network by only prioritizing the bus and tram stops with the highest attraction value. In figure 13 below, only the bus stations which show passenger activity above a certain threshold are highlighted with a green circle. In the case of this scenario only fourteen promising neighbourhood hub locations are identified.

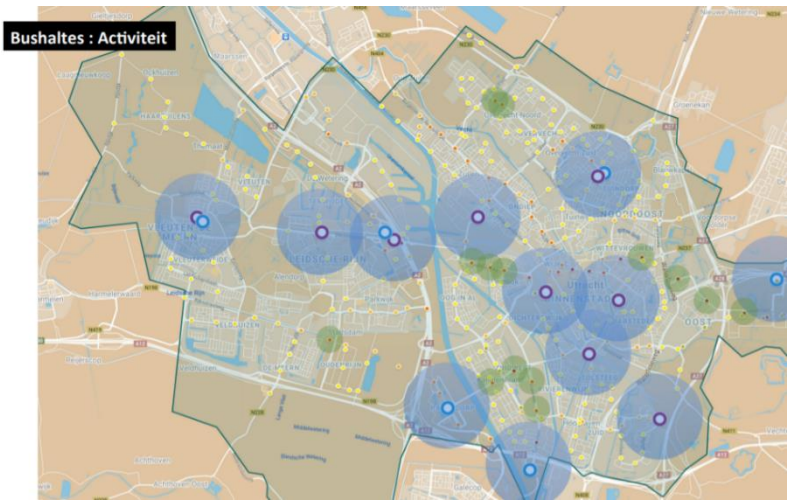

Figure 13 - Grid in scenario with highest activity bus stops (Advier, 2021a).

So one could vary among different scenarios depending on restrictions, limitations, desires and requirements. But the essence of the Advier tool is that it is able to determine locations of a neighbourhood hub grid in a city, based on existing transport nodes and general catchment area assumptions. Figure 14 shows the components of the Advier tool and relationships between them in a conceptual model. The 'Requirements imposed by the client', shown in a dotted box, are applicable after running the Advier tool. Demands from a client or constraints such as budget limitations could determine which locations will actually be chosen to develop neighbourhood hubs (this was also considered in the scenarios by Advier).

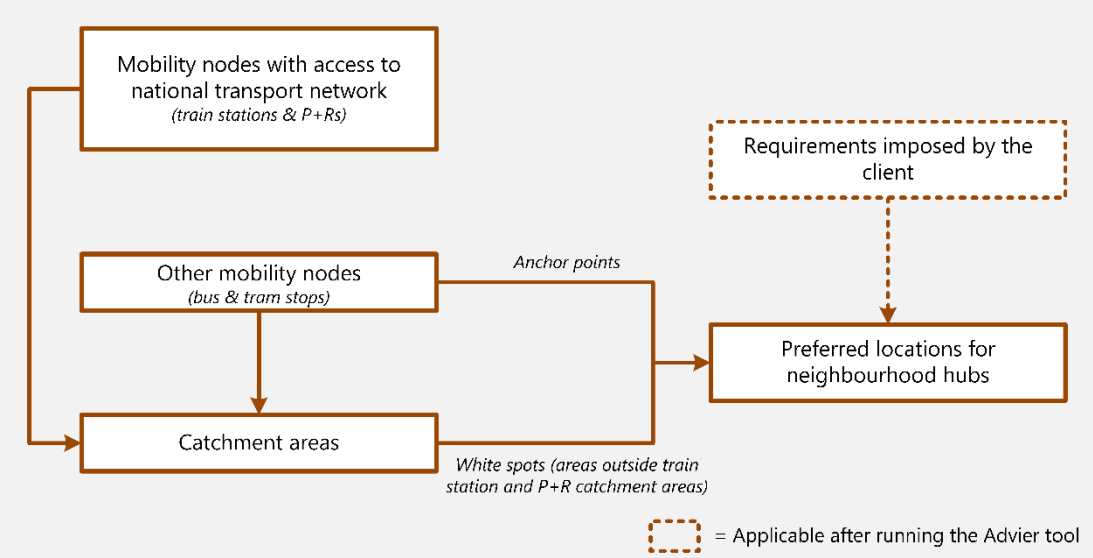

Figure 14 - Advier tool presented as a conceptual model.

5.2.2 The Neighbourhood Hub Design Approach

In accordance with the demands from Advier, the Neighbourhood Hub Design Approach improves on the Advier tool in five ways:

1. Besides determining the neighbourhood hub locations, the Design Approach step sequence also aims to determine which amenities (shared services and transport modes) should be allocated to each neighbourhood hub location.
2. The Design Approach applies a user perspective to determine the range of most preferred amenities at each neighbourhood hub.
3. The Design Approach considers existing locations of the amenities, as it should be known what is already there before adding new locations of those services and transport modes.
4. Instead of considering two types of catchment areas (1 kilometer for train stations and P+Rs; 300 meter for bus and tram stops), the Design Approach considers different catchment areas for each individual amenity.
5. Besides existing transport nodes, the Design Approach step sequence also considers non-mobility nodes for the most preferred neighbourhood hub locations.

The Neighbourhood Hub Design Approach is conceptualized by using the steps from the Advier tool as a basis, and expanding it by incorporating the five aforementioned improvement points. The conceptualization of the Design Approach step sequence has been done iteratively by applying the step sequence on imaginary cities with different sizes and lay-outs, and using input from supervisors.

Figure 15 (see next page) shows the resulting step sequence of the Neighbourhood Hub Design Approach. In essence, the step sequence can be divided into three parts: *I. Hub locations, II. Hub amenities,* and *III. Amenities per hub location*. The titles of these three parts with corresponding steps are also visible in figure 15. Note that each of the three parts is coloured with a different orange tone. The following bullets describe what each part entails.

I. *Hub locations*: the goal of this part is to determine the potential locations for neighbourhood hubs in the study area. It uses data on locations of mobility and non-mobility anchor points to identify potential hub locations. The clustering step is performed as it does not make sense to develop neighbourhood hubs right next to each other. Otherwise, the concept of clustering amenities at central places would be gone.

II. *Hub amenities*: this part aims to determine existing locations of promising hub amenities as well as search for potential new locations of hub amenities. In correspondence with the research objective of this thesis, user profiles are used to determine which amenities should be considered in each district. Figure 15 shows that in total four different data sources are used as inputs for this part.

III. *Amenities per hub location*: this third part combines the results from the first and second part by determining preferred hub amenity types for each hub location. Given a certain hub location and certain amenity type, there are three possibilities:
    1. An amenity is already present at the neighbourhood hub location.
    2. A neighbourhood hub location falls inside the search area for a new amenity location – in this case, the amenity is added to that neighbourhood hub as a 'new' amenity.
    3. The amenity is not present at the hub location, and the hub location falls outside the search area for that amenity – in that case the amenity is not considered for that hub location.

Note that the flow-chart in figure 15 shows another component besides the three aforementioned parts. This component is shown in the darkest orange coloured box and entails the 'Interpretation and implementation of the results'. This means that the Neighbourhood Hub Design Approach does not stop

after having obtained the results in part III. The next step is to interpret these results, and make an implementation plan if policymakers would like to develop hubs in their city. The dotted line around the box means that this component is officially not part of the step sequence, but multiple suggestions are provided after the case study in section 7.3 to prioritize neighbourhood hub locations. Moreover, the final chapter of this thesis provides practical recommendations to interpret and implement the results from the step sequence.

A final component of the step sequence that needs to be discussed is the feedback loop, shown by a dotted line. It could be required to run the step sequence multiple times consecutively with different inputs. For example, considering more and more types of anchor points to increase the neighbourhood hub grid density. Moreover, it could be advisable to run the step sequence with a certain frequency (e.g. yearly) to obtain the most up-to-date results.

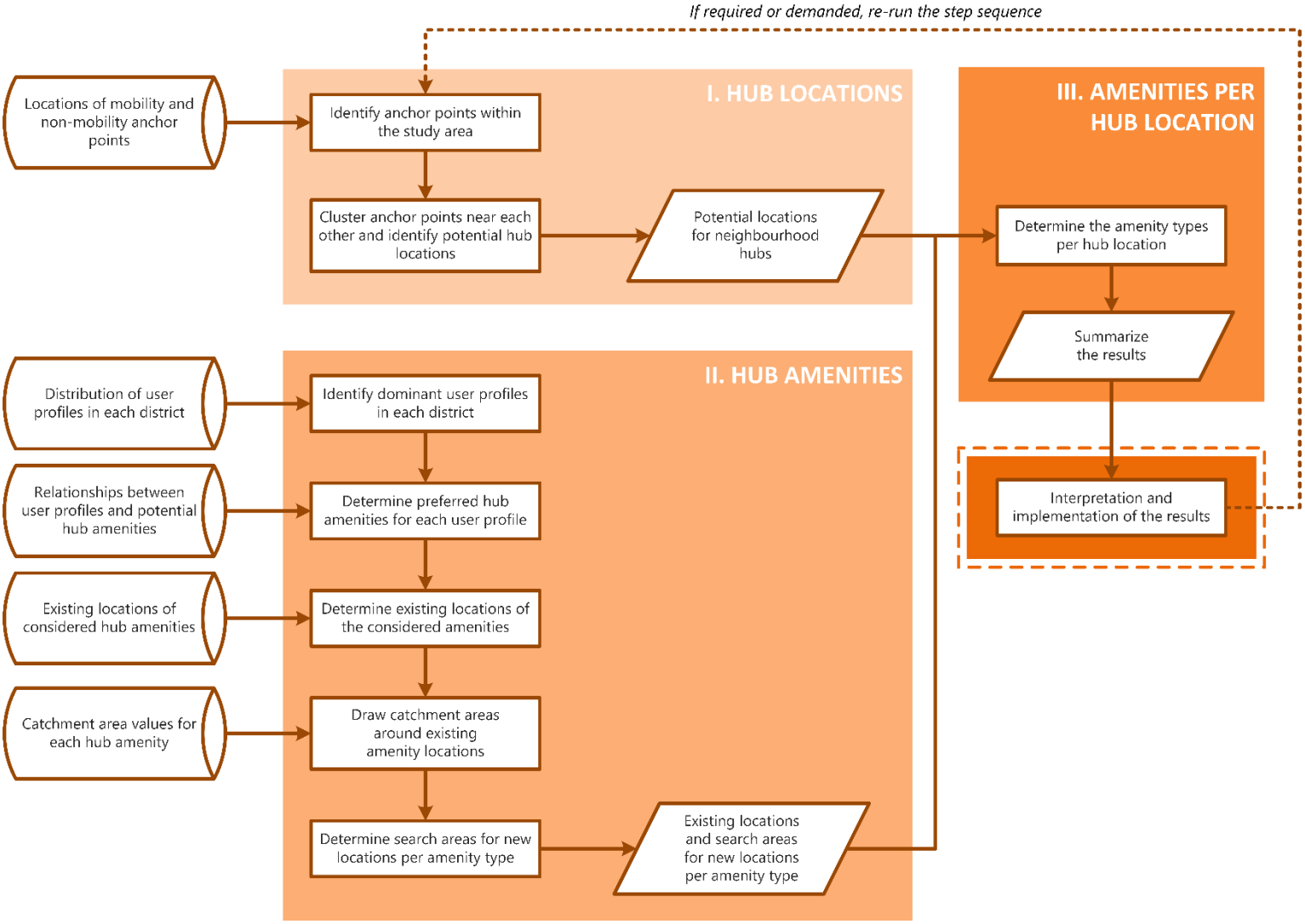

Figure 15 - Neighbourhood Hub Design Approach into conceptualized flow-chart.

Like for the Advier tool in figure 14, components of the Design Approach step sequence and relationships between them are shown in a conceptual model. Figure 16 shows this conceptual model. The first difference with figure 14 is the addition of user profiles which influence the amenities to consider for each user profile. Moreover, user profiles could indicate whether there is a need for a neighbourhood hub in that area (given the probability that a user profiles will adopt hubs). Given the need for a neighbourhood hub in an area, anchor points can be used to determine the most preferred

neighbourhood hub locations. Next, with the existing locations of the preferred hub amenities and their catchment areas, it can be determined which amenities should be placed at each neighbourhood hub location.

The dotted box on the right-hand side now also contains 'Policy objectives from authorities (see chapter 4)'. This implies that authorities should formulate the policy objectives they want to contribute to, as this influences what will be the definitive neighbourhood hub locations, amenities at each hub, and how neighbourhood hubs should be rolled out over a city. The other term 'Desires / requirements from local community' means that policymakers should engage local residents while determining each definitive neighbourhood hub location and the amenities at each neighbourhood hub.

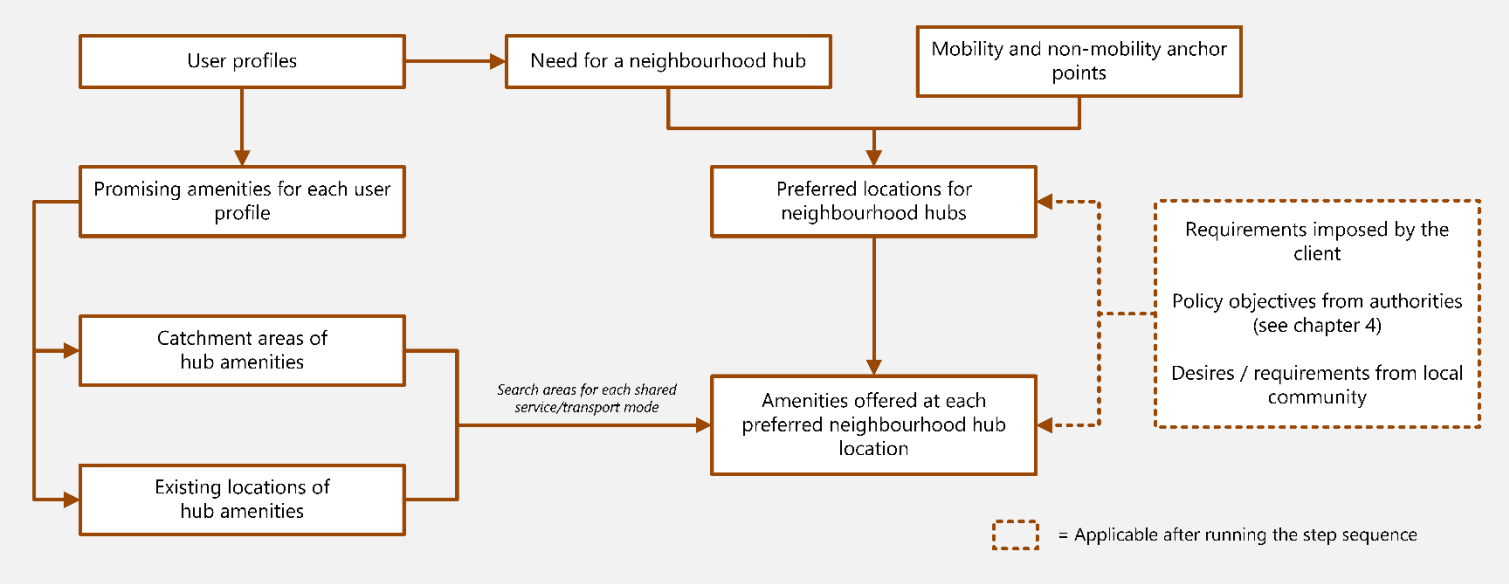

Figure 16 - Neighbourhood Hub Design Approach presented as a conceptual model.

During the development of the Neighbourhood Hub Design Approach, it turned out that if one would want to apply the step sequence in a case study for a real Dutch city, more research is required for multiple components. The next sections 5.3 to 5.6 address the four components:

1. *Section 5.3 - Preferred locations for neighbourhood hubs (anchor points)*: the Advier tool used existing transport nodes, but neighbourhood hubs can also be located at non-mobility nodes. Moreover, it should be determined how we could prioritize certain hub locations.
2. *Section 5.4 – Neighbourhood hub amenities*: there is a large number of possible shared services and transport modes that can be allocated to a neighbourhood hub. The Design Approach aims to determine only the most preferred amenities at each hub location, which requires a selection of amenities.
3. *Section 5.5 – User profiles method:* the Design Approach should be a practical tool. This also requires a practical method to define user profiles which could be applied on any Dutch city.
4. *Section 5.6 - Catchment areas of neighbourhood hub amenities*: in contrast to the Advier tool, this thesis considers specific catchment areas for each individual amenity. Assumptions are required for this.

The influence of user profiles on preferred amenities and locations for neighbourhood hubs is considered separately in chapter 6. This is done because this is part of this thesis' main research objective, and requires a more extensive research compared to the other components.

5.3 Preferred locations for neighbourhood hubs

5.3.1 Anchor point types

In chapter 3 it was found that previous studies have already worked with anchor points to determine locations for hubs. We learned that neighbourhood hubs cannot only be placed at mobility-related anchor points, but can also be located at non-mobility related anchor points – this happens to be one of the improvements of the Design Approach over the existing Advier tool. Thus, for this section we are looking for a reference which provides a set of the most preferred mobility and non-mobility related locations for hubs.

After a literature study, the *Shared Mobility Rocks* guideline from the SHARE-North Academy (2021) was found to contain the most complete set of promising locations for neighbourhood hubs: *central places in neighbourhoods and villages, train, tram, bus,* and *metro stations, business parks, shopping centers, marketplaces, neighbourhood focal points,* and *P+R facilities*. If one would opt for a higher density grid of neighbourhood hubs, more emphasis should be put on on-street sites, for example near a waste container. This thesis however focuses on the most preferred locations for neighbourhood hubs, so the higher level locations are considered. Moreover, the neighbourhood hubs in this thesis have an origin functions, so anchor points should lie within or next to residential area. Therefore, it makes less sense to consider business parks as an anchor point. The resulting overview of anchor points is presented in the following table.

Table 7 - Anchor point overview for higher level neighbourhood hubs.

Mobility	Non-mobility
Train station	Central place/focal point in neighbourhood
Tram station	Shopping center
Bus station	Marketplace
Metro station	
P+R facility	

This corresponds with the findings on mobility hub locations from Blad (2021) who stated that not only locations with a mobility function should be taken into account, but also locations with a social and economic function. Furthermore, the anchor point types from table 7 correspond with other reviewed scientific literature about hub locations in chapter 3 (Coenegrachts et al., 2021; Martinez & Rakha, 2017; Petrović et al., 2019).

5.3.2 Indicators for most preferred locations of hubs

Now it is known what are promising anchor points for neighbourhood hubs, the question is how the most preferred neighbourhood hub locations could be determined in a city. From the literature study in chapter 3 we learned that there are multiple criteria and attributes that can be used to determine the preferred hub locations. Examples from literature are the parking pressure in an area (Blad, 2021; Van Rooij, 2020), numbers of reached residents (Blad, 2021; Petrović et al., 2019), and presence of infrastructure (Blad, 2021). Which criteria are applicable could depend on local policies: if for example the adoption of sustainable transport modes is important, criteria such as a low car-ownership or high population density could be considered. In another example where there are parking issues and unlocking public space is important, a high car-ownership and high parking space occupancy rate might be relevant criteria. But another more generic factor could be the availability of space: if there is no space it is simply not possible to develop hubs.

None of the criteria above are considered in this section for selecting the preferred neighbourhood hub locations. In correspondence with the Advier tool, this thesis looks at anchor points as potential hub locations, and considers user profiles to indicate the preferred locations. This section specifically focuses on anchor points, so it considers the characteristics of the anchor points as criteria. The advantage is that for this step the Design Approach only requires data for the existing anchor point locations, which makes the method more practical. This does not mean however that the other criteria are irrelevant. But, due to the scope of this thesis, and to improve efficiency of the step sequence, these other criteria are not researched.

The following provides indicators for the most preferred hub locations by considering two anchor point characteristics: (1) number of anchor points near other, and (2) network level, as these were suggested by Advier and could be related to the theory from Bertolini (1999).

Number of anchor points near each other

It is often the case that in cities multiple types of anchor points lie close to each other. This clustering of anchor points in an area could indicate that it is promising to search for a neighbourhood hub location in that area. More anchor points lying close to each other could indicate that there are more activities and functions in that area. According to the Node-Place model from Bertolini (1999), a higher diversity and intensity of activities in an area results in a higher place-value. A higher place-value means that there is a higher degree of actual realisation of physical human interaction. Thus, it could be assumed that if there are multiple anchor points close to each other, there is a higher number and diversity of passengers or visitors. Subsequently, it could be stated that if a neighbourhood hub would be located at a place with a higher number of clustered anchor points, there is potentially a higher number and diversity of neighbourhood hub users. The number of clustered anchor points is therefore considered as a logical indicator for the most preferred neighbourhood hub locations in a city.

What distance anchor points should be located from each other to be considered as 'clustered' is determined during the case study in chapter 7.

Network level

Another indicator for the most preferred neighbourhood hub locations is the network level of each anchor point type. Section 1.6 provided a mobility hub hierarchy, showing that different types of mobility hubs could play a role on different levels in the transport network. It also stated that mobility hubs from a higher hierarchical level can function as a neighbourhood hub. Anchor points could also be classified based on this network hierarchy.

Whether the highest network level of an anchor point type is interregional/national, regional, local, or neighbourhood depends on the size of the anchor points. For example, a shopping center could be so large that it attracts people from all over the country, but it could also have only a few facilities for residents in the surrounding neighbourhoods. Still, it is valuable to indicate the network level of each anchor point as this could help to prioritize locations for neighbourhood hubs. The following table indicates what is the highest network level of each anchor point type and the assumption behind it.

Table 8 - Anchor point overview for higher level neighbourhood hubs.

Anchor point type	Highest network level	Assumption
Train station	Regional	Depending on the size of the station, it could be assumed that people from the region come to the station to catch the train.
Tram station	Neighbourhood	Each tram stop serves the surrounding streets or neighbourhood.
Bus station	Neighbourhood	Same as for tram stations, but a difference is that the tramline infrastructure is more fixed.
Metro station	Local	Underground metro networks have an even more fixed infrastructure compared to a tram line. We assume that metro stations serve a larger area (so higher urban level) compared to bus and tram stations.
P+R facility	Regional	We assume a P+R where people come to with their private vehicle, and from there take public transport to their destination. People from villages and towns outside the city come to this P+R. P+R facilities can lie at different locations. For this thesis we only consider P+R in or next to urban areas.
Central place/focal point in neighbourhood	Neighbourhood	These are buildings and places which are located centrally in neighbourhoods, so they are also meant specifically for that neighbourhood.
Shopping center	Local	Shopping centers occur in different sizes. For this thesis we assume that a shopping center has such size, that it could attract people from different neighbourhoods in a city.
Marketplace	Neighbourhood	A marketplace or square is often part of a neighbourhood or district.

The level of an anchor point in the network hierarchy could indicate two aspects: (1) a higher potential for passengers and visitors, and (2) the movability of an anchor point.

Let's start with the first aspect. Like the previous indicator, network level could be related to the Node-Place model (Bertolini, 1999). The *Inspiratieboek Attractieve Mobipunten* commissioned by the Departement Mobiliteit en Openbare Werken of Flanders (2019) indicates that if a node (or anchor point) has a higher position in the hierarchical network, it has a higher node-value. According to Bertolini (1999), a higher node-value indicates that there is more potential for physical human interaction. So placing a neighbourhood hub near a higher level anchor points increases the potential for neighbourhood hub users.

Regarding the second aspect, we could make the assumption that an anchor point which is part of a higher level network has a lower movability. Take for example the comparison between a shopping center and bus stop. Depending on the size, a shopping center often serves one or more entire neighbourhoods in a city, whereas as bus stop usually serves only a part of a neighbourhood. Therefore, it could be assumed that a shopping center is a more fixed location in a city compared to a bus stop. And in practice it is also easier to relocate a bus stop compared to a shopping center. In this case, it makes sense to prioritize neighbourhood hub locations at anchor points with a lower movability.

KEY TAKEAWAYS

- Different types of mobility and non-mobility related anchor points can be used to determine neighbourhood hub locations.
- In correspondence with the Advier tool, thesis focuses on anchor points to indicate the most preferred neighbourhood hub locations. Two anchor point characteristics have been selected.
- A higher number of anchor points near each other could indicate a higher place-value, resulting in a higher number and diversity of potential neighbourhood hub users.
- An anchor point with a higher network level could increase the potential for neighbourhood hub users, and indicate a lower movability.

5.4 Neighbourhood hub amenities

5.4.1 Inventory of amenity types

One of the findings from chapter 3 was that various mobility and non-mobility amenities can be allocated to a hub (Blad, 2021). Therefore, guidelines are required which include sets of mobility and non-mobility related amenities to place on hubs. Among SHARE-North partners, four of such guidelines were found:

1. A 'cookbook' for 'buurthubs' (local or neighbourhood hubs) from Advier (Advier, 2021a).
2. The CoMoUK Guidance on Mobility Hubs which has been created together with partners of the EU Interreg North Sea Region (CoMoUK, 2019).
3. The mobility hub strategy study from SEStran (2020).
4. The guideline *Vlaamse Visie Mobipunten* commissioned by the Departement Mobiliteit en Openbare Werken of Flanders (2019).

All amenities that occur in the four guidelines are gathered into tables which are presented in Appendix C. Appendix C makes a distinction between 'transport modes', 'mobility related services' and 'non-mobility related services'. If a service or transport mode occurs in a guideline, the cell is marked with a light-orange colour. In the most right-hand column '#Total' (see Appendix C), it is counted how many times each service/transport mode occurs in the guidelines (e.g. 'shared cars' occur in each of the four reviewed guidelines so #Total = 4). Note that the more an amenity occurs, the darker the cell colour.

5.4.2 Selection of most preferred amenities

Ideally one would want to take into consideration all possible shared services and transport modes, however for this thesis we have to impose some limitations. First of all, the Design Approach step sequence should be able to effectively and practically determine the set of most preferred shared services and transport modes at each neighbourhood hub, so the list of shared services and transport modes should be workable. Moreover, during the focus groups we would like to determine what are the most preferred amenities for each user profile. So, in order to keep the program of the focus group workable and save enough time for discussion, the list of shared services and transport modes cannot get too long.

To keep the list of considered amenities workable for the step sequence and focus groups, we introduce two criteria. The following explains the two criteria and why they were selected.

Criterium (1): Services as triggers: During the discussions with Advier supervisors, it turned out that the Design Approach should only consider those services which can be a trigger on themselves for people to use a hub. The underlying thought is that this thesis considers neighbourhood hubs to be more than a collection point of transport modes – services could be as, or maybe even more important. By taking into account this criterium, we consider only those services that could attract neighbourhood hub users regardless of whether there are transport modes. Thus, for these services it makes sense to actively search for potential locations in the step sequence.

Criterium (2): Occurrence: Next, the second criterium relates to the occurrence of shared services and transport modes in the reviewed guidelines. The assumption here is that the more a service/transport mode occurs in the guidelines, the more relevant it is to consider for the Design Approach. If we would only consider those amenities that occur 4 times (so in all guidelines), this would result in 6 transport modes and 4 shared services. If would consider those amenities that occur in 3 out of the 4 guidelines, this would result in 6 transport modes and 5 shared services. These selections were found to be not extensive enough by the author, as they exclude for example micro-mobility alternatives, and services

such as the neighbourhood library and co-workings space. Considering those amenities that occur in 2 out of the 4 guidelines would result in 11 transport modes and 11 shared services. These numbers were found to be a good balance between extensiveness and workability.

Applying these criteria results in the following selection of shared services and transport modes.

Table 9 - Selection of suitable shared services and transport modes.

Transport modes	Services
Shared cars	Charging infrastructure for private/shared vehicles
Shared vans	Bicycle parking
Public transport	Bicycle repair stand
Demand-responsive transport	Postal lockers
Taxi	Kiosk
Shared bikes	Neighbourhood library
Shared cargo bikes	Playground
Pushchairs	Sports equipment
Shared scooters	ATM
Shared mopeds	Storage lockers
Trailer	Co-working space

Note (1): a precondition for shared mobility systems is that vehicles must be "docked" at the mobility hub. The reason for this is that in the Neighbourhood Hub Design Approach catchment areas are assumed to be a circle around a point with a certain radius value.

Note (2): all the shared services and transport modes that are not considered in the Neighbourhood Hub Design Approach, are still relevant to take into consideration when designing hubs in more detail and tailoring it to the existing urban context.

KEY TAKEAWAYS

- The Neighbourhood Hub Design Approach requires a limited set of amenities to be able to consider all of them during the focus groups, and to keep the step sequence practical and efficient.
- We only consider those amenities that could be a trigger on themselves for people to use a neighbourhood hub.
- Only considering those amenities that occur at least two times in the four reviewed guidelines results in a set of eleven transport modes and eleven shared services.

5.5 User profiles method

5.5.1 Use of Whize segmentation in this thesis

While in practice all segments from the Whize segmentation can be found in a certain city, it makes sense for the Design Approach to focus on those segments which are over-represented (dominant) in certain city districts. The size of the separate districts should not be too large as we want to distinguish possible differences in preferred amenities between hubs on a certain level of detail. On the other hand, the size of the separate districts should not be too small as the step sequence should be practical. Data available is for the Whize segmentation distribution on a four-digit zip code level. For this thesis, the Design Approach is applied to existing urban areas in the municipality of Almere, so data on the Whize segmentation is collected for four-digit zip codes in this municipality (see Appendix E, first page). Besides, data on the aggregated distribution of Whize segments in Almere is collected (see Appendix E, second page).

First of all, it is interesting to see in Appendix E (second page) that the percentages of segments "Volks & Uitgesproken" and "Gewoon Gemiddeld" are significantly higher in the municipality of Almere compared to the Netherlands as a whole. On the other hand, the percentages of segments "Dromen en Rondkomen", "Bescheiden Ouderen", "Stedelijke Dynamiek", "Landelijke Vrijheid", "Zorgeloos Actief", and "Luxe Leven" are significantly lower in the municipality of Almere compared to the Netherlands as a whole. Appendix E (first page) shows for each zip code the distribution of segments: the higher the share of a segment for a four-digit zip code, the greener the cell in the table. Zip codes which contain existing urban areas are highlighted in bold – these zip codes are considered for the case study. It can be seen for the highlighted zip codes that the dominant segments are either "Jong & Hoopvol", "Volks & Uitgesproken", "Gewoon Gemiddeld", "Gezellige Emptynesters", or "Plannen & Rennen". These Whize segment names are translated for this thesis (in the same order) as: "Young & Hopeful", "Working Class", "Average Joes & Janes", "Friendly Emptynesters", and "Planning & Rushing". Interestingly, except for Young & Hopeful, these are also the segments which have a higher share for the entire municipality of Almere compared to the Netherlands as a whole. For the case study, only the aforementioned five segments are considered. Thus, these are also the segments that should be considered during the focus groups (see chapter 6).

Figure 17 (next page) shows the five selected user profiles from the Whize segmentation, and their location in the age-prosperity diagram. It can be seen that the five selected profiles roughly cover the left, right, lower, upper, and middle parts of the spectrum.

5.5.2 Creating personas

Personas are created to present to user profiles to the experts during the focus groups. A persona is an archetype of a user, or in other words, a characterization of certain type of users (Advier, 2021b). In practice it is more convenient to use personas rather than combinations of data ranges when evaluating potential target groups. This is because personas help to better understand the potential user and ensure that all actors have to same picture of the user (Advier, 2021b). Personas are considered useful for this thesis, as during the focus group they help to efficiently explain the Whize segments to the focus group attendees.

Every persona has been built up in the same way. The Whize brochure is used to determine a name, photo, and imaginary family situation – this is the basis for the personas. For each Whize segment, user and behaviour characteristics from the table in Appendix D are linked to the corresponding persona. The characteristics are used to explain the persona to the experts during the focus groups. These characteristics have been selected in such a way, that experts can imagine themselves what the activity pattern of a persona is during the day, and which (shared) modes he/she uses for the trips between

activities. The name, selection of characteristics, and typical photos from the Whize brochure are merged into a presentable format (i.e. PowerPoint slides). The persona formats from Advier (2021b) have been consulted. Advier (2021b) is perceived to have more than adequate experience in creating personas, as it has developed personas from user profiles during projects for transport agencies. As a final step, all personas in presentation format were assessed by expert judgement from Advier.

Besides the persona format, a general description of the Whize segment was added to provide a general introduction to each Whize segment, before diving into the persona. Appendix F shows the resulting slides. It can be seen that for each of the five user profiles there is one slide with a general Whize segment description, and a second slide with the persona belonging to that Whize segment.

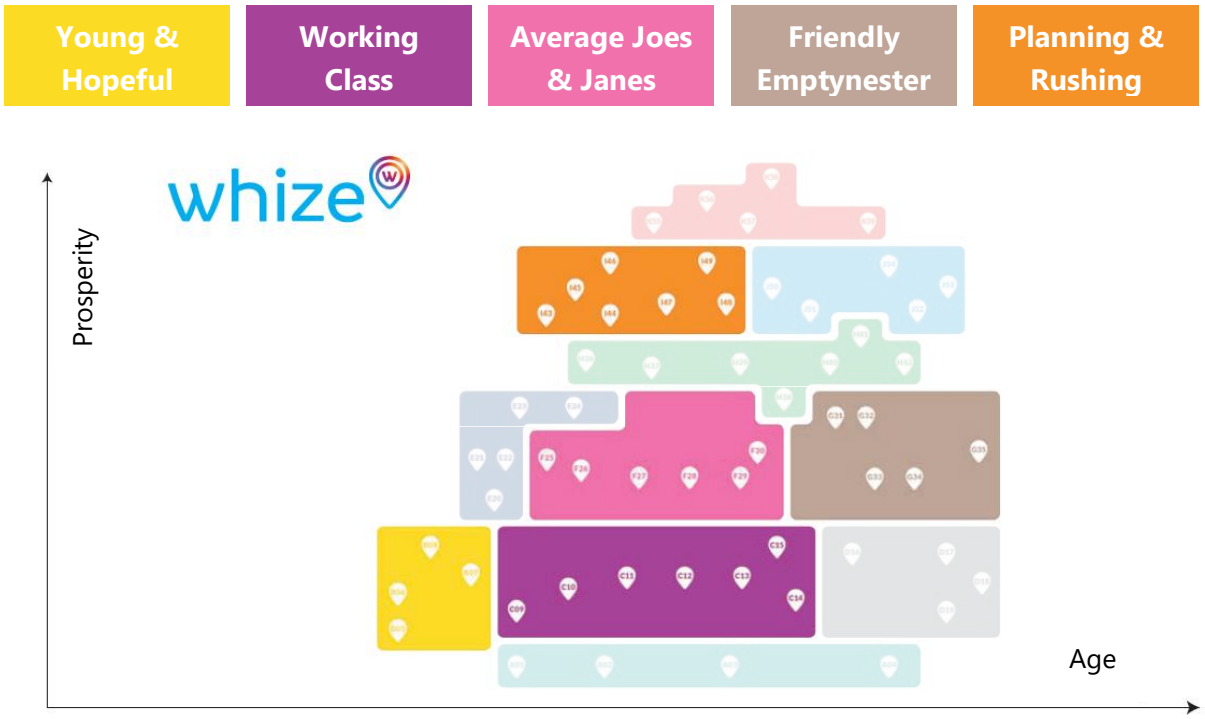

Figure 17 - Overview of Whize segments with five considered user profiles highlighted.

KEY TAKEAWAYS

- The Whize segmentation distribution in the municipality of Almere shows that there are five dominant user profiles on a four-digit zip code level: "Young & Hopeful", "Working Class", "Average Joes & Janes", "Friendly Emptynesters", and "Planning & Rushing".
- Existing templates and expert judgement from Advier have been consulted to create a persona for each user profile in a presentable format for the focus groups.

5.6 Catchment areas of neighbourhood hub amenities

This section reviews existing (scientific) research on catchment area values of amenities at neighbourhood hubs. This is done because catchment areas can help to determine what should be the distance between each service or transport mode location (i.e. neighbourhood hub location, as shared services and transport modes are clustered at neighbourhood hubs).

First, table 10 and 11 present catchment area values of each individual shared service and transport mode. Second, we observe catchment area values of neighbourhood hubs in general (see table 12). For some of the individual services and transport modes existing literature is limited or non-existent. In that case, assumptions have to be made and literature on neighbourhood hubs in general can support those assumptions.

For all catchment area values, it is assumed that people are walking from home to a neighbourhood hub. Behind each catchment area value it is mentioned whether the study relates to the context of the Netherlands ('*NL*') or another country ('*FN*').

Results from literature review on catchment area values

Table 10 shows catchment area values of individual shared services, based on studies shown in the right-hand column 'reference'.

Table 10 - Catchment areas values of shared services from literature.

Shared service	Catchment area values in literature (walking distance)	Reference
Charging infrastructure for private/shared vehicles	250-300 meter (based on municipality guidelines); *NL*	Molster & De Haan (2016);
	261 meter (average in the Netherlands); *NL*	Vattenfall (2020);
	~200 meter; *NL*	Blankers et al. (2021);
Private bicycle parking	100 meter; *NL*	Molster & De Haan (2016);
Bicycle repair stand	*No relevant literature/studies found;*	
Parcel lockers	500 meter; *NL*	ACM (2020);
	150-450 meter (originally for a letter box, but provides an indication); *NL*	Blankers et al. (2021);
	5-10 minutes (~400-800 meter); *FN*	Chaberek (2021);
	200-300 meter; *FN*	Lee et al. (2019);
	500 meter (originally for a letter box, but provides an indication); *NL*	Molster & De Haan (2016);
Kiosk	450 meter (food and daily retail uses); *FN*	Moudon et al. (2006);
	5 minutes (~400 meter; retail businesses); *FN*	Horning et al. (2008);
Neighbourhood library	20 minutes (~1600 meter; public libraries in urban area); *FN*	Huhndorf & Dzialek (2017); Park (2012);
Playground	400 meter ('wijk- of bovenwijkse speelplek"); *NL*	Kennisbank sporten en bewegen (n.d.);
Sports equipment	400 meter ('wijk- of bovenwijkse beweegplek"); *NL*	Kennisbank sporten en bewegen (n.d.);
ATM	*No relevant literature/studies found;*	
Storage lockers	*No relevant literature/studies found;*	
Co-working space	500 meter (classified as 'Werken' by CROW); *NL*	Molster & De Haan (2016);
	250-1000 meter (working in general); *NL*	Blankers et al. (2021);
	~650 meter (walking distance home-work); *FN*	Seneviratne (1985);
Social facility	*No relevant literature/studies found;*	

Next, table 11 shows catchment area values of individual shared transport modes, based on studies shown in the right-hand column 'reference'.

Table 11 - Catchment areas values of shared transport modes from literature.

Shared transport modes	Catchment area values in literature (walking distance)	Reference
Shared cars	100-200 (for private cars); *NL*	Blankers et al. (2021);
	100-350 meter; *NL*	Blankers et al. (2021);
	5 minutes (~400 meter); *NL*	Luites (2020);
	300 meter; *FN*	Becker et al. (2017);
Shared vans	*No relevant literature/studies found;*	
Public transport	**Train**:	
	~1200 meter; *FN*	El-Geneidy et al. (2009);
	0.5 mile (~800 meter); *FN*	Lahoorpoor & Levinson (2020);
	10 minutes (~800 meter); *NL*	Leidelmeijer & Damen (1999);
	1100 meter (on average); *NL*	Keijer & Rietveld (2000);
	~750 meter; *NL*	Methorst (2005);
	Bus:	
	~550 meter; *FN*	El-Geneidy et al. (2009); El-Geneidy et al. (2013);
	400 meter; *NL*	Methorst (2005);
	350 meter; *NL*	Molster & De Haan (2016);
	5 minutes (~400 meter); *NL*	Van der Blij et al. (2010);
	Tram:	
	450 meter; *NL*	Molster & De Haan (2016);
	400 meter; *NL*	Rijsman et al. (2019);
	Metro:	
	700 meter; *NL*	Molster & De Haan (2016);
Demand-responsive transport (DRT)	*No relevant literature/studies found;*	
Taxi	*No relevant literature/studies found;*	
Shared bikes	300 meter; *FN*	Kabra et al. (2019); Mete et al. (2018);
	250 meter; *FN*	Cohen et al. (2014);
Shared cargo bikes	*No relevant literature/studies found;*	
Pushchairs	*No relevant literature/studies found;*	
Shared scooters	250 meter; *FN*	Ham et al. (2021);
	3-4 minutes (~250-300 meter); *FN*	Christoforou et al. (2021);
	2 minutes (~167 meter); *FN*	Reck et al. (2021);
Shared mopeds	500 meter; *FN*	Aguilera-Garcia et al. (2021); Wortmann et al. (2021);
Trailer	*No relevant literature/studies found;*	

Finally, table 12 shows catchment area values of neighbourhood hubs in general, based on studies shown in the right-hand column 'reference'.

Table 12 - Catchment areas values of neighbourhood hubs.

	Catchment area values in literature (walking distance)	Reference
Neighbourhood hub	5 minutes (~400 meter; for an urban area/city center); *NL*	Franken (2021);
	300 meter; *FN*	Witte et al. (2020);
	400 meter; *NL*	Van Rooij (2020);

Discussion on catchment area values

Before determining the catchment area values that are used in the case study of Almere, we first highlight some points of discussion.

Focus on walking as an access mode

The catchment area values in table 10, 11, and 12 are walking distances expressed in meter. But, different means of first/last mile transport to access neighbourhood hubs can be considered. For this discussion, we limit the mode choice set to walking and cycling, because these are the most commonly used access modes in the Netherlands (Ton et al., 2020). The bicycle accounts for the largest share (43%) of home-end trips to train stations in the Netherlands (Stam et al., 2021; KiM, 2019). While this share may be different for amenities or neighbourhood hubs in general, it is relevant to consider cycling as an access mode. The catchment area of transit stations can be enlarged by using the bicycle instead of walking (Kager et al., 2016; Ton et al., 2020). For example, in table 11 it can be seen that for walking the catchment area of a train station is roughly between 750 meter and 1200 meter, but for cycling this number can be enlarged to 5000 meter (Kager et al., 2016; KiM, 2018). Interestingly, Ton et al. (2020) found in their study that walking is generally preferred over cycling as an access mode for tram stations. Shelat et al. (2018) also found that for short distances up to 1000 m, walking is the preferred mode. Moreover, Ploos van Amstel (2020) stated that 'walking distance' should be preferred over 'cycling distance', because walking has some advantages over cycling: it requires less infrastructure, it contributes to social cohesion, and offers opportunities for further densification of cities. This aligns with the objectives of neighbourhood hubs in thesis. Although cycling could indeed be a relevant access mode for neighbourhood hubs, this thesis simplifies the access mode set to walking. It could be hypothesized that the willingness to walk in the Netherlands is shorter than in other countries, because Dutch people often possess their own bicycle. This does not become clear from table 10, 11, and 12.

Travel distance instead of travel time

Ton et al. (2020) took into account both walking and cycling as access mode, and expressed the catchment area of a tram station not only in distance but also in travel time. They found that people are more willing to travel a similar time to access a transit node compared to traveling a similar distance with both walking and cycling access modes. Although both time and distance are related, this finding might suggest that travel time is a more suitable way to express a catchment area compared to travel distance (Verbruggen, 2017). Moreover, in table 10, 11, and 12 it can be seen that a number of the reviewed studies considered travel time instead of travel distance (e.g. Chaberek, 2021; Leidelmeijer & Damen, 1999; Van der Blij et al., 2010). However, for this thesis the author assumes that the step sequence is more efficiently applicable if the catchment area is expressed as a circle with a certain distance radius, instead of calculating the travel time isochrones of each individual location.

Using a single radius instead of distance decay function

The catchment area could be captured by a distance-decay function, which expresses the proportion of people who are willing to walk no more than a certain distance (El Geneidy et al., 2013). In other words, the number of people willing to use a neighbourhood hub decreases if the distance to a neighbourhood hub increases. This principle was for example used for the PINO-model from NS and ProRail in 2006 to estimate to number of train passengers (ProRail, 2009). The Design Approach assumes that the catchment area for each shared service and transport mode is a single circle with a walking distance radius. This seems a fair assumption, because the PINO-model tried to capture effect of the distance-decay function by using radius increases of 500 m. The walking distances used in this thesis are so small, that neglecting this effect is a good assumption.

Other points to consider

The catchment area value could be influenced by a number of factors. One important factor is the physical condition of people. Elderly, disabled, or injured people may be willing/able to walk a significantly shorter distance compared to people who are fit and agile (CROW, n.d.). Moreover, walking speeds can differ among people. The walking distances in table 10, 11, and 12 are calculated using a walking speed of 5 km/h, which is in accordance with the assumptions from the Dutch national government and CROW (n.d.). But, Methorst (2005) found that elderly and younger children have an average walking speed of 4 km/h. Furthermore, catchment area values can differ among trip purposes as concluded by Larsen et al. (2010). A final note is that the accepted walking distance may differ from country to country. Table 10 and 11 show that values from a Dutch context (*NL*) are comparable to a foreign context (*FN*), but this contextual difference should be kept in mind.

All of the above shows that catchment areas are affected by a number of factors. But, these factors are not considered in the remainder of this thesis.

Catchment areas per neighbourhood hub amenity

Now the catchment area values can be determined for the Almere case study. For each shared service and transport mode, the values from table 10 and 11 are used as bandwidths in figure 18 and 19. The catchment area values for the remainder of this report are determined by using a number of assumptions:

- The chosen catchment area value should lie around the middle of a bandwidth, and is rounded to the nearest hundred.
- If there is a significant difference between Dutch and foreign studies, more value should be attached to Dutch studies.
- More value should be attached to empirical studies, compared to studies in which catchment area values are based on common sense.
- It is assumed that DRT and taxi are neighbourhood hub-based, instead of driving in front of someone's house.
- The shared services and transport modes for which no values are available in literature are assumed to have a catchment area of 400 meter, as this value of walking distance has been widely applied in literature (Yang & Diez-Roux, 2012). Moreover, table 12 shows that 400 meter is found the catchment area value for neighbourhood hubs in general.

KEY TAKEAWAYS

- Catchment area values are determined for each individual amenity, based on existing literature. The catchment area of an amenity is a single radius expressed in meter.
- It is assumed that all amenities for which no specific literature is available have a catchment area of 400 m (i.e. the walking distance).
- Besides walking, cycling is another popular access mode in the Netherlands which can increase the catchment area of an amenity, and potentially influence the willingness to walk. For this latter part, no evidence has been found in this study.

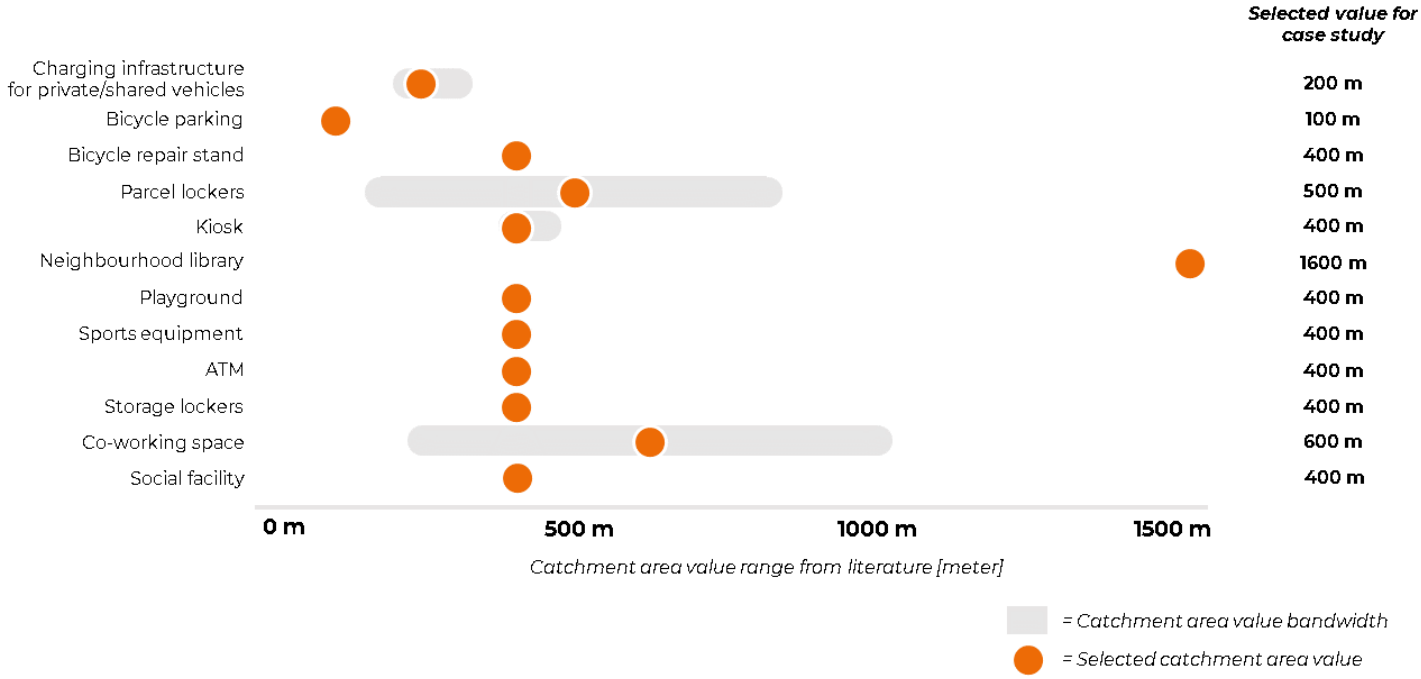

Figure 18 - Catchment area values for each shared service.

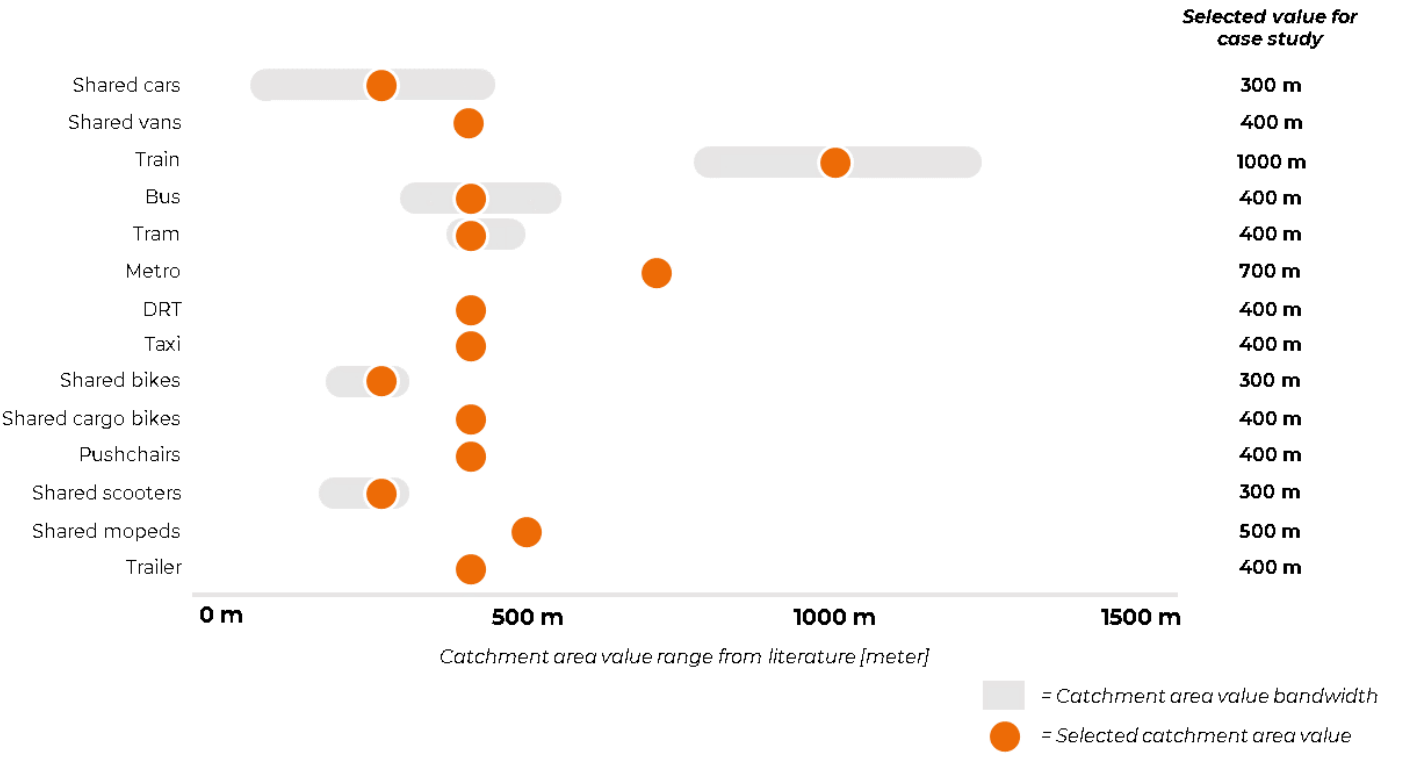

Figure 19 - Catchment area values for each transport mode.

Sub-research question (2): "*What are promising types of locations and amenities for neighbourhood hubs in urban areas?*"

Locations for neighbourhood hubs

A literature study found a number of potential types of locations (i.e. "anchor points") to place a neighbourhood hub. A neighbourhood hub does not have to be placed at an existing transport node per se, but could also be placed at a non-mobility anchor point. The anchor point types that can be used as potential locations for neighbourhood hub with an origin function are presented in table 7.

Different criteria and attributes can be used to indicate which anchor points are the most preferred hub locations. In correspondence with the existing Advier tool, this thesis focuses on anchor points to indicate the most preferred neighbourhood hub locations. Two indicators are proposed, which were suggested by Advier and could be related to the theory from Bertolini (1999).

The first indicator, number of clustered anchor points, assumes that more anchor points lying close to each other indicate more activities and functions in that area. This could be related to a higher place-value, and subsequently a higher intensity and diversity of potential neighbourhood hub users. The second indicator, network level of each anchor point, assumes that different types of anchor points serve on different hierarchical network levels. Table 8 provides the highest network level at which each anchor point type serves. A higher network level could indicate a higher potential for passenger and visitors, and a lower movability of the anchor point type.

Both indicators can be used to determine the most preferred locations for neighbourhood hubs, and prioritize locations for the rollout of neighbourhood hubs.

Amenities for neighbourhood hubs

The Neighbourhood Hub Design Approach requires a limited set of amenities to be able to consider all of them during the focus groups, and to keep the step sequence practical and efficient. Therefore, only those shared services that could be a trigger on themselves for people to use neighbourhood hubs are considered. This is because the step sequence actively searches for existing and new locations for each amenity type. Besides, only those amenities that occur two or more times in the four reviewed hub guidelines are considered. This narrows down the list of amenity types to eleven shared services and eleven transport modes, which are shown in table 9. These amenities can be used for the focus groups.

Sub-research question (3): "*What are the most suitable user profiles to incorporate the influence of users on neighbourhood hub locations and amenities?*"

For this thesis the Whize segmentation was found the most suitable method to define user profiles. Available data of the Whize segmentation distribution in the municipality of Almere shows that there are five dominant user profiles on a four-digit zip code level: "Young & Hopeful", "Working Class", "Average Joes & Janes", "Friendly Emptynesters", and "Planning & Rushing". Thus, these user profiles are considered in the focus groups to determine the most preferred neighbourhood hub amenities, and which user profile has the highest probability to actually use neighbourhood hubs.

Young & Hopeful	Working Class	Average Joes & Janes	Friendly Emptynesters	Planning & Rushing

In order to merge the user profiles into a presentable format, personas were created. Existing templates and expert judgement from Advier were consulted to create a persona for each user profile (see Appendix F for the resulting slides). These personas are used in the presentation for the experts during the focus groups.

6. Influence of user profiles on locations and amenities of neighbourhood hubs

Section 6.1 discusses the set-up and findings from the focus groups. Section 6.2 reviews existing literature on users of neighbourhood hubs, shared services, and transport modes to identify typical characteristics. Section 6.3 compares the insights from section 6.1 and 6.2, after which 6.4 concludes with an assessed set of preferred amenities for each user profile and the probability that each user profile will use neighbourhood hubs. Sub-question (4) is answered at the end of this chapter.

6.1 Perspective (1) – Focus groups

Before conducting the Dutch and foreign focus groups, the draft scenario design was tested in a pilot session internally at Advier. The feedback from this pilot session could be summarized in three main points (see Appendix G). This feedback has been used to make changes for the programme and timing of the official focus groups.

The scenario can be briefly described as follows. As an introduction, the author of this thesis presented the purpose of this thesis and focus groups, so the experts were able to adequately participate in the substantive part of the focus group. The substantive part was divided into five parts according to the five user profiles which are dominant on a four-digit zip code level in the municipality of Almere (see section 5.5). For each of these five user profiles the same procedure was followed. First the author gave a general description of the user profile and presented the corresponding persona. The slides used to present the user profile and persona can be found in Appendix F. Next, the moderator asked three questions to the focus groups attendees:

1. *What are the most suitable transport modes for the profile [user profile] that should be offered at hubs (if implemented properly)?;*
2. *What are the most suitable shared services for the profile [user profile] that should be offered at hubs (if implemented properly)?;*
3. *What is according to you the probability of the profile [user profile] actually using hubs?;*

For the first two questions, the amenities from section 5.4 were used as multiple choice options. For the third question, participants could select a single option, according to a Likert-type scale ranging from 'very low' to 'very high'. After all participants submitted their answers for the three questions, there was time to discuss the results. A detailed description of the scenario with the used discussion guide can be found in Appendix G. This discussion guide uses the same structure as in the study from Krabbenborg et al. (2020).

General comments on poll questions

The number of votes on each of the poll questions can be found in Appendix H. It can be seen that a separate table has been made for each of the three poll questions. One thing that should be noted is that the number of responses differs between the focus groups: for the Dutch focus group there are 10 or 11 responses and for the foreign focus groups there are 4 or 5 responses. The difference in responses for both focus group was due experts leaving and/or joining during the sessions, and due to the timing of poll closure. Besides, Appendix H show the poll results in percentages. For some shared services and transport modes there are significant differences in the poll results between the Dutch and foreign focus group. This is probably partly caused by the difference in number of responses, but another important factor could be the difference in perception that the Dutch and foreign experts have of user profiles/personas, shared services, and/or transport modes.

Findings from focus groups

The focus groups resulted in two types of 'products':

- Tables with suitable shared services and transport modes for each of the five considered user profiles, and the probability that a user profile actually uses neighbourhood hubs (see Appendix H).
- Insights from the discussion part regarding preferred shared services, transport modes, and user profiles (see Appendix I).

The results from the focus group polls and discussions have been merged into an infographic (see figure 20 below).

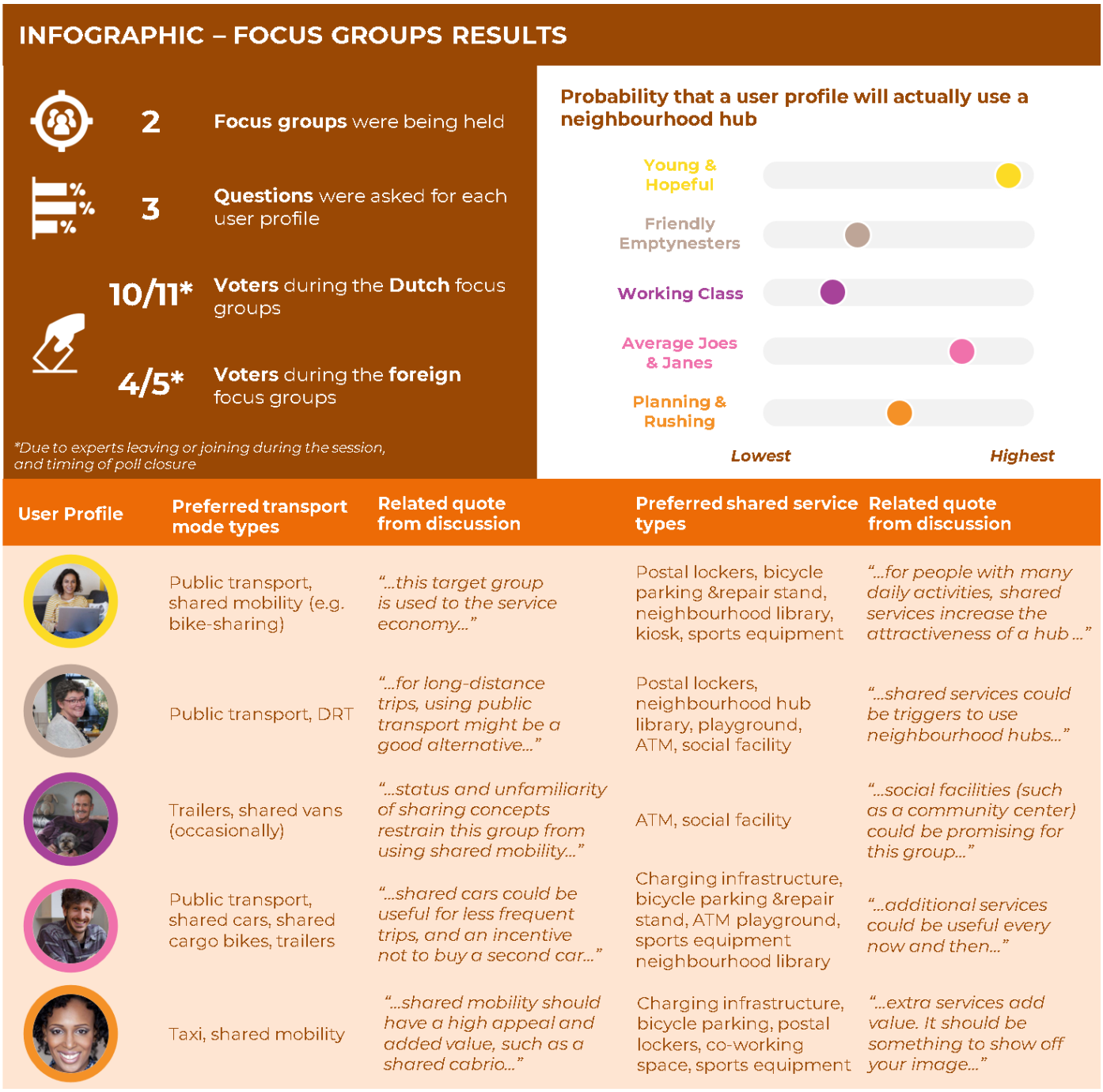

Figure 20 - Focus group polls and discussions summarized in an infographic.

Findings on probability of actually using neighbourhood hubs

For the purpose of this section, poll answers from both the Dutch and foreign focus groups have been combined. This is to make an overall overview for the probability of user profiles to use neighbourhood hubs (see section 6.4). Table 13 shows the combined focus group poll results from the question *"What is according to you the probability of the profile [user profile] actually using hubs?"*.

Table 13 - Poll question on probability of actually using hubs (in percentage of total responses).

Percentage of total responses **Answer**	**Young & Hopeful**	**Friendly Emptynesters**	**Working Class**	**Average Joes & Janes**	**Planning & Rushing**
Very low	7%	33%	31%	0%	0%
Low	0%	27%	38%	7%	20%
Neutral	7%	27%	25%	33%	40%
High	73%	13%	6%	53%	40%
Very high	13%	0%	0%	7%	0%

Table 13 shows that experts think that the Young & Hopeful user profile is (very) likely to actually use neighbourhood hubs. This really depends on the activity pattern and mode choice. They mentioned that if there is a bus stop at a neighbourhood hub, but it is more convenient to cycle to the train station, the persona is less likely to use the bus service offered at the neighbourhood hub. On the other hand, the shared services themselves could be a reason to use neighbourhood hubs.

The experts think that Friendly Emptynesters are less likely to user neighbourhood hubs. During the foreign focus group it was stated that they are less open to new things and services. Also, an expert from the Dutch focus group mentioned that one should target other user profiles, but with complementing transport modes and services you could convince this user profile to use neighbourhood hubs. Like for the Friendly Emptynesters, the experts think that people from Working Class are less likely to user neighbourhood hubs, because the need of this user profile to use neighbourhood hubs is not that big.

For the Average Joes & Janes user profile the poll results show that experts are mainly positive on the probability that this user profile is actually going to use neighbourhood hubs. The experts think that offering shared services and transport modes at neighbourhood hubs could help this user profile during their daily lives. Also, this user profile probably has the financial resources to afford this.

Finally, poll results are quite diffused for the user profile Planning & Rushing. On average experts tend to be neutral. But, the results show that experts from the Dutch focus group seem to lean a bit more to the positive side, while experts from the foreign focus group are a more negative on the probability of actually using neighbourhood hubs (see Appendix H). This might be explained by the discussion during the Dutch focus group, as experts would want to convince this user profile to get rid of their private cars.

Findings on transport modes

Table 14 shows the combined focus group poll results from the question *"What are the most suitable transport modes for the profile [user profile] that should be offered at hubs (if implemented properly)?"*.

Table 14 - Poll question on most suitable transport modes (in percentage of total responses).

Percentage of total responses **Transport modes**	**Young & Hopeful**	**Friendly Emptynesters**	**Working Class**	**Average Joes & Janes**	**Planning & Rushing**
Shared cars	7%	21%	20%	69%	47%
Shared vans	0%	14%	60%	38%	33%
Public transport	100%	57%	47%	88%	27%
Demand-responsive transport	27%	50%	20%	13%	20%
Taxi	13%	29%	7%	0%	60%
Shared bikes	87%	7%	13%	19%	7%
Shared cargo bikes	47%	7%	13%	88%	60%
Pushchairs	0%	14%	0%	13%	0%
Shared scooters	47%	0%	20%	0%	40%
Shared mopeds	60%	7%	27%	6%	60%
Trailer	0%	36%	67%	69%	40%

For the user profile Young & Hopeful two transport modes really stand out: public transport (100% of the combined votes) and shared bikes (87% of the combined votes). During both the foreign and Dutch focus groups it was stated that this persona will probably keep using her own bicycle and public transport from a financial standpoint, so there was a lot of agreement to this regard. In general it can be concluded that the persona is open to shared mobility, because this target group is used to the service economy, and is likely to adopt concepts such as bike-sharing and scooter-sharing fairly quickly. Besides, if the persona would have had a driver's licence, experts thought that she would use shared cars for less frequent trips.

For the user profile Friendly Emptynesters, it was stated that for long-distance trips, using public transport might be a good alternative. The same could be said for demand-responsive transport. So the transport modes offered at neighbourhood hubs are perceived to complement the persona's own vehicles for certain types of trips. Shared mobility was found less suitable as the experts stated that this user profile probably sticks to their own vehicles, and the unfamiliarity with smart phones might be an obstacle to use shared mobility modes.

Regarding the Working Class user profile, the experts thought that this group is less likely to use transport modes at neighbourhood hubs due to status and unfamiliarity with concepts offered at a hub. Besides, the financial aspect was found to restrain this user profile from using shared mobility as complementing transport modes. During the foreign focus group it was mentioned that this user profile is not likely to pay some extra for having access to shared cars, mopeds or bikes besides having their own private vehicles, as they sometimes struggle paying their bills. Moreover, people from Working Class are susceptible for out-of-pocket expenses and they make less rational financial choices.

For the Average Joes & Janes user profile, shared cars, public transport, shared cargo bikes, and trailers are mainly found as preferred transport modes. During the Dutch focus groups it was stated that shared cars could be useful for less frequent trips, and an incentive not to buy a second car. Also, experts from the foreign focus group thought that shared mobility at a neighbourhood hub offers additional mobility

alternatives besides the private car and bikes, supporting people from Average Joes & Janes in their busy schedule during the day.

According to the foreign focus group, the user profile Planning & Rushing is a harder target group for shared mobility and public transport, because they have the luxury of owning two cars which can be used whenever they want. If the user profile was to use shared mobility, it should have a high appeal and added value, such as a shared cabrio. Experts from both focus groups stated that for this user profile, transport modes should be offered that really add value to what the families already possess.

Findings on shared services

Table 15 shows the combined focus group poll results from the question *"What are the most suitable shared services for the profile [user profile] that should be offered at hubs (if implemented properly)?"*.

Table 15 - Poll question on most suitable transport modes (in percentage of total responses).

Percentage of total responses **Shared services**	**Young & Hopeful**	**Friendly Emptynesters**	**Working Class**	**Average Joes & Janes**	**Planning & Rushing**
Charging infrastructure for private/shared vehicles	0%	40%	7%	56%	67%
Bicycle parking	87%	60%	20%	50%	47%
Bicycle repair stand	93%	53%	7%	56%	60%
Postal lockers	80%	33%	40%	88%	93%
Kiosk	67%	40%	40%	19%	40%
Neighbourhood library	53%	87%	33%	94%	20%
Playground	0%	40%	7%	88%	13%
Sports equipment	53%	7%	20%	63%	73%
ATM	27%	60%	53%	19%	27%
Storage lockers	20%	0%	13%	19%	20%
Co-working space	33%	0%	0%	25%	60%

As shown in table 15, poll results on the preferred shared services were quite diffused. This might be caused by how the personas were explained during the focus group, and how the experts had perceived the activity pattern of the personas. Experts associated certain needs or activities with personas based on their own judgement.

During the foreign focus group it was mentioned for Friendly Emptynesters that shared services such as a playground (for the grandchildren), neighbourhood library, and postal lockers could be triggers to use neighbourhood hubs. These activities were not all explained by the author during the persona presentation. Besides, the number of activities during the day could influence the range of promising services at a hub. During the Dutch focus groups it was stated that for people with many activities during the day, shared services such as postal lockers could increase the attractiveness of a hub.

Another important finding is that during the Dutch focus group it was mentioned that for Working Class, social facilities (such as a community center) could be promising. It seems opportune to include 'social facility' as an additional shared service.

For the Average Joes & Janes user profile, experts thought that additional shared services could be useful every now and then. So like for the transport modes, shared services help people during their daily lives. For Planning & Rushing, experts stated the same, but they stressed that the offered services should allow this user profile to show off their image.

In general, the experts thought that services on themselves could already be a reason for people to use neighbourhood hubs. This corresponds with the reasoning that neighbourhood hubs should be perceived in a broader sense than being a place were only transport modes are integrated.

KEY TAKEAWAYS

- Experts think that the user profiles Young & Hopeful and then Average Joes & Janes are most likely to use neighbourhood hubs.
- This does not imply that the other user profiles Planning & Rushing, Friendly Emptynesters, and Working Class should be overlooked. With the right range of amenities, also these groups can be convinced to use neighbourhood hubs. For example, experts think that a social facility could convince people from Working Class to use hubs.
- People from Young & Hopeful and Average Joes & Janes are the main target groups for shared mobility. Planning & Rushing could be convinced to use shared mobility if it really adds value to what they already possess.
- Shared services on themselves could provide an incentive for all user groups to use neighbourhood hubs.

6.2 Perspective (2) – Scientific literature

Literature focusing specifically on potential users for neighbourhood / mobility hubs is scarce, which was also stated by Van Rooij (2020) and Bösehans et al. (2021). Still, four references were found by the author. The first table in Appendix J shows characteristics of typical neighbourhood hub users based on studies shown in the right-hand column 'reference'.

Besides typical user groups of neighbourhood hubs, we would also like to know what are typical users of each shared travel mode. The second and third table show potential user group characteristics for shared travel modes (see Appendix J). The studies included in the second table show user characteristics for shared mobility in general. The third table only includes studies focusing on specific individual transport modes. Note that some studies make a distinction between different types of systems for a certain shared mode, like Ma et al. (2020) who made a distinction between three bike-sharing systems: Mobike, OV-fiets, and Swapfiets. However this thesis only observes each shared travel mode in general (so for the example of Ma et al., 2020: just consider bike-sharing in general).

Finally, shared services are considered. Some shared services such as "charging infrastructure for private/shared vehicles", "bicycle parking", or a "bicycle repair stand" are only used by people who own or share one of the relevant travel modes. For other non-mobility related shared services, such as "parcel lockers", "co-working space", or "kiosk", studies on user groups are limited or non-existent. Only for parcel lockers there are a handful of studies which include characteristics of typical parcel locker users (Lemke et al., 2016; Lai et al., 2022). In other words, it is very hard to include scientific literature on the individual shared services. But, for this thesis the services have one thing in common: they have to be shared. So as part of this literature review, we consider scientific literature on sharing among neighbours / community members, which aligns with the focus on neighbourhood-level hubs in this thesis. The resulting user group characteristics for sharing are shown in the fourth table in Appendix J.

Discussion on literature review findings

The results from the literature study show some interesting findings. First of all, there are a lot of similarities in user group characteristics: it seems that in general, studies on neighbourhood hubs and shared mobility arrive at the same type of characteristics of typical users. Figure 21 shows eight user characteristics which are common in the reviewed literature.

Figure 21 - Common characteristics for neighbourhood hub and shared mobility users.

In general, users of neighbourhood hubs and shared mobility seem to be among younger age groups, highly educated, have a certain level of disposable income, and live in urban areas (often in or near city centers). Some studies mention that elderly also belong to the main target group, but given the right motivation (Bösehans et al., 2021; KiM, 2015; Van Rooij, 2020). Typical households are often singles or

families with younger children. Besides, it was found in existing literature that sustainability is one of their priorities and they often travel with non-car travel modes or even have experience with shared mobility. Ownership of private vehicles is also lower than the average.

There are a few exceptions however for some travel modes. This mainly holds for DRT (Demand-responsive transport) and taxi. Users of DRT are often elderly or younger children with a lower education level and less disposable income. They sometimes have certain conditions such as illness, disability, or infirmity. As a result, access to private cars is rather low. Another reason could be that they live in areas not served well by regular transport. Users of taxi services also tend to be older people. Their main travel mode for commuting is the private car, so they probably use taxi services for special occasions. For the other shared travel modes, user group characteristics are rather homogeneous.

To a certain extent, the similarities between user group characteristics of hubs and shared mobility make sense, as neighbourhood / mobility hubs are often associated with shared mobility, such as in the studies from Bösehans et al. (2021) & Claasen (2020). The homogeneity in potential user groups was observed by Burghard & Dütschke (2018), which could imply that neighbourhood hubs should be mainly designed and planned for users with these specific characteristics. However, in chapter 3 it was concluded that there are no fixed types of hub users and that there could be adopters in every user group (Bösehans et al., 2021; Van Rooij, 2020). Even though there are indeed some user groups that have a higher probability, hubs should be tailored to all residents within a neighbourhood. As mentioned by SHARE-North (2021) in their Shared Mobility Rocks guideline, including groups such as elderly, unemployed, or handicapped persons requires more effort. On the other hand, it contributes to the inclusiveness of neighbourhood hubs, which also appears to be one of the key policy objectives in chapter 4.

This nicely leads to the results from literature study on user group characteristics of sharing among neighbours / community members. The fourth table in Appendix J shows that there are indeed certain socio-demographic characteristics that could be attached to users who are typically willing to share services. But overall little is known about concrete characteristics related to sharing. Unlike socio-demographics, scientific literature seems to agree on the motivations of potential user groups for sharing. Figure 22 shows the motivations of people who typically participate in sharing schemes.

Figure 22 - Common motivations for sharing scheme users.

These motivations suggest that regardless of the socio-demographics, sharing scheme users tend to be environmentally conscious, economically motivated, and/or socially motivated. For example, younger people could be willing to share because they are often found environmentally conscious, elderly could be socially motivated, and lower income households could be economically and socially motivated (Akin et al., 2021; Böcker & Meelen, 2016; Li, 2020). The lack of homogeneity among typical sharing scheme users and their characteristics could be due to the limited amount of research into this area. In general, it could be concluded that all types of people could be users of shared services (at neighbourhood hubs), but the motivation differs among user groups.

It should be noted that motivations to participate in the sharing economy especially varies between different types of shared goods and services (Böcker & Meelen, 2016; Edbring et al., 2016). This means that if someone is willing to share in general, this does not have to be the case for all types of services.

KEY TAKEAWAYS

- In general, existing literature on users of hubs and shared mobility seems to agree on which characteristics increase the probability that someone will use a hub and/or shared mobility.
- There are however also studies that question if there is indeed a fixed user type for hubs and shared mobility.
- This is in line with existing literature on sharing of services among neighbours / community members, which states that the willingness to share is more driven by motivations rather than specific user characteristics.
- Motivations can differ among different user groups. For example, younger people could be environmentally motivated, elderly could be socially motivated, whereas lower income households could be economically motivated to share services.

6.3 Comparison between focus groups and literature study findings

Probability of actually using neighbourhood hubs

The focus group experts seem to agree on the Young & Hopeful user profile that they are (very) likely to use neighbourhood hubs. Actually, experts gave Young & Hopeful the highest probability of using neighbourhood hubs compared to other user profiles. This corresponds with the findings from the literature review. Existing literature shows that the user groups which are most likely to use neighbourhood hubs, are often younger people with a higher education level, living in urban areas, and other characteristics from figure 21.

Another user profile which was given a rather high probability to use hubs is Average Joes & Janes. The experts think that offering shared services and transport modes at neighbourhood hubs could help this user profile during their daily lives. According to the Whize segmentation, people in the user profile are often younger parents with one or more children and an average income. This corresponds with findings from scientific literature, where it is stated that younger households with children also belong to the target group which is most likely to use neighbourhood hubs.

For the other user profiles Friendly Emptynesters, Working Class, and Planning & Rushing, experts attach a neutral or lower probability for using neighbourhood hubs. But, from the focus group discussion it appeared that you should not exclude these user profiles. Given the right incentives (e.g. offering the right range of shared services and transport modes), also these user profiles can be convinced to use neighbourhood hubs. This resonates with the studies from Van Rooij (2020) and Bösehans et al. (2021). For example elderly people (belong to the Friendly Emptynesters user profile) could be a target group for neighbourhood hubs given the right motivation (Van Rooij, 2020).

Transport modes

The focus groups poll results and discussion show that overall the user profile Young & Hopeful is likely to use shared mobility. In scientific literature it was also found that people with characteristics from figure 21 are likely to use shared mobility. Moreover, public transport was found a very promising transport mode for Young & Hopeful by both the focus groups and scientific literature.

For Average Joes & Janes, focus group poll results indicate that shared cars, public transport, shared cargo bikes, and trailers are most promising transport modes. Scientific literature also agrees that this user profile is willing to use shared mobility and public transport. Shared cargo bikes were mentioned explicitly by Claasen (2020) for households with younger children. There are no articles in literature for ‘trailers’, but this transport mode is mainly meant for occasional trips.

Experts stated that shared mobility could be opportune for Planning & Rushing, but it should enable these people to distinguish themselves from others, and add value to what they already possess. Moreover, Planning & Rushing are households with relatively higher income and education levels, which corresponds to scientific literature on shared mobility. The taxi also obtained a high probability in the focus group polls. Literature indicates that taxi users are often (1) older people, who (2) mainly commute by car. Interestingly, the first characteristic does not corresponds with the Whize segment description of Planning & Rushing as this user groups is often between 30 and 55 years old. But, people from Planning & Rushing indeed have their private cars as their main commuting transport mode.

The user profile Friendly Emptynesters is less willing to use shared mobility according to the focus group experts. The focus group poll and discussion indicate that public transport and DRT are the most suitable transport modes for Friendly Emptynesters. Scientific literature contests this as it states that especially younger people are more likely to use public transport on a daily basis. But experts stated that public transport is especially suitable for occasional long-distance trips. The DRT poll results align with scientific literature which states that target groups for DRT are elderly people with a relatively lower level of income/education, and a lower fitness level, or a disability.

Finally, for the Working Class user profile, experts think that this group is less likely to use transport modes at neighbourhood hubs due to status and unfamiliarity of concepts. Literature also indicates that people from this group are not the main target group for shared mobility. During the focus groups it was explained that the persona likes Do-it-Yourself, so this is probably the reason why the shared van and trailer received a relatively high percentage of votes during the focus group polls. Literature on shared vans and trailers is not available, so no comparison can be made for this.

Shared services

From the focus groups it could be concluded that one could convince every user group to use shared services. Providing those shared services that correspond with the needs of users could incentivize anyone to use shared services. This aligns with the findings from scientific literature that the willingness to share services is determined by motivations of people rather than specific socio-demographics. Recall from the Fogg Behaviour Model that motivations (together with ability and triggers) influence whether behaviour will occur. It is therefore advisable that the amenities that were found preferred by the focus groups should be preferred to address each user profiles' needs.

Because scientific literature on individual shared services is limited or non-existent, poll results cannot be compared directly to findings from literature. Therefore, only focus group poll results and discussions are used in section 6.4 to make a selection of the most promising shared services per user profile.

KEY TAKEAWAYS

- Results from the focus groups on the probability that a user group will use neighbourhood hubs align with findings in existing literature.
- In general, the selection of transport modes per user profile from the focus groups corresponds with the characteristics of typical users for each transport mode from literature.
- The selection of shares services per user profile from the focus groups cannot be directly compared to literature. But, from both the focus groups and literature study it could be concluded that shared services on themselves could incentivize any user group to use neighbourhood hubs, if they are in correspondence with the needs of the user profile.

6.4 Results on users of neighbourhood hubs & amenities per user profile

Probability of actually using neighbourhood hubs

Based on the findings from the focus groups and literature study, a ranking can be made for the probability that a user profile will actually use neighbourhood hubs. This is done for the five user profiles which will be considered in the Almere case study (see figure 23).

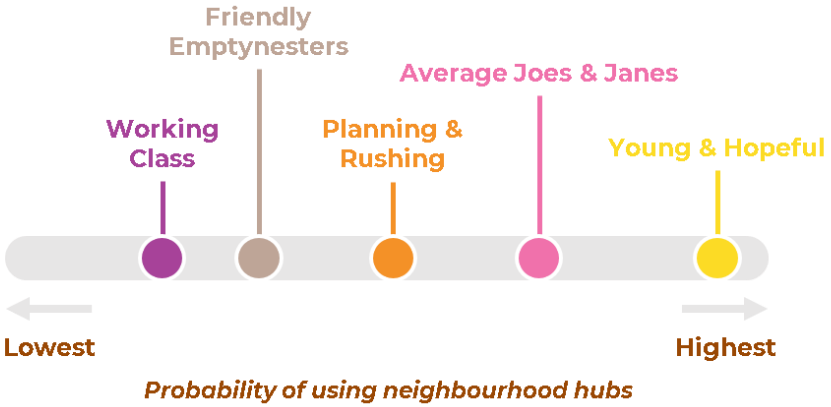

Figure 23 - User profiles and probability to use neighbourhood hubs.

Although it was also found that any user profile can be convinced to use neighbourhood hubs if they have the right motivations, the probability ranking in figure 23 can be helpful to indicate which hub locations should be prioritized from an adoption perspective.

Transport modes

Table 16 shows the proposed selection of transport modes for each user profile. A selected transport mode is indicated with an orange-coloured marking. A transport mode is considered only if the total percentage of respondents which is in favour of a mode is equal to or larger than 50% (so at least half of the focus group attendees think that the transport mode is preferrable). Further adjustments are made based on the focus group discussion and literature.

For Young & Hopeful, shared cars, shared cargo bikes, and shared scooters are marked, even though these transport modes did not receive a majority of votes from focus group experts. Shared cars received a low number of votes, probably because the presented persona did not have a driver's licence. Assuming someone possess a driver's licence, literature states that shared cars are a promising transport mode for people in the Young & Hopeful group. Also, shared cars are marked for Planning & Rushing, because this type of shared mobility was found promising during the focus group discussion.

Table 16 - Selection of transport modes for each user profiles.

Transport modes	Young & Hopeful	Friendly Emptynesters	Working Class	Average Joes & Janes	Planning & Rushing
Shared cars	■			■	■
Shared vans			■		
Public transport	■	■		■	
Demand-responsive transport		■			
Taxi					■
Shared bikes	■				
Shared cargo bikes	■			■	■
Pushchairs					
Shared scooters	■				
Shared mopeds					■
Trailer			■	■	

Shared services

Table 17 shows the proposed selection of shared services for each user profile. This selection is purely based on the focus group poll results and discussion, because literature was limited or non-existent for each individual shared service. It is assumed that the selection of shared services is in correspondence with the needs of each user profile.

Considering the focus group discussions has led to the following adjustments. For the user profiles Friendly Emptynesters and Working Class, an extra service is added to the list which had not been taken into account before the focus groups. During the focus group discussion on the Working Class user profile, it was suggested that a social facility would be promising (see table 17). The social facility is also considered for Friendly Emptynesters, because according on scientific literature elderly people are often socially motivated when sharing services. Also, for Friendly Emptynesters a playground has been selected, because according to the focus group discussion it could be an incentive to go to a neighbourhood hub with grandchildren.

Table 17 - Selection of shared services for each user profiles.

Shared services	Young & Hopeful	Friendly Emptynesters	Working Class	Average Joes & Janes	Planning & Rushing
Charging infrastructure for private/shared vehicles					
Bicycle parking					
Bicycle repair stand					
Postal lockers					
Kiosk					
Neighbourhood library					
Playground					
Sports equipment					
ATM					
Storage lockers					
Co-working space					
Added based on focus group discussion: social facility					

The transport modes and shared services from table 16 and 17 are used in the Almere case study as most preferred amenities per user profile.

Sub-research question (4): "*What is the influence of user profiles on the most preferred locations and amenities for neighbourhood hubs in urban areas?*"

Based on the focus groups and a literature review, it could be concluded that people from any user profile can be incentivized to use neighbourhood hubs if they have the right motivations. This aligns with the Fogg Behaviour Model which states that motivations, together with ability and triggers, influence behaviour. Moreover, this finding contests most of the reviewed literature which states that hubs and shared mobility are mainly for younger people, with a higher income and education level, sustainable mindset, experience with sustainable modes and low private vehicle ownership. Offering those amenities that correspond with the needs of people could convince anyone to use neighbourhood hubs, but motivations can differ among user groups.

Still, some user profiles are more likely to adopt neighbourhood hubs than others. The probability distribution in figure 23 shows that Young & Hopeful was found to have the highest probability for using neighbourhood hubs. Next, the user profile Average Joes & Janes also has a relatively high probability. If it is known for every district which user profile is dominant, the probability distribution can be used to indicate those districts where implementing neighbourhood hubs should be prioritized from an adoption perspective. This prioritization step can be done after running the step sequence.

Also, it could be concluded from the focus groups and literature review which amenities should be considered for each of the five user profiles. The most preferred amenities are different for each user profile and highlighted in table 16 and 17. For example, Young & Hopeful and Average Joes & Janes are the main target groups for shared mobility. Planning & Rushing could be convinced to use shared mobility if it really adds value to what they already possess. The presence of certain user profiles influences the set of most preferred amenities to consider in a district. For the step sequence, only the dominant user profile in each district is considered to evaluate which amenities are most preferrable for hubs.

Thus, the presence of user profiles influences the prioritization of neighbourhood hub locations through the probability of each user profile to use neighbourhood hubs, and it influences the most preferred amenities for neighbourhood hubs through each user profiles' needs for shared services and transport modes.

7. Assessment of the Neighbourhood Hub Design Approach in Almere

This chapter aims to assess the proposed Neighbourhood Hub Design Approach from chapter 5 in a case study. Section 7.1 describes stepwise how the Design Approach step sequence is applied in the municipality of Almere, after which 7.2 presents the results in the form of an infographic. Finally, 7.3 reflects on the application of the step sequence and provides suggestions to consider when interpreting the results..

7.1 Application of the Design Approach step sequence

Section 2.6 explained why the municipality of Almere was selected for the case study. Before applying the step sequence, first the study area has to be determined. The municipality of Almere is divided into 42 four-digit zip codes, but not all of those zip codes are classified as urban area. Due to the scope of this thesis, only those four-digit zip codes are considered which are classified as urban area. CBS offers an open data source for every four-digit zip code in the Netherlands, including the level of urbanity. All zip codes which are classified as 'non-urban' are excluded from this case study. These zip codes are marked with a light orange colour in figure 24. Moreover, there are four zip codes for which the Whize segment distribution is unknown which are marked in grey in figure 24. This is not a big issue as the municipality stated that these zip codes mainly contain industrials or offices. The zip codes which are classified as 'urban' by the CBS are marked with a darker orange colour in figure 24, and considered in the rest of this case study.

In the following, steps from the Design Approach are used as subheadings to clearly indicate each step. All the choices and assumptions made during the case study are summarized in the first table in Appendix K.

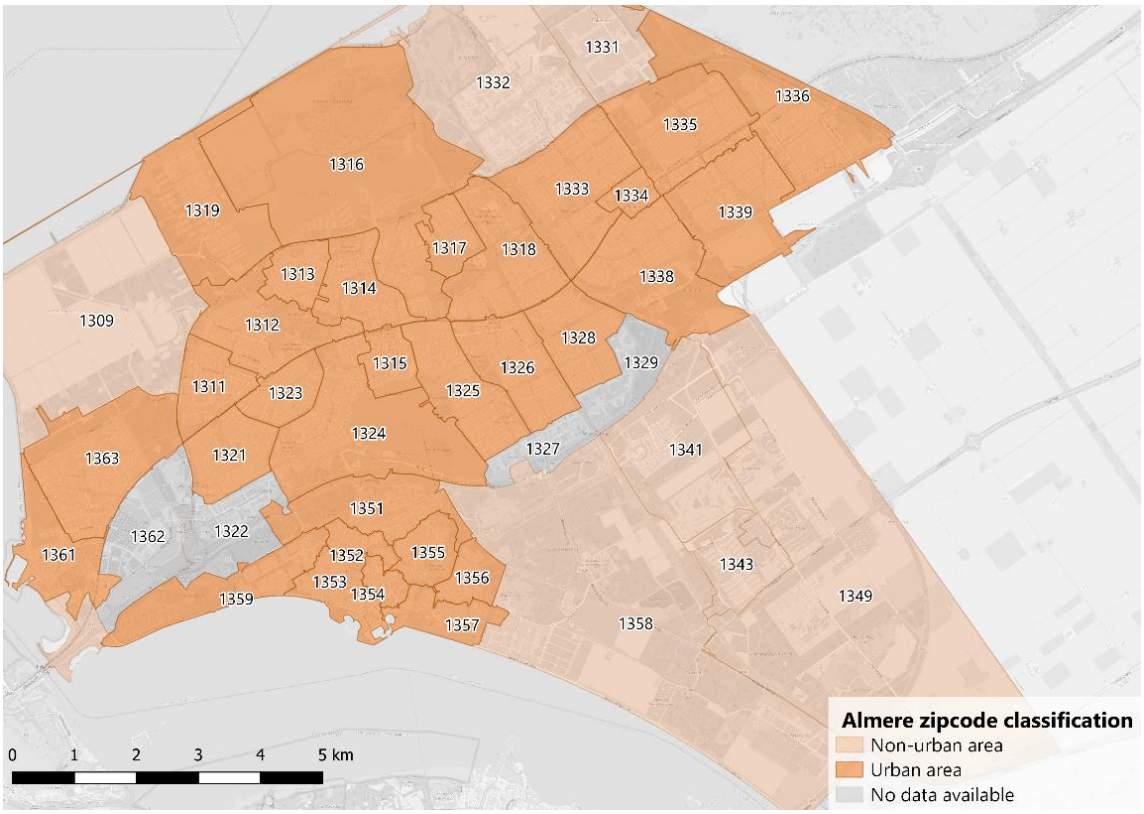

Figure 24 - Study area for the case study.

Identify anchor points

In this step the mobility and non-mobility anchor points are identified in Almere. Section 5.3 identified anchor point types which could be used to indicate the most preferred locations for neighbourhood hubs. Regarding mobility anchor points, Almere contains bus stops, train stations and P+Rs. For the bus stops it is often the case that the quays for both driving directions have a certain distance between each other. In this case study, a single bus stop anchor point has been placed in the middle of both quays. If both quays would be marked as separate anchor points, a bus stop could be falsely marked as a clustered anchor point in the next step. In practice, this does not mean per se that a neighbourhood hub will also be located in the middle of both quays. Anchor points are just used to indicate what are suitable places to search for neighbourhood hub locations. From the mobility anchor points, especially the bus stops are well distributed across urban areas throughout the municipality (see figure 25). The local transport operator exploits an extensive bus system with more than 60 km of separate bus lanes, which could clarify the well-spread bus stop grid (inno-V, n.d.).

Regarding the non-mobility anchor points, Almere contains community centers, squares, and shopping facilities. A location is marked as a square only if there is a significant space dedicated to pedestrians, so a car-free area. These places lend themselves to create attractive public spaces. Besides, a location is marked as a shopping facility if there are multiple facilities near each other. This is done to capture the locations in neighbourhoods where people go to on a daily basis for their groceries or shopping in general. While less dense and spread than the bus stop grid, non-mobility anchor points also occur at various places across the municipality. And this is logical, because often each neighbourhood has its own facilities. Especially the community centers and shopping facilities are responsible for a well spread grid of non-mobility anchor points throughout the municipality.

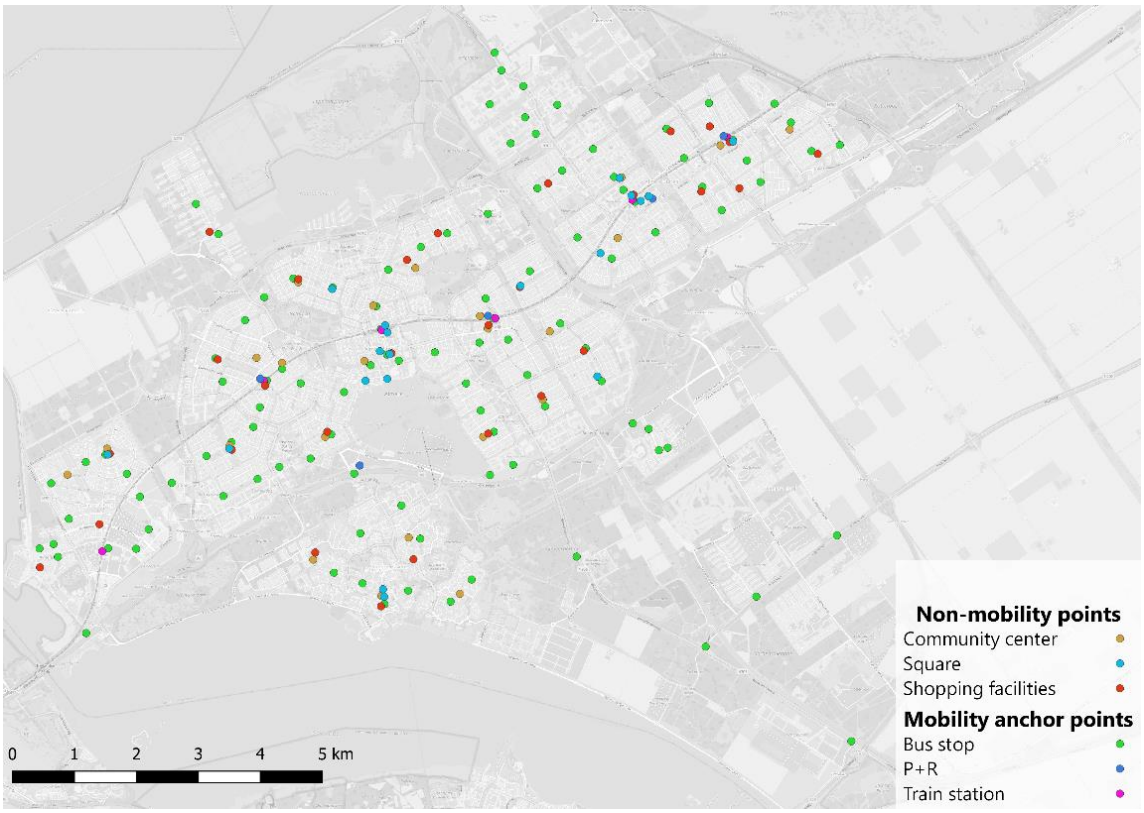

Figure 25 - Overview of mobility and non-mobility anchor points.

At some places it can be observed that multiple anchor point types are located near each other. This is especially for the busier areas near train stations, but also within neighbourhoods. The next explains what will be done with these 'clusters' of anchor points.

Cluster anchor points near each other and identify potential hub locations

Before dealing with the clustering of anchor points, first anchor points outside residential areas have to be filtered out. This can be fixed in two steps. The first step is to filter out all the anchor points that fall within four-digit zip codes which are marked as 'non-urban'. The second step is to also filter out the anchor points that fall within the urban area zip codes, but are not located within or next to urban areas. Therefore, a CBS data source with population density per 100x100 m2 area was imported into QGIS. All anchor points that lie in areas with no population were deleted.

As mentioned, in some areas there are a number of anchor points in the direct vicinity of each other. In this step, anchor points which are located close to each other are merged into a single node, using the clustering function in QGIS. This is done for two reasons:

1. In section 5.3 it was stated that a higher number of clustered anchor points implies that more facilities are located close to each other, which could increase the diversity and intensity of people that visit those places (Bertolini, 1999). To do this, it should be determined at what distance anchor points should be located from each other to consider them 'clustered'.
2. From a practical perspective it does not make sense to develop neighbourhood hubs right next to each other, because otherwise the concept of clustering amenities at central places would be gone. Therefore, a minimum spacing between each hub location should be determined.

So on one hand we need to determine a minimum threshold for the clustering function, but on the other hand this threshold should not be too high to account for the willingness to walk. In section 5.6 it was found that 400 m (or 5 minutes) is a widely value for walking distance, so ideally the threshold value for clustering anchor points should lie below that. For this case study, the threshold value is set at 300 m, because this hub spacing is also applied in Bremen (Witte et al., 2020). The implication is that there will be a minimum spacing of 300 m between each anchor point (so after applying the clustering function). Figure 25 shows that in the municipality of Almere anchor points are well spread across the city. So in practice, most residential areas will fall within the 400 m radius (i.e. walking distance) of an anchor point (this will be showcased in the next figure).

After applying the clustering functions in QGIS with a 300 m threshold, we obtain the grid of single and clustered anchor point as presented in figure 26. A number in a node represents the number of clustered anchor points at that location (so the number of anchor points within 300 m from each other). Besides, a catchment area of 400 m is drawn around each anchor point in figure 26 to mark the walking distance. And indeed, almost all residential areas fall within the walking distance of an anchor point and thus potential hub location. The question is if applying these same steps in another Dutch city also provides such a well-spread anchor point grid. The answer is probably yes as most Dutch cities have a public transport network and a variety of facilities for residents, but this cannot be assessed in this thesis.

In total, figure 26 includes 45 single and 38 clustered anchor points (83 in total). However, from a practical perspective it is not advisable to develop all 83 hubs at the same time. A good first step could be to start with developing neighbourhood hubs at the clustered anchor points. As mentioned in earlier chapters, it can be reasoned that more anchor points could indicate more functions, and thus a higher potential to attract hub users. If we place a neighbourhood hub at locations with two or more clustered anchor points, we obtain a grid of 38 neighbourhood hub locations. These 'most preferred' neighbourhood hubs are shown in figure 27. Also this less dense grid is well spread across the municipality of Almere and provides a first step for the rollout of neighbourhood hubs in the municipality.

This does not imply that the single anchor points should be completely forgotten. In later phases, these anchor points could be used as neighbourhood hub locations once the most preferred ones have be developed. But, the case study in this thesis continues the step sequence only with the most preferred neighbourhood hub locations from figure 27.

Figure 26 - Clustered and non-clustered anchor points with catchment area (R = 400 m).

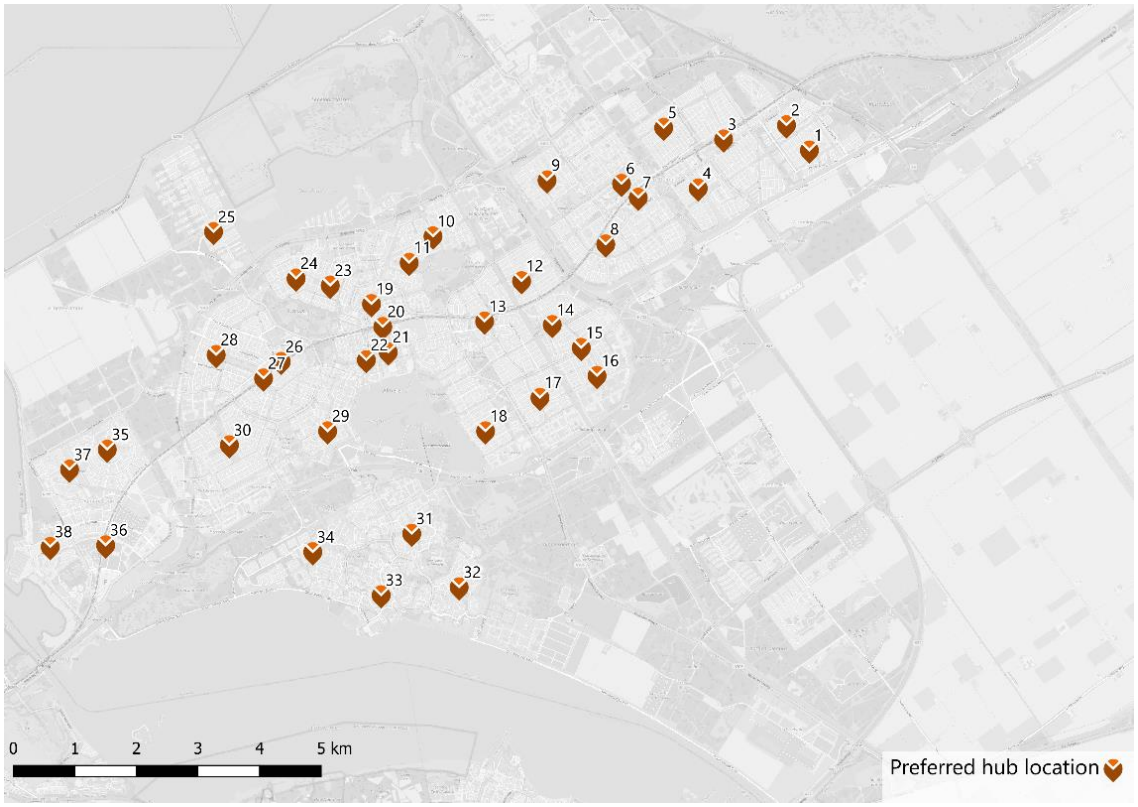

Figure 27 - Grid with most preferred neighbourhood hub locations (numbers indicate hub ID).

Identify dominant user profiles in each district

Now the most preferred neighbourhood hub locations are known, the question is which amenities should be offered at each neighbourhood hub location. To do this, the Design Approach looks at the dominant user profile in each four-digit zip code (referred to as 'district'). The table in Appendix E shows the user profile distribution in each district. The user profile with the highest percentage is the dominant user profile in that district. Figure 28 presents an overview of the dominant user profiles. The colours in figure 28 correspond with the colours from the Whize segmentation (see section 5.5). Especially Average Joes & Janes and Working Class are dominant in many four-digit zip codes, which is in correspondence with the overall distribution of user profiles in the municipality of Almere (see Appendix E).

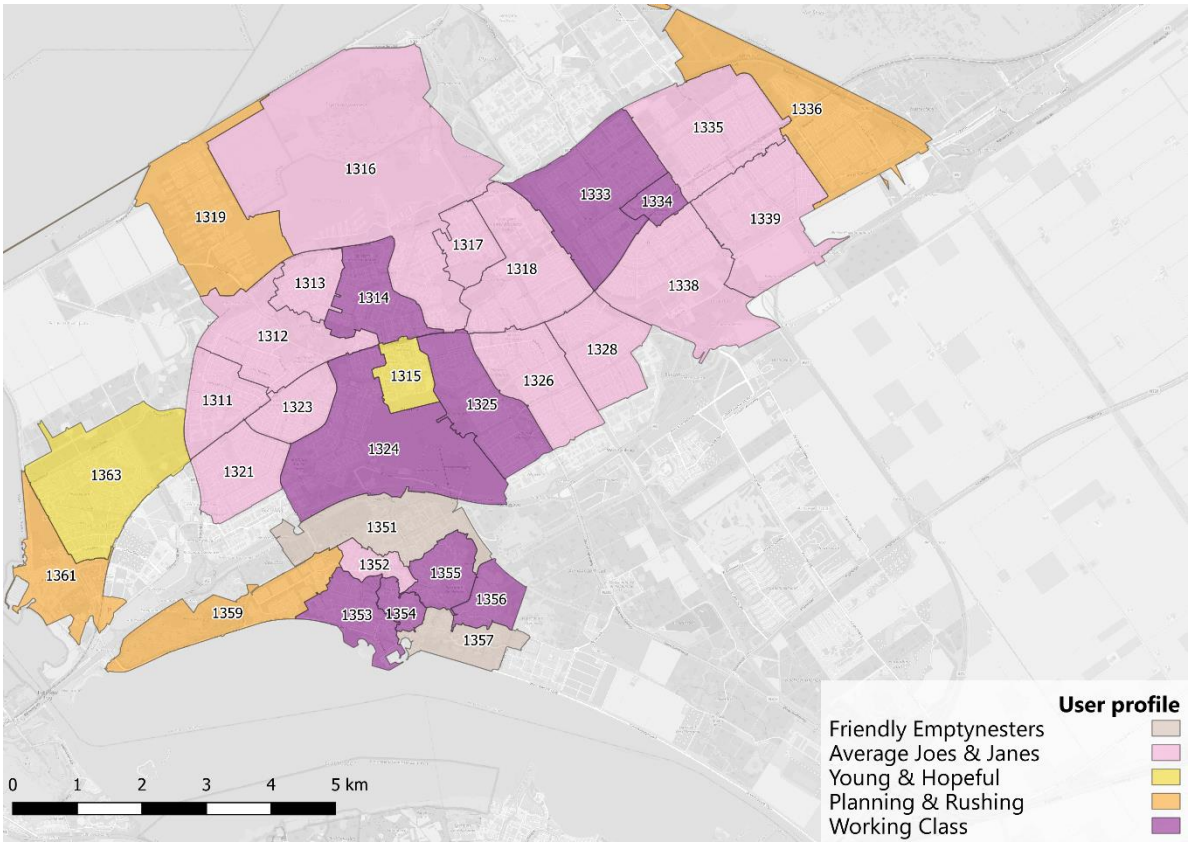

Figure 28 - Overview of dominant user profiles in each district.

Determine preferred amenities for each user profile

This step in the Design Approach relates to research question (4) from this thesis. Section 6.4 provided an overview of preferrable shared services and transport modes per user profile, based on the focus groups and literature review. These selections of amenities per user profile are also assumed in this case study.

Determine existing locations of the considered amenities

Before we can determine which new amenities should be added to each hub location, it should be determined what are the existing locations of considered amenities. Table 18 explains for each individual amenity whether there are existing locations, and if so, which locations are considered.

For almost all shared services there were existing locations. Only public bicycle repair stands could not be found. Moreover, the on-street charging infrastructure for private/shared vehicles and playgrounds were excluded from this case study (see table 18 for explanation). This is not the case for existing transport mode locations however. As mentioned, Almere has an extensive bus network, but especially for the shared modes there are not that many existing locations. There are only four bike-sharing locations, and some car-sharing locations, but the rest of the shared modes are not present.

Figure 29 and 30 show the existing locations for the shared services and transport modes. Note that the locations of bus stops, train stations, and social facilities (community centers) are the same as for the anchor points.

Table 18 - Existing locations of shared services and transport modes.

Transport mode	Which locations?	Shared service	Which locations?
Shared cars	There are different types of car-sharing schemes in Almere, among which peer-to-peer, free-floating, and round-trip. This thesis only considers docked shared mobility. Greenwheels was at the time of the inventory the only provider of shared cars with fixed parking spaces. In total, Greenwheels has 17 locations.	*Charging infrastructure for private/shared vehicles*	These locations are not considered. If shared mobility would be offered at a hub, it makes sense to offer charging infrastructure for that. For private vehicles, Almere currently has a lot of charging sockets which are offered at street parking locations. But, it does not make sense to consider these, because you want to get rid of street parking instead of offering extra street parking facilities.
Shared vans	No existing locations.	*Bicycle parking*	For shared bikes, parking space should be offered at each hub. But also for private bicycles to facilitate the bicycle as an access mode. Only if a hub is located near a large bicycle parking facility, it makes less sense to also offer bicycle parking at that hub. In total 10 bicycle facilities are mapped.
Public transport	Locations of bus stops and train stations, which are also anchor points for this thesis.	*Bicycle repair stand*	No public bicycle repair facilities were found.
DRT	No existing locations.	*Parcel lockers*	Existing locations for parcel lockers as well as pick-up points from PostNL, DHL, DeBuren, and Instabox. In figure 29 both parcel lockers and pick-up points are named 'parcel lockers'.
Taxi	Only Almere Centrum station has a fixed taxi stand.	*Kiosk*	Existing supermarkets, as it is assumed that kiosk will mainly compete for small daily groceries.
Shared bikes	KeoBikes are offered at three locations. The OV-fiets is for this thesis also considered as a shared bike, located at Almere Centrum station.	*Neighbourhood library*	There are currently four large libraries in Almere.
Shared cargo bikes	No existing locations.	*Playground*	Not considered for this case study, in agreement with the municipality.
Pushchairs	No existing locations.	*Sports equipment*	Existing gyms and other locations offering work-out equipment.
Shared scooters	No existing locations.	*ATM*	'Geldmaat' locations.
Shared mopeds	No existing locations.	*Storage lockers*	Different types of storage facilities in Almere.
Trailer	Trailers are offered at various construction markets and gas stations throughout Almere.	*Co-working space*	For this service, locations are mapped which offer flexible working space.
		Social facility	Community centers are considered, which also turned out to be considered as anchor points.

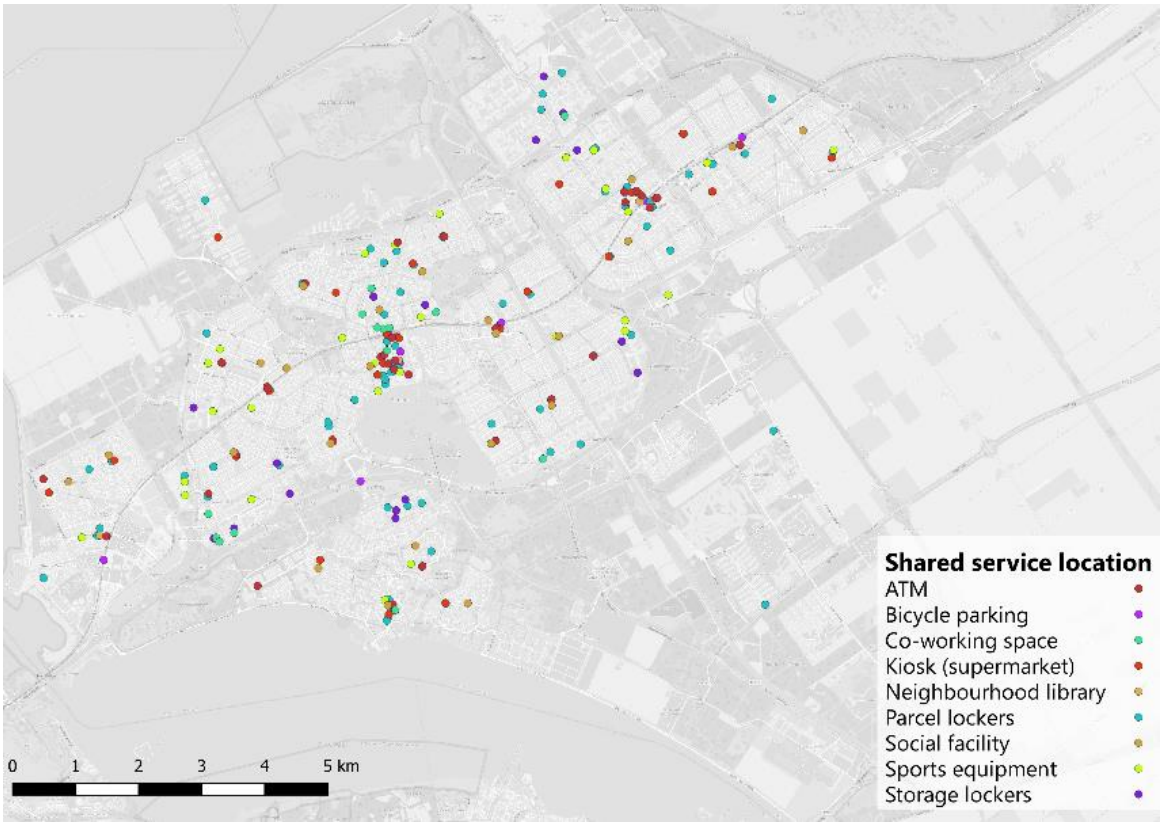

Figure 29 - Overview of existing shared services locations.

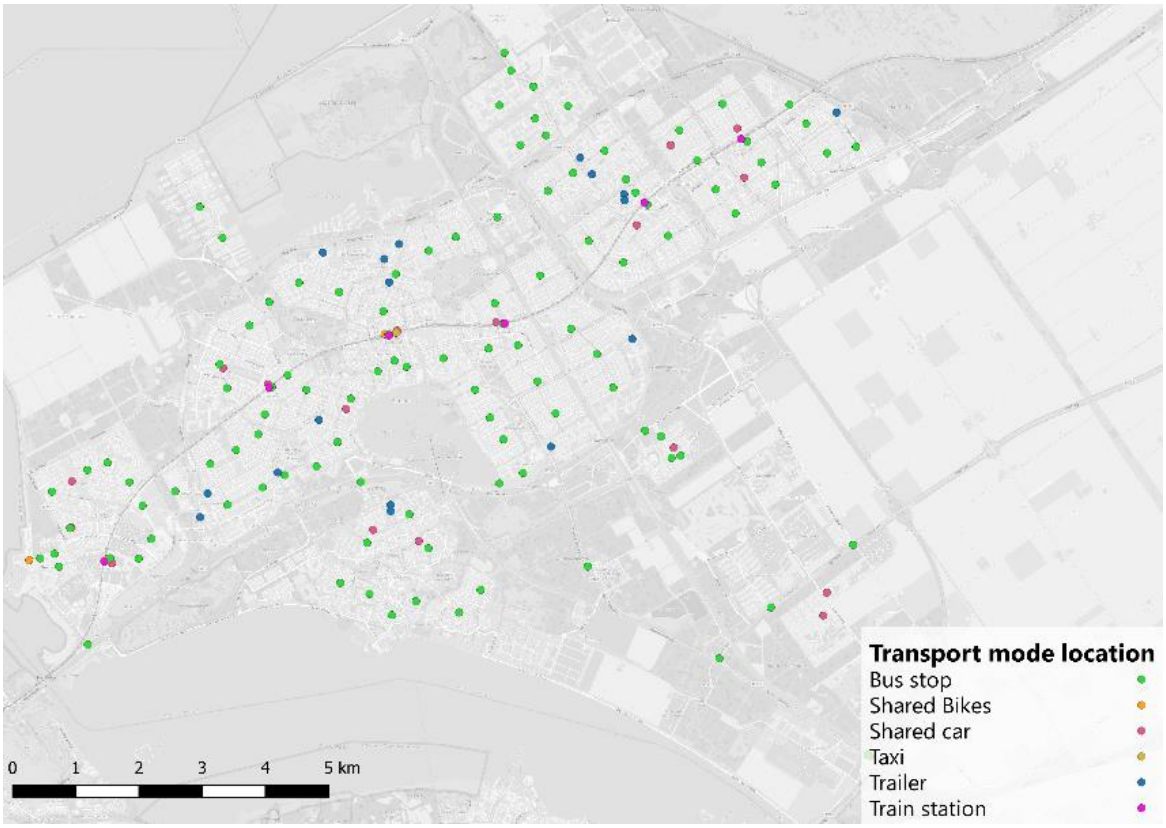

Figure 30 - Overview of existing transport mode locations.

Draw catchment areas around existing amenity locations

Catchment area values for each individual hub amenity were found from literature in section 5.6. For each existing hub amenity, a circle is drawn around the location with a radius corresponding to the catchment area of that amenity. The combination of the catchment area value, and number and spread of existing amenity locations results in completely different coverages of residential areas among amenity types. This is nicely shown by figure 31. The existing car-sharing locations do not cover that much space, not only because there are only 17 locations, but also because the catchment area value was set at 300 m. In contrast, if we take the public transport locations (109 bus stops and 6 train stations with catchment areas of 400 m (bus) and 1000 m (train), nearly all residential areas in the municipality of Almere are covered.

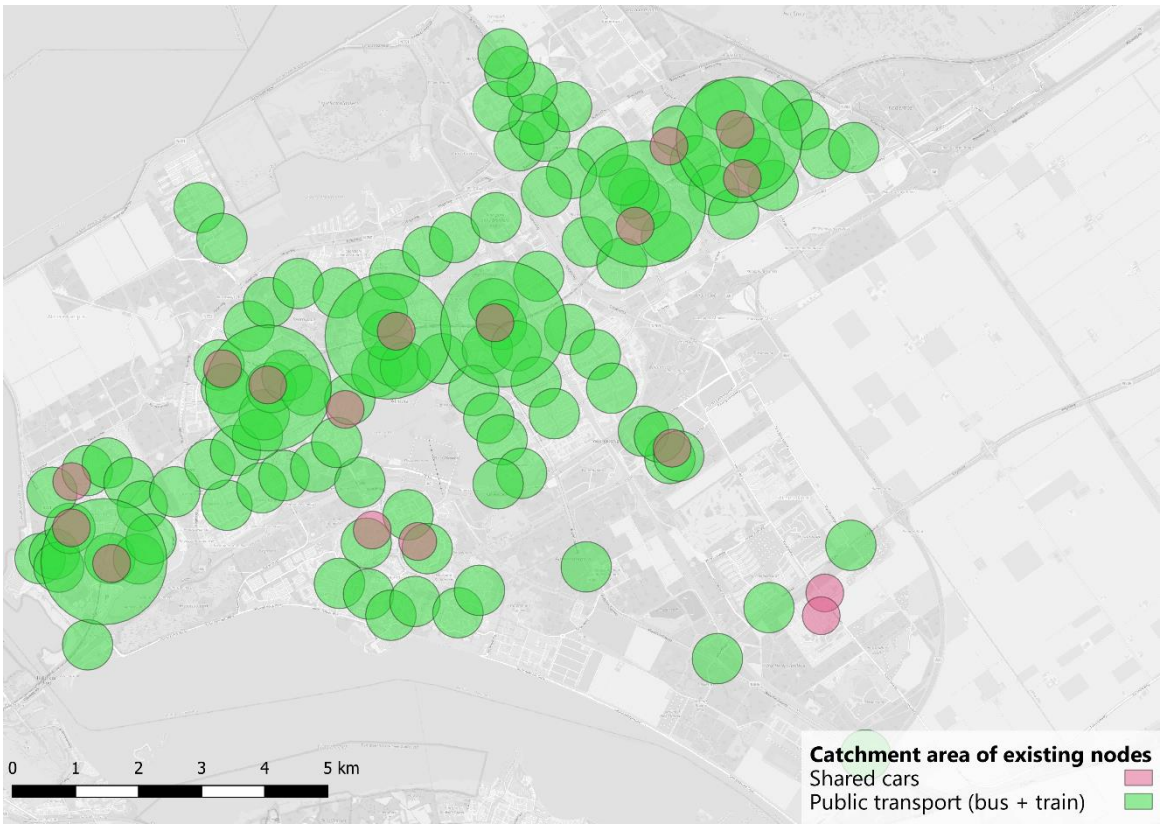

Figure 31 - Catchment areas of existing car-sharing and public transport locations.

The same can be showed for the other amenities. For example, shared vans, shared cargo bikes, shared mopeds, and shared scooters have no coverage because there are no existing locations. On the other hand, there are already a lot of pick-up points and lockers for parcels with a catchment area of 500 m, which results in a high coverage. Not all individual amenities are shown in this chapter, to keep this chapter as concise as possible. The main message is that the coverage of residential areas could differ a lot among amenity types, and this will have an effect on the search area for new locations in the next step.

Determine search areas for new locations per amenity type

Based on dominant user profiles and relationships between user profiles and preferrable hub amenities, it can be determined which districts should be considered for each amenity. Again, shared cars are used as an example with a low coverage by existing locations, and public transport is used as an example with a high coverage by existing locations. Table 19 shows user profiles for which shared cars and public transport are promising, and zip codes in which these user profiles are dominant.

Table 19 - Zip codes for which shared cars and public transport should be considered.

Transport mode	User profiles for which shared cars are considered	Zip codes in which shared cars should be considered
Shared cars	Young & Hopeful, Average Joes & Janes, Planning & Rushing	1311, 1312, 1313, 1315, 1316, 1317, 1318, 1319, 1321, 1323, 1326, 1328, 1335, 1336, 1338, 1339, 1352, 1359, 1361, 1363
Public transport	Young & Hopeful, Friendly Emptynesters Average Joes & Janes	1311, 1312, 1313, 1315, 1316, 1317, 1318, 1321, 1323, 1326, 1328, 1335, 1338, 1339, 1351, 1352, 1357, 1363

Table 19 shows that both car-sharing and public transport were found promising for three user profiles by the focus groups and literature. As a result, car-sharing is considered in 20 four-digit zip codes, while public transport is considered in 18 four-digit zip codes. By using the catchment areas from the previous step, we can determine which area of these four-digit zip codes is already covered by existing locations, and which area is not. The latter will be referred to as the 'search area' for an amenity. In this area we will search for new locations, because it is assumed that there is demand for that amenity from residents. In other words, the search area for an amenity can be determined by subtracting the catchment areas of existing amenity locations from the four-digit zip codes for which that amenity is considered.

Figure 32 and 33 (see next page) show the catchment areas and search areas for car-sharing and public transport. As mentioned, public transport in the municipality of Almere has a way higher coverage compared to existing car-sharing locations. Apart from that car-sharing is considered in two more zip codes than public transport, car-sharing has a significantly larger search area for new locations compared to public transport. In the next step we will see that car-sharing will be added as a new amenity to the majority of neighbourhood hub locations, whereas public transport will be already there for all neighbourhood hub locations. Again, the same reasoning can be done for the other considered amenities.

Note that besides the coverage by existing locations, the number of districts where an amenity is considered also largely influences whether an amenity should be added as a new location. For example, there are no existing shared scooter locations, but this transport mode is only considered in districts where the user profile Young & Hopeful is dominant – these are only 2 districts. As a consequence, there will not be a high number of neighbourhood hubs to which shared scooters are added.

Moreover, in figure 33 there is a considerable amount of area which is not covered by existing public transport, but the majority of these areas includes grass, water, or other non-residential functions. This is accounted for in the next step by only considering neighbourhood hub locations within or next to residential areas.

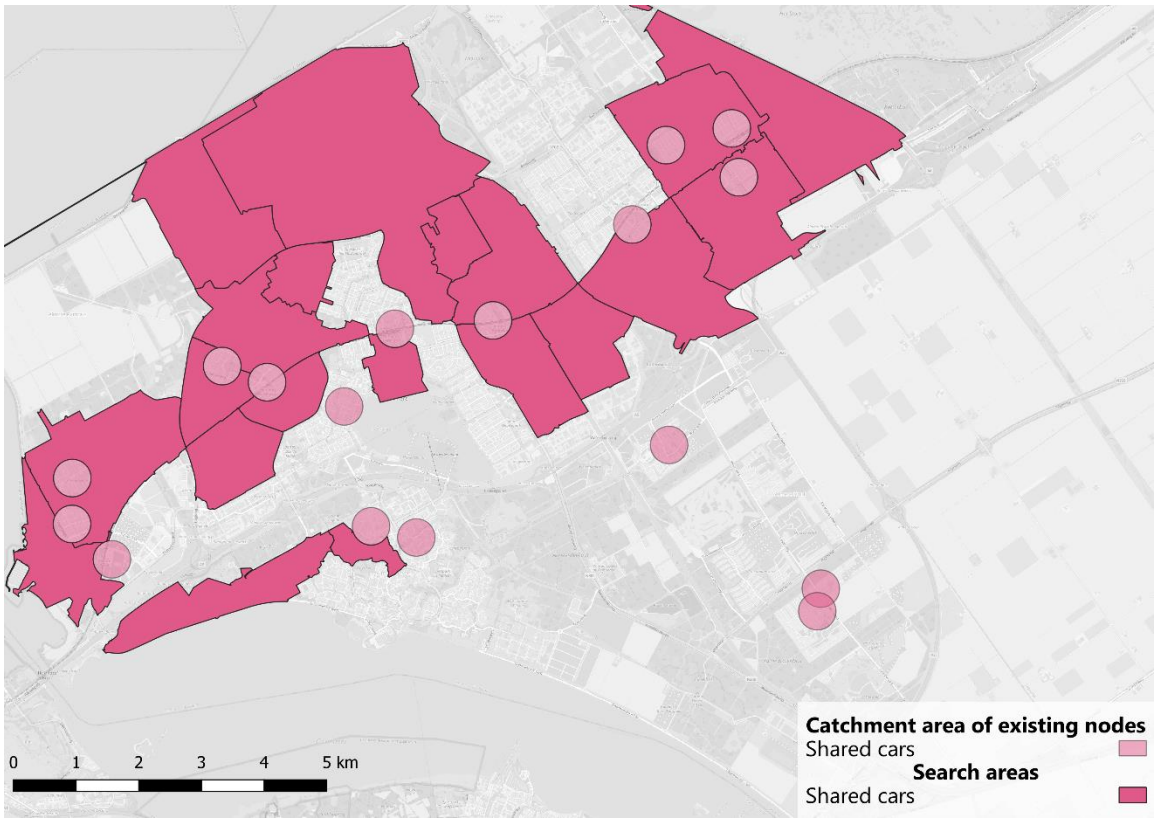

Figure 33 - Catchment areas and search areas for shared cars.

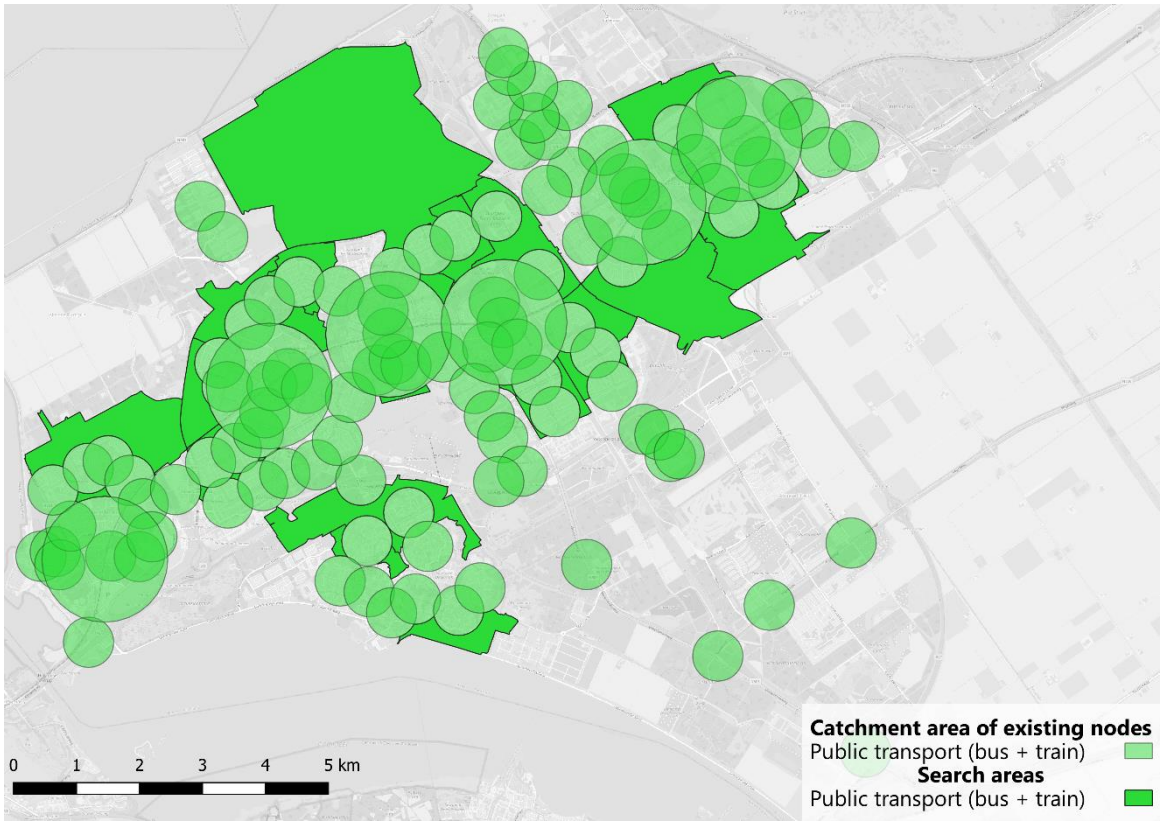

Figure 32 - Catchment areas and search areas for public transport.

Determine the amenity types per hub location

The range of amenities at each neighbourhood hub location can be determined by combining the most preferred neighbourhood hub locations with the catchment areas of existing amenities and search areas for new amenity locations. Again, the following takes shared cars and public transport as example amenities. In QGIS, the layer with most preferred neighbourhood hub locations (see figure 27) was put on top of the layers with the catchment areas of existing car-sharing/public transport locations, and search areas for new car-sharing/public transport locations (see figure 32 and 33). The resulting maps are presented in figure 34 and 35.

Next, for each neighbourhood hub location there are three possibilities:

1. The amenity is already present at the neighbourhood hub location – in that case, the neighbourhood hub location falls inside the catchment area of existing amenity locations.
2. A neighbourhood hub location falls inside the search area for new amenity locations – in this case the amenity is added to that neighbourhood hub as a 'new' location.
3. A neighbourhood hub location does not have an existing amenity location and falls outside the search area – in that case the amenity is not considered at that neighbourhood hub location.

If we do this for shared cars, 9 neighbourhood hub locations already fall within the catchment area of an existing car-sharing location (e.g. hub #5 and #37 in figure 34), 21 neighbourhood hub locations fall within the search area for new car-sharing locations (e.g. hub #14 and #38 in figure 34), and for the other 8 neighbourhood hub locations car-sharing is not considered (e.g. hub #18 and #32 in figure 34). So, this shows that indeed car-sharing is added as a new location to the majority of neighbourhood hub locations. We can do the same for public transport (see figure 35). Interestingly, all of the 38 most preferred neighbourhood hub locations fall within the catchment area of existing public transport locations. Thus, for all neighbourhood hubs, public transport is already there.

If we go through these steps for all 38 neighbourhood hub locations and for each amenity type, we obtain the range of amenities per neighbourhood hub location. The tables in Appendix L are coded as follows: a light orange cell indicates that the amenity is already there, a darker orange cell indicates that an amenity should be added to that neighbourhood hub, and no cell marking means that there are no existing locations and there is no demand.

As expected, the higher presence of existing shared service locations compared to existing transport mode locations translates itself into the final results. For nearly all shared services there is a significant number of neighbourhood hubs were the service is already present. For the transport modes, this is only the case for shared cars and obviously public transport. Moreover, there are a number of transport modes which are present at only a few neighbourhood hubs. If we take shared scooters again as an example, there are no existing locations and only 2 districts where this transport mode is considered. As a consequence, shared scooters are added to only 5 neighbourhood hubs as a new amenity location.

The three transport modes with the highest number of new locations at neighbourhood hubs are: shared cars, shared cargo bikes, and trailers. The three shared services with the highest number of new locations at neighbourhood hubs are: bicycle parking, bicycle repair stands, and sports equipment. All these amenities are added to more than 20 of the 38 most preferred neighbourhood hubs.

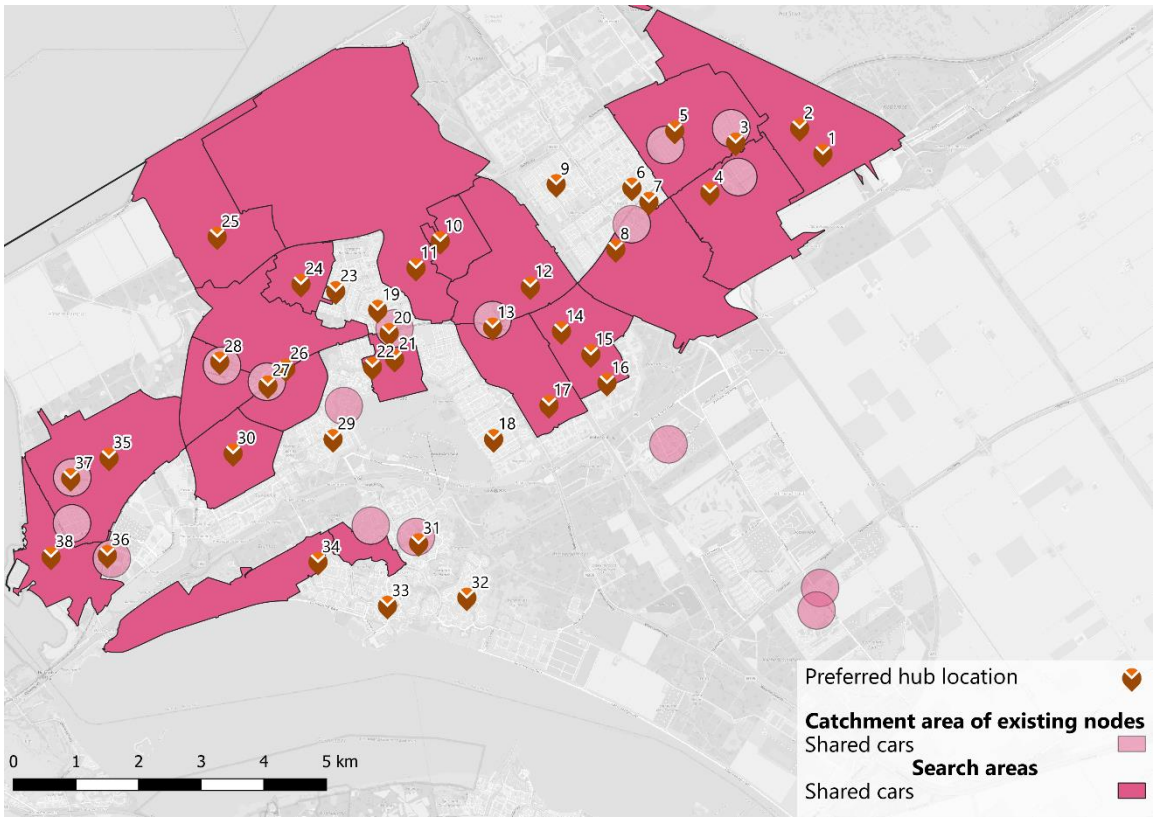

Figure 34 - The most preferred hubs with catchment and search areas shared car.

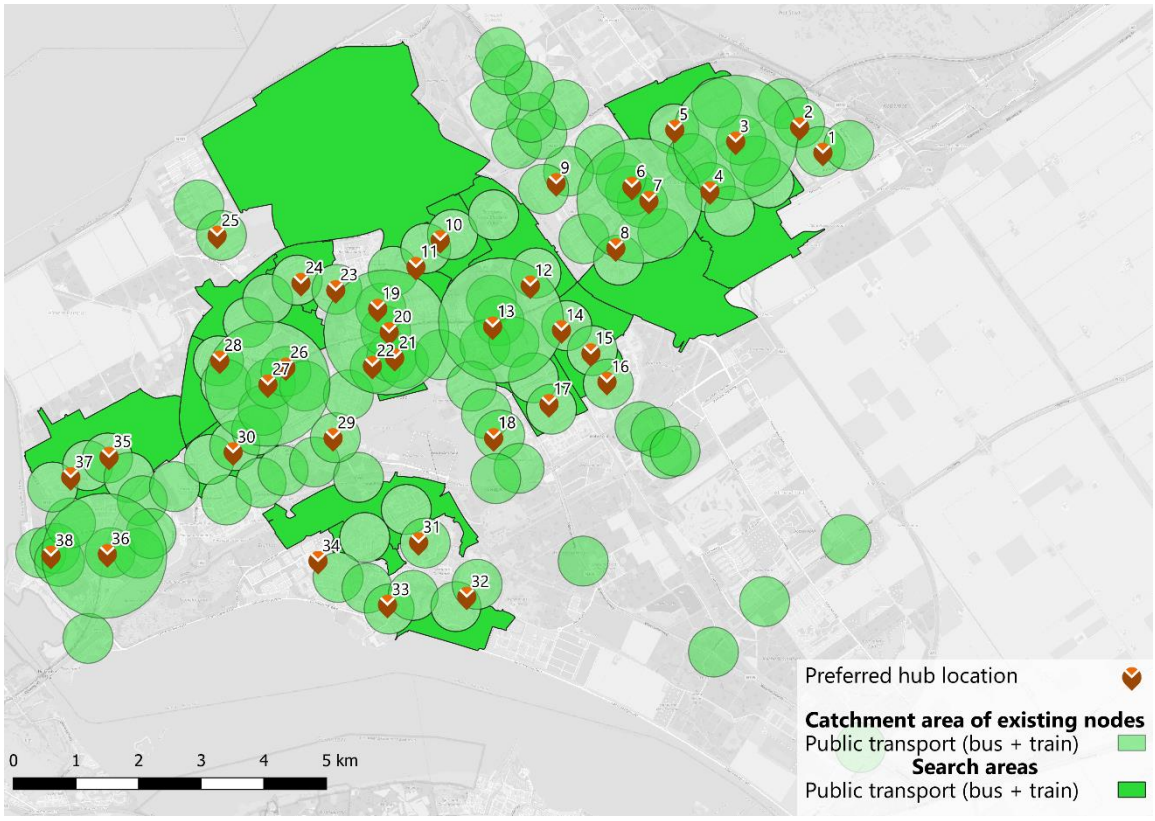

Figure 35 - The most preferred hubs with catchment and search areas public transport.

Now let's zoom in on neighbourhood hub #1 to get a better understanding of how these results could be applied in practice. Figure 36 shows the area in which a neighbourhood hub would be promising. It can be seen that there are already four amenities present: a gym, a supermarket, a pick-up point, and a bus stop. In this case, the bus stop and shopping facilities act as anchor points. The next section will provide suggestions how to determine what should be the exact location of neighbourhood hub #1.

According to the tables in Appendix L, preferrable new transport modes to add are: shared cars, a taxi stand, shared cargo bikes, and shared mopeds. Preferrable new shared services to add are: bicycle parking, a bicycle repair stand, and co-working spaces. The same principle can be done for every neighbourhood hub location.

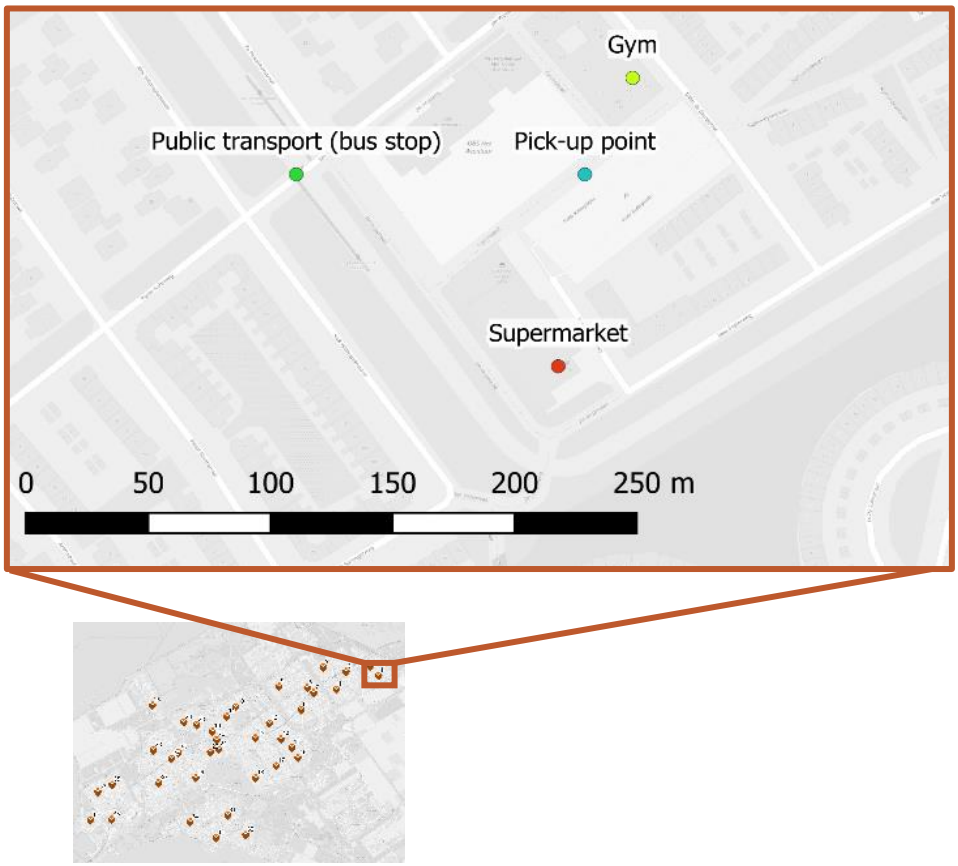

Figure 36 - Zoom in of Neighbourhood hub #1.

In conclusion, the case study shows that Design Approach step sequence is indeed able to indicate the most preferred locations in combination with amenities for neighbourhood hubs, based on user profiles.

KEY TAKEAWAYS

- Especially the bus stops, community centers and shopping facilities contribute to a well-spread grid of anchor points throughout Almere.
- Clustering anchor points within 300 m from each other results in a grid of 45 single and 38 clustered anchor points. The 38 clustered anchor points could be used for the first phase of rolling out neighbourhood hubs in Almere. The other 45 single anchor points could be used in later phases.
- The user profiles Average Joes & Janes and Working Class are most dominant in Almere.
- The search area for new amenity locations is influenced by the density and spread of existing amenity locations, the corresponding catchment area values of each amenity, and districts where an amenity is considered due to the dominant user profiles.
- By combining the layers with most preferred neighbourhood hubs locations, catchment areas of existing amenities, and search areas for new amenity locations, it can be determined for each neighbourhood hub what is the range of most preferred amenities.
- The three transport modes with the highest numbers of new locations at neighbourhood hubs are: shared cars, shared cargo bikes, and trailers. For the shared services these are bicycle parking, bicycle repair stands, and sports equipment.
- The case study in Almere shows that the Design Approach step sequence is able to determine the most preferred locations in combination with amenities for neighbourhood hubs, based on user profiles.

7.2 Case study results summary

This section summarizes the results from running the step sequence on the municipality of Almere into an infographic (see figure 37). It shows the distribution of urban districts, non-urban districts, and districts for which more data was available. Moreover, it shows the distribution of dominant user profiles – as mentioned, Average Joes & Janes and Working Class are dominant in most districts. Next, on the righthand top the number of anchor points from each anchor point type are shown. Clearly, bus stops account for the huge majority of anchor points. Moreover, the infographic shows for 9 transport modes and 9 shared services for how many neighbourhood hubs the amenity is already present, the amenity should be added as a new location, or the amenity should not be considered. For the transport modes DRT and pushchairs there was no demand according to the applied method. Regarding shared services, charging infrastructure for private/shared vehicles and playground are not considered as explained earlier. Besides, there appeared to be no demand for storage lockers.

As mentioned in the previous section, the distributions in the lower part of the infographic clearly show that there are significantly more neighbourhood hubs with existing shared services compared to the transport modes. It also shows that some transport modes are considered at only a few neighbourhood hub locations. Still, there are three transport modes and three shared services which should be added as new locations to more than 20 of the most preferred neighbourhood hubs.

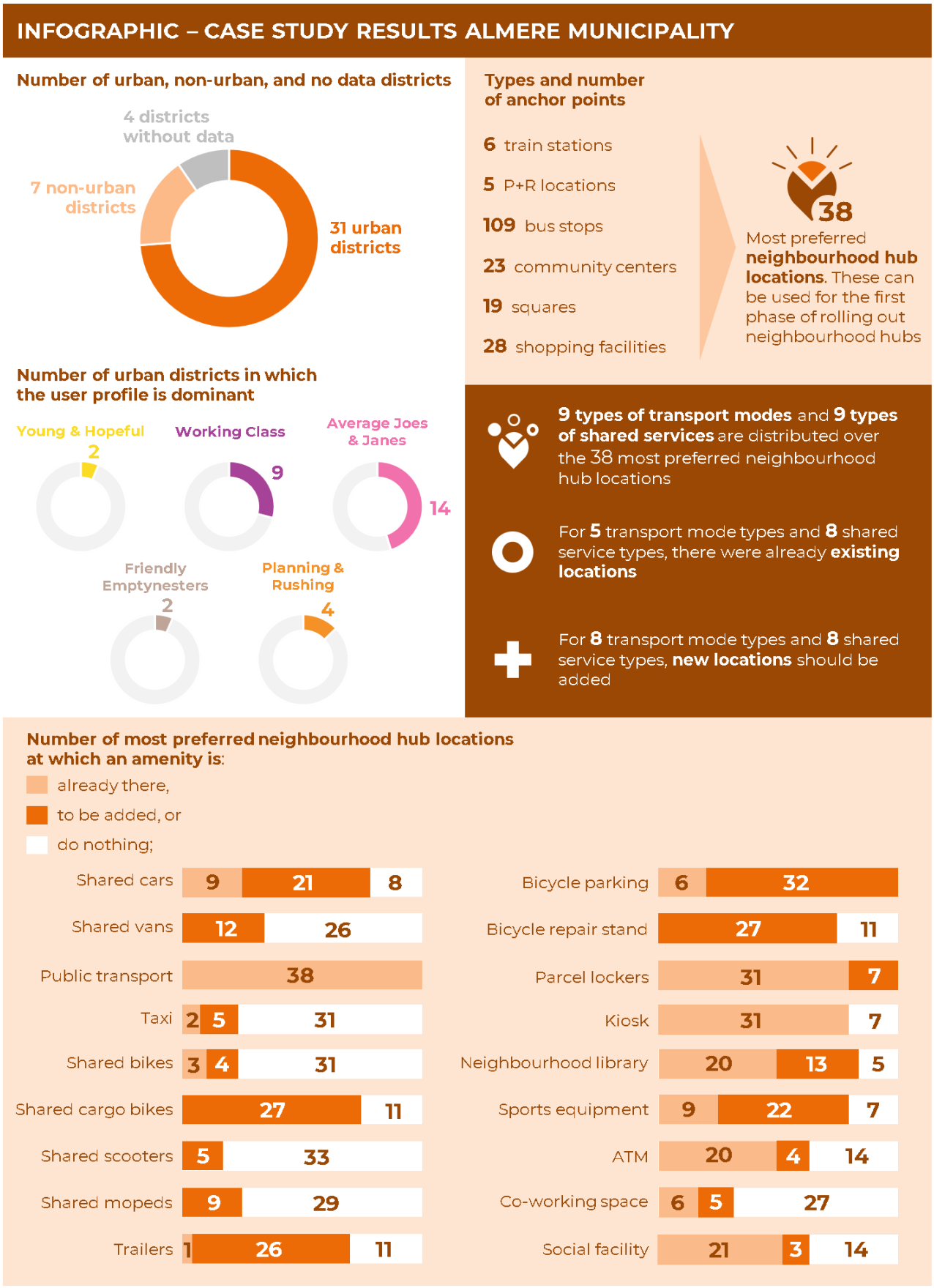

Figure 37 - Case study results summarized in an infographic.

7.3 Reflection on the Neighbourhood Hub Design Approach

7.3.1 Reflection session with municipality of Almere

Section 2.6 explained why reflection sessions have been held. Two goals were formulated for the reflection session with the municipality of Almere:

1. Determine whether the municipality thinks that the Design Approach is a promising tool to use when researching hub locations and amenities for their city. And if so, why.
2. Provide recommendations for future scientific research and improvements of the Design Approach.

Starting with the first goal, representatives from the municipality think that the Neighbourhood Hub Design Approach is a promising tool to use when determining locations in combination with amenities for hubs. During the session they highlighted two specific parts of the tool which could be helpful to design future hub policies in Almere. First, in the current situation the municipality has little to no substantiation for determining the locations of neighbourhood hubs. The use of anchor points offers a stepping-stone to come up with logical hub locations. Second, the potential user groups of hubs remain largely unknown for the municipality as of now. Representatives think that incorporating user profiles into the Design Approach provides first insights in the range of amenities that should be offered at each hub, and which hub locations should be prioritized. Additionally, the municipality mentioned that they would like to further research the 'hub user' by engaging residents and find out what they think of the hub concept.

Regarding the second goal, the representatives from the municipality provided a number of recommendations for future research and ways to improve the Design Approach. First of all, the municipality thinks that it is opportune to also research what are preferred neighbourhood hub locations on the destination-side. Secondly, the municipality agreed that it is not suitable to consider on-street individual charging points. But, they recommended to consider charging stations as a service. With these you can offer charging facilities for private EVs at central locations in neighbourhoods, and gradually get rid of street parking in the future. Third, the municipality thinks that car-ownership is an interesting variable to consider when searching for the most preferred locations. They think that people with fewer cars are more willing to use shared mobility. One could argue whether these people are your main target group if your objective is to use space more efficiently, because their car-ownership is already low. From an adoption perspective however, it makes sense to target this group. Finally, according to the municipality, five-digit or even six-digit zip codes could provide a more detailed picture of preferrable hub amenities based on user profiles. However, for this thesis the user profile data was only available on a four-digit zip code level. Also, the municipality thinks that the needs of residents remain to be a major unknown factor. They suggested to engage residents and gauge opinions on the implementation of neighbourhood hubs. This was also suggested during the reflection with hub experts from Advier.

7.3.2 Reflection session with hub experts from Advier

For the session with hub experts from Advier, three goals were formulated in section 2.6:

1. Determine whether Advier thinks that the Design Approach is a suitable tool to use in future projects about locations and amenities of neighbourhood hubs. And if so, why.
2. Provide recommendations for future scientific research and improvements of the Design Approach.
3. Determine how the results from the Design Approach could be interpreted to provide advice to authorities. Examples could be advice on how to phase the rollout of hubs, or how to determine the locations of each hub in more detail.

First of all, hub experts from Advier think that the Neighbourhood Hub Design Approach is a useful tool for future projects about locations and amenities of hubs. This is because the tool provides a grid of hub locations and amenities at each hub location, which can be used as a starting point for further development of neighbourhood hubs. While the demand from clients is there, no such tools exists currently. Moreover, the findings about user profiles and incorporating this into the Design Approach offers a first indication how to plan hubs in accordance with the needs from residents. The tool can be applied for different types of clients, such as authorities, transport operators, or service providers. To put it even more strongly, at the time of writing the Neighbourhood Hub Design Approach is already being applied in a real project for a service provider in a large Dutch municipality. This highlights the aforementioned relevance and need for a tool to determine locations and amenities for hubs.

For the second goal, a number of recommendations were provided. First, Advier experts suggested to re-run the step sequence multiple times, with in each run more types and an increasing number of anchor points. Waste containers could be an example of anchor points to consider for a higher density grid of neighbourhood hubs. The last iteration would then include such a high number of anchor points, that it results in a grid of neighbourhood hubs within walking distance (~300-400 m) for all households living in urban areas. Having a neighbourhood hub every 300-400 m would be the 'ideal' future scenario if the goal is to place a hub within walking distance for all households. However, it is not known currently whether this is indeed the 'ideal' future scenario, as a lot can change over the years. The Design Approach as applied for the municipality of Almere proved itself to be useful for the current situation in which neighbourhood hub, or mobility hubs in general, are still in an early stage. It is indeed recommendable for cities to think ahead and provide flexibility in their urban and mobility planning.

Another suggestion from Advier is to recommend policymakers to cluster services as much as possible. If services are spread out over an area, it is harder to get rid of abundant infrastructure. In this way, clustering helps to decrease the spread or clutter of services. Moreover, it offers opportunities to use available space more efficiently.

In general, it is advisable for policymakers to first determine their key policy objectives, before starting to implement neighbourhood hubs. The key policy objectives could influence how neighbourhood hubs would be phased during the rollout, but also what should be the exact location of a neighbourhood hub.

Regarding the third goal, hub experts provided suggestions to interpret the results from the case study. These suggestions have been divided into two parts: suggestions to phase the rollout of hubs, and suggestions to indicate the location of a hub in more detail.

Suggestions for phasing of neighbourhood hubs

To phase the most preferred neighbourhood hubs, one suggestion is to use the fixation (or movability) of the considered anchor points. Different anchor points play a role on different hierarchical levels (see 5.3). Train stations for example are part of a(n) (inter-)regional transport network, while bus stops usually serve people on a local level. It could be easier to move a bus stop compared to a train station. Subsequently, this fixation of anchor points could be used to phase the most preferred neighbourhood hub locations: given the movability, one could start with neighbourhood hubs at the least movable anchor points, and implement neighbourhood hubs at the most movable anchor points in the last phase.

Another suggestion to phase the most preferred neighbourhood hub locations is to consider the willingness to use neighbourhood hubs by different user profiles. This was researched with focus groups and literature in chapter 6. In this case, it makes sense to start with the early adopters. The socio-demographics of early adopters fit best to the user profile Young & Hopeful (Burghard & Dütschke,

2019). Also, experts from the focus groups indicated that Young & Hopeful is most likely to use neighbourhood hubs (see section 6.4).

Figure 38 shows the distribution of Young & Hopeful in districts from the case study. There are four districts in which the percentage Young & Hopeful is higher than 20%: zip code 1315, 1334, 1361, and 1363. In 1315 and 1363, Young & Hopeful is the dominant user profile, while in the other two it's not. From an adoption perspective, it makes sense to start with developing those hubs in districts where the percentage Young & Hopeful is higher than 20%, which would be neighbourhood hub #6, #7, #20, #21, #22, #35, #36, #37, and #38. A second phase could be to develop hubs in districts where the percentage of Young & Hopeful is higher than 10%, a third phase higher than 5%, etc. Note that the user profile Average Joes & Janes has also received a relatively high probability to use neighbourhood hubs, so this might be another interesting group to consider if policymakers would focus on adoption.

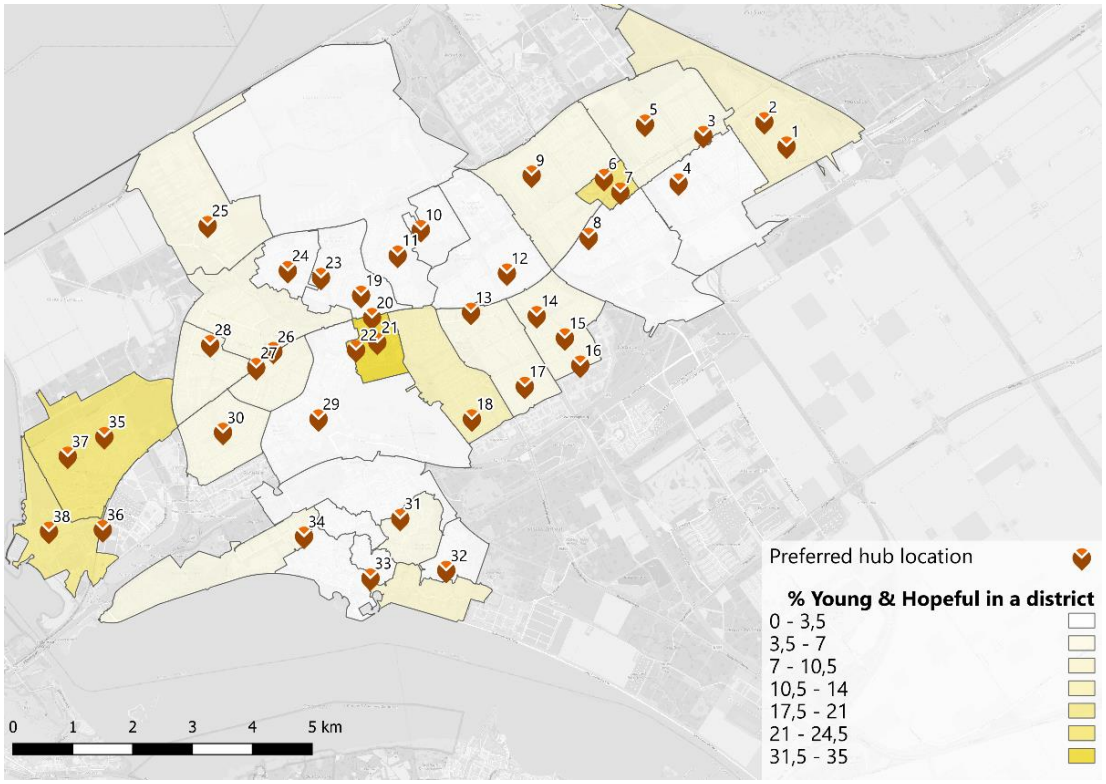

Figure 38 - Percentage of Young & Hopeful in each district.

Suggestions to determine exact neighbourhood hub locations

The movability of anchor points could also be used to determine the exact location of neighbourhood hubs. If there are multiple anchor point next to each other, the movability could be used to determine where exactly a neighbourhood hub should be located. An example could be that a bus stop and supermarket are located 100 m from each other. A bus stop is easier to relocate compared to a supermarket, which is usually a larger and more fixed building. So, based on this reasoning it makes more sense to place a neighbourhood hub at the supermarket.

Another perspective to determine the exact neighbourhood hub locations could be to create attractive places for social cohesion. If there would be a choice between a tram stop and a supermarket, it could make more sense to opt for the supermarket if this anchor point attracts a higher diversity and intensity of people. Besides, the area in front of the supermarket could be more suitable for place-making than a tram stop next to a road. But, these trade-offs between the anchor points are very situation-specific.

8. Conclusion, discussion, contributions & recommendations

This final chapter has the following structure. Section 8.1 provides a conclusion on this thesis. Next, section 8.2 discusses findings from this thesis and limitations of the applied methodology, and concludes with an outside view on neighbourhood hubs. Section 8.3 explains how this thesis contributes to both scientific and practical fields about hubs. Finally, section 8.4 provides recommendations.

8.1 Conclusion

The mobility hub concept is becoming more and more popular in practice and science. It is perceived to be a means which contributes to different goals, such as reducing the required infrastructure in cities, connecting different amenities with each other, and creating attractive and recognizable places. Mobility hubs can only contribute to these goals if they are adopted by users, which is why in practice there is a need for knowledge about users, amenities, and locations of hubs. Besides, there is a need for a tool to determine the locations and amenities of hubs. Advier has already developed such a tool, but it only determines locations for neighbourhood hubs by solely using mobility anchor points. While limited, scientific literature about hub locations focuses primarily on larger scale mobility hubs, it does not consider which amenities should be offered at each hub location, and the influence of users on locations and amenities is not considered as of yet. Therefore, this thesis aims to answer the following main research question.

Main research question: "*What is a suitable design approach to determine the most preferred locations in combination with amenities for neighbourhood hubs, based on user profiles?*"

This thesis proposes the Neighbourhood Hub Design Approach which is able to determine the most preferred locations and amenities of neighbourhood hubs in urban areas, based on user profiles. The underlying principle is to determine the locations in combination with amenities in such a way, that people are more likely to use neighbourhood hubs. The Neighbourhood Hub Design Approach provides a step sequence, and suggestions for the interpretation and implementation of the step sequence results. The step sequence can be divided into three parts: part I determines the most preferred neighbourhood hub locations. Part II determines amenities which are required according to the present user profiles, the existing locations, and search areas for new locations per amenity. Lastly, part III combines part I and part II by determining the range of preferred amenities at each neighbourhood hub location.

Before applying the Neighbourhood Hub Design Approach, it is important that authorities determine which objectives they want to achieve with the development of neighbourhood hubs. The objectives that are mentioned in existing policy documents are often not explicitly linked to hubs, and mainly relate to mobility-aspects of hubs, while neighbourhood hubs can also contribute to wider societal benefits, such as stimulating social inclusiveness, social cohesion, and local economies.

To be able to apply the step sequence on a real-life city, multiple components of the step sequence have been researched. In correspondence with the existing Advier algorithm, anchor points were found suitable to determine neighbourhood hub locations. Research has shown that anchor points could be mobility related as well as non-mobility related. Likewise, amenities that are offered at neighbourhood hubs could be transport modes (mobility related), but also other shared services (non-mobility related). It was found that the number of anchor point types and amenity types that are considered should be limited, because (1) the Neighbourhood Hub Design Approach is looking for the most preferred locations and amenities, and (2) to keep the step sequence as practical and efficient as possible.

To the best of the author's knowledge, this research is the first to explore the influence of user profiles on the most preferred neighbourhood hub locations and amenities at each location. In general, results from a literature study and focus groups indicate that any user profile can be incentivized to use neighbourhood hubs if they have the right motivations. Motivations can differ among user profiles, for example younger people could be environmentally motivated, while older people could be more socially motivated to use neighbourhood hubs. This corresponds with the Fogg Behaviour Model which states that motivations (together with ability and triggers) influence whether behaviour will occur. The finding that any user profile could use a hub contests most of the reviewed literature, which states that hubs and shared mobility are mainly for younger people, with a higher income and education level, who have a sustainable mindset, experience with sustainable modes, and low private vehicle ownership.

Still, it was found that user profiles could influence which locations should be prioritized. From the results it can be learned that from an adoption perspective it is most preferrable to develop neighbourhood hubs in areas with a high share of the Young & Hopeful and Average Joes & Janes user profiles. Moreover, user profiles' needs influence the range of amenities that should be offered at a neighbourhood hub – offering the right range of amenities is required to motivate people to use neighbourhood hubs. Results indicate that Young & Hopeful and Average Joes & Janes are the main target groups for shared mobility. Also the user profile Planning & Rushing could be a target group, but only if the offered shared modes add value to what they already possess.

After all required research was done, the Neighbourhood Hub Design Approach could be assessed in a case study with the municipality of Almere. Especially the bus stops, community centers, and shopping facilities contribute to a well-spread grid of anchor points throughout Almere. The step sequence results in a grid of 38 most preferred neighbourhood hub locations. These can be used in the first phase of rolling out hubs in Almere. Average Joes & Janes and Working Class are the dominant user profiles in most districts. As a result, the three transport modes with the highest number of new locations at neighbourhood hubs are: shared cars, shared cargo bikes, and trailers. For the shared services these are bicycle parking, bicycle repair stands, and sports equipment.

From reflection sessions, it could be concluded that the municipality of Almere thinks that the Design Approach is a suitable tool to consider when implementing neighbourhood hubs. First, in the current situation the municipality has little to no substantiation for determining the locations of neighbourhood hubs. The use of anchor points offers a stepping-stone to come up with logical hub locations. Second, the potential user groups of hubs remain largely unknown for the municipality as of now. Representatives think that incorporating user profiles into the Design Approach provides first insights in the needs of users. Advier also thinks that the Design Approach will be applied in future projects. This is because the tool provides a grid of hub locations and amenities at each location, which can be used as a starting point for further neighbourhood hub developments. While the demand from clients is there, such a tool does not exist currently. The addition of residents also provides a first indication how hub amenities and locations could be tailored to residents.

The reflection sessions contributed in another way to the Design Approach through suggestions to prioritize hub locations. Anchor points with a lower movability and hub locations in districts with a high share of Young & Hopeful could be prioritized. Moreover, the reflection sessions provided suggestions to determine hub locations in more detail. If there are multiple anchor points, the anchor points with the lowest movability could be preferred. Also, policy objectives could play an important role in location choice. For example, a supermarket might be preferrable over a public transport stop if social cohesion is a major objective for authorities.

8.2 Discussion

The results from this thesis have shown that the Neighbourhood Hub Design Approach works in a real-life case study. However, there are a number of discussion points and limitations regarding the Design Approach. This section structures those discussion points and limitations according to a number of topics that were addressed throughout this thesis.

Key policy objectives related to neighbourhood hubs

The Neighbourhood Hub Design Approach is able to successfully determine the most preferred neighbourhood hub locations, but not capable to determine each location in full detail. Chapter 7.3 provided a few suggestions how policymakers can use the results from the Design Approach to prioritize the rollout of hubs, and determine the location of each neighbourhood hub location in detail. However, as mentioned in the conclusion this depends on the policy objectives that policymakers want to contribute to with the implementation of neighbourhood hubs. If efficient use of urban space is very important, it could be logical to place a neighbourhood hub at a tram stop and get rid of abundant infrastructure. But, if for example social cohesion and stimulating local economies are important objectives, shopping facilities could be the preferred neighbourhood hub locations. Thus, how the Design Approach is used to implement neighbourhood hubs depends on the policy objectives from authorities, and the results from chapter 4 can provide a good lead to formulate those.

Only policy documents were reviewed for the formulation of the key policy objectives in chapter 4, while scientific literature on the contribution of hubs to policy and societal goals was not considered. A suggestion to formulate an even better set of key policy objectives is to consider scientific literature on the societal effects from neighbourhood hubs, especially with the finding that current policy documents lack clear objectives for neighbourhood hubs.

Neighbourhood Hub Design Approach in general

One of the main discussion points on the Neighbourhood Hub Design Approach is that it only considers the dominant user profile (or Whize segment) of a zip code to determine which amenities should be considered for that district. On the positive side, this makes the Design Approach very efficient and easily applicable, as only the amenities belonging to that user profile are considered. But on the negative side, user profiles which are not dominant in a zip code could be overlooked. If for example Young & Hopeful only has a presence of 15% in a neighbourhood with a lot of residents, it could still make sense to consider shared mobility at neighbourhood hubs. Of course, when tailoring each neighbourhood hub to its social and urban context such issues can be addressed, but for the step sequence itself there is a risk that under-presented user profiles could be overlooked. This issue could be fixed by considering absolute numbers instead of percentages for the user profile distribution in each district. However, then it should also be determined what is the threshold (i.e. number of residents) for each user profile to consider a certain amenity. This threshold value could depend on various factors. If we take car-sharing as an example, it could depend on the number of car-sharing users required to decrease the parking space demand with a certain percentage, or to offer a positive business case for car-sharing providers. In any case, considering absolute numbers for residents would require more research.

Anchor points

This thesis used a user perspective to determine the locations in combination with amenities in such a way, that people are more likely to use them. In correspondence with this principle and the existing Advier algorithm, user profiles and anchor points have been considered to indicate the most preferred neighbourhood hub locations. The indicators assume that more clustered anchor points and anchor points from a higher network level result in a higher number and diversity of potential hub users. However, no real data was available on the actual number of visitors/travellers at each anchor point to

validate these assumptions. If data would be available in a future study, a better indication can be provided for the preferred hub locations.

Moreover, as mentioned in section 5.3 there are more types of criteria and attributes which could be relevant to indicate the most preferred hub locations, for example the number of residents in an area, parking pressure, or presence of infrastructure. Future studies could elaborate on this study by considering a wider set of criteria. While this would require more data, the choice of most preferred neighbourhood hub locations can be underpinned by more criteria.

As mentioned in the introduction, this thesis is scoped towards neighbourhood hubs which have an origin function, and residents are considered as the 'users' of these hubs. As a consequence, hubs with a destination-function are not considered. But, if people for example take a shared car from a neighbourhood hub to their work, there needs to be parking spaces at the destination side. Furthermore, there could be demand for hubs at the destination side, for example offering shared modes near business parks for work-related trips. A next step could be to adjust the Design Approach so it is also applicable for hubs at the destination-side.

Neighbourhood hub amenities

The amenities (shared services and transport modes) considered for the Neighbourhood Hub Design Approach were based on existing mobility hub planning and design guidelines. An amenity is only considered if it occurs two times or more in the reviewed documents. While this in theory provides a workable set of promising shared services and transport modes to place at a hub, it does not provide a complete overview. For example, during the focus groups a social facility was perceived to be promising to people from Working Class and Friendly Emptynesters. Experts thought that social facilities such as a community center could attract people from these user profiles to neighbourhood hubs. Still, experts do not directly represent the people that actually live in neighbourhoods. A next step could be to directly engage residents from the study area to gain more insights in the needs of people for neighbourhood hub amenities.

User profiles method

The Whize segmentation is used to define user profiles for the Neighbourhood Hub Design Approach. To the best of the author's knowledge, this was the most suitable method to define user profiles for this thesis. But, there are a number of limitations to this method.

First, the clustering techniques behind the Whize segmentation model are not known for this thesis, which is a significant disadvantage. Also, data underlying to the Whize segmentation is not available for this thesis. To gain access, one has to get a licence from WHOOZ BV, however this was not an option due to cost constraints. In scientific research it is desirable to have access to the used data. If the benefits outweigh the costs, one could consider buying a licence for WHOOZ, so the actual data is openly available for the licence-holder. Another direction could be to find out what are the clustering techniques behind the Whize segmentation.

Moreover, for practical reasons, this study considers the 11 main Whize segments rather than the 59 subsegments. Even if the 59 sub-segments were considered, this is a generalization of the entire Dutch population. Considering user profiles from the entire Dutch population provides a good indication, but each study area is unique, so a next step could be to define area-specific user profiles. A stated choice experiment could be used to gather data from residents living in the study area. This method was also used by Winter et al. (2020) to define user profiles. Whether creating area-specific user profiles would have differed significantly from the Whize segments really depends on the study area. But it is very probable that area-specific user profiles give a more valid representation of people living in the area,

thus also more fitting personas. And if the characteristics of personas change, this could lead to different focus group results, and so different amenities that are considered in the Design Approach step sequence.

Influence of user profiles on locations and amenities

The amenities that were considered in the Neighbourhood Hub Design Approach for each user profile were based on focus groups and a literature study. Due to time constraints in the thesis trajectory, it was not possible to validate the results from the focus groups and literature study with actual residents from the study area. In reality, the needs of people may differ from those resulting from theory, so an interesting direction could be to empirically research the most preferred amenities per user profile.

Another discussion point is that one could argue if the most preferred amenities for user profiles based on theory are also desirable from a policymaker perspective. If policymakers for example want to decrease private car ownership with neighbourhood hubs, the impacts from offering shared modes could differ per user profile. If we take the Young & Hopeful user profile, it was concluded that different types of shared mobility are promising. However, is this actually the group to target for shared mobility? They often already use sustainable transport modes, so a higher impact could be reached by focusing on user profiles with two or more cars, such as Planning & Rushing. On the other hand, this does not mean that you should not offer shared mobility for the Young & Hopeful group at all, even though the effects on spatial use might be less significant. A well-known concept is the *option value*, which can be associated with the potential use of the transport system (Geurs et al., 2006). In the context of this thesis, shared mobility might have a certain value to people from Young & Hopeful, as it provides them with more mobility alternatives in case their regularly used transport modes are not available. In the study from Geurs et al. (2006), this possibility to use shared mobility in unexpected situations is called *option use*, it can be perceived as a sort of 'insurance'. A direction to pursue in future research could be to determine the scale of these benefits from offering mobility alternatives at a neighbourhood hub.

The personas as used during the focus groups were static in time, while in reality they are dynamic. People go through different user profiles throughout their lives, and user profiles (and personas) may change overtime. People from Young & Hopeful will eventually go to other user profiles as they grow older, but how this works exactly remains unknown. What we do know is that with current measures we can influence future behaviour. Also, user profiles could be influenced by other user profiles to use neighbourhood hubs. As such, the so-called 'innovators' and 'early adopters' could influence other groups (i.e. 'early majority', 'late majority', 'laggards') to use neighbourhood hubs (in accordance with the Diffusion of Innovations from Rogers, 1962). During the focus groups a few examples were mentioned, like Friendly Emptynesters might get introduced to a local neighbourhood hub if they go to a nearby playground with their grandchildren, or parents from Planning & Rushing could be influenced by their children who are using micro mobility. These were just suggestions, so more research would be required to get a better grip on interactions between user profiles.

Catchment areas of neighbourhood hub amenities

The catchment area values that were used during the step sequence assumed that residents use walking as an access mode from home to a neighbourhood hub. However, in reality the bicycle may be a very suitable access mode for neighbourhood hubs. That is also the reason why it is recommendable to add bicycle parking facilities at each hub location. While cycling would enlarge the catchment area of a node, it could be hypothesized that the availability of bicycles as and access mode could even decrease the distance people are willing to walk. Proof for this was not found, but one could argue that the maximum walking distance to neighbourhood hubs could be decreased from 400 m to for example 300 m, which is in-line with the hub strategy from Bremen (Schreier et al., 2018; Witte et al., 2020). The impact on the results could be that amenities should be placed closer to each other, which would require a denser network of neighbourhood hubs.

Case Study for municipality Almere

The following discussion points are specifically related to the case study for the municipality of Almere.

First of all, the inventory of existing amenity locations in Almere has been done at a specific fixed moment in time. But, locations of certain services and transport modes could change over time. For example, for existing car-sharing locations only the fixed locations from Greenwheels were taken into account, while at the time of writing MyWheels has also introduced a number of car-sharing locations. This means that for some neighbourhood hub locations, the results indicate that a new car-sharing location should be added, while in reality there is already a fixed car-sharing location (in this case from MyWheels). To account for this dynamic in amenity locations, it could be recommendable to run the Design Approach at regular intervals (for example every year).

Moreover, during the case study it could be seen that considering anchor points in the municipality of Almere results in a well-spread grid of anchor points. But, this is a result of the urban structure and offered facilities throughout the municipality. For example, in Almere bus stops are responsible for the majority of anchor points. In other cities, the bus or public transport in general could have a less dense network, which as a consequence would lead to a less dense and spread anchor point grid.

A final point to mention is that the case study could only use data that was openly available or provided by the municipality. As such, there was not enough data to validate whether the user profile distribution from WHOOZ BV aligns with the actual situation in Almere. The municipality indicated that the distribution of dominant user profiles is plausible, but it is recommendable for comparable future studies to validate the user profiles.

Outside view on neighbourhood hubs

Throughout this thesis, different objectives and goals where mentioned to which the clustering of amenities at neighbourhood hubs could contribute. Chapter 1 explained how neighbourhood hubs could increase the connectivity, attractiveness, and recognizability of amenities. Moreover, the decrease of car-dependency could lower the demand for parking spaces to replace these by other functions. Next, chapter 4 revealed other social and economic goals such as improving social cohesion, inclusiveness, and stimulating local economies. While these are indeed promising benefits, it remains unclear how exactly neighbourhood hubs will develop in the future, and if they could be given a fixed place in policies and the planning of Dutch cities. This final part of the discussion is a glance into the future.

Let's start with an outline of the current situation in which neighbourhood hubs have hardly been applied or not at all. Nowadays, we can see that amenities are scattered around the neighbourhood. This is nicely illustrated by the lefthand side in figure 39. For example, EV charging points are placed randomly in residential streets, the same holds for shared cars, and shared mopeds are allowed to park wherever they want (if it is within the service area). The result is that there are no recognizable places for residents if they would like to use a service, and there is little to no connectivity between services. Besides, infrastructure is required to access each amenity location. For example, waste trucks should be able to access waste containers, and shared cars require dedicated parking spaces and roads. This in combination with parking spaces for private vehicles makes that there is less space available for greenery, housing, and other functions. While these negative effects may not be tangible as of yet, planning cities like we do today may cause problems in the future. Take for example the housing developments. The Dutch government is planning to build nearly one million houses until 2030, which requires denser and larger urban areas (Rijksoverheid, 2021). To realize this within the available space, which is already scarce, dimensions of new housing have to be smaller. As a consequence, the scarce public space which is left is becoming more and more important.

Figure 39 - Current situation (scattered) versus future situation (clustered).

So what does the future hold? My vision is that neighbourhood hubs will become a standard in policies and the planning of cities. Developing a grid of neighbourhood hubs is promising, because it has different advantages. The righthand side of figure 39 shows that amenities can be clustered at central places in neighbourhoods – *clustering* instead of *cluttering*. It allows to create attractive places in neighbourhoods with high quality public space which are recognizable for residents. Moreover, it allows for connectivity between amenities: grabbing a shared car, doing groceries, picking up your parcel, and disposing your waste at the same location. As a consequence, less infrastructure will be required to guarantee access to each amenity. Offering those transport modes in correspondence with the needs of

residents could lower car-dependency, and thus the number of private cars per household, which lowers the number of required parking spaces. The gained space can be used for other functions, which can contribute to higher quality public spaces and societal benefits that were mentioned in chapter 1 and 4.

Of course, neighbourhood hubs also have their disadvantages. It was already mentioned that public space in cities is getting scarcer, but it also requires space to realize neighbourhood hubs. Moreover, it remains uncertain if residents will actually use neighbourhood hubs once there are implemented, and if this will also lead to the positive effects as described above. But, the case of Bremen shows that people really use the facilities offered at hubs. During a site visit in Bremen, it was observed that at one of the largest hub locations, eleven of the in total twelve car-sharing parking spaces were empty. Moreover, the effects from their hub strategy have been measured. Halfway 2021, there were already 43 hub locations in Bremen, and research has shown that a single shared car in Bremen replaces sixteen private cars (CoMoUK, 2021; Schreier et al., 2018). Moreover, the municipality of Bremen is also dealing with scarcity of public space, and still manages to develop a city-wide neighbourhood hub network.

All in all, neighbourhood hubs are a very promising concept, and it is very likely that we will head into a future where neighbourhood hubs will play an important role in the planning of cities. The Neighbourhood Hub Design Approach could help authorities which are starting to implement hubs today, while keeping in mind the future situation. By iteratively going through the step sequence with more and more types of anchor points, one could gradually increase the density of neighbourhood hub locations to eventually end up with a future situation with a neighbourhood hub within walking distance of every household. In that way, authorities already have an idea what they are working towards. Furthermore, the incorporation of user profiles makes sure that the offered amenities at each hub location are in correspondence with the needs of residents in the surrounding area, resulting in a higher probability that neighbourhood hubs are actually adopted.

8.3 Contributions

8.3.1 Scientific contribution

This thesis contributes to the scientific research domain of planning neighbourhood hubs as, to the best of the author's knowledge, it is the first to explore the influence of user profiles on the most preferred neighbourhood hub locations and amenities at each location. Therefore, it was also the first research which has asked experts during focus groups to indicate which neighbourhood hub amenities are preferred for each user profile, based on personas. These focus groups were combined with a literature study to gain insights into users of neighbourhood hubs. Moreover, this research indicates how these insights can be used to better align the locations and amenities of neighbourhood hubs with needs of users. Besides, this thesis has researched which potential locations (anchor points) are suitable for neighbourhood hubs, and how the characteristics of these anchor points and presence of user profile can be used to prioritize neighbourhood hubs locations, and determine each location in more detail from a theoretical perspective. Furthermore, research has shown which types of amenities should be offered at neighbourhood hubs for each user profile. Based on the existing tool from Advier, these findings have been translated into the Neighbourhood Hub Design Approach.

This research was also the first to use the Whize segmentation to define user profiles. This Whize segmentation might, despite its short-comings, offer an interesting direction for future studies that want use of more commercially intended data-gathering methods. The results from this thesis can be used as a stepping-stone for future research into the influence of user profiles on the most preferred locations and amenities of hubs.

8.3.2 Practical contribution

This research contributes to practice, as results indicate that the Neighbourhood Hub Design Approach can be applied to determine the most preferred hub locations and amenities at each hub in existing urban areas. Therefore, the Design Approach fulfils the growing need for a practical tool to plan neighbourhood hubs in cities. Moreover, this thesis addresses the need for knowledge about users, amenities, and locations of hubs and has translated this into the Design Approach.

The Neighbourhood Hub Design Approach provides a step sequence and suggestions for the interpretation and implementation of the step sequence results. The step sequence has brought the existing Advier tool to a next step. It can be used by consultancy agencies, such as Advier, to support decision-making for authorities about the most preferred locations and amenities for neighbourhood hubs. Because it incorporates knowledge about the needs from users, these can be considered from the beginning in the development of neighbourhood hubs. Suggestions for the interpretation and implementation of the step sequence results could help authorities to prioritize the rollout of neighbourhood hubs, and determine each neighbourhood hub location in more detail.

Finally, it provides insights into existing policy objectives related to neighbourhood hubs for both Dutch and foreign policy documents. The proposed set of key policy objectives can be used as a stepping-stone for authorities to formulate objectives to which the implementation of neighbourhood hubs could contribute.

8.4 Recommendations

8.4.1 Recommendation for future research

A first direction to pursue in future studies is to gain more insights into the residents, or users of neighbourhood hubs. In the discussion it was mentioned that user profiles are based on the existing Whize segmentation. To elaborate on the user profiles from this thesis, future studies could empirically classify users into area-specific user profiles. This could be done by using data from Whize that is available, but also via a stated choice experiment like Winter at al. (2020) did. It could be interesting for this thesis to compare those area-specific user profiles with the user profiles from the general Dutch Whize segmentation. In addition, it could be interesting to research dynamic user profiles, i.e. taking into consideration age categories, generations, and how user profiles influence each other (using the DOI theory from Rogers, 1962). Because neighbourhood hubs are a relatively new development in the Netherlands, hubs are built for current but also future users. Creating scenarios of future user profile distributions in an area could be an interesting way to design and plan neighbourhood hubs in a future-proof way.

A second direction to gain more insights into users of neighbourhood hubs, is to empirically research what are the needs for amenities from user profiles. In the discussion it was mentioned that focus groups and literature were used to indicate the needs of user profiles for amenities. The results from this thesis certainly provide an interesting starting point, but can be perceived as explorative. Future empirical research into the needs of users for amenities can be combined with the previous recommendation. As such, a stated choice experiment can be used to classify residents into user profiles, and subsequently determine what are the needs for amenities per user profile.

A third direction to pursue which is related to the above is to research what are the effects or benefits from placing certain shared services or transport modes at a neighbourhood hub. This relates to the *option value* from Geurs et al. (2006) that was mentioned in the discussion part about the influence of user profiles on amenities. By using a stated choice experiment, you could give people a number of amenity combinations at hubs, and determine how the removal or addition of certain amenities influence

someone's willingness to use or pay for a service. This mirrors the recommendations from Bösehans et al. (2021) who stated that future research is needed to explore the added value among user profiles from increasing the variety of modes at a hub.

A fourth direction for future research is to consider the actual number of visitors or passengers at anchor points. The discussion on anchor points stated that two indicators were used to make an assumption for the potential number and diversity of hub users. With data available, future studies are able to more accurately indicate what are the most visited places in cities. Moreover, it was mentioned in the discussion that more criteria could be used to indicate the most preferred neighbourhood hub locations. The thesis from Blad (2021) and other studies related to location choice of infrastructure could be used to come up with a set of criteria. Next, one could apply a Multi-Criteria Analysis (MCA) like Blad (2021) did or, if it is possible with the available data, a quantitative analysis such as a Social Cost-Benefit Analysis (SCBA).

A fifth possibility may well point in the direction of also researching hubs with a destination function. In the discussion part about anchor points it was mentioned that this thesis only focuses on neighbourhood hubs with an origin function. But, it could be interesting to research hubs on the destination side. This was also suggested by the municipality of Almere. The step sequence could be re-used for this, but some adaptations would be required:

- It requires different types of anchor points. Literature showed a number of anchor points at the destination side, such as business parks, education campuses, or tourist attractions. One should carefully look where a hub with a destination function would be promising.
- It requires different user profiles than those from the Whize segmentation. For each type of destination a classification could be made of user profiles which travel to that destination. Next, for each user profile it can be determined which transport modes and services would be promising to place at each destination hub.

8.4.2 Recommendations for policymakers

This thesis has shown that the Neighbourhood Hub Design Approach is able to successfully determine the most preferred locations and amenities of neighbourhood hubs. Before using the step sequence results, policymakers should have a clear definition of the 'neighbourhood hub' which looks further than the mobility aspects, and point out the policy objectives to which neighbourhood hubs should contribute. In the end, policy objectives determine how the results from the step sequence are used. It was also found that a clear formulation of policy objectives is lacking in existing policy documents. Therefore, it is recommendable for Dutch authorities to develop such policy plans and policy goals. They do not have to reinvent the wheel – there is already plenty of experience with hub-related policies in other countries (e.g. partners from SHARE-North). Moreover the key policy objectives from this thesis could provide a lead.

Furthermore, if authorities would like to develop a neighbourhood hub in a certain area, it is important that policymakers engage the people living in that neighbourhood during the development process. The Neighbourhood Hub Design Approach used predefined user profiles, and their needs for amenities were based on focus groups and literature. Therefore, the Design Approach provides a first indication of promising amenities to offer at a hub location, but in the end, it is important to consider opinions of people that are actually going to use neighbourhood hubs. So determine if there is actually demand for neighbourhood hubs, and if so, what should be offered at each hub location.

It is recommendable that policymakers consider the dynamic characteristic of a neighbourhood hub. Applying the step sequence only once like the author has done for the Almere case study, provides the most preferred neighbourhood hub locations and amenities for a single moment in time. But, the locations of anchor points, services, or transport modes could change over time, as mentioned in the case study part of the discussion. It is recommendable that once authorities start to implement neighbourhood hubs, they monitor user profiles and the actual use of facilities over time. Also, re-run the step sequence on a regular basis (e.g. yearly) to gather the most up-to-date results and see if this results in significant changes.

Next, the clustering function of hubs is only able to operate to its full potential, if services are really located near each other. This principle of clustering is also applied by Bremen when developing hubs, and it may even require the replacement of existing amenity locations. However, a possible limiting factor to realize this is the availability of space. The city of Bremen shows an interesting example of location choice, as the municipality has deliberately chosen to place a neighbourhood hub ~150 meter from a tram stop. This was done simply because there was no other space available. Thus, clustering of services is recommendable, but policymakers should determine if there is also space available to do that.

Also, even if the Neighbourhood Hub Design Approach would be able to perfectly locate neighbourhood hubs and determine the ideal set of amenities at each hub location, this does not imply that all people will actually use the hubs. According the theory from Fogg (2009), a trigger is required to move people to action. These triggers can be embodied in for example texts, videos, or graphics. Moreover it could be a signal to indicate when certain behaviour is appropriate (compare it with a traffic light). It is recommendable that policymakers actively stimulate the use of neighbourhood hubs if these would be implemented in their city.

Finally, this thesis has really focused on pull factors, as the Neighbourhood Hub Design Approach aims to place neighbourhood hubs at logical locations, and determine the amenities that should be offered in accordance with the needs of residents. But besides making neighbourhood hubs as attractive as possible, authorities could also introduce push factors to make it less attractive to own a private car, and thus save space for other functions. One could think of car-free zones, higher parking pricing, and other regulations.

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Appendix A. Scientific Paper

Exploring the influence of users on locations and amenities for neighbourhood hubs

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Keywords: Mobility hubs, neighbourhood hubs, user profiles, locations, amenities

Abstract: Nowadays, many cities and regions are dealing with increasing levels of urbanization due to population and economic growth, demanding for more urban densification through urban developments. It requires space to realize these development projects, build infrastructure to allow for growing mobility demand, and at them same time improve liveability, sustainability, health, and social equity. This demands for mobility solutions use urban space more efficiently while maintaining and improving accessibility. A grid of neighbourhood hubs could contribute to a better use of space, which requires users to actually adopt the amenities offered at these hubs . However, in existing research it is unknown how the locations and amenities of hubs could be aligned with the needs of users. This paper addresses this gap by researching the influence of users on locations and amenities for neighbourhood hubs. Users are merged into user profiles using the Whize segmentation. Subsequently, a literature study and focus groups with Dutch and foreign hub experts have been used as methods for this research. From the results it can be learned that any user profile can be incentivized to use neighbourhood hubs, if they have the right motivations. Still, from an adoption perspective it is most preferrable to develop neighbourhood hubs in areas with a high share of the Young & Hopeful and Average Joes & Janes user profiles. Besides, the presence of user profiles influences which amenities should be offered at each neighbourhood hub, for example, Young & Hopeful and Average Joes & Janes are also the main target groups for shared mobility. Future research could build on this paper by empirically researching the needs of user profiles and the potential effects from placing certain amenities at hubs.

1. Introduction

Cities and regions are dealing with increased levels of urbanization due to population and economic growth, demanding for more urban densification (Wang et al., 2019). It requires space to realize the development projects. Moreover, the addition and/or expansion of functions is often accompanied with a higher mobility demand. Infrastructure allowing for growing mobility flows also occupies space. At the same time, goals such as liveability, sustainability, health, and social equity are becoming increasingly important for cities (Valcárcel-Aguiar et al., 2018; UNSD, 2020). All of the above demands for mobility solutions to use urban space more efficiently while maintaining and improving accessibility (CoMoUK, 2019; KiM, 2021).

Mobility hubs have received attention in a number of recent studies (Bösehans et al., 2021; Coenegrachts et al., 2021; Franken, 2021; Van Gerrevink, 2021; Van Marsbergen et al., 2022). According to Advier, a grid of mobility hubs could contribute to a better use of space dominated by inefficiently used private vehicles. A mobility hub is a recognizable place which integrates a range of transport modes (e.g. car-sharing, bike-sharing), and shared services (e.g. postal lockers, neighbourhood library). These hubs occur in different sizes, varying from larger hubs like train stations, to neighbourhood hubs which serve the needs of people on a local level. Through clustering of different amenities, mobility hubs can organize them in a more efficient way. This could potentially lead to less required infrastructure, connect different amenities with each other, and increase the attractiveness and recognizability of shared mobility alternatives. Furthermore, according to Coenegrachts et al. (2021) and CoMoUK (2019), a grid of mobility hubs in combination with shared mobility could lower the car-dependency, subsequently lowering the required number of parking spaces in an area.

A grid of mobility hubs can only contribute to a better use of space if amenities at these hubs are actually used by people. This seems obvious, however authorities and consultancy agencies lack knowledge about users of mobility hubs. Moreover, existing literature on locations and amenities of hubs has not incorporated users as of yet. While a few studies researched typical users of mobility hubs, the influence of users on hub locations and offered amenities at each hub location remains unknown (Bösehans et al., 2021; Claasen, 2020; Van Rooij, 2020). Moreover, it can be observed that studies focusing specifically on locations of mobility hubs mainly consider larger scale mobility hubs, rather than the smaller scale neighbourhood hubs (Blad, 2021; Martinez & Rakha , 2017; Petrović et al., 2019). Also, none of the existing literature has researched which amenities should be placed at each hub.

This paper aims to be a first in-depth exploration into the role of users in determining the most preferred locations and amenities of neighbourhood hubs. Therefore, the main

objective is to research what is the influence of users on locations of neighbourhood hubs, and the required amenities at each hub. This research will approach this objective from a user perspective, which implies that hub locations and amenities should be determined in such a way, that people are more likely to use them.

For practical reasons this paper merges individual users into user profiles. Because user profiles exists of people who are hard to quantify, two qualitative methods are applied for this research.

The first method are *focus groups* with hub experts. Focus groups allows for interaction between focus group attendees. This paper is the first to explore the influence of users on preferred neighbourhood hub amenities and locations. Therefore, it is assumed that attendees do not have any prior experience with this and probably do not have fully developed perspectives about it. The attendees of focus groups can be influenced by the arguments of others while developing their own perspectives (Kitzinger, 1994). Moreover, focus groups can give insights in the motivations and extent of agreement or disagreement between the experts (Morgan, 1996). A disadvantage of focus groups is that, given the number attendees, there is in most cases not sufficient time to allow every attendee to give their full perspective on each topic. Still, the author considers the interaction between experts crucial due to the novelty of using user profiles.

The second method is a *literature study*. Literature on the influence of users of hubs locations and amenities at hubs is non-existent. But, we can consider literature about typical users for neighbourhood hubs in general, and other scientific studies about typical users for each individual amenity. Besides, the literature study could help to determine what types of users have the highest probability to use neighbourhood hubs, which influences locations that should be prioritized. Moreover, knowledge from the literature study can be used to properly design the discussion guide for the focus groups.

After this introduction, the remainder of this paper is organized as follows. Section 2 explains the most important theoretical underpinnings for considering the influence of user profiles, reviews existing literature about methods to define user profiles, and reviews literature on typical users of neighbourhood hubs and the individual amenities. The methodology of the focus groups is detailed in section 3, followed by the findings and a comparison to literature in section 4. Section 5 provides conclusions and contributions of this research, after which section 6 lists the main recommendations for future research.

2. Literature

2.1 Fogg Behaviour Model

This research incorporates the influence of user profiles to determine hub amenities and locations in such a way, that people are more likely to use them. The Fogg Behaviour Model (FBM) by Fogg (2009) is considered to provide a theoretical underpinning for this. In scientific literature, there are only a few mobility related studies in which the FBM has been used (Slavenburg, 2018; Van Gent et al., 2019). But, the author considers it as a suitable model to explain behaviour change in a very practical way. According to Fogg (2009), it is especially relevant to use the FBM when designing or studying so-called persuasive technologies. In this paper, we would like to persuade people to use neighbourhood hubs, by aligning the locations and amenities with their needs.

The FBM has two axes where the *motivation* has been placed on the vertical axis and *ability* has been placed on the horizontal axis (see figure 1 on the next page). Besides, it shows the blue Action Line – this is the behaviour activation threshold. The motivation and ability must be at such a level, that the combination of both results in a point above the Action Line. The curved shape of the Action Line shows that there is a trade-off between motivation and ability. A person could have very low motivation to use shared cars, but if it is very easy, the person could still be willing to use them. The motivation of someone is determine by three core motivators, each having two sides: Pleasure / Pain, Hope / Fear, and Social Acceptance / Rejection. Hope / Fear is often anticipated as it considers the consequences from behaviour, while Pleasure / Pain is a response on what is happening at the moment itself. Next, ability is referred to as 'simplicity' by Fogg (2009). Making things easier or simpler to do increases the probability that someone performs behaviour. Fogg defines six elements of simplicity: Time, Money, Physical Effort, Brain Cycles, Social Deviance, and Non-Routine. Each person has a different simplicity profile. Ultimately, simplicity is a function of someone's scarcest resource, which can be addressed by reducing the barriers to perform behaviour. Finally, the motivation and ability of someone could be very high, but behaviour only occurs if there is a trigger. A trigger could occur in different forms, such as a message, a graphic, or sound.

The influence of user profiles is mainly captured in the motivation part of the FBM. For example, if a user profile is willing to use shared mobility, this could be offered at a hub. Next, users can anticipate on using these transport modes for their trips. So, by addressing the needs of users and aligning the offered amenities at a hub with those needs, it is assumed that people are more likely to use an amenity from a hub. Likewise, offering hubs near user profiles who are willing to use neighbourhood hubs could increase the motivation of those user profiles to actually use hubs. The involvement of user profiles could also be related to ability, because each user has a different simplicity profile. However, most elements of simplicity are very person-specific so hard to incorporate into user profiles.

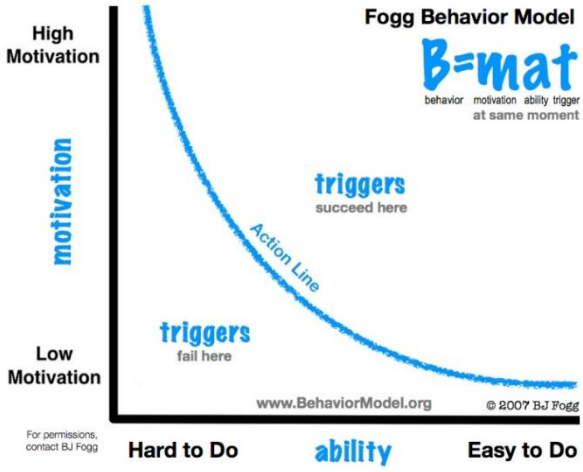

Figure 1 – Fogg Behaviour Model (Fogg, 2007).

2.2 Existing methods to define user profiles

Different methods could be used to gather data and subsequently create user profiles. The following briefly goes through a number of these methods. In science, an often applied method for data gathering is a survey. This could be a survey which was held separately from the scientific study (Shelat et al., 2018), or a survey which was held specifically for that study (Alonso-González et al., 2020; Bösehans et al., 2021; Winter et al.,2020). Methods to cluster data into user profiles vary from a latent class cluster analysis (Alonso-González et al., 2020; Molin et al., 2016; Shelat et al., 2018) to a nested logit model with latent classes (Winter et al., 2020), to a combination of Ward's method with the k-means clustering procedure (Bösehans et al., 2021). In the end, the goal of all clustering methods is to obtain a set of homogeneous groups.

Besides, this paper covers two methods which are primarily meant for commercial purposes. These methods also use clustering techniques to create user profiles out of data, but the data itself is usually collected in a less scientific way. The Mentality-model from Motivation BV (2019) classifies the Dutch population into eight classes based on their values and lifestyle. For each class, the Mentality-model provides a brief description of their ambitions, societal, and political perspectives, the role of work, lifestyle, social relationships, and socio-demographics.

The other method is the Whize segmentation model by WHOOZ BV (2019). The Whize segmentation classifies 7.8 million Dutch households into 59 segments, which are subsequently merged into 11 main segments. Figure 2 shows these segments in an age-prosperity spectrum. This classification uses a database which has been collected for over 30 years with over 2,000 user characteristics. For every segment, Whize distinguishes five categories of characteristics: demographic characteristics, living environment, lifestyle, media, and mentality.

The Whize segmentation has been found most suitable to use in this paper, and there are a number of reasons for this. To be able to properly substantiate why the Whize segmentation model is the most suitable method to create user profiles, Minze Walvius from Advier has been interviewed by the author.

First, the underlying database of the Whize segmentation model is more extensive compared to databases used by scientific studies. The Whize segmentation uses a combination of open data sources and commercial data sources. Open data sources are accessible by everyone, while commercial data sources include data for which you have to pay to gain access. WHOOZ BV is especially interested in online consumer behaviour data, which is predominantly commercial data. Second, the Whize segmentation model has been based on clustering techniques using statistical analysis, like the methods used in scientific research so in this regard the methods are similar. Third, the Whize segmentation model describes the segments as personas. While user profiles in scientific research are often combinations of data ranges, the Whize segmentation model takes a step further by describing the segments as personas. Personas are considered useful for this paper, as during the focus group they help to efficiently explain the Whize segments to the focus group attendees (see section 3). The reason why the Whize segmentation model is preferred over the other commercial method, the Mentality-model from Motivaction, is related to the availability of information on segments. The openly available brochure from Whize segmentation does contain information on demographic characteristics, living environment, lifestyle, media, and mentality, while the brochure of the Mentality-model does not.

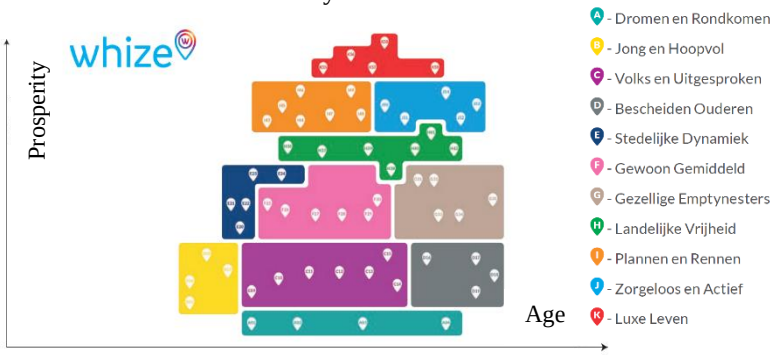

Figure 2 – Age-prosperity spectrum (WHOOZ BV, 2019).

2.3 Existing literature overview about typical users

Literature focusing specifically on potential users for hubs in general is scarce, which was also stated by Van Rooij (2020) and Bösehans et al. (2021). Still, four references could be found by the author (Bösehans et al., 2021; Claasen, 2020; Knippenberg, 2019; Van Rooij, 2020). In general, these studies agree on the characteristics of hub users. People who are most likely to use neighbourhood hubs seem to be among younger age groups, highly educated, have a certain level of disposable income, and live in urban areas (often in or near city centers). Typical households are often singles or families with younger children. Besides, it was found in existing literature that sustainability is one of their priorities and they often travel with sustainable travel modes. Ownership of private vehicles is also lower than the average.

Interestingly, existing literature on users of shared mobility identifies comparable user characteristics as the aforementioned studies about hub users (Aguilera-Garcia et al., 2021; Arendsen, 2019; Becker et al., 2017; Becker & Rudolf, 2018; Burghard & Dütschke, 2018; Eccarius & Lu, 2020; Fishman, 2015; Mitra & Hess, 2021; Münzel et al., 2019; Van Marsbergen et al., 2022; Winter et al., 2020). A similar picture is sketched by literature on public transport users (Molin et al., 2016; Ton et al., 2019). To a certain extent, the similarities between user group characteristics of hubs and transport modes make sense, as hubs are often associated with shared mobility and public transport, such as in the studies from Bösehans et al. (2021) and Claasen (2020). On the other hand, some studies also state that there are no fixed types of hub users and that there could be adopters in every user group (Bösehans et al., 2021; Van Rooij, 2020). Even though there are indeed some user groups that have a higher probability, hubs should be tailored to all residents within a neighbourhood.

For most shared services, literature is limited to non-existent. So, this part of the literature review considers scientific literature about sharing among community members. Overall little is known about user characteristics related to sharing. Meanwhile, scientific literature seems to agree that regardless of the socio-demographics, sharing scheme users tend to be environmentally conscious, economically motivated, and/or socially motivated (Akin et al., 2021; Böcker & Meelen, 2016; Edbring et al., 2016). For example, younger people could be willing to share because they are often environmentally conscious, elderly could be socially motivated, and lower income households could be economically and socially motivated (Akin et al., 2021; Böcker & Meelen, 2016). This implies that all types of people could be users of shared services, but the motivation differs among user groups.

3. Methodology

This section describes the methodology of the focus groups. The first part of this section points out how the focus groups have been designed. This is followed by an explanation about data collection and analysis.

3.1 Design of focus groups

3.1.1 Pilot

Before conducting the focus groups, the draft scenario was tested in a pilot session internally at Advier. Doing the pilot was considered essential by the author, as significant changes were made to the contents and timing of the draft scenario. Overall, the feedback could be summarized in three main points:

1. During the pilot, a typical day in the life of each persona was presented with time stamps and mode choice for each trip. The participants found that this limits their imagination. Therefore, each persona was explained by only showing the characteristics during the focus groups.
2. The question whether a user profile would use neighbourhood hubs was formulated as a binary question in the draft scenario. Instead, during the official focus groups a probability range was used so experts could bring more nuance to their answers.
3. During the pilot focus group, the discussion part was only held at the end of the session after successively going through all personas and corresponding questions. The pilot participants found this too repetitive. Thus, during the official focus groups there was time to discuss after each single user profile.

3.1.2 Scenario

The focus groups were held online using Microsoft Teams. During the introduction, the author of this paper presented the purpose of the paper and focus group, so the experts were able to adequately participate in the substantive part of the focus group. In agreement with Advier, five user profiles have been selected to consider for the focus groups: Young & Hopeful (Jong & Hoopvol), Friendly Emptynesters (Gezellige Emptynesters), Working Class (Volks & Uitgesproken), Average Joes & Janes (Gewoon Gemiddeld), and Planning & Rushing (Plannen & Rennen). For each of these five user profiles the same procedure was followed. First the author gave a general description of the user profile, and presented the persona. Each presented persona is in accordance with the description provided by the Whize segments, and translated into a presentable format for the focus groups by using persona templates and expert judgement from Advier. Next, the moderator asked the focus group participants to image how the activity pattern of the presented persona would look like, followed by the questions (3) and (4) from the discussion guide (see table 2).

The software that was used to ask the questions is called the 'Polls' function which is integrated with Microsoft Teams. All three questions that were asked for each user profile were multiple choice type questions. For question (3) the participants were able to select multiple options. The set of shared services and transport modes was created based on existing hub design guidelines from SHARE-North (n.d.).

Table 1 – Selection of considered amenities.

Transport modes	**Services**
Shared cars	Charging infrastructure for private/shared vehicles
Shared vans	Bicycle parking
Public transport	Bicycle repair stand
Demand-responsive transport	Postal lockers
Taxi	Kiosk
Shared bikes	Neighbourhood library
Shared cargo bikes	Playground
Pushchairs	Sports equipment
Shared scooters	ATM
Shared mopeds	Storage lockers
Trailer	Co-working space

For question (4), the participants were able to only select one option. For this probability question, a Likert-type scale has been used ranging from 'very low' to 'very high'.

Table 2 – Discussion guide for focus groups.

Minutes	Round	Topics	Questions
10	Intro	**Introduction**: introductory round (name & organization), thesis and focus group purpose, programme	*1. Could you place tell me your name and organization you represent?* *2. Does everyone feel comfortable with us recording the audio of this session?*
45 (5*9)	User profiles	For each of the five user profiles: • **Introduce the persona** with its socio-demographics and lifestyle; • **Transport modes and services** that should be offered at hubs for the persona; • **Probability** that the persona will use hubs; **Discussion** on poll results from question (3) and (4) – general questions **User profile-specific questions** Young & Hopeful Friendly Emptynesters Folksy & Outspoken Average Joes & Janes Planning & Rushing	*Try to image the activity pattern of this persona,* *3. What are the most suitable shared services and transport modes for the profile [user profile] that should be offered at hubs (if implemented properly)? [Multiple choice with Forms]* *Given that these transport modes and services are offered at mobility hubs,* *4. What is according to you the probability of the profile [user profile] actually using hubs? [Multiple choice with Forms]* *Depending on the answers provided to question (3) and (4):* *5. Why do you think it is very likely/unlikely that this persona will use mobility hubs?* *6. Why do you have a neutral perspective on this persona using mobility hubs?* *7. Why did you choose transport mode/service X for this persona?* *8. To what extent would the set of suitable transport modes and services change if the persona would not study but work a full-time job instead?* *9. Do you think the set of suitable transport modes and services would be different for regular trips compared to irregular trips? (this user profile does not have to commute on a daily basis)* *10. To what extent would your answers differ if this persona would have higher income?* *11. To what extent would the set of suitable transport mode and services differ if the children would be older and able to travel to their activities themselves?* *12. To what extent does the shift to working-from-home influence the set of suitable transport modes and services? And the probability of this persona using mobility hubs?*
5	Ending	**Processing the focus group data and final remarks**	*13. Do you have any important questions or remarks to make regarding this session?*

After all participants submitted their answers for the three questions, there was time to discuss the poll results and elaborate on certain responses if required.

3.1.3 Number and composition of focus groups

Focus groups typically consist of 6 to 10 participants, but the ideal number of participants depends on the context of the research design (Morgan, 1996). The sample size should promote discussion and at the same time enable the moderator to keep the group on the task Nagle & Williams (2013). According to Morgan (1996), discussions may flow more smoothly in focus groups with a homogeneous composition. Besides, differences between participants are equally important. It encourages them to re-think their point-of-view, which could enrich the discussion (Kitzinger, 1994).

Regarding the number of focus groups, two have been conducted for this research to include both the perspective from the Netherlands and other European countries. The Dutch focus group has been held because this paper focuses on a Dutch urban environment. The foreign focus group is conducted because foreign countries, i.e. SHARE-North partners, are perceived to have greater experience with the design and planning of mobility hubs.

3.1.4 Sampling and recruitment of focus group attendees

This study has utilized the internal network of Advier to recruit the focus group participants. 14 December 2021, 11:00-12:00 had been selected for the Dutch focus group, and 15 December 2021,14:00-15:00 for the foreign focus group. An invitation has been sent to all participants who are available on the predefined dates. Finally, the Dutch focus group sample consisted of 11 participants, while the foreign focus group sample consisted of 5 participants (see table 3).

Table 3 – Focus groups attendees.

Dutch focus group participants	Foreign focus group participants
KiM (Dutch knowledge institution for mobility)	Mpact
Deloitte	SEStran
TNO	Autodelen.net
NS (Dutch Railways)	Municipality of Bergen, Norway
Gemeente Amsterdam	Advier
Gemeente Utrecht	
Gemeente Zwolle	
Provincie Gelderland	
Vervoerregio Amsterdam	
UT (University of Twente)	
RUG (Groningen University)	

3.2 Data collection

The official Dutch focus group has been conducted in Dutch and the foreign focus group has been conducted in English to allow all participants to comfortably give their opinions. Both sessions lasted 60 minutes, including the introduction, substantive part, and ending.

One of the thesis supervisors from Advier was the moderator of both focus groups, while the author took notes. The moderator is experienced in supervising sessions with different stakeholders. Moreover, knowledge about the topic of mobility hubs was required to adequately moderate the focus groups.

3.3 Data analysis

The author of this paper has transcribed all verbal data from the discussion parts. Non-verbalism statements such as nodding one's head have not been transcribed, as requiring a video camera during the session could have made the participants feel uncomfortable. The verbal data has been systematically analysed using the content analysis principles as described by Elo & Kyngäs (2008). This paper uses an inductive content analysis approach to conduct and analyse the focus groups without any a priori theoretical assumptions, because personas have never been applied in this context before.

The main findings from the discussion were summarized in bullets, assigned to the five user profiles, and sent to all focus group participants via e-mail. In this way, all participants were given the opportunity to verify the findings and make suggestions for adjustments if required. Ultimately, the focus group has provided two types of 'products':

- Tables with suitable amenities for each of the five considered user profiles, and the probability that a user profile actually uses neighbourhood hubs;
- Insights from the discussion part;

4. Findings

The first three parts of this section show the poll results from the focus groups and clarify these, using input from the discussions. The fourth part compares the focus group results with findings from section 2.3.

4.1 Probability that a user profile uses a neighbourhood hub

Table 4 shows the combined focus group poll results from the question *"What is according to you the probability of the profile [user profile] actually using hubs?".*

Experts think that the Young & Hopeful user profile is (very) likely to actually use neighbourhood hubs. This really depends on the activity pattern and mode choice. Moreover, experts think that Friendly Emptynesters are less likely to user neighbourhood hubs. During the foreign focus group it was stated that they are less open to new things and services. Like for the Friendly Emptynesters, the experts think that people from Working Class are less likely to user neighbourhood hubs, because the need of this user profile to use hubs is not that big. For the Average Joes & Janes user profile the poll results show that experts are rather positive on the probability that this user profile is actually going to use neighbourhood hubs. The experts think that offering shared services and transport modes at neighbourhood hubs could help this user profile during their daily lives. Also, this user profile probably has the financial resources to afford this. Finally, poll results are quite diffused for the user profile Planning & Rushing. On average experts tend to be neutral.

4.2 Preferred transport modes per user profile

Table 5 shows the combined focus group poll results from the question *"What are the most suitable transport modes for the profile [user profile] that should be offered at hubs (if implemented properly)?".*

For the user profile Young & Hopeful two transport modes really stand out: public transport (100% of the combined votes) and shared bikes (87% of the combined votes). During both the foreign and Dutch focus groups it was stated that this persona will probably keep using the private bicycle and public transport from a financial standpoint. In general it can be concluded that the persona is open to shared mobility, because this target group is used to the service economy, and is likely to adopt concepts such as bike-sharing and scooter-sharing fairly quickly. For the user profile Friendly Emptynesters, it was stated that for long-distance trips, using public transport might be a good alternative. The same could be said for demand-responsive transport. So the transport modes are perceived to complement the persona's own vehicles for certain types of trips. Regarding the Working Class user profile, the experts thought that this group is less likely to use transport modes at neighbourhood hubs due to status and unfamiliarity of concepts offered at neighbourhood hub. During the foreign focus group it was mentioned that this user profile is not likely to pay some extra for having access to shared cars, mopeds, or bikes besides having their own private vehicles, as they sometimes struggle paying their bills. Moreover, people from Working Class are susceptible for out-of-pocket expenses and they make less rational financial choices. For the Average Joes & Janes user profile, shared cars, public transport, shared cargo bikes, and trailers are mainly found as promising transport modes. During the Dutch focus groups it was stated that shared cars could be useful for less frequent trips, and an incentive not to buy a second car. Also, experts from the foreign focus group thought that shared mobility at a neighbourhood hub offers additional mobility alternatives besides the private car and bikes. According to the foreign focus group, the user profile Planning & Rushing is a harder target group for shared mobility and public transport, because they have the luxury of owning two cars which can be used whenever they want. Experts from both focus groups stated that for this user profile, transport modes should be offered that really add value to what they already possess.

Table 4 – Poll question results on probability of actually using hubs.

Percentage of total responses	Young & Hopeful	Friendly Emptynesters	Working Class	Average Joes & Janes	Planning & Rushing
Very low	7%	33%	31%	0%	0%
Low	0%	27%	38%	7%	20%
Neutral	7%	27%	25%	33%	40%
High	73%	13%	6%	53%	40%
Very high	13%	0%	0%	7%	0%

Table 5 – Poll questions results on transport modes.

Percentage of total responses **Transport modes**	Young & Hopeful	Friendly Emptynesters	Working Class	Average Joes & Janes	Planning & Rushing
Shared cars	7%	21%	20%	69%	47%
Shared vans	0%	14%	60%	38%	33%
Public transport	100%	57%	47%	88%	27%
Demand-responsive transport	27%	50%	20%	13%	20%
Taxi	13%	29%	7%	0%	60%
Shared bikes	87%	7%	13%	19%	7%
Shared cargo bikes	47%	7%	13%	88%	60%
Pushchairs	0%	14%	0%	13%	0%
Shared scooters	47%	0%	20%	0%	40%
Shared mopeds	60%	7%	27%	6%	60%
Trailer	0%	36%	67%	69%	40%

Table 6 – Poll question results on shared services.

Percentage of total responses **Shared services**	Young & Hopeful	Friendly Emptynesters	Working Class	Average Joes & Janes	Planning & Rushing
Charging infrastructure for private/shared vehicles	0%	40%	7%	56%	67%
Bicycle parking	87%	60%	20%	50%	47%
Bicycle repair stand	93%	53%	7%	56%	60%
Postal lockers	80%	33%	40%	88%	93%
Kiosk	67%	40%	40%	19%	40%
Neighbourhood library	53%	87%	33%	94%	20%
Playground	0%	40%	7%	88%	13%
Sports equipment	53%	7%	20%	63%	73%
ATM	27%	60%	53%	19%	27%
Storage lockers	20%	0%	13%	19%	20%
Co-working space	33%	0%	0%	25%	60%

4.3 Preferred shared services per user profile

Table 6 shows the combined focus group poll results from the question *"What are the most suitable shared services for the profile [user profile] that should be offered at hubs (if implemented properly)?"*.

As shown in table 6, poll results on the suitable shared services were quite diffused. This might be caused by how the personas were explained during the focus group, and how the experts had perceived the activity pattern of the personas. Experts associated certain needs or activities with personas based on their own judgement. During the foreign focus group it was mentioned for Friendly Emptynesters that shared services such as a playground (for the grandchildren), neighbourhood library, and postal lockers could be triggers to use neighbourhood hubs. These activities were not all explained by the author during the persona presentation. Besides, the number of activities during the day could influence the range of promising services at a hub.

Another important finding is that during the Dutch focus group it was mentioned that for Working Class, social facilities (such as a community center) could be promising. It seems opportune to include 'social facility' as an additional shared service for this user profile, but also Friendly Emptynesters. For the Average Joes & Janes user profile, experts thought that additional shared services could be useful every now and then. Finally, for Planning & Rushing, experts stated the same, but they stressed that the offered services should allow this user profile to show off their image.

4.4 Comparing focus group results with literature

For each of the three previous sections, results can be compared with the findings from literature (see section 2.3.). Experts gave Young & Hopeful and Average Joes & Janes the highest probabilities of using neighbourhood hubs compared to other user profiles. This corresponds with the findings from the literature review. Existing literature shows that the user groups which are most likely to use neighbourhood hubs, are often younger households, single or a couple with children, highly

educated, living in urban areas, and other characteristics mentioned in section 2.3. For the other user profiles Friendly Emptynesters, Working Class, and Planning & Rushing, experts attach a neutral or lower probability of using neighbourhood hubs. But, from the focus group discussion it appeared that you should not exclude these user profiles. This resonates with the studies from Van Rooij (2020) and Bösehans et al. (2021). For example elderly people (belong to the Friendly Emptynesters user profile) could be a target group given the right motivation.

Next, the findings for transport modes are compared. The focus groups poll results and discussion show that overall the user profile Young & Hopeful is likely to use shared mobility. In scientific literature it was also found that these people are likely to use shared mobility. Moreover, public transport was found a very promising transport mode for Young & Hopeful by both the focus groups and scientific literature. For Average Joes & Janes focus group poll results indicate that shared cars, public transport, shared cargo bikes, and trailers are most promising transport modes. Scientific literature states also agrees that this user profile is willing to use shared mobility and public transport. Shared cargo bikes were mentioned explicitly by Claasen (2020) for households with younger children. Experts stated that shared mobility could be opportune for Planning & Rushing, but it should enable these people to distinguish themselves from others, and add value to what they already possess. Moreover, Planning & Rushing are households with relatively higher income and education levels, which corresponds to scientific literature on shared mobility. The user profile Friendly Emptynesters is less willing to use shared mobility according to the focus group experts. The focus group poll and discussion indicate that public transport and DRT are the most suitable transport modes for Friendly Emptynesters. Scientific literature states that target groups for DRT are elderly people with a relatively lower level of income/education, and a lower fitness level or even a disability. However, it also states that especially younger people are more likely to use public transport on a daily basis. Finally, for the Working Class user profile, experts think that this group is less likely to use transport modes at neighbourhood hubs due to status and unfamiliarity of concepts. Literature also indicates that people from this group are not the main target group for shared mobility.

Overall, the results from literature and focus groups are very comparable for the probability that a user profile will use neighbourhood hubs and transport modes. This comparison is harder to do for the individual shared services, as literature for this is limited to non-existent. But, there are some overall conclusions. From the focus groups it could be concluded that one could convince every user group to use shared services. Providing those shared services that correspond with the needs of users could incentivize anyone to use shared services. This aligns with the findings from scientific literature that willingness to share services is determined by motivations of people rather than specific socio-demographics. Recall from the Fogg Behaviour Model that motivations (together with ability and triggers) influence whether behaviour will occur. It is therefore advisable that the shared services from table 6 should be preferred to address each user profiles' needs.

5. Conclusion

The hub concept is becoming more and more popular in practice and science. It is perceived to be a means which contributes to different goals, such as reducing the required infrastructure in cities, connecting different amenities with each other, and creating attractive and recognizable places. Hubs can only contribute to these goals if they are adopted by users, which is why there is a need for knowledge about hub users. This study provides a first in-depth exploration into the influence of user profiles on the locations and amenities for smaller scale mobility hubs (i.e. neighbourhood hubs). Focus groups and literature are used as methods to research how the amenities and locations of hubs could be adjusted to the needs from residents.

From the results it can be learned that any user profile can be incentivized to use neighbourhood hubs, if they have the right motivations. This contests most of the reviewed literature which states that hubs and shared mobility are mainly for younger people, with a higher income and education level, sustainable mindset, experience with sustainable modes and low private vehicle ownership. Motivations can differ among user profiles, for example younger people could be environmentally motivated, while older people could be more socially motivated to use neighbourhood hubs. This corresponds with the Fogg Behaviour Model which states that motivations (together with ability and triggers) influence whether behaviour will occur.

Still, it was found that user profiles could influence which locations should be prioritized. From the results it can be learned that from an adoption perspective it is most preferrable to develop neighbourhood hubs in areas with a high share of the Young & Hopeful and Average Joes & Janes user profiles. Moreover, user profiles' needs influence the range of amenities that should be offered at a neighbourhood hub – offering the right range of amenities is required to convince people to use neighbourhood hubs. Focus groups showed that there are differences in needs between different user profiles. In this way, the presence of user profiles influences which amenities should be offered at each neighbourhood hub. Results indicate that Young & Hopeful and Average Joes & Janes are the main target groups for shared mobility. Also the user profile Planning & Rushing could be a target group, but only if the offered shared modes add value to what they already possess.

6. Recommendations

This papers provided new insights into how the locations and amenities of neighbourhood hubs could be influenced by user profiles. Following these results, there are a number of recommendations for future studies.

A first direction to pursue in future studies is to gain more insights into users of neighbourhood hubs. The user profiles for this research were based on the existing Whize segmentation. A next step could be to identify a study area (i.e. one or multiple neighbourhoods), and empirically classify residents from that area into area-specific user profiles. This could be done by using data from Whize that is available, but also via a stated choice experiment like Winter at al. (2020) did. A major disadvantage from the Whize segmentation is that the exact clustering techniques behind the Whize segmentation model are not known. Also, data underlying to the Whize segmentation is not available for this paper. To gain access, one has to get a licence from WHOOZ BV, however this is not an option for this paper due to cost constraints. Therefore, It could be interesting to use a stated choice experiment to create area-specific user profiles and compare them with the user profiles from the Whize segmentation. It is very probable that area-specific user profiles give a more valid representation of people living in the area, thus also more fitting personas. And if the characteristics of personas change, this could lead to different focus group results.

In addition, it could be interesting to research dynamic user profiles, i.e. taking into consideration age categories, generations, and how user profiles influence each other. People from Young & Hopeful will eventually go to other user profiles as they grow older, but how this works exactly remains unknown. It is known that future behaviour can be influenced with current measures. Because neighbourhood hubs are a relatively new development in the Netherlands, hubs are built for current but also future users. Creating scenarios of future user profile distributions in an area could be an interesting way to design and plan neighbourhood hubs in a future-proof way.

Next, future research could gather more insights into users by empirically researching what are the needs from user profiles. This paper has taken a theoretical approach by using focus groups and literature. Future empirical research into the needs of users for amenities and hub locations can be combined with the previous recommendations. As such, a stated choice experiment can be used to classify residents from an area into user profiles, and subsequently determine what are the needs for amenities and hubs in general per user profile.

Another way to elaborate on this paper, is to research whether the most preferred amenities for user profiles based on theory are also actually desirable. If the goal is to decrease private car ownership with neighbourhood hubs, the impacts from offering shared modes could differ per user profile. For the user Young & Hopeful, it was concluded that different types of shared mobility are promising. However, is this actually the group to target for shared mobility? They often already use sustainable transport modes, so a higher impact could be reached by focusing on user profiles with two or more cars, such as Planning & Rushing. On the other hand, this does not mean that you should not offer shared mobility for the Young & Hopeful group at all, even though the effects on spatial use might be less significant. Future studies could research what are the effects or benefits from placing certain shared services or transport modes at a neighbourhood hub. This relates to the *option value* from Geurs et al. (2006). By using a stated choice experiment, you could give people a number of amenity combinations at hubs, and determine how the removal or addition of certain amenities influence someone's willingness to use or pay for a service. This mirrors the recommendations from Bösehans et al. (2021) who stated that future research is needed to explore the added value among user profiles from increasing the variety of modes at a hub.

All in all, it is very important to develop neighbourhood hubs with the potential user in mind. This research offers a stepping-stone for future research into this topic. Besides, it is advisable that policymakers who have to implement neighbourhood hubs in their cities also engage residents, and try to tailor each neighbourhood hub as well as possible to those residents.

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Appendix B. Overview methods for user profiles

Different methods have been used in mobility-related literature to create user profiles from a sample of people. The first study from Shelat et al. (2018) specifically focused on the combined bicycle and transit mode. Part of their study was to derive user and trip characteristics to eventually discover prototypical users of this combined bicycle and transit mode in the Netherlands. They used the Dutch national one-day trip survey 'OViN' as a data source as this contains personal, household, and trip characteristics. As in their study one of the aims was to classify mode users in natural groups, the latent class cluster analysis (LCCA) was used as clustering method. This statistical method has a number of advantages. First, it is able to handle categorical as well as numerical characteristics. Moreover, the number of clusters is found based on formal statistical criteria. Eventually, the LCCA tries to find the optimal number of classes, i.e. "*the smallest number of latent classes which can adequately describe the associations between the indicators*" (Molin et al., 2016; Magidson & Vermunt, 2002). So, the least number of user profiles where the covariation between the indicator variables (in the case of Shelat et al. (2018), the socio-demographics) is insignificant. The LCCA from Shelat et al. (2018) resulted in an optimal number of seven clusters, each subjectively provided with a name.

Alonso-González et al. (2020) also used the LCCA model to determine user profiles. Their underlying reason was to identify clusters regarding individual's inclinations to adopt MaaS in the context of urban mobility. Inputs for the LCCA were collected by using a survey among respondents from the Netherlands Mobility Panel, an annual household panel to study travel behaviour in the Netherlands. Applying the LCCA resulted in five clusters with each a different name: 'MaaS-FLEXI-ready individuals', 'Mobility neutrals', 'Technological car-lovers', 'Multimodal public transport supporters', and 'Anti new-mobility individuals'. Another study from Winter et al. (2020) identified potential user classes for shared and automated mobility services. For data gathering they used a stated choice experiment among adults from the four largest Dutch cities (Amsterdam, Rotterdam, The Hague, Utrecht). In contrast to the previous two studies, Winter et al. (2020) used a nested logit model with latent classes, which determined the probability of being a member of a certain class. Three classes were defined: "Brisk Shares", "Public Transport Enthusiasts", and "Car Captives". Finally, the study from Bösehans et al. (2021) defined user groups specifically for shared electric mobility hubs, referred to as eHUBs in their paper. A survey was used to gather data from an adult-population in the municipality of Amsterdam. A Categorical Principal Components Analysis (CATPCA) was used as a method to analyse the attitudinal statements from the respondents. Next, a two-step clustering process was used to define four clusters (existing of Ward's method, followed by a k-means clustering procedure). Additionally, the Diffusion of Innovation (DOI) theory from Rogers (1962) was applied to assign each respondent to one of the four adoption categories ('Early adopters', Early majority', 'Late majority', and 'Laggards').

Outside scientific literature, there are other methods to define user profiles. This thesis covers two methods which are more intended for commercial use: *Mentality-model* from Motication BV (2019) and the *Whize segmentation* from WHOOZ BV (2019). These methods also use clustering techniques to create profiles out of user data, but the data itself is collected in a less scientific way.

Motivaction is a company which has been researching the drivers and motivations on consumer behaviour since 1984, and offers different types of target group analyses. From these different types of analyses, the so-called 'Mentality-model' would be the most suitable analysis method to identify user profiles. It classifies the Dutch population into eight classes based on their values and lifestyle. For each class, the Mentality-model provides a brief description of their ambitions, societal, and political perspectives, the role of work, lifestyle, social relationships, and socio-demographics (Motivaction BV, 2019).

The other method is the Whize segmentation model by WHOOZ. WHOOZ is an organization which has been collecting and aggregating consumer data for over 30 years, and offers a range of services (such as Whize) aimed at other organizations to support them in fact-based marketing (WHOOZ BV, 2019). Whize has been designed to classify 7.8 million Dutch households into 59 segments, which are subsequently merged into 11 main segments. For this classification, a database with over 2,000 user characteristics has been used. The Whize brochure provides an abstract diagram with the 11 segments categorized by age and prosperity. For every segment, Whize distinguishes five categories of characteristics: demographic characteristics, living environment, lifestyle, media, and mentality (see Appendix D). Moreover, the most right-hand column shows the percentage of Dutch households fitting in each user profile.

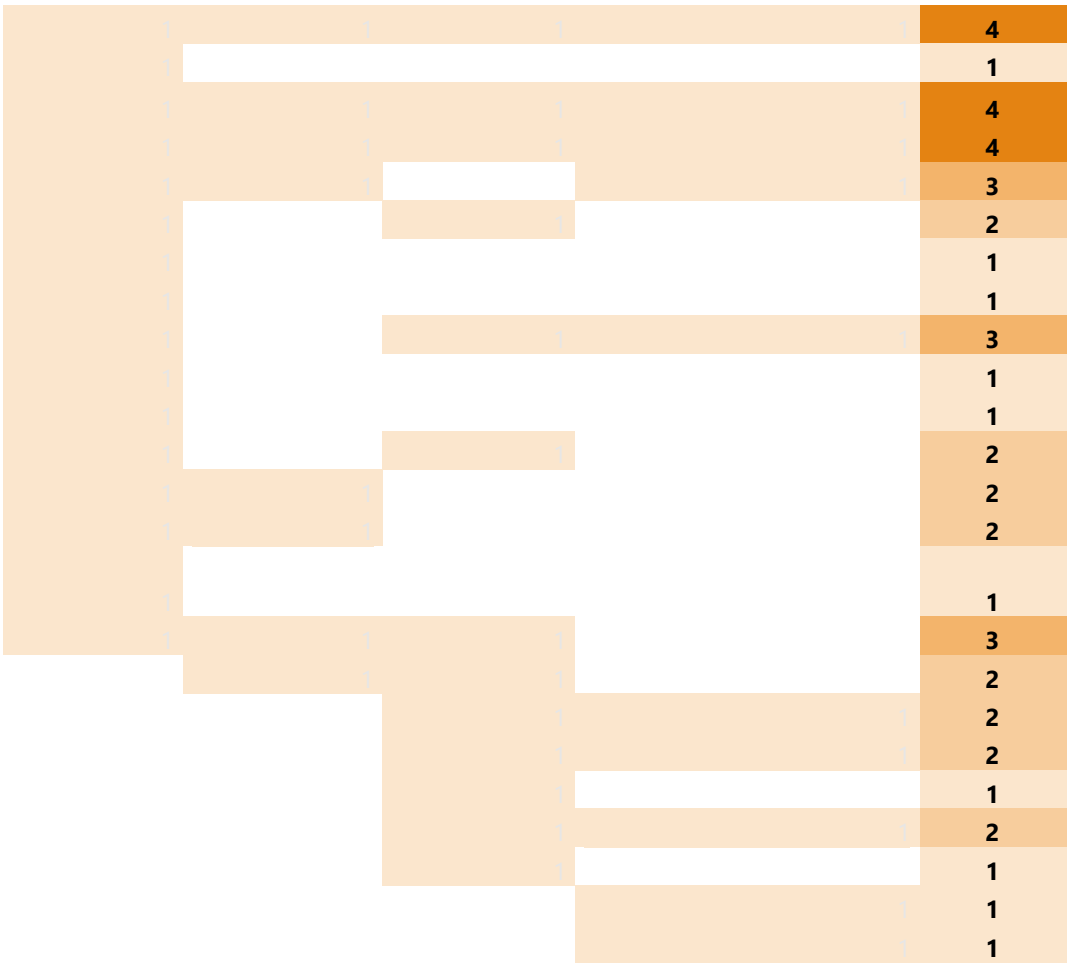
The Whize segmentation can be used for different purposes such as marketing campaigns for new products, but also optimizing location-specific policies (WHOOZ BV, 2019). Especially the latter is interesting as this thesis aims to determine potential mobility hub locations, and shared services and transport modes at these hubs taking into consideration potential users in the surrounding area.

Appendix C. Total overview of amenities from mobility hub guidelines

Transport mode	Advier (2021a)	CoMoUK (2019)	SEStran (2020)	Departement Mobiliteit en Openbare Werken of Flanders (2019)	#Total
Shared cars	1	1	1	1	4
Shared vans	1	1			2
Public transport	1	1	1	1	4
Demand-responsive transport	1	1	1	1	4
Taxi	1	1	1	1	4
Shared (e-)bikes	1	1	1	1	4
Shared cargo bikes	1	1	1	1	4
Carpooling	1				1
Pushchairs	1			1	2
Go-carts	1				1
Shared scooter	1			1	2
Shared mopeds	1			1	2
Segways	1				1
Wheelchairs	1				1
Trailers	1	1			2
Park & Ride			1		1
Kiss & Ride				1	1

Services (mobility related)	Advier (2021a)	CoMoUK (2019)	SEStran (2020)	Departement Mobiliteit en Openbare Werken of Flanders (2019)	#Total
Charging infrastructure for EVs	1	1	1	1	4
Street crossing system	1	1			2
(Un-)loading docks for logistic services	1	1			2
Travel information	1	1	1	1	4
Integration with MaaS platform	1				1
Community-software ('buurtapp')	1				1
Bicycle parking	1	1	1	1	4
Bicycle repair stand		1	1	1	3

Services (non-mobility related)	Advier (2021a)	CoMoUK (2019)	SEStran (2020)	Departement Mobiliteit en Openbare Werken of Flanders (2019)	#Total
Pillar with recognizable logo/signage	1	1	1		3
Postal lockers	1	1	1	1	4
Kiosk	1	1	1	1	4
Water fountain	1			1	2
Waste containers	1				1
Bio digester	1				1


Waiting zone (covered) 4
Letterbox 1
WiFi-hotspot 4
USB-charger 4
Ticketing services 3
Lighting 2
Safety facilities 1
Solar panels 1
Toilets 3
Benches 1
Picknick tables 1
Neighbourhood library 2
Playgrond 2
Sports equipment 2
Location for sharing services / equipments 1
Greenery, grass roofing, planters 3
Community art 2
ATM 2
Storage lockers 2
Vending machines 1
Co-working space 2
CCTV camera's 1
Information desk 1
Restaurant 1

Appendix D. Main features Whize segments

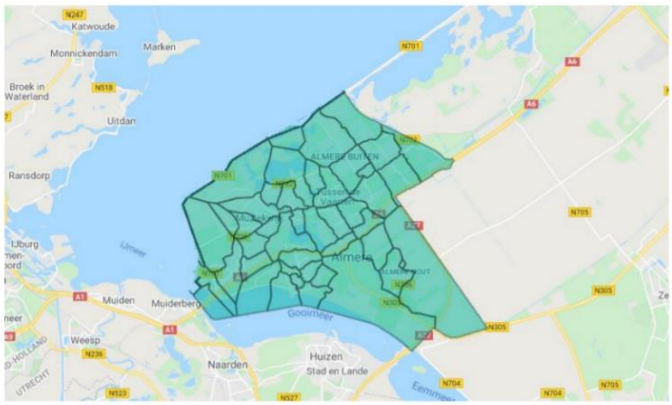
Segments / user profiles	Demographic characteristics	Living environment	Lifestyle	Media	Mentality	
Dromen & Rondkomen	**Age**: between 30 and 50 years old; **Family**: many single-parent families; the age of any children varies a lot; **Education**: vocational education; **Job and salary**: simple function with below average income;	**Location**: urban areas in the middle of cities like Rotterdam and Den Haag; **Liveability**: moderate; **Housing type**: value of houses on average 150,000 EUR. Most people rent simple and small apartments;	**Daily mobility**: low car-ownership, using bus and tram for commuting, walking or moped for groceries; **Holiday**: little budget for travelling; **Recreation**: cinema, sauna, casino;	**Newspaper**: Metro and other free newspapers; **Magazines**: Story, Privé; **Television**: Comedy Central, FOX Sports; **Other**: Snapchat, SLAM!, FunX;	On one hand this group accepts their situation. But on the other hand these people try to make their lives a bit more pleasant. They find it difficult sometimes to take into account other people's interests;	**5.4%**
Jong & Hoopvol	**Age**: mainly below 30 years; **Family**: single without children; **Education**: higher educational levels (bachelor or master); **Job and salary**: simple function in a shop or restaurant with below average income. However, after their graduation this will change;	**Location**: near universities in large cities like Delft, Leiden, Groningen, Utrecht; **Liveability**: good; **Housing type**: value of houses on average 200,000 EUR. Most people rent simple and small apartments;	**Daily mobility**: low car-ownership, using public transport and bicycle to travel for education, shopping and groceries; **Holiday**: this group like adventurous trips; **Recreation**: festivals, sports like running or snowboarding;	**Newspaper**: NRC.next; **Magazines**: Glamour, Psychologie Magazine; **Television**: - **Other**: Snapchat, YouTube, LinkedIn, Instagram;	This is a relatively young group which offer themselves and others the ability to develop. They like to share their achievements on social media. Also, they are very open for other lifestyles and cultures;	**7.0%**
Volks & Uitgesproken	**Age**: mainly between 45 and 60 years old; **Family**: single or living with their partner, mainly without children; **Education**: vocational education; **Job and salary**: simple function (e.g. construction worker, driver, catering employee). Despite the surcharges, this group sometimes has difficulty to manage financially;	**Location**: towns and cities like Wageningen, Den Helder, Eindhoven, Nijmegen; **Liveability**: this group is satisfied with their living environment; **Housing type**: value of houses on average 200,000 EUR. Most people rent relatively cheap houses;	**Daily mobility**: using a moped or scooter for commuting, shopping and groceries; **Holiday**: little budget for travelling. But they like to visit activities in their neighbourhood; **Recreation**: Gaming, television, internet for shopping, interested in sports cars;	**Newspaper**: Metro; **Magazines**: Story, Privé; **Television**: TLC **Other**: Snapchat, SLAM!, FunX;	This group likes familiarity and reliability and accept whatever crosses their path. They think from their own perspective and find it calming to keep expectations from society low;	**16.6%**
Bescheiden Ouderen	**Age**: above 65 years old; **Family**: living together with their partner or alone, their children are adults; **Education**: vocational education; **Job and salary**: most people in this group are retired and have a relatively low income for their age group;	**Location**: villages or towns like Krimpen aan den IJssel, Ridderkerk, Leerdam; **Liveability**: good; **Housing type**: value of apartment or house on average 100,000 to 200,000 EUR. The next step will be a nursing/care home;	**Daily mobility**: the physical and mental health is getting worse which means mobility activity also decreases. They use the e-bike, rollator, or wheelchair to go for shopping and groceries; **Holiday**: They often stay at their homes, but occasionally they go for an organized trip; **Recreation**: puzzling, keeping track of the news;	**Newspaper**: Regional newspaper; **Magazines**: Plus Magazine; **Television**: Omroep MAX and regional channels; **Other**: They often call with their prepaid phones;	People in this group are used to live with limited resources. They avoid risks and take precautionary measures if possible. Moreover, they are proud to have a Dutch nationality;	**10.4%**
Stedelijke Dynamiek	**Age**: below 50 years old; **Family**: a large group is single but there are also families with children (often up to 11 years old); **Education**: higher educational levels (bachelor or master); **Job and salary**: often high-income jobs like doctor, IT-specialist, banker. A portion is self-employed;	**Location**: cities like Amsterdam, Rotterdam, Den Haag and also urban environments next to large cities like Rijswijk, Schiedam; **Liveability**: great; **Housing type**: value of houses on average 200,000 to 400,000 EUR. Most people rent simple and small apartments;	**Daily mobility**: this group often travels with public transport which is convenient in cities. Often, groceries are delivered due to their busy agendas; **Holiday**: cultural holidays, city trips in Europe; **Recreation**: swimming, surfing, fitness, cooking. Also they like to visit cafes, museums, concerts;	**Newspaper**: Parool; **Magazines**: Cosmopolitan, Glamour; **Television**: Comedy Central; **Other**: SLAM!, Radio 538, Snapchat, Instagram, LinkedIn;	For this group it is important that everyone is happy: they are openminded for different lifestyles. Besides, people like to seek for excitement and sensation with for example holidays and spots;	**5.6%**
Gewoon Gemiddeld	**Age**: between 30 and 55 years old; **Family**: parents with one, two, or three children; **Education**: the breadwinner often has a vocational education diploma; **Job and salary**: many work in healthcare, for authorities, or for an industrial company;	**Location**: low-density neighbourhoods in cities like Barendrecht, Duiven, Almere; **Liveability**: good; **Housing type**: value of houses on average slightly above 200,000 EUR. Mainly they live in a terraced house;	**Daily mobility**: high car-ownership (in some cases two (lease-)cars at their front door); **Holiday**: caravan or bungalow park with their children); **Recreation**: running, bringing and picking the children from sports activities, going for a day out to amusement parks;	**Newspaper**: -; **Magazines**: Ouders van Nu; **Television**: Nickelodeon, series, movies; **Other**: Qmusic, Radio 538, Pinterest, Gaming;	People in this category often have busy agendas: they constantly have to make sure that everyone is at the right place at the right time. It is often too much to ask for them to also take into account people other than their family members. Still, they like to relax during their busy lives;	**13.6%**
Gezellige Emptynesters	**Age**: above 60 years old; **Family**: partners often living together without their children; **Education**: on average medium-skilled training; **Job and salary**: they often work as a volunteer for free;	**Location**: villages and towns like Volendam and Landgraaf; **Liveability**: good; **Housing type**: value of houses on average slightly below 250,000 EUR. Mainly they live in a terraced house;	**Daily mobility**: the majority has a small (new) car in front of their door. This gives them the freedom to go wherever they want; **Holiday**: organized trips via tour operators or on their own with the caravan; **Recreation**: hobbies such as walking, cycling, photography, playing tennis;	**Newspaper**: regional newspapers; **Magazines**: Fiets, Kampioen; **Television**: Omroep Max, local channels; **Other**: they often have a tablet and smartphone but do not do too much complicated tasks;	This group often has a strong bonding with their direct living environment and appreciates the informal relationships. They like to be informed with the latest updates;	**12.2%**

Landelijke Vrijheid	**Age**: between 45 and 80 years old; **Family**: some live on their own, some together with their partner and children from all age categories; **Education**: higher educational levels (bachelor or master); **Job and salary**: a large part of this group has their own business right at the house. If people are still working, it is often related to agricultural, fishing, forestry, gardening, or painting;	**Location**: small villages and rural area like Westerwolde, Westerveld, Aa en Hunze; **Liveability**: excellent; **Housing type**: free-standing house with a lot of land around it. The value ranges from 250,000 to 750,000 EUR;	**Daily mobility**: this group enjoys recreational trips by car or motor. But also functional trips are done by one of their cars; **Holiday**: during holiday they like to seek for nature in countries such as Austria and Switzerland; **Recreation**: they like the peace and space they have around their property, and often love animals and nature. Younger children like to visit a zoo, while teenagers like to visit a sports game or club;	**Newspaper**: regional newspapers; **Magazines**: Landleven, Buitenleven; **Television**: local channels; **Other**: they do not always want the latest tech-devices, shopping via Marktplaats.nl;	Through their job and living environment they love originality and craftmanship. Also they keep close connection with their environment and want to maintain it. Status is not important, they prefer staying healthy;	**7.5%**
Plannen & Rennen	**Age**: between 30 and 55 years old; **Family**: partners with children in all age categories; **Education**: higher educational levels (bachelor or master); **Job and salary**: both parents often have a good job, one of them working part-time for the children. They work in the financial/healthcare sector, or for authorities. Their salary is above average;	**Location**: suburban areas of cities or towns such as Vleuten, Houten, Haarlem, Leiden; **Liveability**: excellent; **Housing type**: relatively new terraced house or free-standing house of averagely 400,000 EUR;	**Daily mobility**: families in this category have a busy life. They often have at least two (leased) cars in front of their house; **Holiday**: luxurious house somewhere in Europe. They also like to go on a ski holiday; **Recreation**: soccer, hockey, tennis, restaurant, cinema, or a daytrip to a zoo or amusement park;	**Newspaper**: -; **Magazines**: WIJ Jonge Ouders, Ouders van Nu; **Television**: Netflix; **Other**: online shopping, Qmusic, Radio 538, LinkedIn, investments;	Families in this group often have busy daily lives with many to-do's. Everything is important so it is hard to skip something. They like to own the newest smartphone or latest clothing collections, and often show that to the outside world;	**9.7%**
Zorgeloos & Actief	**Age**: above 50 years old; **Family**: living together without their children; **Education**: higher educational levels (bachelor or master); **Job and salary**: some people in this group are still working, often as a manager or self-employed. Others have retired and work as a volunteer;	**Location**: suburban areas of mid-size cities or towns like Soest and Oegstgeest; **Liveability**: excellent; **Housing type**: relatively new or old terraced house or free-standing house. The value is above average;	**Daily mobility**: this group often has two (new) cars, and can afford a boat or motor for recreation; **Holiday**: using the car or plane to go for a cultural trip to Italy, Switzerland or Portugal; **Recreation**: cycling, concerts, museums, having drinks, tennis, fitness;	**Newspaper**: NRC Handelsblad; **Magazines**: National Geographic Traveler; **Television**: NPO3, NPO 2, intellectual programmes; **Other**: NPO 4, Classic FM, investments, smartphone or tablet for shopping;	People in this group have an open and honest attitude. They observe the technological developments and want to reap the benefits from it. Also, they like the connection with neighbours and society as a whole;	**8.9%**
Luxe Leven	**Age**: 45 to 75 years old; **Family**: living together with or without their children; **Education**: higher educational levels (bachelor or master); **Job and salary**: people that are still working have a high management position. Others have already retired;	**Location**: relatively wealthy villages like Wassenaar, Naarden and Vught; **Liveability**: very excellent; **Housing type**: luxurious villa's or historic properties with a value above 600,000 EUR;	**Daily mobility**: this group often has at least two (new) cars; **Holiday**: intercontinental trips to South-America and Asia or ski holidays during winter; **Recreation**: horse riding, golfing, shopping luxurious items;	**Newspaper**: NRC Handelsblad; **Magazines**: Residence, Eigen Huis & Interieur; **Television**: Intellectual programmes, VPRO; **Other**: BNR radio, LinkedIn, often with iPhone or iPad, (video-)calls;	People in this group have proven themselves in life and enjoy their luxurious position. They feel high responsibility for their environment, but also like the excitement and kicks in life;	**3.1%**

Appendix E. Data on Whize segments – Almere municipality

Zip code	Dromen & Rondkomen	Jong & Hoopvol	Volks & Uitgesproken	Bescheiden Ouderen	Stedelijke Dynamiek	Gewoon Gemiddeld	Gezellige Emptynesters	Landelijke Vrijheid	Plannen & Rennen	Zorgeloos & Actief	Luxe Leven
1309	0%	0%	0%	0%	0%	0%	0%	94%	0%	0%	6%
1311	0%	7%	17%	9%	3%	28%	24%	0%	6%	6%	0%
1312	2%	5%	22%	9%	3%	28%	15%	0%	8%	8%	0%
1313	3%	0%	26%	9%	1%	33%	23%	0%	2%	3%	0%
1314	13%	3%	45%	8%	3%	17%	10%	0%	0%	0%	0%
1315	9%	35%	21%	9%	15%	1%	6%	0%	1%	2%	0%
1316	1%	2%	17%	2%	1%	30%	23%	7%	5%	8%	4%
1317	0%	2%	29%	10%	1%	37%	20%	0%	0%	0%	0%
1318	1%	3%	26%	6%	1%	31%	11%	0%	12%	8%	0%
1319	0%	6%	12%	1%	1%	8%	4%	11%	41%	11%	5%
1321	1%	4%	14%	5%	1%	28%	12%	0%	23%	12%	0%
1323	1%	5%	19%	14%	1%	30%	23%	0%	3%	3%	0%
1324	11%	2%	32%	10%	5%	24%	14%	0%	0%	1%	0%
1325	0%	12%	23%	6%	2%	22%	14%	0%	8%	12%	1%
1326	2%	4%	26%	8%	1%	32%	13%	0%	8%	6%	0%
1328	0%	5%	14%	7%	2%	30%	12%	0%	20%	10%	1%
1331	0%	0%	1%	0%	0%	1%	0%	88%	4%	0%	6%
1332	17%	0%	17%	0%	0%	0%	0%	67%	0%	0%	0%
1333	4%	4%	31%	8%	2%	29%	18%	0%	2%	3%	0%
1334	9%	24%	27%	23%	5%	9%	3%	0%	0%	0%	0%
1335	1%	4%	24%	4%	2%	34%	10%	0%	12%	7%	1%
1336	1%	8%	12%	3%	4%	24%	8%	1%	29%	10%	1%
1338	3%	0%	29%	10%	0%	32%	18%	0%	4%	4%	0%
1339	2%	3%	21%	2%	2%	37%	12%	0%	13%	8%	0%
1341	0%	11%	19%	1%	0%	36%	0%	10%	17%	6%	1%
1343	0%	0%	0%	0%	0%	0%	0%	72%	4%	0%	23%
1349	0%	1%	0%	0%	0%	0%	0%	60%	1%	0%	38%
1351	0%	0%	7%	1%	0%	32%	38%	1%	9%	11%	0%
1352	1%	2%	20%	10%	2%	28%	26%	0%	5%	6%	1%
1353	13%	2%	39%	21%	1%	12%	11%	0%	1%	1%	0%
1354	18%	2%	43%	14%	4%	12%	7%	0%	1%	1%	0%
1355	2%	5%	36%	13%	3%	18%	18%	0%	2%	3%	0%
1356	0%	2%	29%	14%	0%	22%	23%	0%	5%	5%	0%
1357	3%	10%	20%	12%	7%	17%	20%	0%	3%	7%	0%
1358	0%	0%	0%	0%	0%	0%	0%	21%	0%	0%	79%
1359	2%	4%	9%	2%	2%	5%	4%	0%	32%	29%	11%
1361	0%	21%	4%	2%	0%	0%	0%	15%	37%	17%	3%
1362	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1363	0%	24%	21%	2%	11%	10%	2%	0%	22%	7%	1%

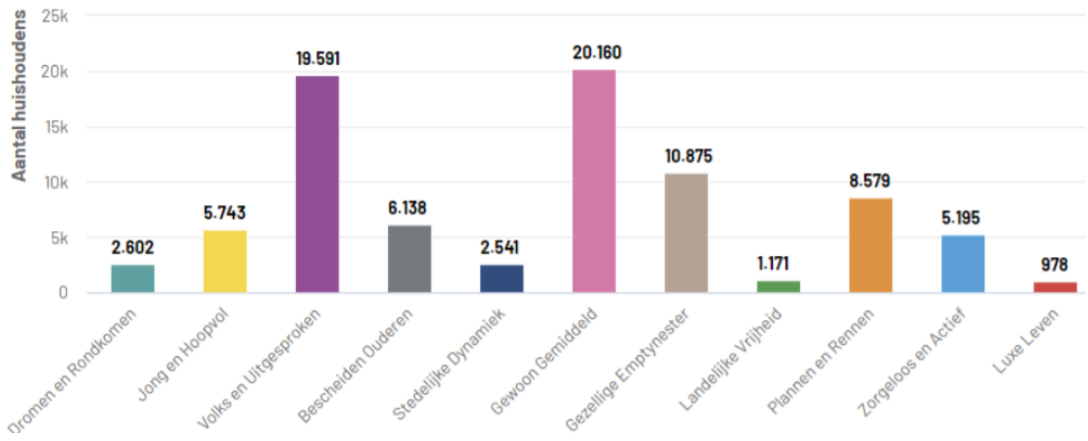
ALMERE



Postcodes (PC4) in gebied (**48**)

300, 1301, 1302, 1303, 1305, 1309, 1311, 1312, 1313, 1314, 1315, 1316, 1317, 1318, 1319, 1320, 1321, 1322, 1323, 1324, 1325, 1326, 1327, 1328, 1329, 1331, 1332, 1333, 1334, 1335, 1336, 1338, 1339, 1341, 1343, 1349, 1351, 1352, 1353, 1354, 1355, 1356, 1357, 1358, 1359, 1361, 1362, 1363

Aantal huishoudens per type huishouden in verzorgingsgebied



Gebiedsprofiel

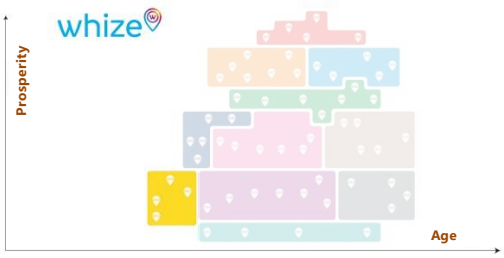
In onderstaande tabel staan de gegevens uit de grafieken hierboven nog eens verzameld weergegeven.

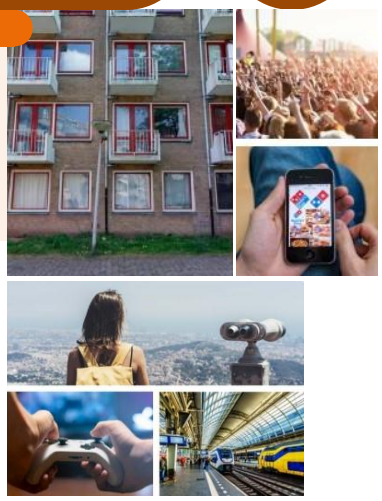
Motief	Verzorgingsgebied	%	Nederland	%	Gebiedsindex
Dromen en Rondkomen	2.602	3,11%	419.963	5,45%	57
Jong en Hoopvol	5.743	6,87%	554.019	7,19%	96
Volks en Uitgesproken	19.591	23,44%	1.357.497	17,62%	133
Bescheiden Ouderen	6.138	7,34%	787.171	10,22%	72
Stedelijke Dynamiek	2.541	3,04%	426.955	5,54%	55
Gewoon Gemiddeld	20.160	24,12%	1.004.375	13,04%	185
Gezellige Emptynester	10.875	13,01%	910.720	11,82%	110
Landelijke Vrijheid	1.171	1,40%	607.274	7,88%	18
Plannen en Rennen	8.579	10,27%	737.134	9,57%	107
Zorgeloos en Actief	5.195	6,22%	667.479	8,66%	72
Luxe Leven	978	1,17%	231.409	3,00%	39
Totaal	**83.573**	**100%**	**7.703.996**	**100%**	

Appendix F. Personas in presentable format (English version)

User profile – Young & Hopeful

They are mostly single without children, and are still in college or just started working. There is one thing they have in common: their future is wide open. For Young & Hopeful, things can still go in any direction! One will start a family; the other a career. A third will do both.





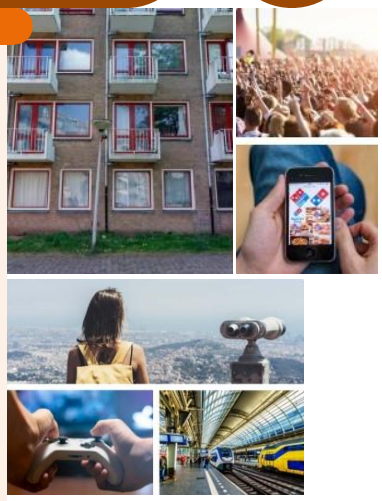
Source: Jarco Vianen in cooperation with Advier & WHOOZ BV (photos)

User profile – Young & Hopeful

Natalie

"I find it important to develop myself but also to give others the opportunity to do so"

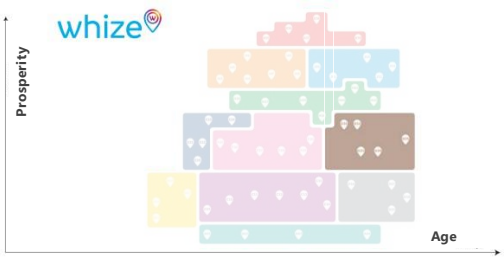
- 23 years old;
- Single and living on her own;
- Rents an appartment in the city center of Almere;
- Born and raised in Almere (her family also lives there);
- Following a masters program at Amsterdam University;
- Doing an internship at a hospital in Almere, and will probably receive a job offer;
- Works as a waitress on Saturdays;
- Interest: festivals, shopping, travelling, fitness, social media (especially Instagram);
- Has a normal bicycle, OV chip card (free travelling with Dutch public transport), and no driving licence;



Source: Jarco Vianen in cooperation with Advier & WHOOZ BV (photos)

User profile – Friendly Emptynesters

Their children have moved out and their agenda is no longer filled with work. Some are volunteers, but the Friendly Emptynesters no longer have any fixed obligations. They sometimes look after their grandchildren and enjoy cycling, gardening and travelling. They enjoy their time together while their health still allows to do that!



Source: Jarco Vianen in cooperation with Advier & WHOOZ BV (photos)

User profile – Friendly Emptynesters

Aunt Sarah

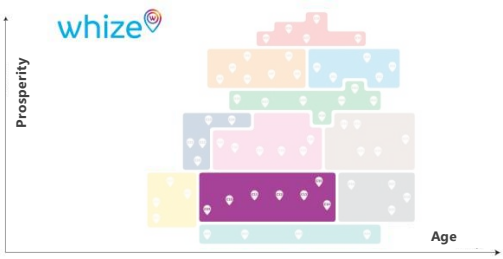
"I like to be aware of the doings of others, and try to help where I can"

- 66 years old;
- Married and living with Matthew. Her daughter Nina (29) has moved out of the house;
- Terraced house in Kerkrade;
- Has retired and volunteers in a nursing home for her mother on a regular basis ;
- Interest: making trips with the grandchildren, walking, cycling, playing tennis, following local news, TV quizzes;
- Has a phone, but finds it difficult to use it;
- Has an electric bicycle and small car;

Source: Jarco Vianen in cooperation with Advier & WHOOZ BV (photos)

User profile – Working Class

The people from the profile Working Class always like to give their opinion. This is how it should be and not otherwise; after all, this is how it used to be. This user profile often has relatively simple jobs, and realizes that there are not many opportunities to improve this. That's fine; with pleasant neighbours, family, and friends, life is fun.



Source: Jarco Vianen in cooperation with Advier & WHOOZ BV (photo)

User profile – Working Class

Thomas

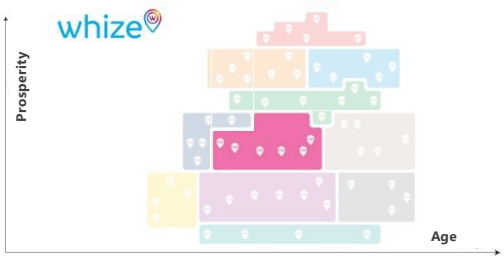
"Just be yourself"

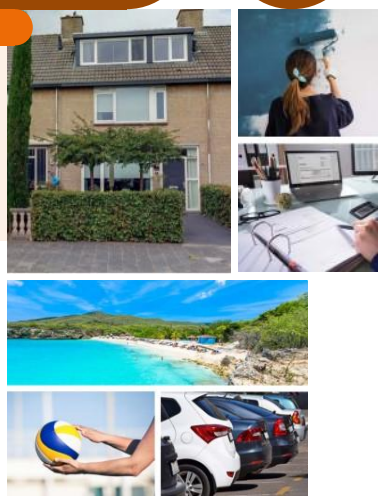
- 54 years old;
- Married and living with Ruth; no children;
- Rents a terraced house in a working-class neighbourhood in the southern part of Rotterdam;
- Breadwinner, works as a bus driver during the week;
- Ruth does not have a job, but occasionally works as a housekeeper in the neighbourhood;
- They sometimes have trouble paying all their bills;
- Interest: pets, DIY, darts, Formula 1, showbizz;
- Owns a moped and simple car;

Source: Jarco Vianen in cooperation with Advier & WHOOZ BV (photo)

User profile – Average Joes & Janes

They are in the middle of their lives, have children and own a terraced house. Just like the average family. Nevertheless, this user profile is certainly not struggling financially. Because both parents work a job with average income, there is enough money to do activities with their children. Although sometimes their agendas are a bit overloaded with all obligations and activities…





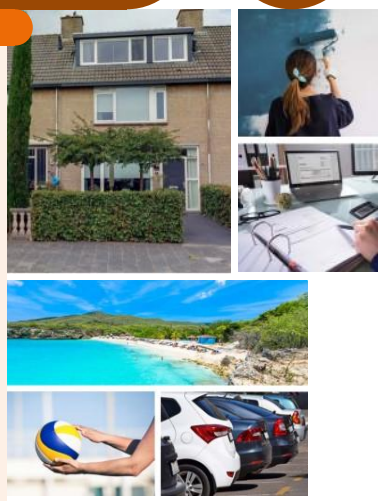
Source: Jarco Vianen in cooperation with Advier & WHOOZ BV (photos)

User profile – Average Joes & Janes

Philip

"Our family is almost always busy, but I like to help others when my agenda allows for it"

- 37 years old;
- Married and living with Nouria. They have two children: Nour (3) and Yasmine (6);
- Terraced house in Tilburg, elementary school is very close to their house;
- Works for the local municipality, Nouria works in a clothing store;
- Likes to do some voluntary work for poorer families in his neighbourhood;
- Interest: play volleyball, activities with the kids, reading;
- Nour goes to daycare three times a week;
- Has a bicycle, family car, and OV chip card (paid);

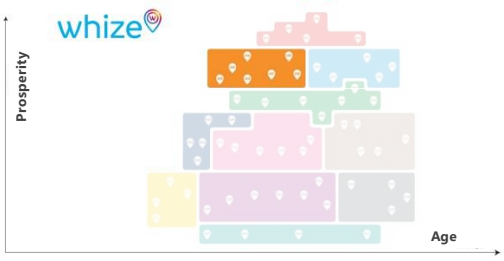


Source: Jarco Vianen in cooperation with Advier & WHOOZ BV (photos)

User profile – Planning & Rushing

Making lunch boxes. Taking the children to and from school. Sending emails for the office. Having dinner with friends at that trendy restaurant. Checking homework. Shopping for the youngest's birthday party. The people from Planning & Running are always busy! There are so many obligations in daily life, but they do not know any better.







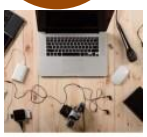
Source: Jarco Vianen in cooperation with Advier & WHOOZ BV (photos)

User profile – Planning & Rushing

Michelle

"When the agenda allows, I like to shop online for the most trending cloths and gadgets"

- 44 years old;
- Married and living with Frank. Their daughter Liz (16) lives at home;
- Semi-terraced house in Haarlem;
- Works full-time as a marketeer for a clothing company in Hilversum. Her husband Frank also works full-time.
- A woman from the neighborhood helps with housekeeping;
- Interest: travelling to other continents, fashion, running, listening to podcasts;
- Daughter Liz plays hockey on a high level;
- Has two cars in front of their house and own a bicycle;




Source: Jarco Vianen in cooperation with Advier & WHOOZ BV (photos)

Appendix G. Focus group scenario & discussion guide

The table below shows the three feedback points, and how this has influenced the set-up of scenario and discussion guide for the official focus groups.

Feedback point	How the feedback has been processed for the official focus groups
During the pilot focus group, a typical day in the life of each persona was presented with time stamps and mode choice for each trip. The participants found that this limits their imagination of the activity pattern of a persona. Moreover, activity patterns could differ from day to day and mode choice could differ between regular (e.g. daily) and irregular (e.g. weekly, monthly) trips.	During the official focus groups, each persona was explained by only showing the underlying characteristics instead of providing details for each trip. This allowed the participants to create their own perception of each persona.
The second feedback point relates to the three questions asked for each user profile. During the pilot focus group, the first question was whether the user profile would use mobility hubs, and the participants could only answer with 'yes' or 'no'. The participants found that it is more appropriate to first ask the experts to select suitable shared services and transport modes, because this is illogical to ask after and expert would answer 'no' on the question whether a user profile would use a mobility hub.	For the official focus groups, this question was formulated as a probability question. Instead of having the options 'yes' or 'no', experts could select a probability ranging from 'very low' to 'very high'. In this way experts could bring more nuance in their answers, and so the poll results are comparable to existing scientific literature to a larger extent.
The final point relates to both the program and timing of the focus group topics. During the pilot focus group, the discussion part was only held at the end of the session after successively going through all user profiles and corresponding questions. The participants found that this was quite repetitive and they were not allowed to explain their answers until the discussion part.	Initially, the program as used during the pilot focus group was chosen as it was uncertain how much time it would take to explain each user profile and answer the questions. After the pilot focus group, it appeared that there was sufficient time. Instead of having a discussion part at the end of the session, there was time for discussion after each single user profile and the corresponding three questions during the official focus groups.

Scenario

The feedback from the pilot focus groups has been used to improve the scenario and discussion guide of the official focus groups. During the official focus groups, the moderator followed a semi-structured discussion guide. This discussion guide uses the same structure as in the study from Krabbenborg et al. (2020). The focus groups were held online using Microsoft Teams. During the introduction, the moderator asked the participants to briefly introduce themselves and mention their main mode of transport for commuting. Also, the moderator asked if there were any objections to record the audio for the focus group. The participants of the focus groups were as follows:

Dutch focus group participants	Foreign focus group participants
KiM (Dutch knowledge institution for mobility)	Mpact
Deloitte	Autodelen.net
TNO	Municipality of Bergen, Norway
NS (Dutch Railways)	Advier
Gemeente Amsterdam	SEStran
Gemeente Utrecht	
Gemeente Zwolle	
Provincie Gelderland	
Vervoerregio Amsterdam	
UT (University of Twente)	
RUG (Groningen University)	

Afterwards, the author of this thesis presented the purpose of the thesis and focus group, so the experts were able to adequately participate in the substantive part of the focus group. The substantive part was divided into five parts according to the five user profiles which are dominant on a four-digit zip code level in the municipality of Almere:

1. Young & Hopeful;
2. Friendly Emptynesters;
3. Working Class;
4. Average Joes & Janes';
5. Planning & Rushing;

For each of these five user profiles the same procedure was followed. First the author gave a general description of the user profile, and explained where it can be found in the Age-Prosperity spectrum. Following this, the author presented the persona for the user profile. Each presented persona is in accordance with the description provided by the Whize segments, and adjusted into a presentable format for the focus groups with expert judgement from Advier. The slides used to present the user profile and persona can be found in Appendix F. Next, the moderator asked the focus group participants to image how the activity pattern of the presented persona would look like. After roughly thirty seconds, the moderator sequentially activated the following three questions:

1. *What are the most suitable transport modes for the profile [user profile] that should be offered at hubs (if implemented properly)?;*
2. *What are the most suitable shared services for the profile [user profile] that should be offered at hubs (if implemented properly)?;*
3. *What is according to you the probability of the profile [user profile] actually using hubs?;*

The software that was used to ask the questions is called 'Polls' function which is integrated and free to use with Microsoft Teams. An advantage of using this function is that participants did not have to connect to third party software using a link or code. When activating a question in 'Polls', it automatically appears on the screen of the participants, as well as in the chat of the meeting.

All three questions that were asked for each user profile were multiple choice type questions. For question (1) and (2) the participants were able to select multiple options. These can be seen in the left table below, which is in accordance with the set of shared services and transport modes selected based on existing mobility hub guidelines (see section 5.4). Moreover, there was also the option "Else, … (please type in chat)" to allow participants to share services and transport modes which were not shown in the multiple choice set. For question (3), the participants were able to only select one option. For this probability question, a Likert-type scale has been used (see table on the righthand side).

Transport modes	Shared services
Shared cars	Charging infrastructure for private/shared vehicles
Shared vans	Bicycle parking
Public transport	Bicycle repair stand
Demand-responsive transport	Postal lockers
Taxi	Kiosk
Shared bikes	Neighbourhood library
Shared cargo bikes	Playground
Pushchairs	Sports equipment
Shared scooters	ATM
Shared mopeds	Storage lockers
Trailer	Co-working space

Probability alternatives
Very low
Low
Neutral
High
Very high

After all participants submitted their answers for the three questions, there was time to discuss the results. This was done after each of the five user profiles. The moderator asked one of the questions 5 to 7 from the discussion guide (see discussion guide), dependent on the results from the poll questions. If there was time left for discussion, the moderator asked one the reserve questions 8-12 (see discussion guide). Due to time limitations, we were not able to go through all questions for each user profile.

In the closing part of the focus group, the author briefly explained to the participants how the focus group results are used in the thesis project. The focus group session was closed by allowing the participants to ask overall questions, followed by final comments from the author.

The discussion guide that used during the focus groups can be seen in the following table.

Minutes	Round	Topics	Questions
10	Intro	**Introduction**: introductory round (name & organization), thesis and focus group purpose, programme	*1. Could you place tell me your name and organization you represent?* *2. Does everyone feel comfortable with us recording the audio of this session?*
45 (5*9)	User profiles	For each of the five user profiles: • **Introduce the persona** with its socio-demographics and lifestyle; • **Transport modes and services** that should be offered at hubs for the persona; • **Probability** that the persona will use hubs; **Discussion** on poll results from question (3) and (4) – general questions **User profile-specific questions** Young & Hopeful Friendly Emptynesters Working Class Average Joes & Janes Planning & Rushing	*Try to image the activity pattern of this persona,* *3. What are the most suitable shared services and transport modes for the profile [user profile] that should be offered at hubs (if implemented properly)? [Multiple choice with Forms]* *Given that these transport modes and services are offered at mobility hubs,* *4. What is according to you the probability of the profile [user profile] actually using hubs? [Multiple choice with Forms]* *Depending on the answers provided to question (3) and (4):* *5. Why do you think it is very likely/unlikely that this persona will use hubs?* *6. Why do you have a neutral perspective on this persona using hubs?* *7. Why did you choose transport mode/service X for this persona?* *8. To what extent would the set of suitable transport modes and services change if the persona would not study but work a full-time job instead?* *9. Do you think the set of suitable transport modes and services would be different for regular trips compared to irregular trips? (this user profile does not have to commute on a daily basis)* *10. To what extent would your answers differ if this persona would have higher income?* *11. To what extent would the set of suitable transport mode and services differ if the children would be older and able to travel to their activities themselves?* *12. To what extent does the shift to working-from-home influence the set of suitable transport modes and services? And the probability of this persona using hubs?*
5	Ending	**Processing the focus group data and final remarks**	*13. Do you have any important questions or remarks to make regarding this session?*

Appendix H. Focus group poll results

Poll question:

Given that these transport modes and services are offered at hubs,

What is according to you the probability of the profile [user profile] actually using hubs? [Multiple choice with Forms]

Poll answer:

Absolute numbers	**Young & Hopeful**		**Friendly Emptynesters**		**Working Class**		**Average Joes & Janes**		**Planning & Rushing**	
Answer	**NL**	**EN**	**NL**	**EN**	**NL**	**EN**	**NL**	**EN**	**NL**	**EN**
Very low	1	0	4	1	5	0	0	0	0	0
Low	0	0	4	0	4	2	1	0	1	2
Neutral	1	0	2	2	2	2	5	0	4	2
High	9	2	1	1	0	1	4	4	5	1
Very high	0	2	0	0	0	0	0	1	0	0
Total responses	**11**	**4**	**11**	**4**	**11**	**5**	**10**	**5**	**10**	**5**

Heatmap of poll question on probability of actually using hubs (in percentage of total responses).

Percentage of total responses	**Young & Hopeful**		**Friendly Emptynesters**		**Working Class**		**Average Joes & Janes**		**Planning & Rushing**	
Answer	**NL**	**EN**	**NL**	**EN**	**NL**	**EN**	**NL**	**EN**	**NL**	**EN**
Very low	9%	0%	36%	25%	45%	0%	0%	0%	0%	0%
Low	0%	0%	36%	0%	36%	40%	10%	0%	10%	40%
Neutral	9%	0%	18%	50%	18%	40%	50%	0%	40%	40%
High	82%	50%	9%	25%	0%	20%	40%	80%	50%	20%
Very high	0%	50%	0%	0%	0%	0%	0%	20%	0%	0%

Poll question:

What are the most suitable transport modes for the profile [user profile] that should be offered at hubs (if implemented properly)?

Poll answers:

Absolute numbers	**Young & Hopeful**		**Friendly Emptynesters**		**Working Class**		**Average Joes & Janes**		**Planning & Rushing**	
Transport modes	**NL**	**EN**	**NL**	**EN**	**NL**	**EN**	**NL**	**EN**	**NL**	**EN**
Shared cars	0	1	2	1	1	2	6	5	6	1
Shared vans	0	0	1	1	6	3	4	2	4	1
Public transport	11	4	6	2	3	4	9	5	3	1
Demand-responsive transport	2	2	4	3	1	2	0	2	2	1
Taxi	1	1	3	1	0	1	0	0	5	4
Shared bikes	10	3	0	1	0	2	0	3	1	0
Shared cargo bikes	4	3	1	0	1	1	9	5	6	3
Pushchairs	0	0	2	0	0	0	1	1	0	0
Shared scooters	5	2	0	0	0	3	0	0	2	4
Shared mopeds	7	2	0	1	1	3	0	1	6	3
Trailer	0	0	5	0	8	2	9	2	6	0
Total responses	**11**	**4**	**10**	**4**	**10**	**5**	**11**	**5**	**10**	**5**

Heatmap of poll question on most suitable transport modes (in percentage of total responses).

Percentage of total responses	**Young & Hopeful**		**Friendly Emptynesters**		**Working Class**		**Average Joes & Janes**		**Planning & Rushing**	
Transport modes	**NL**	**EN**	**NL**	**EN**	**NL**	**EN**	**NL**	**EN**	**NL**	**EN**
Shared cars	0%	25%	20%	25%	10%	40%	55%	100%	60%	20%
Shared vans	0%	0%	10%	25%	60%	60%	36%	40%	40%	20%
Public transport	100%	100%	60%	50%	30%	80%	82%	100%	30%	20%
Demand-responsive transport	18%	50%	40%	75%	10%	40%	0%	40%	20%	20%
Taxi	9%	25%	30%	25%	0%	20%	0%	0%	50%	80%
Shared bikes	91%	75%	0%	25%	0%	40%	0%	60%	10%	0%
Shared cargo bikes	36%	75%	10%	0%	10%	20%	82%	100%	60%	60%
Pushchairs	0%	0%	20%	0%	0%	0%	9%	20%	0%	0%
Shared scooters	45%	50%	0%	0%	0%	60%	0%	0%	20%	80%
Shared mopeds	64%	50%	0%	25%	10%	60%	0%	20%	60%	60%
Trailer	0%	0%	50%	0%	80%	40%	82%	40%	60%	0%

Poll question:

What are the most suitable shared services for the profile [user profile] that should be offered at hubs (if implemented properly)?

Poll answers:

Absolute numbers	Young & Hopeful		Friendly Emptynesters		Working Class		Average Joes & Janes		Planning & Rushing	
Shared services	**NL**	**EN**	**NL**	**EN**	**NL**	**EN**	**NL**	**EN**	**NL**	**EN**
Charging infrastructure for private/shared vehicles	0	0	4	2	0	1	5	4	7	3
Bicycle parking	9	4	6	3	2	1	4	4	4	3
Bicycle repair stand	10	4	7	1	1	0	5	4	9	0
Postal lockers	9	3	4	1	2	4	10	4	9	5
Kiosk	8	2	4	2	4	2	1	2	3	3
Neighbourhood library	4	4	10	3	3	2	10	5	3	0
Playground	0	0	4	2	0	1	10	4	1	1
Sports equipment	6	2	1	0	2	1	7	3	7	4
ATM	3	1	6	3	5	3	2	1	3	1
Storage lockers	2	1	0	0	0	2	0	3	1	2
Co-working space	3	2	0	0	0	0	2	2	4	5
Total responses	**11**	**4**	**11**	**4**	**10**	**5**	**11**	**5**	**10**	**5**

Heatmap of poll question on most suitable shared services (in percentage of total responses).

Percentage of total responses	Young & Hopeful		Friendly Emptynesters		Working Class		Average Joes & Janes		Planning & Rushing	
Shared services	**NL**	**EN**	**NL**	**EN**	**NL**	**EN**	**NL**	**EN**	**NL**	**EN**
Charging infrastructure for private/shared vehicles	0%	0%	36%	50%	0%	20%	45%	80%	70%	60%
Bicycle parking	82%	100%	55%	75%	20%	20%	36%	80%	40%	60%
Bicycle repair stand	91%	100%	64%	25%	10%	0%	45%	80%	90%	0%
Postal lockers	82%	75%	36%	25%	20%	80%	91%	80%	90%	100%
Kiosk	73%	50%	36%	50%	40%	40%	9%	40%	30%	60%
Neighbourhood library	36%	100%	91%	75%	30%	40%	91%	100%	30%	0%
Playground	0%	0%	36%	50%	0%	20%	91%	80%	10%	20%
Sports equipment	55%	50%	9%	0%	20%	20%	64%	60%	70%	80%
ATM	27%	25%	55%	75%	50%	60%	18%	20%	30%	20%
Storage lockers	18%	25%	0%	0%	0%	40%	0%	60%	10%	40%
Co-working space	27%	50%	0%	0%	0%	0%	18%	40%	40%	100%

Appendix I. Focus group discussion results

Dutch focus group

Young & Hopeful

Comments from the focus group discussion
Met de aanname dat de persona veel gebruik maakt van het openbaar vervoer en dat dit aangeboden wordt op een hub, zal de persona veel gebruik maken van hubs.
Deze persona zal uit financieel oogpunt waarschijnlijk gebruik blijven maken van haar eigen fiets en het gratis openbaar vervoer (met de aanname dat de persona nog studeert). Voor deelvervoer moet je nu eenmaal betalen.
Tegelijkertijd is dit wel de doelgroep die al gewend is aan de service-economie en concepten zoals deelfietsen en deelscooters snel oppakt.
Dat in dit geval de familie van de persona in dezelfde stad woont zou ertoe kunnen leiden dat vervoerswijzen onderling binnen de familie worden uitgewisseld.
Verder kijkend naar de toekomst zou je misschien juist wel concepten zoals autodelen willen aanbieden om mensen uit dit gebruikersprofiel deelmobiliteit te laten gebruiken in plaats een eigen auto aan te schaffen. Op een gegeven moment gaan deze mensen in een volgend gebruikersprofiel belanden.
Naast de mobiliteitscomponent heb je ook de services-component. Voor iemand die veel dingen onderneemt is de attractiekant van een hub door services zoals pakketkluisjes wel interessant. In plaats van vervoer kunnen juist de niet-mobiliteit gerelateerde faciliteiten het gebruik van wijkhubs bepalen.
Het type hub is belangrijk voor het aanbod. Gaat het om een bestaand OV-station of kleinschalige wijkhub.

Friendly Emptynesters

Comments from the focus group discussion
Een deelauto zou goed kunnen passen voor niet-frequente trips, maar dit gebeurt alleen als je dit sterk afdwingt, en dan op lange termijn. Voor dit gebruikersprofiel is dat dus niet echt van toepassing.
Voor langere afstanden zou het OV, een taxi of vraagafhankelijk vervoer geschikt zijn, omdat de eigen auto voor deze trips spannend of lastig zou kunnen zijn. Maar deze zijn dan echt aanvullend op de eigen vervoersmiddelen.
Over het algemeen zit dit gebruikersprofiel echt vast aan de eigen auto. Dit komt onder andere omdat ze het lastig vinden nieuwe dingen te proberen.
Als je grotere familieauto's als deelauto's aanbiedt zou dit aantrekkelijk kunnen zijn wanneer deze persona op pad gaat met de kleinkinderen.
Hoofdzakelijk richten op andere doelgroepen, maar met aanvullend aanbod zou je dit gebruikersprofiel wel mee kunnen vangen.

Working Class

Comments from the focus group discussion
Kijkend naar services is de behoefte om naar een hub te gaan voor bijv. pakketkluisjes is niet heel erg groot, vooral ook als één van de personen binnen het gezin vaak thuis zit.
Een sociale voorziening / ontmoetingsplek zou kansrijk zijn voor dit gebruikersprofiel.

Omdat de persona vaak klust zou een aanhangwagen of busje van toepassing zijn, maar je moet het vooral zoeken in sociale activiteiten.
Wanneer het inkomen hoger zou zijn, zou dit gebruikersprofiel waarschijnlijk ook bij hun eigen leefstijl blijven (wellicht een grotere auto?).
Status en onbekendheid met concepten spelen een rol bij het gebruik van vervoerswijzen en services op wijkhubs.
Dit is wellicht juist een groep waarvan je zou willen dat ze deelmobiliteit ontdekken omdat ze krap in de financiën zitten. Echter is deze groep ook gevoelig voor out-of-pocket uitgaven, en maken minder rationeel financiële keuzes. De meest logische business case, zoals die in Excel klopt, wordt bij dit gebruikersprofiel niet altijd gekozen, omdat er bepaalde voorkeuren zijn.

Average Joes & Janes

Comments from the focus group discussion
Een deelauto voor minder frequente trips zou handig kunnen zijn om naast de eigen auto beschikbaar te hebben (en een reden om geen tweede auto aan te schaffen).
Aanvullende mobiliteitsservices zoals een busje of aanhanger zijn praktisch wanneer er veel bagage vervoerd moet worden. Deze groep heeft hier ook waarschijnlijk de financiën de middelen voor in het geval dat.
Andere vormen van deelvervoer zijn wat minder van toepassing, ook omdat deelvervoer op dit moment nog relatief kostbaar is. Een deelbakfiets zou zeker wel kansrijk kunnen zijn voor het gebruikersprofiel.

Planning & Rushing

Comments from the focus group discussion
Waarschijnlijk zal dit profiel wat minder open staan voor deelmobiliteit, en gebruik blijven maken van de twee auto's die voor de deur staan. Dit is een groep die je eigenlijk wel wilt verleiden om de tweede auto weg te doen, maar gemak zal hoog in het vaandel staan.
Wanneer er veel thuisgewerkt wordt, zou deze groep misschien wel te verleiden zijn om hun tweede auto weg te doen.
In tegenstelling tot het gebruikersprofiel Volks & Uitgesproken heeft dit gebruikersprofiel het niet zo hard nodig om geld te besparen, maar als ze financieel onderlegd zijn zou het wegdoen van de tweede auto (en deelmobiliteit te gebruiken) wel waarschijnlijker zijn.
Ook hier zou een aanhanger of busje handig zijn in het geval dat grotere spullen vervoerd moeten worden.
De dochter van het gezin zou de trigger kunnen zijn om deelmobiliteit (zoals deelscooters), en daarmee andere faciliteiten op een hub te gebruiken.
In het geval van de gepresenteerde persona hockeyt de dochter op hoog niveau, waardoor je door het land moet reizen naar plekken die met het OV slechter te bereiken zijn.
Voor deze groep interessant maken door specials aan te bieden die wat toevoegen op wat ze nu al hebben.
Zo zou ook hier de services-component misschien nog wel een belangrijkere rol kunnen spelen dan mobiliteit. Dit kunnen praktische dingen zijn die dit gebruikersprofiel helpen in het drukke leven van ze, of luxe-facetten.

Foreign focus group

Young & Hopeful

Comments from the focus group discussion
Because the persona is a student with her own bicycle and free public transport, she is less likely to use shared modes. If public transport is offered at a neighbourhood hub, there is also a chance that this persona will use a neighbourhood hub. However, this depends on available public transport services. If there is for example a bus stop at a neighbourhood hub, but it is more convenient to cycle to the train station, the persona is less likely to use the bus service offered at the neighbourhood hub.
Because the persona does not have a driving licence and private car, other transport modes that could be offered at mobility hubs become more interesting.
Services such as postal lockers (buying new clothes and other stuff online) and a neighbourhood library could be an incentive to use a neighbourhood hub.
If the persona would work full-time instead of studying, it really depends on the time zone, distance, connections, and costs whether the persona would get a driving licence or use other transport modes. Even with a driving licence, the persona could still keep using public transport and her bike, but use shared cars for less frequent trips – there is a difference between regular and irregular trips in terms of needs for transport modes.
If the persona would work, she would still be using the neighbourhood hub, but maybe a different mix of functions than when she was a student.

Friendly Emptynesters

Comments from the focus group discussion
Assuming that this user profile still has good health, they are able to use their own e-bike and/or small car. But for certain trips, such as long-distance trips, using public transport might be a good alternative.
Shared cargo bikes could be useful for making trips with the grandchildren.
It is a bit harder to convince this user profile using other transport modes than their private vehicles for regular trips. They are less open to new things and services.
The unfamiliarity with smart phones might be an obstacle to use shared mobility modes.
Cozywheels might be a suitable solution as the members of Cozywheels are pretty much in line with this user profile (https://www.cozywheels.be/).
Shared services such as a playground (for the grandchildren), neighbourhood library, lockers are more likely to be triggers to use neighbourhood hubs compared to transport modes. This user profile does not realize what car-sharing has to offer by simply walking past a mobility hub.
Daughter Nina could persuade this persona to get rid of the private vehicle (so influence from other user profiles).

Working Class

Comments from the focus group discussion
This user profile is not likely to pay some extra for having access to shared cars, mopeds or bikes besides having the own private vehicles, as they sometimes struggle paying their bills.
It is a status for this user profile that they can own a car, so getting rid of it is not probable at this moment in life.
This might be a target group for shared mopeds, but then they should get rid of their private moped.
A shared van might be attractive for taking stuff home for DIY activities (but this is occasionally).
Public transport or a taxi might be a good alternative for the private vehicles when going in town having a drink at a café.

Average Joes & Janes

Comments from the focus group discussion
Shared mobility at a neighbourhood hub offers additional mobility alternatives besides private car and bikes, supporting the persona and his family in their busy schedule with all types of activities.
In the case of the persona, the commuting distance is relatively short (work and home are in the same city). So car-sharing has quite some potential.
Shared cargo bikes might be suitable for families with younger children.
Additional shared services such a co-working spaces could also be useful for the persona every now and then (alternative to working-from-home).

Planning & Rushing

Comments from the focus group discussion
In terms of mobility the persona the user profile has the luxury of owning two cars which can be used whenever she wants. Hard target group for public transport and shared mobility.
A taxi might be viable for occasional trips.
If you would like this user profile to user shared mobility it should have a high appeal and added value, such as a shared cabrio.
This user profile could get rid of the second car, depending on the distance to work of both parents.
The extra shared services like postal lockers or a shared cargo bike could add value and make the user profile use neighbourhood hubs. It should be something to show off your image.

Appendix J. Literature study on user characteristics

Potential user groups for neighbourhood / mobility hubs.

	Potential user group characteristic	Reference
Neighbourhood / Mobility hubs	Lives in a high density urban area – probably due to high parking pressure;	Claasen (2020); Van Rooij (2020)
	Younger people;	Knippenberg (2019) Claasen (2020); Van Rooij (2020) Bösehans et al. (2021)
	High level of education;	Knippenberg (2019) Bösehans et al. (2021)
	Elderly people, given the right motivation;	Van Rooij (2020) Bösehans et al. (2021)
	Certain level of disposable income;	Van Rooij (2020)
	Green and sustainable mindset;	Claasen (2020); Van Rooij (2020) Bösehans et al. (2021)
	Already show (multimodal) travelling with sustainable modes;	Knippenberg (2019) Bösehans et al. (2021)
	Living together with family (partner and/or children);	Knippenberg (2019) Van Rooij (2020) Bösehans et al. (2021)
	Experience with shared mobility;	Van Rooij (2020)
	Relatively low private car-ownership;	Knippenberg (2019) Van Rooij (2020)

Potential user groups for shared mobility in general.

	Potential user group characteristic	Reference
Shared mobility	Previous experience with shared modes;	Arendsen (2019);
	Higher income households;	Claasen (2020);
	Younger people;	Arendsen (2019); Claasen (2020); Winter et al. (2020);
	Green and sustainable mindset;	Claasen (2020);
	High level of education;	Arendsen (2019); Winter et al. (2020);

Potential user groups for individual shared travel modes.

Travel mode	Potential user group characteristic	Reference
Shared cars	Lives in a high density urban area;	CROW (n.d.); Doornbos (2019); Jorritsma et al. (2021); KiM (2015); Münzel et al. (2019); Prieto et al. (2017);
	Younger people;	Becker et al. (2017); Burghard & Dütschke (2018) CROW (n.d.); Doornbos (2019); Jorritsma et al. (2021); KiM (2015); Prieto et al. (2017);

	Elderly people without children;	KiM (2015);
	Green and sustainable mindset;	Münzel et al. (2019);
	Active and social life;	CROW (n.d.);
	High level of education;	Becker et al. (2017); Burghard & Dütschke (2018) CROW (n.d.); Doornbos (2019); KiM (2015); Münzel et al. (2019); Prieto et al. (2017);
	Higher income households;	KiM (2015);
	Single households and households with younger children;	Burghard & Dütschke (2018) Doornbos (2019); KiM (2015);
	Already show (multimodal) travelling with sustainable modes;	Becker et al. (2017); Burghard & Dütschke (2018) CROW (n.d.); Doornbos (2019);
	Low private car-ownership;	Anable (2005); Becker et al. (2017); CROW (n.d.); Jorritsma et al. (2021);
DRT (Demand-responsive transport)	In possession of a driving license;	Bronsvoort et al. (2021);
	Low level of access to private car;	Jain et al. (2017); Nelson & Phonphitakchai (2012);
	Young people (children);	Jain et al. (2017);
	Elderly people;	Jain et al. (2017); Nelson & Phonphitakchai (2012);
	Low income households;	Jain et al. (2017); Nelson & Phonphitakchai (2012);
	Low level of education;	Nelson & Phonphitakchai (2012);
	People with conditions of illness, disability or infirmity;	Jain et al. (2017); Nlson & Phonphitakchai (2012);
	People living in areas not served by regular public transport;	Jain et al. (2017);
Taxi	Older people;	Winter et al. (2020);
	Mainly commuting by car;	Winter et al. (2020);
Trailer	*No scientific literature available*	
Pushchairs	People with physical disabilities;	May et al. (2014);
	Parents with younger children;	May et al. (2014);
Shared vans	*No scientific literature available*	
Public transport	Lives in an urban area;	Molin et al. (2016); Ton et al. (2019);
	Higher level of education;	Molin et al. (2016); Ton et al. (2019);
	Smaller household size;	Krueger et al. (2018); Molin et al. (2016); Ton et al. (2019);
	Younger people;	Molin et al. (2016); Ton et al. (2019);
	Favoured ecological normative beliefs;	Krueger et al. (2018);
	Subscription to public transport;	Ton et al. (2019);
	Low level of access to private car;	Krueger et al. (2018); Ton et al. (2019);
Shared scooters	Living in the city (center);	Nikiforiadis et al. (2021);
	Younger people;	Bielinski & Wazna (2020); Eccarius & Lu (2020);

		Mitra & Hess (2021); Nikiforiadis et al. (2021);
	Already show (multimodal) travelling with sustainable modes (mobility habits);	Eccarius & Lu (2020);
	Single households;	Mitra & Hess (2021);
	No driving license;	Eccarius & Lu (2020);
	Low private car-ownership;	Eccarius & Lu (2020);
	Own private (e-)scooters;	Bielinski & Wazna (2020);
	Green and sustainable mindset;	Eccarius & Lu (2020); Mitra & Hess (2021);
Shared mopeds	Younger people;	Aguilera-Garcia et al. (2021);
	Higher level of education;	Aguilera-Garcia et al. (2021);
	Living in inner urban areas;	Aguilera-Garcia et al. (2021);
Shared cargo bikes	Living together with children;	Claasen (2020);
	Younger people;	Hess & Schubert (2019);
	Reliance on the bicycle in daily lives;	Becker & Rudolf (2018); Dorner & Berger (2020); Hess & Schubert (2019);
	Green and sustainable mindset;	Becker & Rudolf (2018);
	Higher level of education;	Dorner & Berger (2020);
	Already show (multimodal) travelling with sustainable modes;	Hess & Schubert (2019);
Shared bikes	Already show (multimodal) travelling with sustainable modes;	Bachand-Marleau et al. (2012) Ma et al. (2020);
	Lives in urban areas;	Jorritsma et al. (2021)
	Younger people;	Bielinski & Wazna (2020); Fishman (2015); Jorritsma et al. (2021) Van Marsbergen et al. (2022);
	Middle/higher income households;	Bachand-Marleau et al. (2012) Fishman (2015);
	High level of education;	Fishman (2015); Jorritsma et al. (2021) Van Marsbergen et al. (2022);
	White ethnicity;	Fishman (2015);
	Lives and/or works in a city (center);	Fishman (2015);
	Low private bicycle-ownership;	Bachand-Marleau et al. (2012)
	Low private car-ownership;	Fishman (2015); Ma et al. (2020); Jorritsma et al. (2021)

Potential user groups for shared services.

	Potential user group characteristic	Reference
Sharing among neighbours / community members	People who are environmentally conscious;	Akin et al. (2021); Böcker & Meelen (2016); Edbring et al. (2016);
	People who are more economically motivated;	Akin et al. (2021); Böcker & Meelen (2016); Edbring et al. (2016);
	People who are more socially motivated;	Akin et al. (2021); Böcker & Meelen (2016); Edbring et al. (2016);
	Older people who have the right motivation;	Akin et al. (2021);
	Low-income groups are more economically and socially motivated;	Böcker & Meelen (2016);
	Living in an urban area;	Edbring et al. (2016);
	Living in shared living communities;	Li (2020);
	Younger people;	Li (2020);

Appendix K. Almere case study: choices and assumptions for each step

Step	Choice/assumption	Clarification
Study area definition	Only consider four-digit zip codes which are marked as 'urban'.	This thesis focuses on neighbourhood hubs which have an origin function. Therefore, we want to develop neighbourhood hubs within or next to residential areas (which have a certain number of residents, or potential hub users).
Identify anchor points	A bus stop with two separate quays (for both driving directions) is marked as a single anchor point in the middle of both quays.	If one would consider each separate quay as an anchor point, there would be two anchor points right next to each other. In a next step, these places could be falsely indicated as clustered anchor points.
	A place is marked as a square if there is significant space dedicated to pedestrians.	These are places where people interact and are suitable to create attractive urban spaces.
	A place is marked as a shopping facility if there are multiple facilities near each other.	There places attract people on a daily basis and could be interesting places for neighbourhood hubs.
Cluster anchor point near each other and identify potential hub locations	Filter out all anchor point outside urban / non-residential areas	As mentioned, we want to develop neighbourhood hubs within or next to residential areas.
	Cluster anchor points which are in the direct vicinity of each other.	1. It does not make sense to develop neighbourhood hubs right next to each other, because otherwise the concept of clustering amenities at central places would be gone. 2. More anchor points near each other could increase the potential to attract neighbourhood hub users.
	Use 300 m as a threshold value for the clustering function in QGIS.	300 m is used as hub spacing value in Bremen (Witte et al., 2020). Moreover, with sufficient density and spread of anchor points, there will be an anchor point within 400 m of most residential areas.
	Out of the in total 83 anchor points, consider the 38 clustered anchor points as most preferred neighbourhood hub locations.	From a practical perspective it is not advisable to develop all 83 hubs at the same time. The 38 clustered anchor points could be indicated as 'most preferred' hub locations, because these have a higher potential to attract hub users. They offer a good first step for the municipality to start with developing hubs.
Identify dominant user profiles in each district	Only consider the dominant user profile in each district.	For this thesis we are searching for the most preferred amenities at each hub location. This is the essence of the step sequence.
Determine preferred amenities for each user profile	For each user profiles we consider those amenities that were found most promising by experts and literature in chapter 6.	See comment above.
Determine existing locations of the considered amenities	Table 18 in chapter 7 shows for each individual shared service and transport mode whether there are already existing locations, and if so, which of the existing locations have been considered	See table 18 for clarification per amenity.
Draw catchment areas around existing amenity locations	The catchment area values for each individual amenity are used.	See section 5.6 for the explanation how the catchment area values have been determined.

Determine search areas for new locations per amenity type	Search areas for new amenity locations are determined by subtracting the catchment areas of current locations from the district areas where that amenity is considered.	An amenity is considered in a district if there is a dominant user profile for which the amenity is found promising in an earlier step. Next, it does not make sense to place a new location of that amenity if there is already an existing location nearby. So, by working with the catchment areas we can determine in what areas we should search for new locations for each amenity type.
Determine amenity types per hub location	If an amenity is already present at a neighbourhood hub location, no new location of that amenity should be added.	If an amenity is already there, it does not make sense to add a separate new location. At most, the capacity or size of the existing location could be expanded if there is demand for that.
	If a neighbourhood hub falls inside the search area of an amenity, the amenity should be added to that neighbourhood hub as a new location.	Based on the assumptions from previous steps, there is demand for a certain amenity in an area. Then the neighbourhood hub is a logical place to place that amenity.
	If a neighbourhood hub location falls outside the search area and catchment area of existing locations for an amenity, the amenity is not considered at that neighbourhood hub.	If there is no demand for an amenity, it makes sense to exclude it in the step sequence. Note that in a later development stage, the amenity can still be considered if there is demand for it.

Appendix L. Almere case study: amenities for each preferred neighbourhood hub location

Already there (= 1), to be added (=2), or do nothing (= 3), for transport modes and shared services per preferred neighbourhood hub location in Almere.

#	Shared cars	Shared vans	Public transport	DRT	Taxi	Shared bikes	Shared cargo bikes	Pushchairs	Shared scooters	Shared mopeds	Trailers
1	2	3	1	3	2	3	2	3	3	2	3
2	2	3	1	3	2	3	2	3	3	2	3
3	1	3	1	3	3	3	2	3	3	3	2
4	2	3	1	3	3	3	2	3	3	3	2
5	1	3	1	3	3	3	2	3	3	3	2
6	3	2	1	3	3	3	3	3	3	3	1
7	1	2	1	3	3	3	3	3	3	3	2
8	2	3	1	3	3	3	2	3	3	3	2
9	3	2	1	3	3	3	3	3	3	3	2
10	2	3	1	3	3	3	2	3	3	3	2
11	2	3	1	3	3	3	2	3	3	3	2
12	2	3	1	3	3	3	2	3	3	3	2
13	2	3	1	3	3	3	2	3	3	3	2
14	2	3	1	3	3	3	2	3	3	3	2
15	2	3	1	3	3	3	2	3	3	3	2
16	2	3	1	3	3	3	2	3	3	3	2
17	2	3	1	3	3	3	2	3	3	3	2
18	3	2	1	3	3	3	3	3	3	3	2
19	1	2	1	3	1	1	3	3	3	3	2
20	1	3	1	3	1	1	2	3	2	2	3
21	2	3	1	3	3	2	2	3	2	2	3
22	2	2	1	3	3	2	2	3	2	2	3
23	3	2	1	3	3	3	3	3	3	3	2
24	2	3	1	3	3	3	2	3	3	3	2
25	2	3	1	3	2	3	2	3	3	3	3
26	2	3	1	3	3	3	2	3	3	3	2
27	1	3	1	3	3	3	2	3	3	3	2
28	1	3	1	3	3	3	2	3	3	3	2
29	3	2	1	3	3	3	3	3	3	3	2
30	2	3	1	3	3	3	2	3	3	3	2
31	3	2	1	3	3	3	3	3	3	3	2
32	3	2	1	3	3	3	3	3	3	3	2
33	3	2	1	3	3	3	3	3	3	3	2
34	2	2	1	3	2	3	2	3	3	2	3
35	2	3	1	3	3	2	2	3	2	2	3
36	1	3	1	3	3	1	3	3	3	3	3
37	1	3	1	3	3	2	2	3	2	2	3
38	2	3	1	3	2	3	2	3	3	2	3

#	Bicycle parking	Bicycle repair st.	Parcel lockers	Kiosk	Neighbour. library	Sports equipment	ATM	Storage lockers	Co-working s.	Social facility
1	2	2	1	1	3	1	3	3	2	3
2	2	2	2	3	3	2	3	3	2	1
3	1	2	1	1	2	2	1	3	3	1
4	2	2	1	1	1	2	3	3	3	3
5	2	2	1	1	1	2	3	3	3	3
6	2	3	1	1	1	1	1	3	3	1
7	1	3	1	1	1	1	1	3	3	2
8	2	2	1	1	1	2	3	3	3	1
9	2	3	1	1	1	3	2	3	3	2
10	2	2	1	1	2	2	1	3	3	3
11	2	2	1	1	1	2	3	3	3	1
12	2	2	1	1	2	2	3	3	3	3
13	1	2	1	1	2	2	1	3	3	1
14	2	2	2	3	2	1	3	3	3	1
15	2	2	1	3	2	2	1	3	3	3
16	2	2	2	3	2	2	3	3	3	3
17	2	2	1	1	2	2	1	3	3	3
18	2	3	1	1	3	3	1	3	3	1
19	2	3	1	1	1	3	2	3	1	1
20	1	2	1	1	1	2	1	3	1	3
21	1	2	1	1	1	1	1	3	1	3
22	2	2	1	1	1	1	1	3	1	1
23	2	3	1	1	1	3	2	3	1	2
24	2	2	1	3	2	2	1	3	3	1
25	2	2	2	1	3	2	3	3	2	3
26	2	2	1	1	2	2	1	3	3	1
27	1	2	1	1	2	2	1	3	3	1
28	2	2	2	1	2	1	1	3	3	3
29	2	3	1	1	3	3	1	3	3	1
30	2	2	1	1	2	2	1	3	3	1
31	2	3	1	1	1	1	1	3	3	1
32	2	3	1	3	1	3	2	3	3	1
33	2	3	1	1	1	1	1	3	1	1
34	2	2	2	1	1	2	3	3	2	1
35	2	2	1	1	1	2	3	3	3	1
36	2	3	1	1	1	3	1	3	3	3
37	2	2	2	1	1	2	3	3	3	1
38	2	2	1	3	1	2	3	3	2	3