Reclaiming scarce public space

Developing a framework for the bottom-up integration of micro mobility hubs in dense urban neighbourhoods with limited free space

MSc Thesis

Y.Y. (Ydze) Rijff

MSc MADE

ARUP

AMS AMSTERDAM INSTITUTE FOR ADVANCED METROPOLITAN SOLUTIONS

TU Delft

WAGENINGEN UNIVERSITY & RESEARCH

Image by Natuur & Milieu (2022)

In order to obtain the degree Master of Science in Metropolitan Analysis, Design & Engineering at Delft University of Technology and Wageningen University & Research

To be publicly defended at the Amsterdam Institute for Advanced Metropolitan Solutions on July 8th, 2022 at 11:00 AM

Colofon

Version
Final version

Date
July 1st, 2022

Author
Y.Y. (Ydze) Rijff
MSc Student
TU Delft 5435749
WUR 1047535
Graduate Intern
Arup

Universities
Delft University of Technology
Faculty of Architecture & the Built Environment
Julianalaan 134
2628 Delft

Faculty of Civil Engineering & Geosciences
Stevinweg 1
2628 CN Delft

Wageningen University & Research
Droevendaalsesteeg 4
6708 Wageningen

Hosting companies
Amsterdam Institute for Advanced Metropolitan Solutions
Building 27W, Kattenburgerstraat 5
1018 JA Amsterdam

Arup
Naritaweg 118
1043 CA Amsterdam

Graduation Committee
dr.ir. M.G.A.D. (Maurice) Harteveld
Lead supervisor
Urban Design
TU Delft

ir. G.K. (Koen) de Clercq
Daily supervisor
Transport & Planning
TU Delft

dr.ir. B.J.M. (Bas) van Vliet
ITAC Member
Environmental Policy
WUR

ir. M. (Matt) Bearden
External supervisor
Sustainable Cities & Transport
Arup

Preface

Ever since I was a kid, I have been fascinated by cities and everything that moves within them. From playing Sim City in primary school to navigating my parents through the Parisian underground as a ten-year old, it was destined that I would do something related to these topics later in life. And so it happened in 2016 when I started my bachelor's in Spatial Planning & Design.

Six years later, I finished this MSc MADE thesis, which I consider the crowning achievement of my studies. It allowed me to merge my passion for cities and transport and to apply all the knowledge, skills, and personal development I gained throughout my time as a student. Looking back, it has been the ultimate opportunity to express my favourite aspects of the field, and to make a tiny but real contribution to the wider body of knowledge.

Considering the latter, it was my deepest motivation to find a topic that piqued my interest, whilst, at the same time contributes to what I consider the greatest challenge of my time: climate change. This thesis, which touches upon various sustainable development goals, is thus intended to give a little nudge towards shaping a better world.

All in all, the whole process has been one that got off to a slow start but turned out to be a highly educational adventure. Therefore, I would hereby especially like to thank my supervisors for their intensive guidance during this process. Maurice, thank you for your role as an experienced lead supervisor and perspectives from the field of urban design. Koen, thank you for your role as the daily process supervisor and perspectives from the field of transport planning. Matt, thank you for your role as a bridge between the academic and professional industry and your perspectives as an industry expert.

I would also like to thank all the other people who have supported me during the process in one form or another, including my girlfriend, family, friends, fellow students from MADE, colleagues from Arup and AMS, all the participants from the Bellamybuurt and not forget, my dear aunt who helped me collect the survey data.

I thank you all and hope you will enjoy the read.

Yours sincerely,

Ydze Rijff

“The difficulty lies, not in the new ideas, but in escaping the old ones, which ramify, for those brought up as most of us have been, into every corner of our minds.”

- John Maynard Keynes
(1883 – 1946)

Abstract

Ever since the reconstruction after World War II, it has become impossible to imagine our streets without the automobile. A car-centred public space has become the status quo, while this appears to have far-reaching consequences for both climate and society. Herefore, the transition toward more people-centric cities is brought into full swing. Stimulating and aggregating the use of shared mobility with mobility hubs is one of the multiple strategic interventions for this purpose. Regarding the latter, significant knowledge has yet been produced and applied, however, little is known about inclusive design in existing neighbourhoods with limited free space. Moreover, existing approaches generally fail to integrate the end-user's needs from the starting phase of the designing process. This thesis develops an approach for this context by putting through a bottom-up design process for a specific testbed in Amsterdam. This case study consists of a literature review bundling existing guidelines for mobilty hubs, the integration of co-creation to tailor the design principles, a subsequent designing phase, and finally testing the designs among a sample from the population. The results showed that there were either additional conditions (e.g. vandalism prevention and late adopter guidance) or that conditions deviated from what was suggested beforehand (e.g. location choice and network density). The subsequent designs generated wide public acceptance, thus proving the method to be successful for this particular case, also emphasising the added value of such a bottom-up approach. Thus, this thesis recommends a similar tailor-made approach in future situations with a more critical note against suggested assumptions from theory. When put in broader context, having executed the process even exposed a possible flaw in the still ubiquitous approach of urban planning in existing neighbourhoods, often struggling to generate sufficient support from society. Hence, this thesis insists that a tailor-made planning approach could be applied more broadly, even for stimulating the wider sustainability transition.

Key words climate change; mobility transition; public space; neighbourhood hub; co-creation; planning; design

List of Abbreviations

AM – Active Mode
CO2 – Carbon Dioxide
CROW- Dutch Centre for Regulation and Research in Civil Engineering and Traffic Technology
DPH – Density per hectare
EV – Electric Vehicle
GHG – Greenhouse Gas
ICE – Internal Combustion Engine
LEV – Light Electric Vehicle
MaaS – Mobility as a Service
NGO – Non-Governmental Organisation
NIMBY – “Not In My Backyard”
OSR – Open Space Ratio
SDG - Sustainable Development Goal

Table of Contents

1 Introduction

This thesis is examining the planning process of neighbourhood hubs in densely populated urban neighbourhoods with limited available public space, from out integrating the perspectives of Urban Design and Transport Planning. Although from this angle, the thesis focusses on respectively the design of public space and the implementation of future mobility systems in a specific testbed in Amsterdam, the problem is set in major global challenges: climate change, the mobility transition, and the domestication of public space. These are underlying the desire to find conditions for urban dwellers to move away from the status quo of a car-based public space, by introducing shared mobility hubs, particular with micro mobility and active modes, in space-poor neighbourhoods.

1.1 Background

Accelerating the decarbonisation of automotive mobility by means of introducing micro-mobility as a worthy alternative is key in order to address the climate problem. As is well known, global warming is significantly influenced by the emission of greenhouse gases, particularly CO2 (Intergovernmental Panel on Climate Change, 2021). Evidently, there is a wide range of sectors responsible for these greenhouse gas emissions but transport alone accounts for a shocking 37 percent of total CO2 emissions for end-use sectors worldwide (International Energy Agency, 2022). This number indisputably highlights the importance of the transport sector in the transition towards a sustainable society. When the impact of transport within an urban context is considered, even more negative externalities of the current transport system come into play, also impacting social and economic factors (Parry et al., 2007). Hence, it is entirely logical that the United Nations has included this matter in their 17 Sustainable Development Goals (United Nations, 2022). This is particularly contained within Goal 9 (Industry, Innovation, and Infrastructure), within which the pursuit of a sustainable urban transport system is a key pillar for achieving these goals. Thus, lightweight micro-mobility and active modes of transport play an important role, because they place less pressure on public space due to their smaller size and generate a significantly lower carbon footprint due to their generally human powered or electric propulsion (Bozzi & Aguilera, 2021)

1.1.1 The mobility transition

The transition away from the fossil fuel car and towards transport systems using more sustainable energy technologies goes together with stimuli of electric vehicles, and shared mobility, next to traditional public transport and active modes of transport. This also adds to global sustainability goals.

Nowadays, people around the world still mainly move around in vehicles with an internal combustion engine (ICE), such as automobiles. According to Munoz (2019), more than 90% of the cars sold worldwide were ICEs and only 9% were Electric Vehicles (EVs). Nearly fifty years ago, Lanzilotti & Blair (1973) already addressed negative externalities coming with the use of ICE-automobiles. Over the years, this issue has been increasingly studied and several reports on the negative externalities of transport (and car use in particular) have been published (Parry et al., 2007; Maibach et al., 2008; van Essen et al., 2020). The most recent version lists congestion-, accident-, noise, pollution-, climate change- and habitat damage costs as the main externalities. In addition, there are indirect up- and downstream consequences, such as water- and soil pollution and energy dependency. Solving or at least mitigating these externalities requires a fundamental change of the urban mobility system. According to (Loorbach et al., 2021), the focus should therefore not merely be on vehicle electrification, but certainly also on stimulating sustainable travel behaviour and choice of transport mode. A one-sided focus on electrification of the vehicle fleet would ignore the other negative externalities that are influenced not so much by the type of engine drive, but rather by the physical characteristics of the car and its application. Examples of externalities that are not necessarily solved by emission-free cars include problems such as traffic congestion, road safety and excessive public space occupation.

Amongst other things, this seems to have been the trigger for the start of the mobility transition: from a regime predominantly based on the dichotomist model including private cars and public transport to a hybrid urban mobility system that still includes public transport, but also more active forms of transport and the use of shared vehicles in the broad sense. Again, the Sustainable Development Goals (United Nations, 2022) support this challenge. Goal 7 aims affordable, reliable, sustainable, and modern energy, to which the transition towards sustainable transport modes such as EVs, LEVs and Active Modes play a significant contribution due to their lower energy consumption.

Canitez (2019) describes this as a socio-technical transition since it is heavily subject to both social and technical factors. Examples of these factors include matters such as government structures and human behaviour, as well as the development pace of electric engines and battery technology. The latter ties in with the reasoning of Martens & Rotmans (2005) that contemporary changes such as the mobility transition, the urgency of which is inextricably linked to the changing climate, require a holistic approach and cannot be solved from merely one perspective.

Furthermore, a transition theory paper from Bergman et al. (2008) argues that human behavioural change has a greaterimpact on socio-technical transitions than technological innovation alone. Thinking that the mobility transition, and especially in the urban context, can just be solved by technology can thus be considered an illusion. The fact that this is expressed in various movements and policies, such as *Paris Sans Voiture* (2014), *Barcelona Climate Emergency* (Barcelona for Climate, 2019) and *Agenda Amsterdam Autoluw* (Municipality of Amsterdam, 2020), indicates that more and more European cities are embracing the transition from this integrated perspective.

1.1.2 Definitions regarding mobility hubs

This section provides background and definitions on the most important concepts that are central to this thesis.

Mobility hub

The concept of a mobility hub that is scrutinised in this thesis could bridge the gap between providing the different modes of transport previously mentioned (LEVs, EVs, AMs) and is in potential a solution to a more sustainable transport system and thus more sustainable cities. However, the concept is easily mistaken due to different interpretations that can be made of it, therefore the concept is first explained from the core. Schemel et al. (2020, p. 4) define a mobility hub as follows:

"In the current transport system, mobility hubs are commonly seen as physical places that connect a variety of transport modes. A mobility hub can be anything from a bus stop and a bike sharing station to an inner-city main train station.".

In essence, this definition covers the scope, but for the thorough understanding of this research, a more in-depth definition is needed. The Dutch knowledge institute CROW (Bekhuis et al., 2021) explains the concept in a broader sense. They argue that, despite its name, a mobility hub is more than just a hub for mobility. At first, apart from established forms of public transport, these hubs often also offer smart, new and/or sustainable forms of mobility, such as shared mobility access via MaaS service providers. Moreover, in larger hubs, the quality of stay and experience is also central besides the main mobility function. A hub can thus be a place of departure, transfer, as well as an end residence. According to the guidelines of CROW (Bekhuis et al., 2021), the emergence of hubs asks us to think about bundling functions and new ways of transport, where car mobility does not always remain the standard. Mobility hubs are seen as places where living, working and recreation will come together in the future. Increasingly, these will be healthy, liveable, and pleasant places with sufficient facilities for stays. These places or hubs thus contribute to a more efficient use of infrastructure, means of transport and transport capacity. Finally, they contribute to more efficient and effective use of space.

Shared mobility

Shared mobility is generally central to the development of mobility hubs, because mobility hubs are in principle part of the strategy to promote vehicle sharing, which ultimately aims to reduce the proportion of private car owners. Shaheen et al. (2015, p. 3) define shared mobility as *"the shared use of a vehicle, bicycle, or other mode"* and classify it as an innovative transportation strategy that is meant to give end-users short-term access to transportation modes on an on-demand basis. Within this strategy, the same vehicle is thus used by several people and fewer individuals own a vehicle. Particularly car sharing is commonly known as it emerged in the late 1980s, and boomed in the recent decade (Shaheen, 1998). Yet, an emerging trend within shared mobility is micro mobility. It is difficult to find a scientifically unanimous definition for this term, but this term generally refers to the transport of people over short distances below the speed of 50 kilometres per hour (Yanocha & Allan, 2019). This could in fact also be done by car but is mainly done by human-powered vehicles (AMs) or light electric vehicles (LEVs) such as (e-)bicycles, e-scooters, and e-mopeds. Encouraging the use of these alternative vehicles is often part of a broader strategy to entice urban dwellers to leave their cars behind, which ultimately contributes to a more sustainable and liveable city (Abduljabbar et al., 2021). Potentially, it could even lead to a further reduction of the utilisation of public space for parking.

Free-floating versus station-based

There are two different network models on which shared mobility and MaaS rely, and effect parking in the public space. These two models are free-floating and station-based. Within a free- floating model, vehicles can be left at any location that the end-user chooses. Within the station-based model, vehicles must be returned to designated stations or areas (Boyaci et al., 2015; Rijkswaterstaat, n.d.). Within the station-based models, a further distinction can be made between back-to-one and back-to-many. The latter provides the opportunity to make point-to-point trips and vehicles can thus be returned to any station, thus presuming recognisable micro-mobility hubs distributed over the city, while back-to-one models only facilitate roundtrips where the vehicle should remain at the same station, one hub. The figure (1) below visualises the differences in network structure.

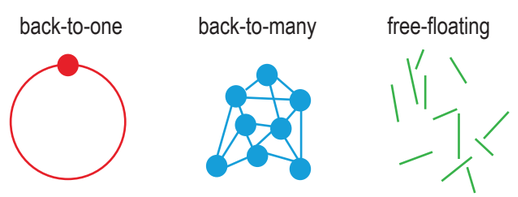


Figure 1. Infographic of different network typologies, illustrated by author

1.1.3 Shifting demand for the utilisation of public space

From a historical perspective, many cities have developed car-based mobility-regimes (Geels et al., 2012). This implies that the public space is literally designed for and around the car. During the emergence of the automobile, it was normal practice to make room for the car in historic city centres. The private car was a symbol of freedom and comfort. The latter is often still considered as perk, but perceived freedom is increasingly being questioned, especially in the urban context (Kunerth, 2020; Meyer, 2011). In recent decades, there has been an increasing movement towards looking at the use of cars in the city differently (Topp & Pharoah, 1994). This transition has everything to do with a different view of the potential use of public space. Alternative transport systems, such as car-sharing systems and micro-mobility limit resource consumption and foster sustainable urban development, because these forms of transport take less parking- and operational space, which fits the shifting demand for the utilisation of public space.

A study from Harteveld (2020) shows that the COVID-19 pandemic has reinforced this changing demand for the use of public space. This follows long-existing trends such as increase of remote working, increase of online shopping and services, increase of appreciation and appropriation of the public space near the house, combined with a decrease in commuting. The study (Harteveld, 2020) uses the case of Rotterdam as an example. During the first weeks of the pandemic, the street life changed dramatically. Everybody had to work from home, resulting in hardly any transport movements taking place. Due to the compulsory closure of almost all facilities, people sought out the outdoor space *en masse* and used this space more than ever for recreation, exercising and socializing. It thus turned out that *"the city is our common house"* (Harteveld, 2020, p. 60). Even though 'normal' life is likely to partially return, Harteveld (2020) explains that there will be fewer long-distance trips and an increased demand for local public space. People's desire to be together and to have public space as an extension of their living room will have a lasting effect on the demand for this outdoor space, leaving plenty of work for the spatial designers of these times.

These trends can be beneficial to the sustainability aims of Goal 11 which endeavours Sustainable Cities and Communities, as cities continue to be hotbeds of diseases, poverty, and greenhouse gas emissions. The benefits that can be achieved by redesigning the public space are significant; according to Nieuwenhuijsen & Khreis (2016), transitioning to more human-oriented city centres with less private car use is likely to have both direct and indirect health benefits, considering the potential reduction of traffic accidents, greenhouse gas emissions and air pollution. Moreover, shifting towards a shared-based mobility system can be a steppingstone for walkable neighbourhoods (Villarino, 2021), which also increases potential for placemaking and pedestrian liveability (Appleyard & Riggs, 2021). According to Zwikker et al. (2021), up to 90% of public space could be freed up in existing neighbourhoods when moving to a station-based shared mobility system.

All in all, these findings are widely embraced and reflected in global policy agendas. UN Habitat's (2022) most recent annual report, for example, notes that covid-19 is a great opportunity for cities to redefine their agendas and strategic frameworks, putting public spaces as key driver of change. Moreover, the International Panel on Climate Change (2022) has embraced this by acknowledging the crucial role of public space for mitigating climate change.

1.1.4 Relevance in the Dutch context

The majority of Dutch cities are undoubtedly among those that have built up car-based regimes over time. For example, the now UNESCO-protected inner city of Amsterdam almost had to endure in the post-war era if it had been up to the planners of that time (van Rossem, 2013). Although most radical plans faced resistance from citizens and did not make it through, car dominance of public space is still pervasive in Amsterdam. Figure 2 on the right clearly visualises this disproportional allocation (Municipality of Amsterdam, 2020).

Given that the population density of the entire country of the Netherlands, at 508 inhabitants/km2 (World Data Bank, 2020), is almost five times the average density of metropolitan areas in the United States of America (109 inhabitants/km2) underpins the scarcity of public space in the Netherlands (Center for Sustainable Systems, 2021) and the urgency to use this space in an efficient and sustainable manner (Ministry of Home Affairs and Kingdom Relations, 2020).

Figure 2 is limited only to land take per vehicle mode, but one could also consider transport capacity per mode as well, which again results in a negative image for the automobile. Figure 3 clearly depicts the inefficiency of mixed traffic in relation to other modalities of urban transport (Botma & Papendrecht, 1991).

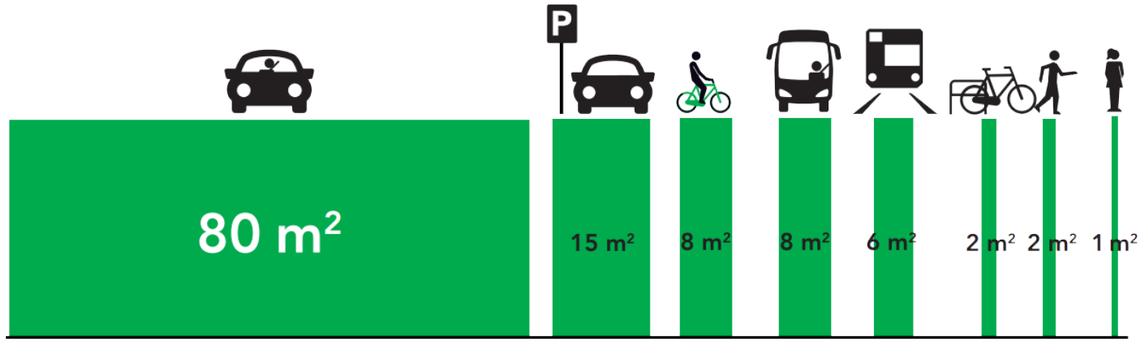


Figure 2. Land take per modality in Amsterdam (Municipality of Amsterdam, 2017)

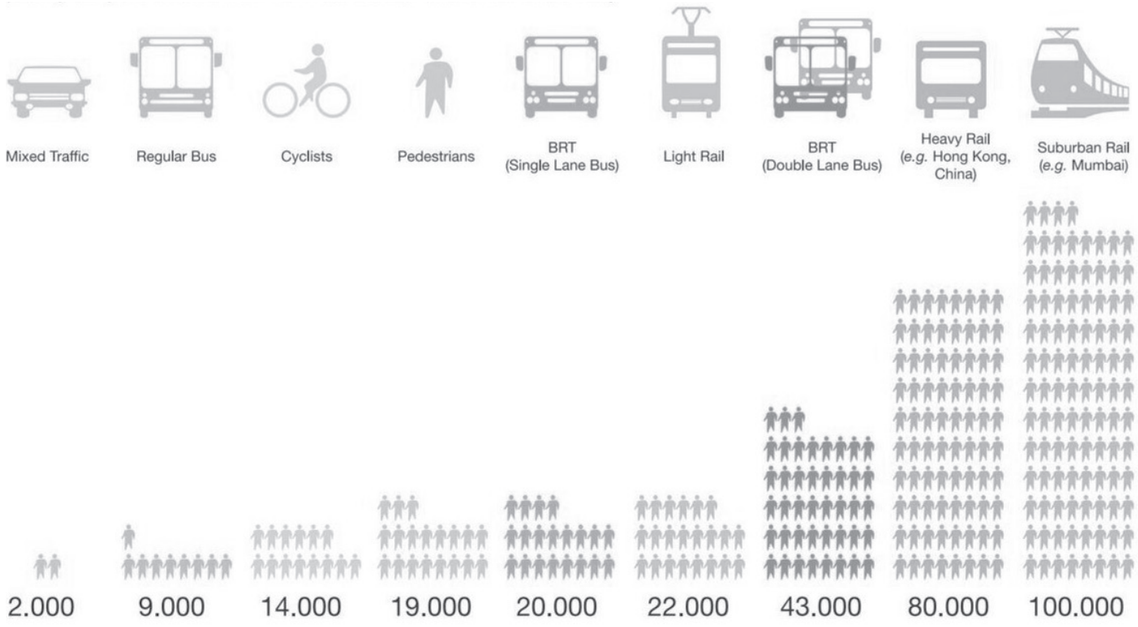


Figure 3. Corridor Capacity: people per hour on 3.5-meter-wide lane (Botma & Papendrecht, 1991)

1.1.5 Scope of the study: space-poor urban neighbourhoods

The figures on the previous page stress the urge to break this regime in cities overall, however, there are specific urban neighbourhoods in which the dominance of cars seem to have the strongest implications. These are particularly the pre-war neighbourhoods situated close to the historical city centres. These neighbourhoods are typically densely populated, have little unoccupied public space and limited climate adaptive capacities, such as urban greenery.

Examples

Figure 4. Bellamybuurt, Amsterdam. Picture from Hasebroekstraat (Google Streetview, 2022)

Figure 5. Zeeheldenkwartier, the Hague. Picture from Heemskerck-straat (Google Streetview, 2022)

Figure 6. Oude Noorden, Rotterdam. Picture from Gerard Scholten-straat (Google Streetview, 2022)

Figure 7. Wittevrouwen, Utrecht. Picture from Griftstraat (Google Streetview, 2022)

Test-site: Amsterdam, Bellamybuurt

The city of Amsterdam is a progressive municipality in the Netherlands with regards to the mobility transition, with coherent policy agendas for clean air (Municipality of Amsterdam, 2019a), phasing out cars in the city centre (Municipality of Amsterdam, 2020) and implementing smart mobility (Municipality of Amsterdam, 2019b). With this, the city recognises the climate challenge and serves as an interesting case for this thesis. In particular, this thesis zooms in on the Bellamybuurt. This neighbourhood is located on the western edge of the city centre and fits perfectly into the picture of a neighbourhood where there is much to be gained if the residents were to be moved to a more sustainable mobility pattern.

The Bellamybuurt is a densely populated neighbourhood and inhabits a young population, most of whom are highly educated. In addition, there is relatively little car ownership, while about half of the public space is still reserved for private cars (PDOK, 2022). Densely populated areas generate high demand due to high parking pressure (van Hack et. al, 2021) and since the early adopters of mobility hubs are pre-eminently young and highly educated people, it is likely that the concept will catch on more quickly in such an area (Bosehans et. al, 2021). This combination of factors indicates a high potential for the successful rollout of mobility hubs.

Chapter 4 (Context Analysis) describes a deeper analysis of the testbed but is easier understood after reading the problem statement and theoretical framework. Therefore, this analysis is explained in more detail later in this thesis.

Map 1. Location reference of testbed, illustrated by author

1.2 Description of the problem

This section describes the problem underlying this research and addresses the scientific and societal relevance of this research. Furthermore, the ethical considerations are stated, and the research questions are described.

The concept of a mobility hub is frequently mentioned nowadays. It is widely praised as an important contributor to the mobility transition, in which a fundamental transition to a sustainable mobility pattern also requires a different layout of public space. Over the past years, various research has been conducted on frameworks for successful mobility hubs, both nationally (Bekhuis et al., 2021; van Hack et al., 2021; Zwikker et al, 2021) and internationally (Benison & Anderson, 2021; Roberts, 2019). These frameworks provide a comprehensive picture of which spatial and functional characteristics are crucial for success, which developing stakeholders need to be involved and which steps need to be taken for implementation.

However, these frameworks usually emphasise the development and implementation of these hubs in new housing developments, or in areas where there is no extraordinary shortage of space, such as in the outskirts of the city. Both van Hack et al. (2021) and Bekhuis et al. (2021) stress that the challenge lies in implementing mobility hubs in existing neighbourhoods, predominantly in inner cities where the available public space is scarce, such as the Bellamybuurt.

In these areas, a certain lifestyle already prevails where residents have their established needs and habits. In places like this, an existing function of the public space often must be removed in order to make room for the mobility hub. In many cases, the choice then falls on the sacrifice of street parking spaces, which often results in a fuss from private car owners (Zwikker et al., 2021). This can be regarded as unfortunate, as it is precisely in these areas that there is much public space to be gained by mobility hubs and that the implementation of a different mobility pattern could have a significant positive impact (Glotz-Richter, 2016).

Zwikker et al. (2021) conducted research on the potential of mobility hubs in existing neighbourhoods of the five biggest Dutch cities. In this study, the focus is on which typologies would be appropriate here and where they could be spatially implemented in theory. However, this study also identifies the difficulty of implementing smaller scale hubs in these existing neighbourhoods but does not elaborate on how this bottleneck could be circumvented. Not surprisingly, there are still numerous examples of existing neighbourhoods where a car-free mobility strategy is advocated, but where political resistance or NIMBY-voices subsequently arise when it turns out that this will be at the expense of car parking spaces (Claus, 2019; Kirschner & Lanzendorf, 2020).

Hence, the question remains what planning strategy should be adopted and whether other requirements may need to be imposed on these hubs in this type of situation. This is in line with the statement of Scholten et al. (2021) that the organisational issue is constantly underexposed, while this is a crucial element for the proper functioning of mobility hubs.

Problem Statement

"Mobility hubs are a ubiquitous phenomenon in contemporary strategies for sustainable mobility and reclaiming public space. These mobility hubs come in different shapes and sizes, as there is no one size fits all principle in this matter. In previous research, many frameworks for planning and designing mobility hubs have been developed, especially aimed at implementation in new construction projects or places where there is no explicit lack of space. However, little research has been done on implementation of particularly open air- and smaller scale hubs in existing neighbourhoods where there is a lack of space. Here lies the problem setting, and thus the metropolitan challenge. It is precisely in these neighbourhoods that neighbourhood hubs can be of significant added value, but at the same time are also met with societal resistance and it is not known how a compromise could here be reached. Hence, this thesis aims to find the conditions for this compromise so that moblity hubs could also be applied as an inclusive strategy in this context."

1.3 Research Questions

How should neighbourhood hubs be planned and designed in order to gain societal acceptance for their realisation in existing neighbourhoods with limited available space?

What are existing planning approaches for mobility hubs and how can they be combined into an initial planning framework for realising neighbourhood hubs in existing neighbourhoods with a lack of available space?

What are the perceptions of societal stakeholders towards neighbourhood hubs and how do these values adapt the initial planning framework?

What are possible typologies and optimal network structures for neighbourhood hubs, bearing in mind the adapted planning framework?

To what extent do the proposed designs find societal support amongst the residents of the testbed and what lessons can be learned for the planning framework?

1.4 Societal relevance

Given the prospective catastrophic consequences of climate change (Intergovernmental Panel on Climate Change, 2021), mitigating this crisis is in everyone's interest, as the long-term physical consequences may fall on everyone's plate in one form or another. Any form of research that contributes to shaping a more sustainable world is therefore in society's interest. Given the nature of this research to ultimately contribute to a more sustainable mobility pattern and climate-proof public space, this research can also be placed in the list of research that contributes to a more sustainable world.

Moreover, in the long term, this research may contribute to a fairer distribution of public space, which is currently very unevenly distributed in the Netherlands (Milieudefensie, 2017), while there is at the same time an increasing demand for a different distribution of this outdoor space (Harteveld, 2020).

According to a study by Zwikker et al. (2021), in existing neighbourhoods, which is the focus of this thesis, up to 90% of the public space can be regained by implementing a successful mobility hub network. Let it be precisely those neighbourhoods with a scarcity of public space, where there is little knowledge of how to implement here with a broad base of support.

1.5 Scientific relevance

Judging by the many frameworks that have been developed for planning mobility hubs (Bekhuis et al., 2021; Benison & Anderson, 2021; van Hack et al., 2021; Tran & Draeger, 2021; Zwikker et al., 2021), it becomes clear that a great deal of research has been done into what functions could go into a mobility hub once it is allowed to be realised. It is widely known that these hubs should become more than just a transport hub, but also a pleasant place with additional functions for the surrounding area.

However, there is little knowledge about how small-scale mobility hubs should be planned in existing neighbourhoods where the public space available for their realisation is scarce. In these neighbourhoods, societal resistance is often encountered when existing public space facilities are planned to be sacrificed for the sake of new mobility hubs (Bekhuis et al., 2021; Claus, 2019; Kirschner & Lanzendorf, 2020, van Hack et al., 2021; Zwikker et al., 2021). Furthermore, these existing planning frameworks tend to be solely data-driven (Tran & Draeger, 2021) or involve the end-user only at an advanced stage of the process.

Thus, the academic relevance of this research is two-fold. On the one hand, this research tests a novel bottom-up method of planning mobility hubs in existing neighbourhoods, thus enriching the knowledge in this field. On the other hand, this research aims to identify and map the motivations and conditions of a group of residents in such a neighbourhood, which may allow a better response to the needs of similar contexts in the future.

1.6 Ethical considerations

The issue of changing the layout of public space is a politically sensitive issue. Therefore, it must always be made clear to all parties participating in this study, that the results of this study will not have any direct effects on their municipality's policy or the physical layout of their public space.

Furthermore, given that this research is being conducted from three different motives, namely those of graduation (author), science (universities and research institute) and professionalism (Arup), it is important that the reliability of this research always remains paramount and that any possible conflicts of interest do not interfere with it.

2 Theoretical Framework

This chapter describes the theoretical basis for this study, by synthesising different frameworks and concepts related to the planning and development of mobility hubs. The conceptual model (Figure 8) describes how these theories and concepts related to mobility hubs and their planning frameworks relate to each other, thus providing a direct overview of the coherence of the concepts used in this thesis. Hereafter, the different concepts are set out in more detail.

2.1 Conceptual Model

In light of the overall aim of this thesis, which is to develop a planning framework for a specific context, this model forms the starting point for building this method. During the research process and based on the results of the data collection and analysis, this framework will be scrutinised and further improved to produce a framework that is applicable to the planning of neighbourhood nodes in existing urban neighbourhoods with a lack of available space.

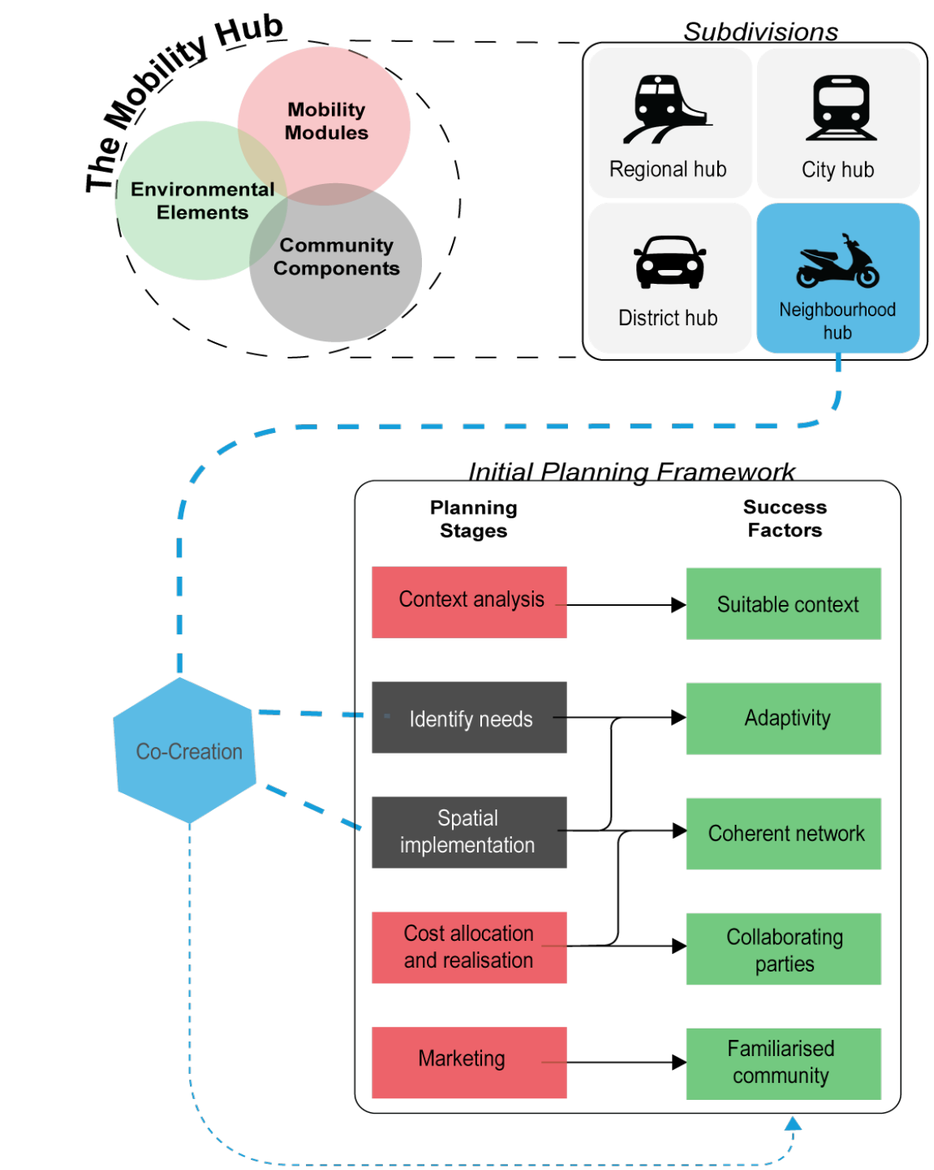


Figure 8. Conceptual model, illustrated by author

2.2 Core functions of mobility hubs

This section describes the core functions of mobility hubs as described by the framework of Benison & Anderson (2021) and is supported by other sources. These elements are crucial for conveying the functions that mobility hubs have for society and the environment and to so reach the general objectives of mobility hubs to create inclusive mobility, healthy streets, and vibrant neighbourhoods.

Mobility modules

The mobility modules are central to the design of the mobility hub and depicts its primary function. The primary function of a mobility hub is to provide its environment with sustainable mobility services that can meet residents' needs for urban transport and, in the long run, can also be an alternative to the private car. It is this element of the mobility hub that facilitates the possibility for people to switch from one (shared) modality to another, where walking is also counted as a modality. Furthermore, the mobility functions are crucial in order to realise the integration of shared mobility in urban space. The latter is key to reclaim street space, which gives a significant contribution to the mobility transition, according to Glotz-Richter (2016). Depending on the context and mobility needs of surrounding residents, a hub offers a variety of modalities consisting of Public Transport, EVs, LEVs and bicycles. Depending on the size of the hub, this ranges from a large hub with a combination of all the modalities to a smaller hub limited to tiny vehicles such as LEVs and bicycles. (Ministry of Infrastructure and Water Management, 2021).

Community components

Besides the primary mobility function of a mobility hub, there is another large potential that can be exploited, as it is directly connected to public space. This potential lies amongst other things in the integration of facilities for the community. Due to the large amount of space that is potentially freed up, there is the possibility of giving other facilities in return. This is also important in the context of placemaking, as according to Klekotka & Hiniker (2021), the mobility hub of the future must be a safe, comfortable, and accessible environment that offers a welcoming and positive experience. Community components are physical elements in or around the hub that aim at serving social, cultural, and leisure purposes (Bell, 2019). Examples include adding artworks, lockers or charging stations to the mobility hub. According to Zaręba et al., 2016), including such societal functions could facilitate local identity and contribute to social cohesion in the neighbourhood. Depending on the size of the hub, it can turn into a neutral centre that brings the community together and strengthens it, which according to (Bovenhoff & Meier, 2015) is important in times of increasing individualisation.

Environmental elements

The third core function of mobility hubs are its environmental elements. An important pillar in contemporary guidelines for the design of public space is to make these spaces climate adaptive (Ministry of Home Affairs and Kingdom Relations, 2020). The new mobility hubs therefore also have a role to play here. Besides the mobility and community functions, environmental elements could be added to contribute to greening and biodiversity of the city, along with making the places healthy and integrated with their environments (Benison & Anderson, 2021). Examples of such elements include flower gardens or greenbelts. Besides the earlier mentioned climate problem, metropolitan environments also tend to get hotter due to high densities of pavements, buildings and other surfaces that absorb and retain heat. This effect is also known as the Urban Heat Island effect and can be reduced by putting heat mitigating measurements in place, such as increasing the amount of greenery (Mabon & Shih, 2018). Moreover, increasing the amount of urban greenery has additional benefits for the urban fabric. These benefits include positive impact on socio-economic, cultural, aesthetic, and environmental aspects such as property value, historical identity, and biodiversity (Virtudes, 2016).

Figure 9. Example of multifunctional hub conceptualisation (Mobipunt, 2022)

2.3 Subdivisions of mobility hubs

Bekhuis et al. (2021) distinguish four types of hubs:

Medium scaled hubs outside the city centre in a built entity. Usually smaller train- and bus stations or locations where people can transfer from the car to public transit. ..... *Regional*

Big scale hub within the city centre in a built entity. Often an intercity train station, supplemented with other urban modalities such as buses, trams and metros. ..... *City*

Small scale hub serving a city district in a built entity. Often situated on the edges of neighbourhoods with a low parking norm. Usually offers a large (50-500) mix of shared vehicles and micro mobility modes. ..... *District*

Smallest scale hub serving parts of city districts on a street level, in both unbuilt and built entities. Typically offering a small number of shared vehicles or micro mobility modes ..... *Neighbourhood*

Figure 10. Subdivisions of mobility hubs

Given that the focus of this thesis is predominantly on neighbourhood hubs, these are to be set out in more detail. When the conceptualisation of Bekhuis et al. (2021) is paralleled with the conceptualisations of Zwikker et al. (2021), they can be further distinguished into two scales:

Small hub

- unbuilt or built
- 200-meter catchment
- 20-30 vehicles
- cars, bikes, scooters

Figure 11. Small hub typology (Zwikker et al., 2021), purple = small hub

Micro hub

- unbuilt ground level
- 100-meter catchment
- 5-10 vehicles
- bikes, scooters

Figure 12. Micro hub typology (Zwikker et al., 2021), purple = micro hubs

Example of micro hub

Figure 13. Example of a micro hub in Amsterdam

2.4 Success factors of mobility hubs

This section combines several frameworks (Benison & Anderson, 2021; Bekhuis et al., 2021; van Hack et al., 2021; Zwikker et al., 2021) developed for successful mobility hubs and integrates them into success factors applicable within the Dutch context.

Suitable context

The context is of indisputable importance for the functionality of mobility hubs. First, the size of the surrounding area is important. A highly sprawled neighbourhood with few residents in its vicinity is not likely to bring about a significant demand for shared mobility. The framework of van Hack et al. (2021) applies the rule of thumb that a mobility hub should be surrounded by at least 100 houses in order to be viable.

Furthermore, the demographics of a neighbourhood are decisive. Various studies (Bosehans et al., 2021; Burghard & Dütschke, 2019; Reck & Axhausen, 2021) have shown that highly educated people aged between 18 and 30 who do not own a car are most likely to use shared mobility in the earliest stage. This is not to say that there are no other target groups using the mobility services that could be offered at a hub, but the so-called early adopters are crucial for using and thus informally advertising the concept in the start-up phase. Following the example of the early adopters, highly educated people that do have a car or, for example, families with children are likely to adopt the new concept. This is the so-called early majority. Hereafter, the late majority, and laggards will eventually pick up the concept when it has become the new norm. These groups tend to include elderly, less educated or single households. Based on the Diffusion of Innovation (DOI) theory from Rogers (1995), Bosehans et al. (2021) explain in what proportion these different groups take up such a concept in relation to the market share (figure 11).

Other context-related factors important for the functionality are the applicated parking policies. A neighbourhood with high parking pressure and a low parking-norm generates more demand for shared mobility than vice versa (van Hack et al., 2021). The crux, however, is that it can also be more difficult to find suitable locations for mobility hubs in these types of neighbourhoods (Zwikker et al., 2021).

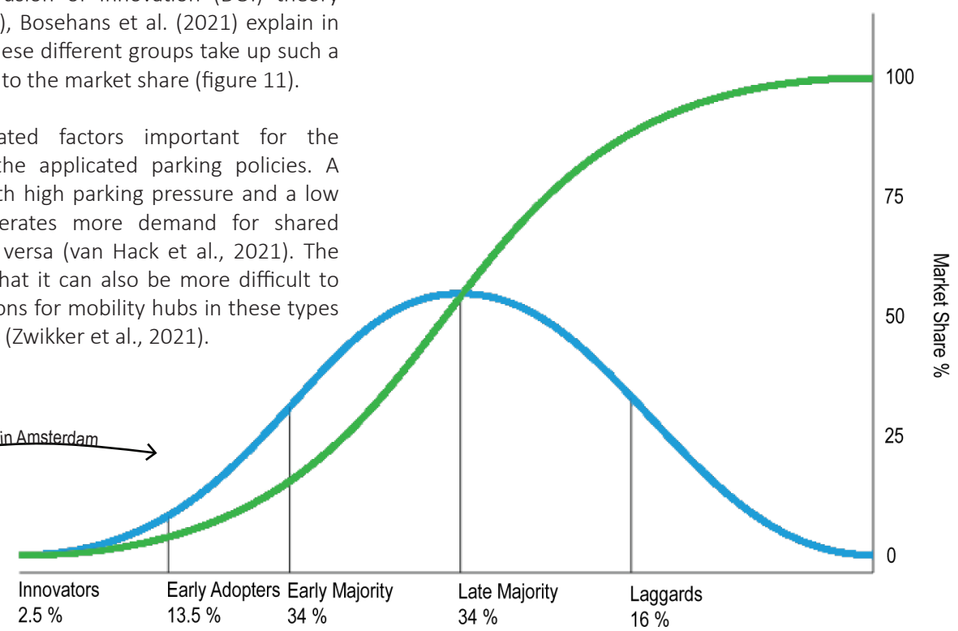


Figure 14. Adopter categories based on DOI Theory (Rogers, 1995). Published by Bosehans et al. (2021).

Adaptivity

The success factor of adaptivity refers both to the flexibility in composition of the hub at the start and the adaptability of this composition over time. To begin with, the offer of these mobility hubs must be attuned to the wishes and needs of the surroundings (van Hack et al., 2021; Benison & Anderson, 2021; Klekotka & Hiniker, 2021). For example, a neighbourhood with many students and starters has a fundamentally different modal preference than a neighbourhood inhabited mainly by retirees and the elderly. It is therefore crucial that the types of mobility modules are adapted accordingly.

In addition to the mobility modules, other facets such as the community and environmental functions must also be adapted to the context. According to Benison & Anderson (2021), it is important that a mobility hub also blends with the context in terms of aesthetics. Thus, it is desirable to, for example, use the same colours and building styles as in the surrounding area, thus avoiding an unnatural mix of designs. This also tends to reduce the triggering of NIMBY resistance from residents.

With regards to the adaptivity of mobility hubs over a longer time span, it is important that they can adapt to changing mobility needs due to whatever reason. Moreover, in the context of circularity and decarbonisation, it is not desirable that public space requires to be redesigned repeatedly. Therefore, the guiding principle in this regard should remain to keep the public space functional for as long as possible with as little effort as possible.

Coherent network

A coherent network of mobility hubs in different sizes, ranging from city hubs to neighbourhood hubs, is important for multiple reasons. At first, the interplay of these different facilities improves the accessibility and flexibility of the system. A large and cohesive network of hubs extends the reach and ensures that more groups have such a hub in their immediate vicinity (Bekhuis et al., 2021; Zwikker et al., 2021). In addition, for back-to-many systems to function properly, it is important that a user has many choices of where to park their rented vehicle upon return. If there is no coherent network and therefore only few places where an end-user can also return his vehicle, it is likely to merely function as a back-to-one system where the user always must return his vehicle at the same location. In practice, this does not meet the needs of many end-users, as many trips are intended to be made from point-to-point (Choi et al., 2021). Moreover, a coherent network is important in case a hub appears to be full because the end-user is then able to choose another hub for closing the rent.

Furthermore, a coherent network is important to provide a certain guarantee of availability. If urban residents wish to use shared mobility, there must be some guarantee that this shared mobility will be available to them there. Of course, this cannot always be achieved with complete certainty, but a coherent network does contribute to the certainty that there is a suitable means of transport nearby (van Hack et al., 2021; Tran & Draeger, 2021). The optimal density of this network cannot be stated unanimously and seems to depend strongly on the context and maximum willingness of the residents to walk.

Collaborating parties

According to Bekhuis et al. (2021), the fruitful collaboration of parties is crucial for the success of mobility hubs. Sijtsma et al. (2021) distinguish three types of parties involved in the development of mobility hubs: traditional mobility parties, market parties and supporting parties.

Traditional mobility parties predominantly involve policy making. They provide guidelines for the realisation of hubs and set requirements in various areas such as legislation and regulation, infrastructure management and investment agreement. These parties are generally local- and or regional governments but could also include traditional transit authorities such as the NS. Market parties are the parties capable of building the facility or offering the service. These typically include the MaaS providers but might also be project developers or electricity suppliers. The supporting parties are parties that contribute to successful exploitation of mobility hubs. These include NGOs such as area advisors.

Type	Role	Example(s)
Traditional Mobility Parties	Policy making	Various governments, Public Transit authorities
Market Parties	Providing facilities and/or services	Electricity supplier, MaaS provider
Supporting Parties	Supporting	NGO's

Table 1. Summary of collaborating parties during development of mobility hubs.

The development and operation of mobility hubs can thus be seen as an interplay between government and market. The figure (15) below describes a set of government and market stakeholders to be potentially involved within a Dutch context, dependant on the site and scale of the hub. A striking fact in this is that the end-user is left out of the equation here.

Figure 15. Political and corporate stakeholders in development of mobility hubs (Sijtsma et al., 2021)

Yet another important reason for parties to collaborate, is to be able to facilitate a diverse supply of modalities. A wider range in this ensures that you can serve more people from the adjacent community and is therefore also part of the crucial success factor (van Hack et al., 2021).

These collaborating parties should, however, not be confused with the entire set of stakeholders involved with mobility hubs. These stakeholders are site- and scale dependent and include the end-users of the mobility hub. The complete group of stakeholders for the realisation of mobility hubs in a specific case could be a combination of:

- a selection of parties from the scheme
- a selection of end-users that represent the population in a specific site.

Familiarised community

The last success factor that is put forward by Bekhuis et al., (2021) and van Hack et al. (2021) is that the community should be familiarised with the concept of mobility hubs. Once the hub is realised, name recognition and awareness must be generated that the facilities are there so that the community will be intended use them. This is in line with the argument of Bosehans et al. (2021) about how different groups of people tend to adopt the concept within a different frame of time. Informing the community aims at involving the early majority with the emerging concept. Zwikker et al. (2021) sets out two growth strategies for this, namely, to start with a few small-scale hubs, after which more hubs can be built. The other strategy is to create a large hub at the very beginning, generating a lot of publicity and eventually adding more small hubs to the network. What is striking here is that the focus seems to be on generating awareness for plans already been lined out, rather than prior to or during the development process of a mobility hub.

2.4.1 Summary of initial success factors

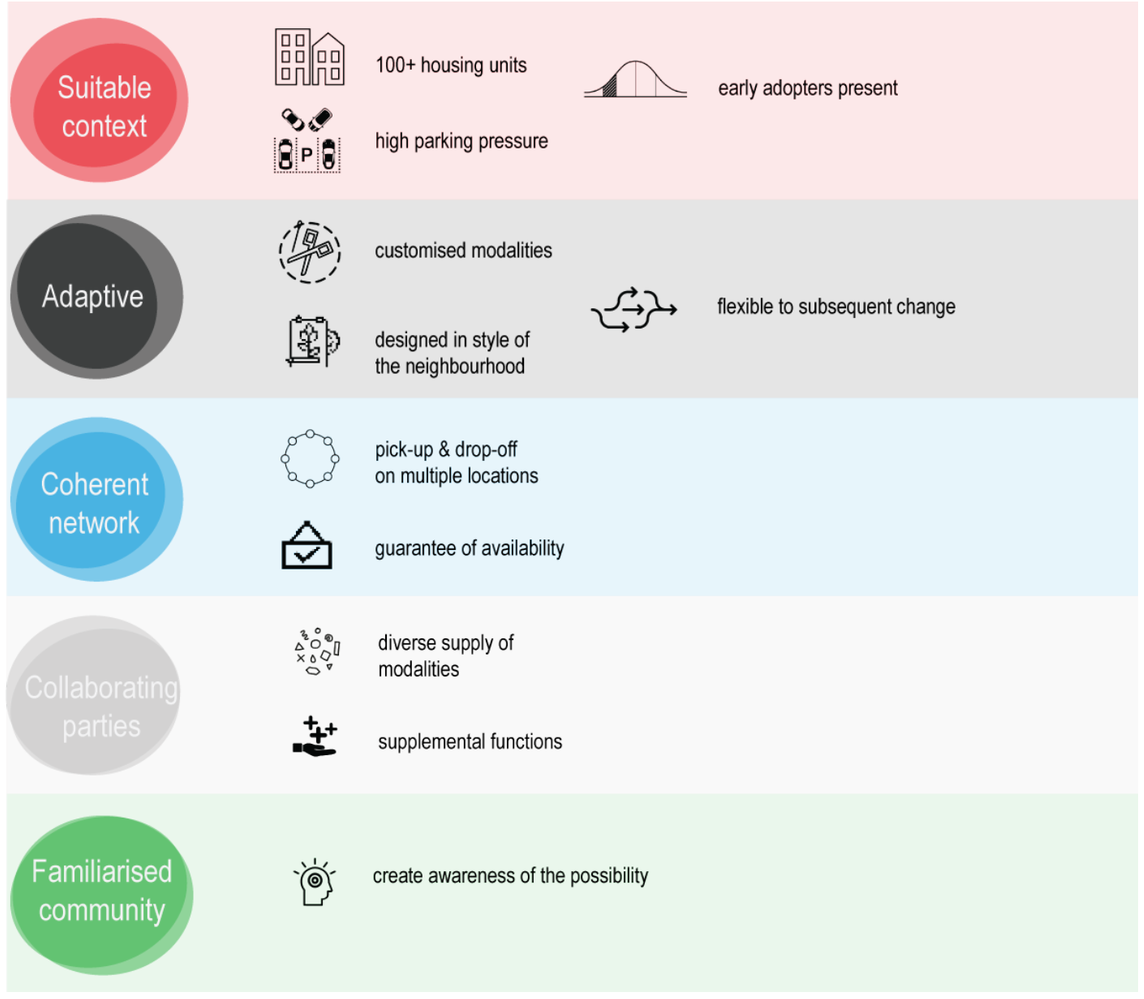


Figure 16. Summary of initial planning framework, illustrated by author, icons from The Noun Project (2022)

2.5 Stages of the planning process

This section identifies the components of the planning process, but does not yet elaborate on the exact order, as these slightly vary from one method to another.

Context analysis

This part of the planning process is where the context is analysed and subsequently judged whether it is potentially suitable to habit a successful mobility hub (network). This component consists of analyses such as stakeholder identification, demographics, and spatial characteristics.

Identifying needs

This is where the specific needs of the end-users are identified. In this phase, a determination is made which mobility modules are demanded within the neighbourhood and the demand for any additional community and/or environmental elements are investigated. These needs are generally identified based on secondary data analysis or equivalent desk research. Sometimes surveys are used, but rarely is an interactive dialogue established with end users at this stage. This conflicts with the paper of Enbel-Yan & Leonard (2012) that stresses the importance of interdisciplinarity and collaboration in planning in order to achieve successful station areas.

Spatial implementation

This phase is only emphasised in detail in the framework for existing neighbourhoods of Zwikker et al. (2021). In other types of development, such as where there is a lot of free space or a neighbourhood is built from scratch, this phase is of minor importance.
Nevertheless, in the framework of Zwikker et al. (2021), it mainly discusses where all types of hubs could theoretically fit in. For neighbourhood hubs, they here argue that existing parking spaces are preferable, but pays little or no attention to the interests of the end user in this respect. This could indicate a shortcoming, considering the potential of integrating shared mobility in public space for the mobility transition (Glotz-Richter, 2016) as well as the argument of Enbel-Yan & Leonard (2012) that transportation cannot be seen separately from its surroundings.

Cost allocation and realisation

This phase is about making the hubs a reality and which parties are foreseen to cooperate in this. This is mainly a debate between the organising stakeholders, where it is also decided how the costs will be shared.

Marketing

This phase is about getting the community acquainted with the neighbourhood where the mobility hubs will be realised. Shared mobility is not yet an inclusive concept and so it is not obvious that every member of the community is already familiar with it. To make sure that this does happen, and the majority develops intentions to use the concept, the word must be spread. However, this usually happens after the master plan has been completed and, at that point, the end users no longer have any say in the content of the development plans.

2.6 Existing planning process approaches

The three planning process approaches drawn in parallel in this section are the planning approach for new neighbourhood developments from *BouwInvest, Hely & ParkBee* (van Hack et al. (2021), the planning approach for existing neighbourhoods from *Sum-One, PosadMaxwan, APPM & Vereniging Deltametropool* (Zwikker et al., 2021) and the planning approach for hubs centred around bus stops from *Arup & Go-Ahead* (Benison & Anderson, 2021).

The order in which the planning of mobility hubs is sequenced, differs between the frameworks. However, when attempting to identify a pattern within these sequences, a tendency can be observed that most methods start with the identification of context and needs, based predominantly on data and desk research. The phase in which efforts are made to involve stakeholders and make them acquainted with the mobility hub concept seems to take place mainly towards the end phase of the planning.

2.6.1 Comparison of planning approaches

Step/ Framework	New neighbourhood developments (van Hack et al., 2021)	Centred around bus stops (Benison & Anderson, 2021)	Existing neighbourhoods (Zwikker et al., 2021)
1st	Identifying context, such as parking pressure, target group and size of the proposed hub	Identifying core mobility modules demanded by the target group and realise these elements around the existing bus stop	Perform a site analysis in order to identify the context and demographics in the existing neighbourhood.
2nd	Identify mobility needs based on the potential users in the neighbourhood that is to be built	Expand the mobility hub with community- and environmental elements, based on the needs of users that started utilising the hub on a daily basis.	Examine where mobility hubs could be spatially implemented in theory, based on the spatial characteristics of the neighbourhood.
3rd	Actively market for the planned mobility hub in order to get future residents acquainted with the concept	Complete the hub with any additional elements demanded by the users.	Formulating a strategy how to grow the hub network and how to arrange cost coverage and realisation.

Table 2. Comparison of existing planning approaches

2.7 Co-creating sustainable cities

Mobility consultants Sijtsma et al. (2021) of management consulting firm APPM confirm the contemporary tendency in planning mobility hubs. The foundation of most plans is laid through traffic analyses and location choices based on desk research. This means that not all relevant parties are involved from the start, which is in line with the frameworks discussed earlier in this paper, where this trend is also reflected. As a response, Sijtsma et al. (2021) propose to incorporate the Mutual Gains Approach from Massachusetts Institute of Technology and Harvard (Susskind & Field, 1996) into the process. This approach entails the integration of all relevant developing stakeholders from the beginning of the process, through which can be worked on a shared vision and shared value with regards to the development of mobility hubs. However, this is still primarily focused on the collaboration of developing stakeholders and not on the end-user group within the proposal of Sijtsma et al. (2021).

An approach that does integrate end-users from the starting phase is the AMS way of working from Sena & Meesterberends (2018). This approach starts with identifying the target group and a method to involve them, in order to end up with a shared vision and goal. When drawing this approach in parallel with a designing method, it is much alike Design Thinking (Razzouk & Shute, 2012) and the Double Diamond method (figure 17). This method entails starting with having empathy for your stakeholders, then designing and ultimately testing the design amongst the stakeholders.

This element of co-creation is therefore precisely the part that in this research is blended into the existing framework, resulting in those components of the planning process are approached in a different way, which is depicted in more detail in the conceptual model.

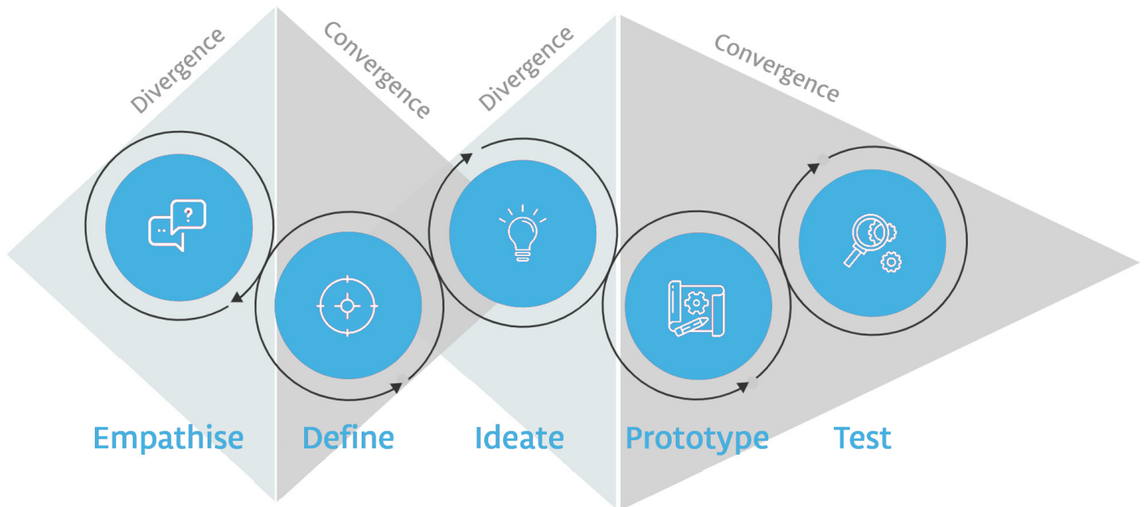


Figure 17. Visualisation of double diamond method in design thinking (MSG Group, 2022)

Amsterdam Centraal, photo by ©Moritz Ludtke

3 Methodology

This section describes the overall research strategy elaborates on the methods applied in order to answer all the research questions in this thesis.

3.1 General Research Strategy

The overall aim of this research is to develop a framework for planning neighbourhood hubs in the specific context of space-poor neighbourhoods where this is not yet widely established. The first step in this strategy was to bundle existing frameworks that were originally purposed for other contexts and utilize these components as a starting point for the new context. These components are, together with a novel element of stakeholder engagement in the form of co-creation, compiled into a draft framework for planning neighbourhood hubs in existing neighbourhoods with a lack of available public space. This draft framework is the conceptual model as shown in the previous chapter. In order to scrutinise the draft framework and iterate it into a suitable planning method applicable to the new context, the framework is applied to a case. As mentioned afore, the case neighbourhood is the Bellamybuurt in Amsterdam. The subsequent step is to analyse the context and stakeholders of this case neighbourhood. Hereafter, a few minor alterations to the draft framework are made, because some of the components appeared to be irrelevant or unapplicable to the Bellamybuurt.

Next, the stakeholder engagement phase took place. Since the focus of this thesis is on finding societal acceptance, the stakeholders this project focuses on are from the societal side of the stakeholder spectrum. In other words, the stakeholders engaged are a representative group of the residents from the Bellamybuurt. By taking this cross-section of the population, an attempt is made to include as complete a picture as possible of all the different perspectives on mobility and public space. By means of conducting a set of semi-structured interviews with these residents, every individual is asked about their perspective, whereafter these findings are coded and analysed in order to integrate them with the draft framework. In this way, the draft framework is iterated and adapted to the specific wishes and needs of the testbed.

This iteration of the framework, hereafter, functions as the starting point to build upon for the design of a neighbourhood hub network in the Bellamybuurt. This draft design consists of a map of the neighbourhood, showing where all the hubs would be located and several visual impressions showing how these neighbourhood hubs would blend into the public space, using several typical examples.

Lastly, a simplified infographic of the design principles that resulted from the semi-structured interviews, together with the design proposals, are shown to a wide range of citizens in the Bellamybuurt. By means of an online survey, consisting of the adapted principles and proposed designs, the citizens are asked about their opinion towards this bottom-up generated plans. In this way, the effectiveness of the method is measured with regards to successfully building proposals that find societal support and the extent to which the invited stakeholders form a representative group of setting planning conditions for the population in the entire neighbourhood. Furthermore, an additional element is added to the survey, through which the impact of visual communication on the citizens perception is measured.

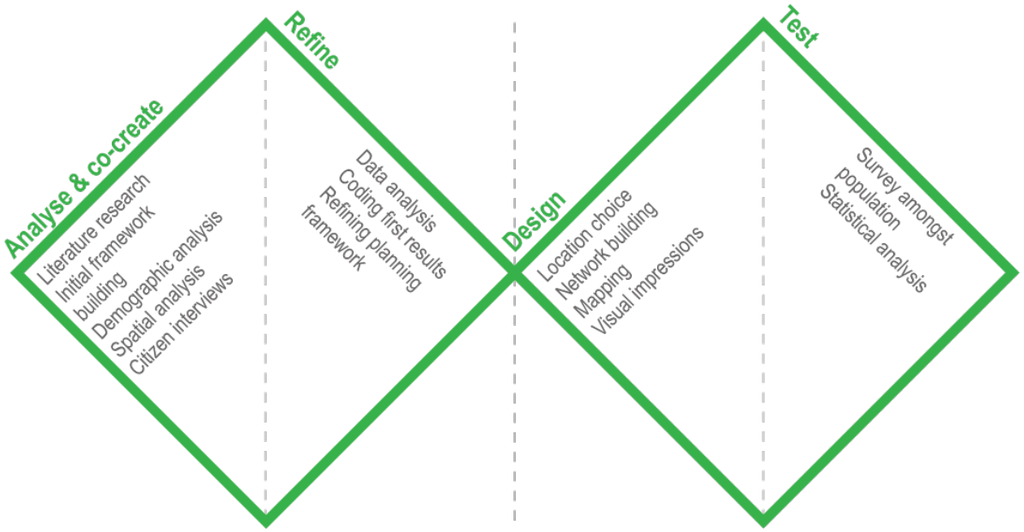


Figure 18. Double Diamond model applied, illustrated by author

3.2 Collection of secondary data

Literature research

By means of literature research, a combination of peer-reviewed academic papers, policy documents, reports, and websites were consulted in order to summarise existing knowledge concerning the topic. By doing so, the underlying motivations for this thesis are underpinned and all relevant definitions are explained. Furthermore, literature research is used in order to build up the theoretical framework and compare several existing planning frameworks for mobility hubs.

Site analysis

This method of secondary data collection consists of analysing the case neighbourhood on its characteristics. Within this analysis, an overview is given on various underlying factors that lay the foundation for the context worked with in this neighbourhood. This analysis consists of a historic context, demographic data, current land uses of public space and current micro mobility use. This data is collected through internet search, existing reports, statistical- and spatial data, and is represented in the form of text, pictures, infographics, and maps of the neighbourhood.

Stakeholder analysis

The stakeholder analysis consists of a demographic analysis of the Bellamybuurt, which gives an indication for the composition of a representative group of citizens. This group of citizens reflects a representative image of the population in the case neighbourhood and forms the basis for the stakeholders invited for the interviews.

The stakeholders that are involved in the development and operation of potential neighbourhood hubs are left out of the analysis, since researching market- and governmental parties are not within the scope of this research.

3.3 Collection of primary data

Semi-structured interviews

The first phase of primary data collection is meant to gain the end-users perspective towards the concept of mobility hubs and its corresponding planning process. These end-users are in this case the residents of the Bellamybuurt, which are approached through a representative group. The explicit constitution of this representative group is further elaborated on in Chapter 4.
At first, the aim was to organise a focus group and get this representative group around the table at a joint time. This method lends itself perfectly to an interactive and dynamic discussion in which different participants can pick up on each other's points of view. However, the execution turned out to be either less interesting or unfeasible in several respects. To recruit participants for my research, I simply went out into the streets to talk to residents. While doing so, it turned out that many of the residents were hesitant towards attending a plenary meeting with strangers. Besides, it appeared to be a logistical challenge to find a suitable timeslot with mutual availability. Later in a personal talk with a municipal officer from the municipality of Amsterdam, these findings were acknowledged.

Furthermore, professor M. Dijk from Maastricht University stressed, during another personal talk, that not everyone feels comfortable talking in larger groups. This could have resulted in an interview session in which some of those present do not speak up and do not dare to express their deepest opinions, whereas this is crucial for creating inclusive design principles.
The combination of these limitations made me decide in the meantime to apply a different research method. This method was interviewing the representative group independently based on a semi-structured interview guide. The advantage of this method is that there is more time per individual and that, as an interviewer, I could go deeper into individual statements and opinions, resulting in a deeper understanding of each perspective.

During these interviews, the draft framework for planning neighbourhood hubs was taken as a starting point and built upon further, to ultimately create a framework that adapted to the group of stakeholders and thus the neighbourhood. The interviews emphasise on finding the elements where the current framework seems to fall short. These elements are location prioritisation of micro hubs in public space, preferred density of the network and any additional conditions that are brought forward and significantly relate to the stakeholder group. The entire interview guide can be found in detail in Appendix I and II.

Research through design

The subsequent phase consists of research through design. Based on the adapted planning framework that is formulated as a result of the first data collection, supplemented by the transport planning principles of Arup Amsterdam (2022), a potential design is made for the network of mobility hubs in the Bellamybuurt. These principles are further explained in the design chapter.
Utilising GIS analysis and empirical observations in the neighbourhood, suitable locations were found, after which the network map could be made. In addition, a number of visual impressions were made of different ways in which neighbourhood hubs would blend into the existing landscape.

Ultimately, these designs are used for the subsequent research phase, whereby further research is carried out through the use of self-created designs.

Online survey

To test the iterated planning framework and the proposed design for neighbourhood hubs in the testbed on societal support, a short survey was conducted amongst a group of residents from the Bellamybuurt.

The survey consists of several elements. Due to the primary function of testing the proposals, these were deliberately kept as simple and short as possible to keep the threshold for participation low and to generate as inclusive a response as possible.

Starting with several introductory questions regarding personal characteristics, the profile of every respondent is identified, whilst at all times maintaining the anonymity of every respondent. Hereafter, half of the respondents were shown an animation of a potential future scenario of Amsterdam streetscapes (Appendix III). This is done to ultimately test if there is a significant difference in response trend between respondents who have and have not seen the visual future perspective. By doing so, a conclusion is drawn on what the impact of visual communication is on generating societal support for rather disruptive public space plans amongst residents.

In the last part, the respondents are shown the design principles, the network map, and the visual impressions of neighbourhood hubs, after which they were asked to score their satisfaction of them on a Likert scale from 1 to 5. The entire build-up of the survey is to be found in Appendix V.

The survey was distributed physically by putting a small flyer invitation through the mailbox of 750+ residents. Here, a short explanation of the research purpose is set out and there is a link to the survey. Again, the text on this flyer was intentionally simplified. A copy of the invitation flyer is to be found in Appendix IV.

Given the specific target group of the survey, it was not feasible to achieve the minimum sample size of 364, which would also make the survey statistically representative of the entire population. In the end, the survey generated a total of 62 responses, 52 of which actually live or do business in the Bellamybuurt. With this, the sample size does amply meet the minimum size of n=30 for statistical significance. In combination with the diversity and characteristics of this group, which are explained in more detail later in the thesis, it is therefore likely that this sample provides a reliable indication of the population.

3.3.1 Representativeness of the samples

The figure (19) below shows a simplified comparison between the different samples of data collection and the population of the Bellamybuurt. Judging by the matrix, the distribution of age seems to be similar across all groups. However, education, parenthood and car ownership show slight differences in proportion. The percentage of highly educated people, parents and car owners seems to be higher in both samples than in the actual population. Since the number of representatives is thus proportionally higher than in the real population, it is plausible that the opinions of these groups would not be so strongly represented if they were measured among the entire population. Therefore, the data must also be interpreted in this way.

Figure 19. Comparison of sample characteristics.

3.4 Methods of data analysis

This section describes the methods applied to analyse the semi-structured interviews and the online survey. Both exact methods of analysis are set up through an inductive approach, meaning the data was first observed, after which patterns were identified and suitable methods of analysis were conducted. The complete datasets of all primary data collected are bundled in an external data report, which can be found for verifiability on the online repositories of TU Delft & Wageningen UR.

3.4.1 Analysis of interviews

The response to the interviews was collected in a hybrid method. As usual, all interviews are recorded and transcribed anonymously. However, since the interview guide consists of a combination of closed and open questions, not all response had to be coded. The closed multiple-choice questions were registered through an online form application, so only the additional comments towards the conversation had to be coded.

The transcriptions of the interviews are to be found in chapter 1 of the data report. The subsequent section describes the coding scheme applied to these transcriptions.

Final coding template

Table 3 below depicts the inductive coding scheme used for the coding of the semi-structured interviews. Theme A categorises the interviewees' perception towards the alternative Amsterdam streetscape as visualised by Technisch Bureau Lindhout (2022) and attached to this document in Appendix III. Theme B consists of the concerns expressed by the interviewees about this alternative future scenario. Theme C categorises any (in)direct suggestions made to the planning principles, while Theme D categorises the attitude towards these existing principles from theory. Theme E categorises the preference of the interviewees for the type of sharing system and Theme F categorises any additional and potentially interesting comments made throughout the interviews.

Main theme	Subcodes
A Perception alternative streetscape	**A1** Positive **A2** Negative **A3** Mixed feelings
B Concerns	**B1** Having to lug with goods **B2** No guarantee of available remote parking **B3** Insufficient private parking **B4** Unable to meet demand during peak hours **B5** Resistance from critical car users **B6** Hinder for goods distribution **B7** Disputes between neighbours with private sharing **B8** Anti-social behaviour **B9** Difficulties for stragglers
C Suggestions	**C1** Stimulating through legislation **C2** Stimulating through monetary policy **C3** Integration with public transport **C4** Tailor-made parking policy **C5** Multi-functional use of public space functions **C6** Utilise as socio-economic catalyst **C7** Family/friends packages **C8** Security measure **C9** Extra support for stragglers / ease of use
D Comments on framework	**D1** Agrees, No comments to existing principles **D2** Agrees and emphasises importance of one or more elements **D3** Disagree, neglect importance of one or more elements
E Sharing system preference	**E1** Commercial **E2** Private **E3** Neutral
F Other comments	**F1** Policy-related **F2** Site-related **F3** Public space-related **F4** Sidenote

Table 3. Final inductive coding scheme semi-structured interviews

3.4.2 Survey analysis

The online survey set out in the Bellamybuurt is analysed by means of both descriptive and visual statistics, as well as several non-parametric tests. Given the survey's main objective of measuring residents' support for the plans and designs made, this was the starting point of the analysis. However, after reading the responses, it appeared that additional analysis could provide more interesting insights. This additional analysis consists of non-parametric tests between groups of respondents, testing the influence of several parameters on the perception of the respondents.

It is important to note that different sample sizes were used for both test series. To measure the public acceptance among residents, only those respondents were included who actually lived or worked in the neighbourhood. These were 52 respondents in total, referred to in the results section as ***'the neighbourhood'***. To examine whether different parameters influenced the generation of public acceptance, all respondents were included. For this purpose, it was not important whether people actually lived or worked in the neighbourhood, but only that they had an affinity with it, which was confirmed by their presence in the neighbourhood during the distribution of the surveys on location. The latter group consisted of 62 respondents, referred to in the results section as ***'the community'***.

Descriptive statistics

Using descriptive statistics, an indication was given of the extent to which public acceptance was achieved and to what extent this was spread among the respondents. Furthermore, several descriptive visualisations were used in order to strengthen the narrative, such as pie- and bar charts.

Non-parametric tests

Given the fact that the outcome of the survey resulted in merely ordinal variables, a set of non-parametric tests were conducted on the dataset, in order to test whether there are correlations or statistically significant differences between groups and characteristics. Table (4) below shows the different tests applied, explaining its purpose, and providing an exemplary application of it.

Type of non-parametric test	Purpose	Example
Mann-Whitney U Test	Compares the sum of rankings of scores between two independent samples	How does the perception differ between people who have seen the animation and those who have not?
Kruskal Wallis H Test	Compares the ranking of scores between groups in between three or more independent samples	To what extent do age groups differ in their opinions about the plans and designs?
Wilcoxon Signed Ranks Test	Compares the sum of rankings of scores between two or more related samples	Are there differences in the perceptions between the first and last designs?

Table 4. Types of non-parametric tests used in the survey analysis

4 Context Analysis

As previously described in the introduction, the Bellamybuurt is a neighbourhood in the city of Amsterdam. The site is chosen due to its suitable demographic and spatial characteristics. This section describes these characteristics in more detail and summarises the image of the neighbourhood, underpinning the scarcity of public space as well as the high potential for further adoption of shared mobility.

4.1 General characteristics

District

The Bellamybuurt is a neighbourhood situated within the city district Oud-West.

Inhabitants

As of 2021, the total amount of inhabitants in the Bellamybuurt is 6735 (Open Info, 2022)

Average income

The average income per household is €41.000 (Municipality of Amsterdam, 2022)

Area size

The entire neighbourhood has a land size of 25 hectares (Google Maps, 2022)

Population density

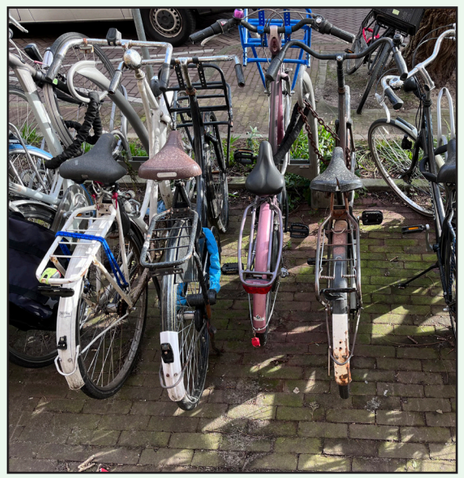
The neighbourhood is rather densely populated with an average density of 269,4 dwellings per hectare

Housing units

The area has a total of 3.823 housing units (Municipality of Amsterdam, 2022)

Cars

Roughly 30% of the households owns a private car (Municipality of Amsterdam, 2022), which is just below the average of 40% for the municipality of Amsterdam (Municipality of Amsterdam, 2020), which comes down to an estimate of 1147 cars in total.



4.2 Demographics

The figures below clearly depict the demographic image of the Bellamybuurt. Figure (20) shows that the majority of the population belongs to the workforce. Roughly 70 percent of the population is aged between 25 and 65, meaning this group is relatively large, even when compared to the average of Amsterdam where this group is roughly 12% smaller (Municipality of Amsterdam, 2022). Furthermore, the high proportion of people aged under 45 and small proportion aged above 65, indicates the youth of the community. Figure (21) shows that more than half of the population is high educated, while the average for the Netherlands is about 40 percent (Social and Cultural Planning Agency, 2020). This underpins that the level of education in the Bellamybuurt is above average. Last, figure 22 shows that the population does merely have a Dutch background, but also people with both western and non-western migration backgrounds.

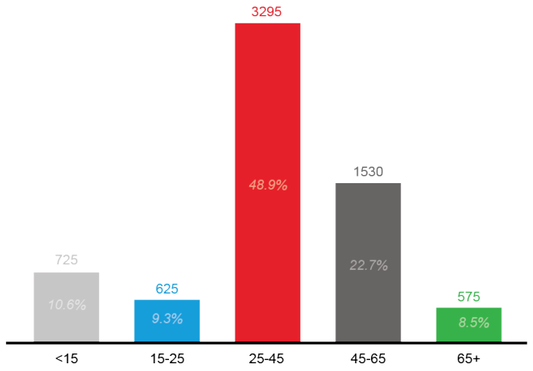


Figure 20. Age division Bellamybuurt (Open Info, 2022), illustrated by author

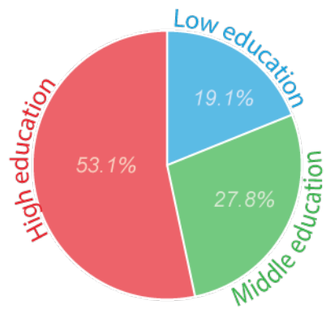


Figure 21. Education level Bellamybuurt (Open Info, 2022), illustrated by author

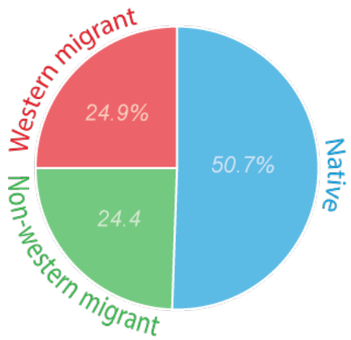


Figure 22. Origin of population Bellamybuurt (Open Info, 2022), illustrated by author

In summary, the demographics of the Bellamybuurt underpin its suitability for the further adoption of shared mobility, given that the population groups labelled as early adopters and early majority by Bosehans et al. (2021) are frequently present in this neighbourhood. Furthermore, the demographic analysis lays an important basis for the stakeholder analysis in Chapter 4.4.

4.3 Spatial Analysis

This chapter includes a comprehensive analysis of the spatial characteristics of the neighbourhood. It serves both to substantiate the urgency of making sustainable interventions in the public space and to indicate the current impact of mobility on land use.

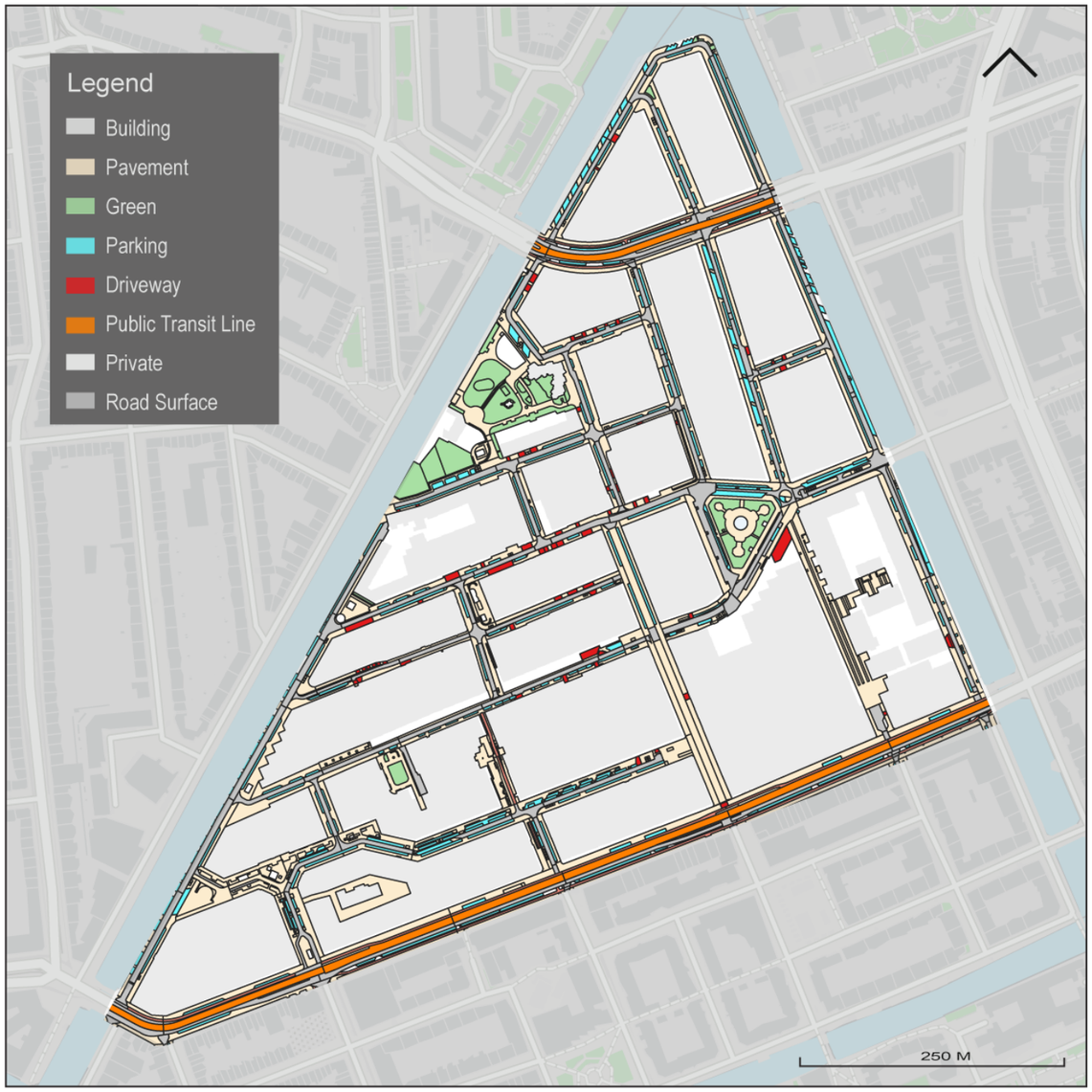
Overview

The Bellamybuurt is bounded by the Kinkerstraat to the south and by two canals to the northwest and northeast respectively. The neighbourhood has two collector roads, namely Kinkerstraat on the south side and De Clercqstraat on the north side. These roads are both important corridors for public transport and have active plinths across the entire width of the neighbourhood. The other roads are neighbourhood roads or pedestrian zones due to their mainly residential function. Furthermore, the district has a local market (Ten Kate Markt), a trendy indoor shopping centre within an old tram depot (de Hallen) and two small parks (Landje van Ome Kick & Bellamyplein).

Map 2. Overview of the Bellamybuurt. Data from Google Maps (2022), illustrated by author

Land use

The land use of the open space is dominated by road surface and pavement. Other repeating functions are parking spaces and entrances. Clearly, limited space is dedicated to climate mitigating surfaces such as greenery inside the neighbourhood.



Map 3. Land use. Data from PDOK (2022), illustrated by author

Built-up area

The majority of the neighbourhood consists of built entities and thus clearly indicates the scarcity of public space. This is also underpinned by the neighbourhoods' OSR (Open Space Ratio) of 0.34 (Rudifun, 2022).

Map 4. Built-up area. Data from Maps Amsterdam (2022), illustrated by author

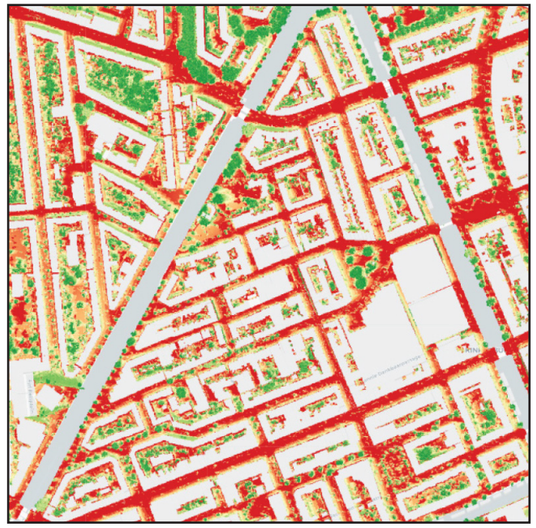
Parking pressure

Due to the scarcity of public space, there is a high pressure on the car parking spaces. The majority of the neighbourhood encounters a parking pressure of at least 85% (Municipality of Amsterdam, 2022)

Map 5. On-street parking pressure. Data from Maps Amsterdam (2022)

Heat stress

Like other neighbourhoods in the adjacent vicinity, the Bellamybuurt suffers from considerable heat stress in the warmer months due to the Urban Heat Island Effect.



Map 6. Heat stress (ARUP,2021)

Green-blue structures

The green-blue structures in the neighbourhood are mainly found in the surrounding canals and trees across the neighbourhood, however, there is room for improvement especially in the heart of the area.

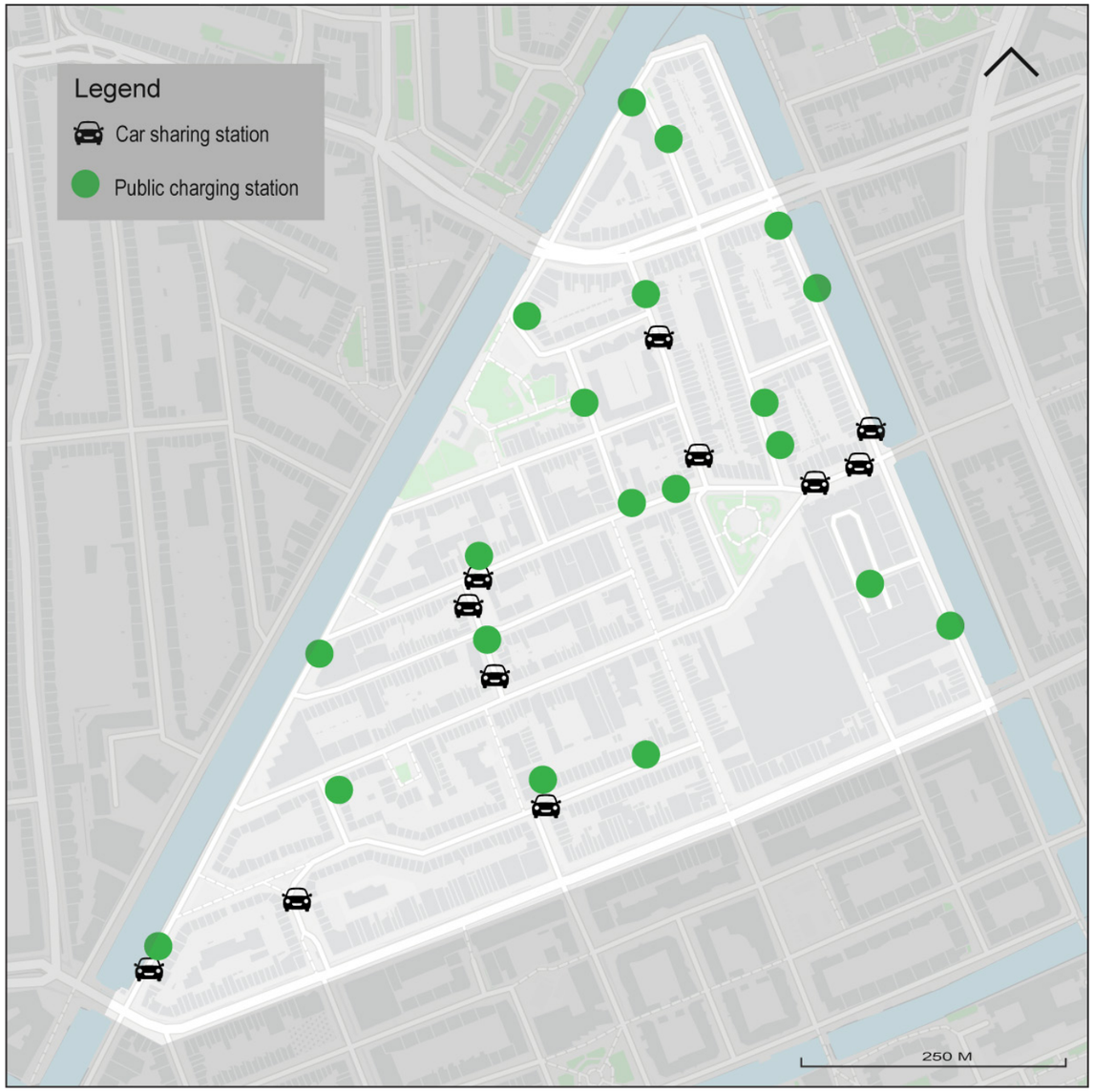
Map 7. Green-blue structures (ARUP, 2021)

Station-based (shared) mobility facilities

The map (8) below depicts to what extent shared and electric mobility is already fixed in the public space of the Bellamybuurt. This is identified through the presence of two facilities: public charging stations (public parking spaces with electricity supply) and car sharing stations (reserved parking spots for shared cars, some with electricity supply, dependent on propulsion of car type it homes).

With regards to the charging stations, the neighbourhood has a decent coverage, which indicates that part of the (private)car fleet here has already been electrified. With regards to the charging stations, the coverage here is again solid, indicating that the shared car is an existing facility in the neighbourhood

This map does not include free-floating shared mobility services, since they do not have a fixed location in the public space.



Map 8. Station-based mobility facilities fixed in public space. Data from Maps Amsterdam (2022), illustrated by author

4.4 Stakeholder Analysis

This section describes the main stakeholders that are engaged in the co-creation. Based on the earlier (demographic) analysis in this chapter, a list of the most common population types or ***personas*** in the Bellamybuurt could be drawn up. Given the emphatic focus of this thesis on the reconfiguration of public space, eight target groups were identified, all of whom have a different perspective on this. In order to compile a cross-section as representative as possible of the population, the following target groups with their respective perspectives were sought for:

Student

Aged under 25, highly educated and living in a small home. Does not own a car and does not have kids. Particularly uses the outdoor space as an extension of his or her balcony. The student needs the space for outdoor activities such as sports, relaxation, or entertainment.

Car owner

Could be of any age and education level and might have kids, but has a specific interest for the public space in terms of parking his or her vehicle.

Shop owner

Mostly aged above 25, but could have any education level. He or she might own a car and have kids, but the most important factor is that he or she owns a shop and therefore utilises the public for things such as goods distribution. Furthermore, the shop owner benefits from good accessibility and might thus have a specific view on that.

Retiree

Aged above 65 and does not have a job or kids living at home. He or she could have any eduction level. Generally, the retiree does not like many changes in the landscape due to long periods of habituation and likes a quiet outdoor environment.

Young Urban Professional

A 'YUP' is the characterisation of a relatively young, native, and highly educated person that has started working. He or she might have a (first) car or young kids. Furthermore, the YUP might regularly work at home and uses the outdoor space for relaxation or entertainment.

Parent

Typically aged above 25 and might own a car. Could be of any education level, but he or she logically has a different perspective on public space because of having a child at home. This might make him or her advocate for safety on the street but might also make him or her dependent on the car due to having to transport a child.

Expat

Typically aged above 25, but could have any education level. He or she might have a car or a child. Most important is that an expat or short-stay resident mostly has a short-term interest for the layout of the public space. He or she only resides in the area for a short period of time and might not be so involved with politics.

Job specialist

He or she is typically aged above 25 and might have a car or child. The job specialist is someone with a professional education background and spends most of his time on the job. He or she does not spend too much time in the public and mostly uses the space to navigate through.

Ten Katemarkt, photo by ©Koen Smilde

5 Results

This chapter describes the results from the several phases of data collection. Starting with the co-creation phase, in which the foundation was laid for the design and planning principles for neighbourhood hubs in urban neighbourhoods with a scarcity of public space. Hereafter, the resulting designs are presented. Finally, the opinions of the wider public on these are described, as well as several statistical tests to test whether significant differences can be identified between groups and their aligning responses.

5.1 Co-creation

This section describes the results from the co-creation phase, consisting of a set of eight semi-structured interviews

5.1.1 Overview of coding results

Table 5 shows the frequency of coding's identified in the interviews. Each of the components are further explained and interpreted later in the chapter.

		Count		Respondents						
Main Label	Final Code	#	%	1	2	3	4	5	6	7	8
A Perception alternative streetscape	**A1** Positive	4	50%	1	0	0	0	0	1	1	1
	A2 Negative	2	25%	0	1	1	0	0	0	0	0
	A3 Mixed feelings	2	25%	0	0	0	1	1	0	0	0
B Concerns	**B1** Having to lug with goods	2	25%	0	1	1	0	0	0	0	0
	B2 No guarantee of available remote parking	1	13%	0	1	0	0	0	0	0	0
	B3 Insufficient private parking	3	38%	0	0	1	1	1	0	0	0
	B4 Unable to meet demand during peak hours	2	25%	0	0	1	0	1	0	0	0
	B5 Resistance from critical car users	3	38%	1	0	1	0	1	0	0	0
	B6 Hinder for goods distribution	3	38%	1	0	1	0	1	0	0	0
	B7 Disputes between neighbours with private sharing	5	63%	1	1	1	0	1	0	0	1
	B8 Anti-social behaviour	4	50%	1	0	0	0	1	1	1	0
	B9 Difficulties for stragglers	3	38%	0	0	1	1	0	0	1	0
C Suggestions	**C1** Stimulating through legislation	2	25%	1	1		0	0	0	0	0
	C2 Stimulating through monetary policy	3	38%	0	1	0	1	1	0	0	0
	C3 Integration with public transport	1	13%	0	0	0	1	0	0	0	0
	C4 Tailor-made parking policy	2	25%	0	0	1	0	0	0	1	0
	C5 Multi-functional use of public space functions	4	50%	0	0	1	1	0	0	1	1
	C6 Utilise as socio-economic catalyst	1	13%	0	0	0	0	0	0	1	0
	C7 Family/friends packages	1	13%	0	0	0	0	0	0	1	0
	C8 Security measure	2	25%	0	0	0	1	0	1	0	0
	C9 Extra support for stragglers / ease of use	2	25%	0	0	1	1	0	0	0	0
D Comments on framework	**D1** Agrees, No comments to existing principles	1	13%	0	0	0	0	0	0	0	1
	D2 Agrees and emphasises importance of one or more elements	7	88%	1	1	1	1	1	1	1	0
	D3 Disagree, neglect importance of one or more elements	0	0%	0	0	0	0	0	0	0	0
E Sharing system preference	**E1** Commercial	5	63%	1	1	1	1	1	0	0	0
	E2 Private	2	25%	0	0	0	0	0	1	1	0
	E3 Neutral	1	13%	0	0	0	0	0	0	0	1
F Other comments	**F1** Policy-related	5	63%	1	1	1	0	1	0	0	1
	F2 Site-related	4	50%	1	0	1	0	1	1	0	0
	F3 Public space-related	5	63%	1	0	1	1	0	1	1	0
	F4 Sidenote	4	50%	1	0	1	0	1	0	0	1

Table 5. Inductive coding results

5.1.2 Identifying needs

The figure on the right (23) provides a comprehensive overview of the respondents and their corresponding answers. The diagram confirms the diversity of the sample group and illustrates how they differ in terms of habits, travel patterns and attitudes. These data have not been mapped to draw any apparent conclusions, as the sample is not large enough for statistical significance. However, it is interesting to identify initial patterns and build on them in the remainder of the study.

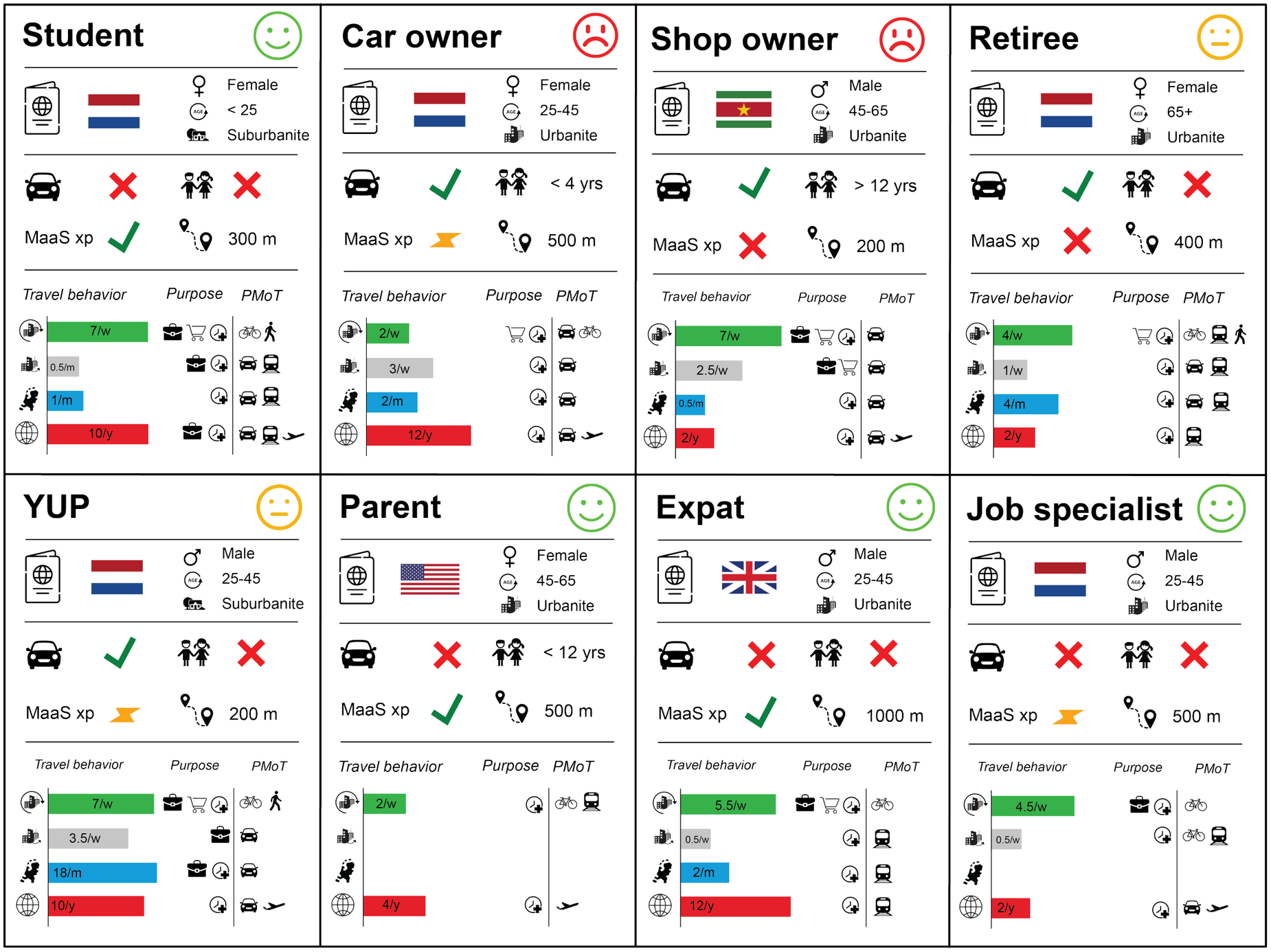
Striking comparisons between personas

Several interpretations emerge from the figure (23) on the right. First of all, it is striking that the people who do not own a car seem to have a more negative image towards the outlined future image with car-free streets. However, it is not surprising to find this, since the future scenario is significantly less welcoming to the car. In addition, it seems that people who do own a car have no or at least less experience with shared mobility. This could indicate that owning a car or not has a certain influence on the extent to which people are willing to use shared mobility. On the other hand, it could also indicate that people who have regular experience with shared mobility do not experience the necessity to own a car.

Furthermore, there seems to be a tendency between this group - that owns a car and expresses a more negative perception towards the future scenario - and the travel behaviour. The same group seems to make more transport movements on the second (out of town) and third (across the country) level. This could indicate that shared mobility is currently lacking on these levels and that there is no confidence in such a future image among people who regularly make these transport movements.

It is also striking that the willingness to walk varies greatly, so that the average of these distances is probably not a good starting point for determining the network density. Apart from this, there seem to be no striking correlations between the answers of the different stakeholders.

However, the story that does emerge from this analysis is that there appears to be a value conflict in this case. On the one hand, there is a group of residents who do not own a car, who move around the city in a different way, who are disadvantaged by the current distribution of public space and who are therefore positive about restructuring in this respect. On the other hand, there is a group of residents who, in one form or another, consider themselves dependent on the car and evidently benefit from the current layout of the public space. This group is therefore more negative towards change in this respect.



It was precisely by talking to these different groups that an attempt was made to establish a shared perspective. In the remainder of this chapter, these perspectives are explored in more detail, after which they are synthesised into inclusive principles. The next chapter, in which these principles are translated into spatial designs, ultimately attempts to resolve this value conflict.

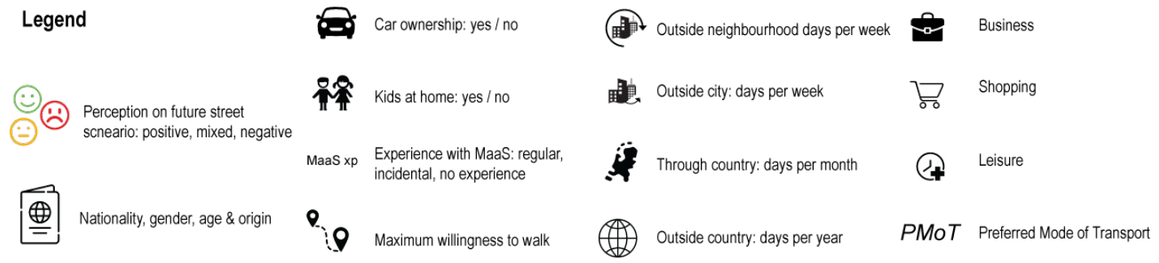


Figure 23. Comparison of stakeholder perspectives

5.1.3 Spatial Implementation

The second part of the planning process where co-creation is applied, is the phase and determination of spatial implementation. This phase, which is often done based on desk- or data analysis, was in this case approached from a bottom-up perspective, leading to the outcomes as described in this section.

Location choice

The images below show the different functions of the testbed its public space. During the interviews, all respondents were asked which functions, in their opinion, should or should not be sacrificed for the realisation of a neighbourhood hub. The outcomes are summarised below.

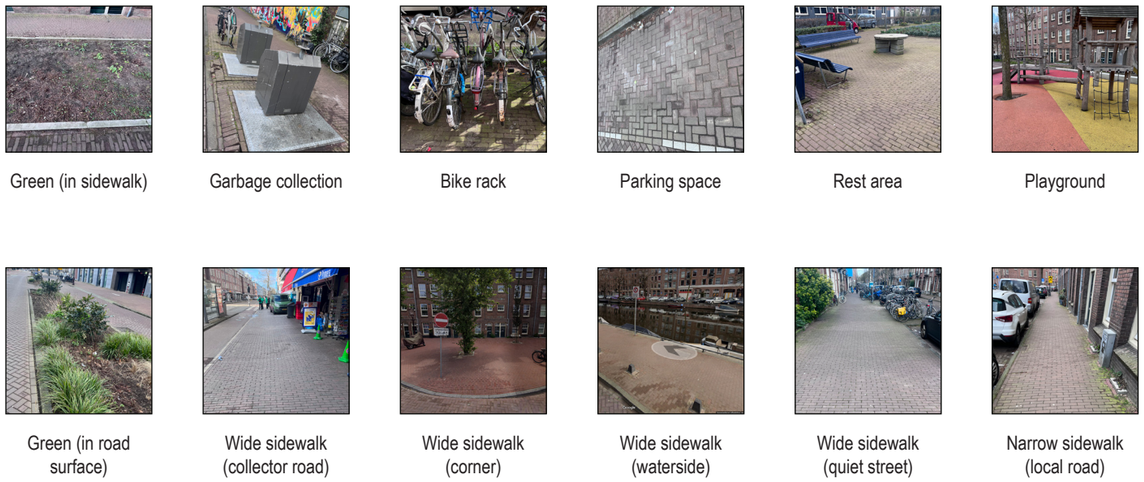


Figure 24. Functions of the public space in the Bellamybuurt, captured by author

Based on the results of the diagram on the right, a clear direction can be chosen for the location choice of neighbourhood hubs. Firstly, there are several functions for which it must be clearly avoided that they are eliminated. These are greenery in the pavement, playgrounds, rest facilities, waste collection and bicycle racks.

Regarding the functions that should be prioritised, the wider pavements immediately catch the eye. The wider pavements seem to be the most popular choice of sacrifice among the sample. But perhaps more importantly, no one has listed these sidewalks as a location to be avoided at all costs, so implementation at this location would at least not provoke. The context in which this wide pavement is located seems to make less of a difference.

Furthermore, car parking spaces and greenery in the road surface are mentioned as possible options for locating hubs. However, sacrificing the latter is not in accordance with the development of a more sustainable urban fabric, which is, after all, what mobility hubs are mostly intended for. Therefore, this choice of location is subordinated to the other options given by the respondents.

Network density

Maximum willingness to walk	Count
500 meter	3
200 meter	2
300 meter	1
400 meter	1
1000 meter	1

Table 6. Descriptive statistics willingness to walk

minimum	—	200
maximum	+	1000
mean	$\overline{X}$	450

Based on the numbers above, it is not obvious what maximum walking distance should be used when designing a mobility hub network for the Bellamybuurt. 7 out of 8 respondents give an answer of between 200 and 500 metres. Because of the outlier of 1000, the average of 450 metres is thus not a reliable value. Even if this outlier would be left out of consideration, the average would still come to 371 metres, which would still mean that the willingness of 3 of the 8 would not be met. Considering that the aim of this thesis is to assess how societal support can be achieved for the implementation of neighbourhood hubs in such neighbourhoods, it is obvious to use a higher density and thus lower maximum walking distance. Precisely in order to also meet the needs of the less positive, this is of high importance. A distance between 200 and 300 metres would thus be more appropriate and has therefore been used for the remainder of the research process.

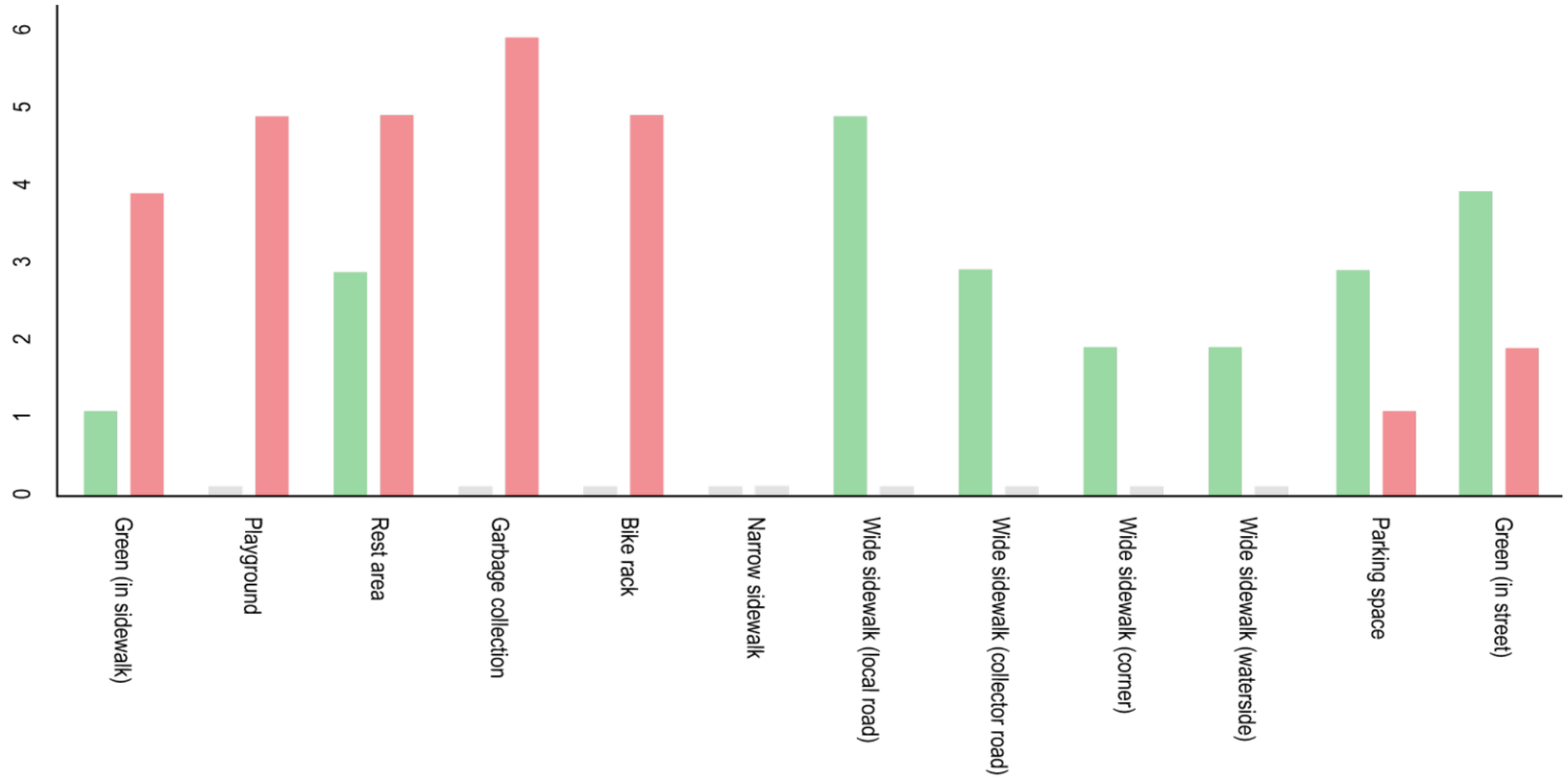


Figure 25. Function prioritisation

5.1.4 Suggestions, concerns & comments

This section elaborates on the open part of the interviews. The results from the coding scheme are explained and clarified with quotes from the respondents.

Attitude towards future scenario

Prior to the open questions asked during the interview, an animation of a possible future scenario of the streets of Amsterdam (Lindhout Technical Architects, 2022) was shown to each respondent. Hereafter, each respondent was asked about their opinion on this future scenario. An impression of the animation is to be found in Appendix III.

Although the reactions were already set out in figure x (Comparison of stakeholder perspectives), this section aims to provide further depth by inserting a list of quotes from the respondents.

4 out of 8 participants were ***positive*** towards the future scenario, for example:

Parent

"Beautiful. It definitely makes it seem like a more desirable neighbourhood."

2 out of 8 participants had ***mixed feelings*** towards the future scenario, for example the YUP who states that he likes it from a residing perspective, but has its doubts for people who use the public space for job-related purposes:

YUP

"Yes, it scares me a bit more, I think, than most people. Look, I think... it looks good, nice, a nice place to live, so I think in terms of living it's ideal. I just think in terms of efficiency, it would be very difficult, for work for example."

2 out of 8 participants were ***negative*** towards the future scenario, for example:

Car Owner

"It makes me itch a bit, because what my biggest frustration in the street is, obviously you pay a lot of money every quarter for your parking permit. You drive up and the only spot left is a car date for 'The Green Choice' or something and you're not allowed to park it there."

Concerns about future scenario

The concerns regarding the outlined future scenario come from different perspectives and highlight aspects that may also relate to the realisation of mobility hubs. Therefore, these concerns are detailed in this section.

2 out of 8 participants mention to be concerned for ***people having to lug more with goods*** in this future streetscape, for example:

Car Owner

"Look, I have a child of 3. Think of a car seat, for example. Do I have to carry it under my arm every time I use a shared car? You know, these are things that make me think: yes, that is the convenience of your own car."

2 out of 8 respondents mentions ***pessimism about availability of remote parking spaces*** when the supply of car parks is significantly reduced in inner cities:

Car Owner

"If I had no knowledge of the Park & Rides now, I might have been positive, but because, if I go to the Park & Ride at the Olympic Stadium, for example. 9 times out of 10 it's full. So that's immediately at the back of my mind. Yes, that's nice if there is such a thing, but I'm bit pessimistic about if that works."

3 out of 8 respondents mention their concern about the ***reduction of available private parking*** after the implementation of mobility hubs, for example:

Retiree

"Because, where are we then supposed to park our cars?"

2 out of 8 participants mention the concern of ***shared mobility not being able to meet the demand during peak hours***, for example:

Shop owner

"If you have, say, you have 100 cars in the street here. And you have but say 5 shared cars. Then how do you want to share 5 share cars with 100 people? And most people usually need a car at the same time..."

3 out of 8 participants mention to ***expect resistance from people for whom the use of a (private) car is critical***, for example:

Student

"But I also think, I'm sitting here now looking out the window and I see all these residents here thinking, yes: I just want my private car, I want it in front of my door, because I want to go in the morning. I mean, how are you going to manage that?"

or;

YUP

*Well, you just said 30%, which means that 30% of the people have their car here at the door. They think it's really *** to take away those parking spaces. I think it's very convenient for people who travel by car to have their car parked outside their door. And they already think it's a real pain when their car is parked two streets away."*

3 out of 8 participants mention to ***expect hinder for entrepreneurs in goods distribution***, for example:

YUP

"Then of course there's the market here with the entrepreneurs. I think in itself they are happy that people can come here by car for supplies and things like that. So I think it's going to be difficult to... I think there are a lot of complications."

4 out of 8 participants are concerned about ***anti-social behaviour with shared vehicles***, for example:

Student

"Of course, with commerce, what you get is that maybe, because it's nobody's actual property, people might treat it quite carelessly."

3 out of 8 participants mention to expect ***difficulties for late adopters or laggards who are not comfortable with using shared mobility***, for example:

Expat

"Yeah, like Felyx and Cargoroo when you have, I believe you have apps for all of them, um and those work quite well, but I think there are also quite… what's the word.. Not an obstacle, but they're quite hard to kind of get, or to realise that they are a thing, because you see these bikes, but there's not much promotion for how to use them. Like, an old person is not very tech savvy, so may not be able to, you know, pick up on these things, unlike a young professional or a family would."

Comments on existing framework

8 out of 8 participants ***agree with the existing principles*** for successful hubs and do not neglect any of them. Meanwhile, *7 out of 8* participants do ***emphasise one of the principles to be extra important*** to them:

Adaptivity

Car owner

"Especially the adaptive part seems important to me, because, I mean, it is something new that is being tried and that people are looking at: How can it be optimised? And does it work?"

Coherent network

Shop owner

"It should not be something just for the neighbourhood. If you are going to share, then you have to share, you know, in the whole of Amsterdam. So that means you have to have these places everywhere in Amsterdam. So if I go from here to East, I have to be sure, when I get there, that there's a place to park my car."

Informed community

Retiree

"The ease of use for everyone is very important to me"

Suggestions for the framework

Throughout the entire course of the co-creation phase, attention was paid to responses of participants that either directly or indirectly hint at a suggestion for the planning framework. These findings are summarised and further set out in this section.

2 out of 8 participants suggest ***stimulation of shared mobility or neighbourhood hubs through legislation measures***, for example:

Car owner

"So I think that the rules from the municipality can have an influence on whether or not you are able, or intend, to make use of the facilities that are available. "

3 out of 8 participants suggest ***stimulation of shared mobility or neighbourhood hubs through monetary policy***, for example:

YUP

"Well look, if you want to make a successful hub, I think you have to make those parking permits more expensive. You have to hit people where it hurts. And that is in the wallet."

2 out of 8 participants suggest ***implementing tailor-made parking policies*** in order to gain societal support, such as dynamic parking:

Shop owner

"Most people work, so they take the car, they go to work, that's good, when I come here, there are lots of parking spaces. So when I leave here in the evening, it means that the space becomes available for the residents again."

4 out of 8 participants suggest ***multi-functional use of public space functions***, such as rest areas and playgrounds:

Parent

"These rest areas.. I think a lot of them in Amsterdam are way too big and there's a lot of impervious surfaces which just.. There is something can go there, whether that they can bring up the tiles for green, or they can put something on there cause it's just a waste of space in my opinion."

or;

YUP

"Look, in these rest areas, people are going to smoke joints, so that's more for the loitering youth. And if an old granny wants to sit, she could go and sit by the playground or something."

2 out of 8 suggest ***extra security measures***, for example:

Expat

"Like I mentioned with the bike getting stolen would be to have some sort of like security measure. So yeah, whether that's like cameras or uhm, yeah, if you have like spots that have like, uhm, alarmed locks or something. I think it's a security measure. Would be nice."

2 out of 8 participants suggest ***extra support for late adopters***, for example:

Retiree

"And if you have to handle the shared car like that, it has to be properly instructed. Or give a very simple explanation of a sign or how to do it."

Extra suggestions

The following suggestions were mentioned amongst less than 25% of the respondents, however it is worth mentioning them. These suggestions were the following:

Stimulate use of shared mobility or neighbourhood hubs with friends&family packages

Expat

"Well. I think to get their cars off the street and to have this more shared car, sort of motive going on, it could be quite nice to have those more private sort of things that you do amongst neighbours or friends or family. That sort of collective thing would actually work really, really well."

Utilise hubs as socio-economic catalyst

Expat

"There's a lot of homeless people along Kinkerstraat, because there's a homeless shelter just by the car park at Waterkant. I think there's a… I'm just trying to think of anything that would be helpful towards them.."

Integration with public transport in order to foster the ease of use

Retiree

"If you can open it with your ov chip card, for example, or something like that, you don't have to have all kinds of different apps for it. That would be very easy."

Sharing system preference

As an additional component to possibly enrich the framework, the participants were asked about their preference for a commercial or private sharing system. Commercial means that a group of commercial parties offers a service that the customer can use on demand. Private-based means a group of people mutually own a (set of) vehicle(s) and share it amongst them.

5 out of 8 participants stated to have a ***preference for a commercial system***, whilst ***1 out of 8*** participants was ***neutral***. However, ***5 out of 6*** of these participants mentioned to be ***scared for disputes between neighbours with private sharing*** and stated that as a reason to choose for a commercial system:

YUP

"That can never happen, can it? If a car breaks down, who pays for it? A kind of VvE on the car.... That will never work, you have to make a commercial party for that."

On the other hand, ***2 out of 8*** participants have a ***preference for private sharing***, because they think it will be ***beneficial to the guarantee of availability*** of shared vehicles at a neighbourhood hub:

Parent

"The private way seems more guaranteed to have the vehicle there, because with like the commercial one you can drop it off anywhere. So I think if it was like this kind of thing where it's really a dedicated space and you want to always have an option in that space, or an option to return to that space, then I would think that the private way is just better."

Additional comments

Throughout the entire course of the co-creation, several comments were placed by participants that did not provide a general suggestion or concern. However, they are worth mentioning and might be of interest to the reader of this thesis. Therefore, they are categorised and listed in the below section.

Policy-related

Irritation about poor catchment areas

Student

"Well, what I find very annoying and that's why we don't usually use shared scooters to Central Station, is that you can't park there in a sort of range of 4 minutes."

Public space-related

Added value of rest areas for community feeling

Student

"That gives a very nice neighbourhood feeling. So the provision of rest areas, especially in places where there is activity, gives a lot of dynamism, people linger, see each other's faces, recognise faces, etcetera, etcetera."

Importance of kid-friendly public spaces

Parent

"There are certain neighbourhoods where you like… you just wouldn't go with your kids and not because it's dangerous, but because people think it's not kid friendly."

Site-related

Free space in market street on sundays

Student

"But that market, of course, is a space that is often used, but on Sundays it is completely empty and that gives a lot of space. So that's where children play, but of course that also applies to the rest facilities and the playground. So children rollerskate there and run around there. That's really nice."

Vibrant rest area near the market

Student

"What I notice that's really nice is that rest area. We have one coffee shop in that market and the whole market comes through there, the whole neighbourhood comes through there, that guy is doing very well."

Above average sense of community in Bellamybuurt

Student

"Yes, what I like about the Bellamy neighbourhood is that there is this market. It has a very big function. I do have a great sense of community, much more than I had in Oostpoort, because you see many of the same faces, even though you don't know each other."

Market is service for elderly and/or people with lower income

Shop Owner

"Which target group goes to the market? People who are less fortunate… If you have a fat salary, you can go to Albert Heijn in the evening and get your groceries. And then you're home or you order online, which old people can't do."

Nostalgic feeling about old car-oriented city, certain entrepreneurs seem to have lost customers from outside the city due to restricted car access

Shop Owner

"Very simple, I mean, I like good food. I could just go to the Zeedijk, if I want to eat Chinese now, you have to be in pairs. One of you is going to drive around and the other one is going to pick up food. So what are you going to get, then you're going to have to leave the centre, then you're going to be in the suburbs. Somewhere with a shopping centre where you can park your car easily... In the past, it was a friendly atmosphere, really friendly. All the entrepreneurs knew each other, everyone knew each other. It was just lively. The market was lively. Just walk down Kinkerstraat for fun and count how many businesses are still there."

Niche market entrepreneurs might have customers with special accessibility requirements

YUP

"And yes, so it is also very difficult for the people who want to buy a product from us to reach, while they have improved the metro, only if you are going to spend fifteen to sixteen hundred euros, then you don't want to be in the metro."

Sidenotes

Complains about full bike racks (4 out of 8):

Student

"The racks here are totally overflowing, they are like a bomb of bicycles"

Complain about top-down planning

Shop Owner

"There is a need for parking spaces here, but they are taking them away. Without consulting, without asking what we need."

5.1.5 Adapted design framework

After performing and analysing the co-creation, an adapted planning framework is compiled in figure 26. This framework can be considered the final piece in which all parts of the co-creation phase come together and serves as a basis for the subsequent designs.

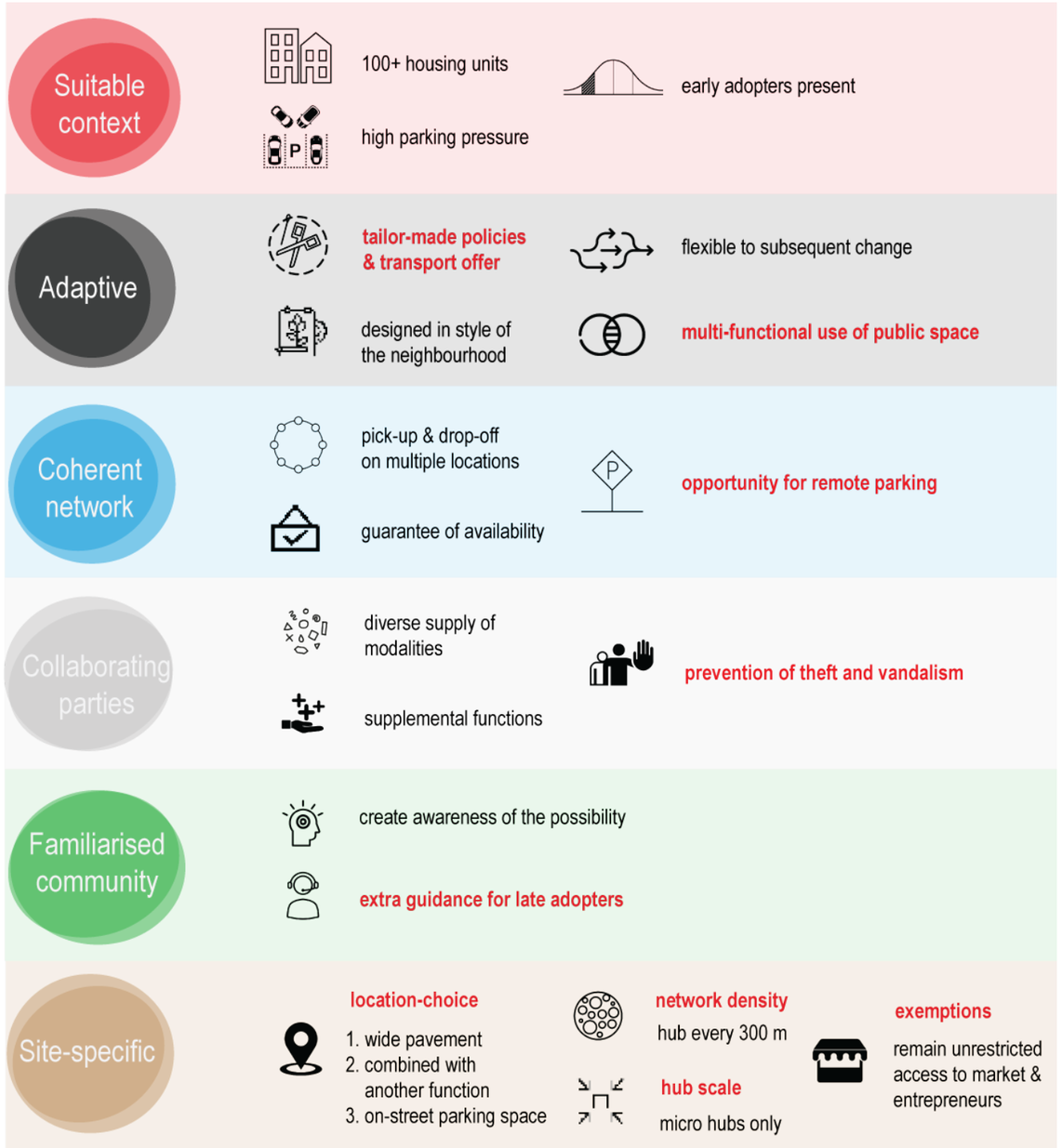


Figure 26. Adapted planning framework, illustrated by author, icons from The Noun Project (2022). red = adapted or added principles

Tailor-made policies

Complex situations require specific policies. Besides the customisation of modalatities, polices might also need further customisation. Especially in the case of neighbourhood hubs in existing neighbourhoods with a scarcity of public space, there seems to be no 'one-size fits all' principle. Judging from the residents' perspectives, the standard policy measures are not always sufficient. For example, it is not necessarily common to implement monetary or legal policies to encourage shared mobility, but this should not be ruled out in this context. Possibilities include the imposition of additional requirements on receiving parking permits, or in other words, screening residents to see if the permit is crucial for them before granting it, could potentially lead to a lower demand for parking spaces.

Multi-functional use of public spaces

A scarcity of space should trigger planners to look at the space with a different perspective. Whereas in other contexts there is no reason to combine functions, in densely populated neighbourhoods such as the Bellamybuurt this could offer solace. When every square metre counts, the possibility of combining functions such as rest areas, playgrounds and neighbourhood hubs should not be ruled out. However, without compromising the primary function of each.

Opportunity for remote parking

When looking at the current system of external parking spaces in the Netherlands, it is mainly focused on transport movements into the city. Take the P&R system, where motorists coming from outside the city can park their car at the edge of the ring road, after which they can continue their journey towards the city centre by public transport. But what if you turn this around? This system fails to facilitate parking for the city-dweller who does not necessarily need to have his car at his door 24/7. The latter was mentioned several times by participants and was seen as an important condition when the car is driven further away from the city centre.

Prevention of theft and vandalism

The soundness of the means of transport is an important condition for residents to want to use them. So perhaps more attention should be paid to this in one form or another. Possibly, the responsibility for preserving the condition of shared mobility devices can be placed with the municipality or the providers.

Provide guidance for late adopters

Developing neighbourhood hubs and shared transport as a serious alternative to the private car means that it must be inclusive. However, there is clearly still a group that will not go along with this, so extra effort will have to be made to attract, but also to support, these groups.

Site-specific principles

Regarding the Bellamybuurt, there are a couple of factors to consider. Firstly, the choice of location and network density. Ideally, a network of neighbourhood hubs should be developed, whereby a hub can be reached from any point within the neighbourhood within a radius of 250 metres. This means approximately one hub at 2 to 3 minutes walking distance.

These hubs should preferably be located on wide pavements, while maintaining a minimum passage for wheelchairs and the like. If this is not possible for a specific location, it will be considered whether a combination with another function of the public space can be made, while not disturbing that function
3. in. As a final option, removing a parking space is an option.

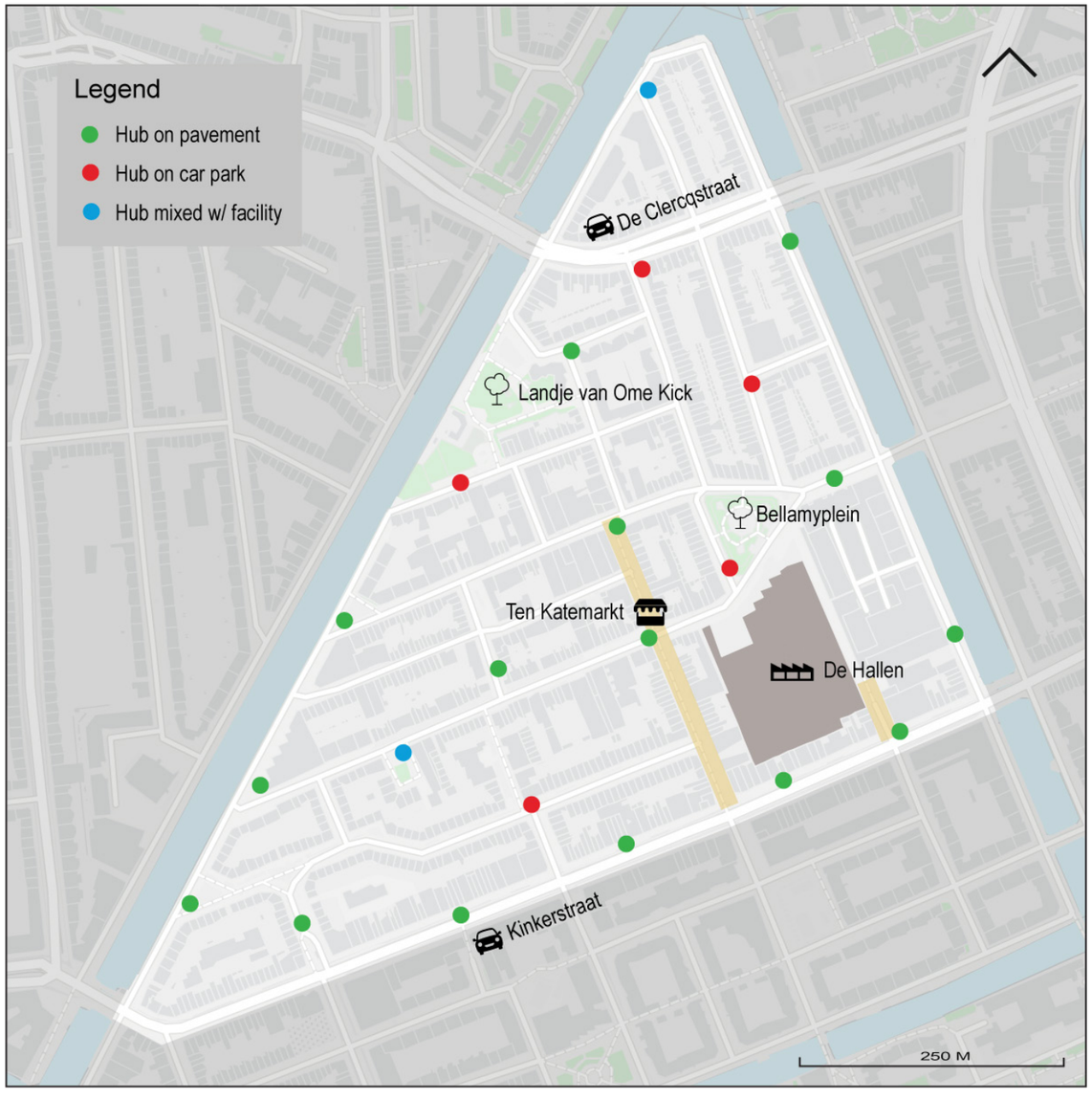
Furthermore, it is essential for the Bellamybuurt and its residents to always keep the market and entrepreneurs accessible. These functions are the lifeblood of the neighbourhood and should not be obstructed.
Ultimately, the co-creation process revealed that, in this phase, larger scale hubs than the micro-hubs should not be considered, as there is simply not enough room for them in the public space.

5.2 Design

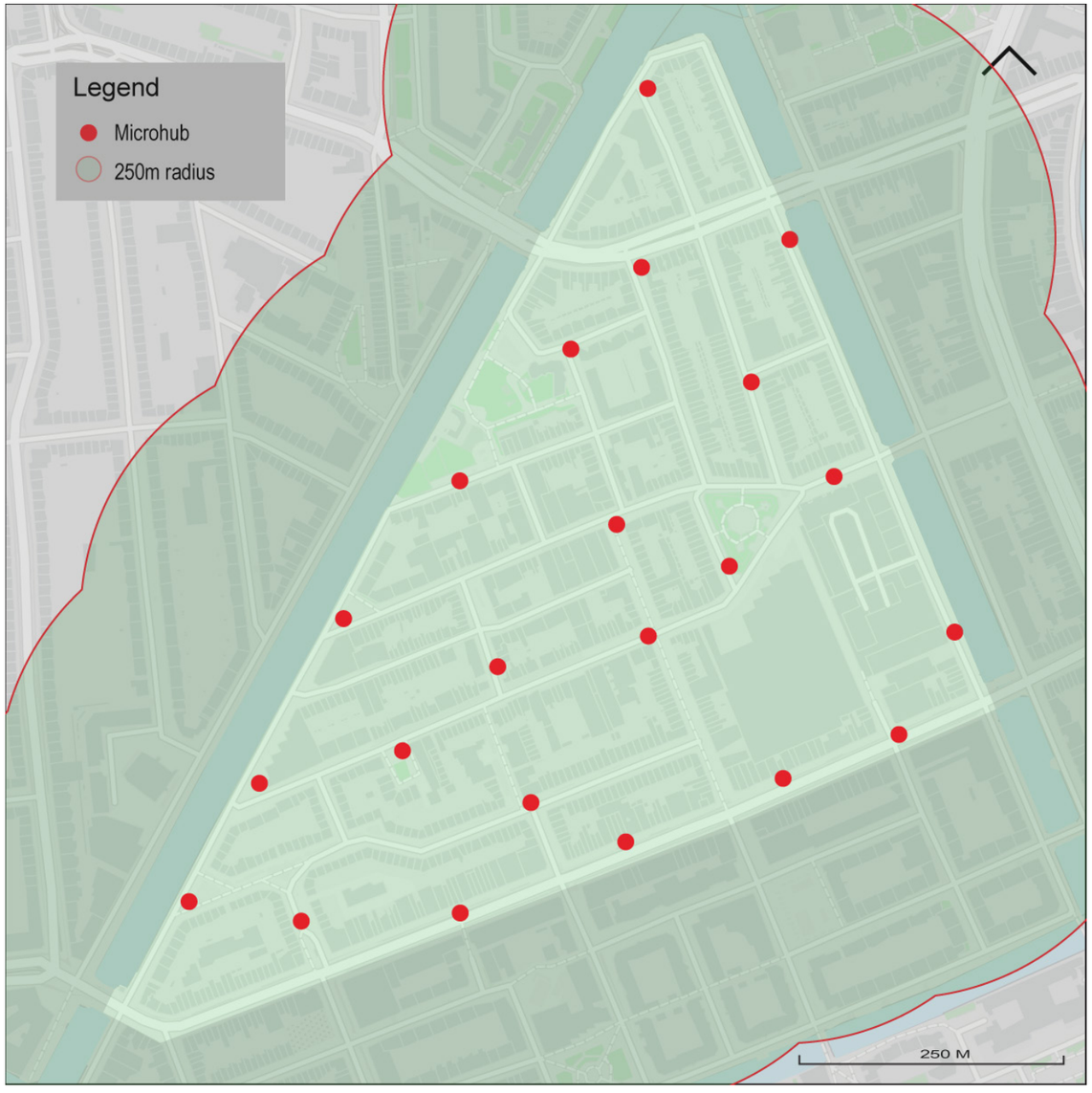
This section describes the design of a neighbourhood hub network for the Bellamybuurt. This design is based on the principles according to the adapted planning framework, in combination with the location selection principles of Arup Amsterdam (2022).

5.2.1 Network of neighbourhood hubs

The following network of 22 micro hubs (map 9) has been created with the aim of achieving an even distribution of locations, with as many as possible on street corners near existing amenities (Arup Amsterdam, 2022). In choosing the location, preference was given to implementation on wide pavements with non-occupied space. Where this was not possible, hubs were implemented in combination with an existing facility or in place of a car parking space, as required by the adapted planning framework.



Map 9. Network map of neighbourhood hubs in testbed, illustrated by author



In order to meet the residents' maximum willingness to walk of 2 to 3 minutes, a radius of 250 metres was targeted. As can be seen in the map above, this network more than fulfills this criteria. However, this radius indicates the distance as the crow flies, whereas in reality it may be greater because the street pattern has to be followed. Nevertheless, the radius is so large that it remains more than sufficient.

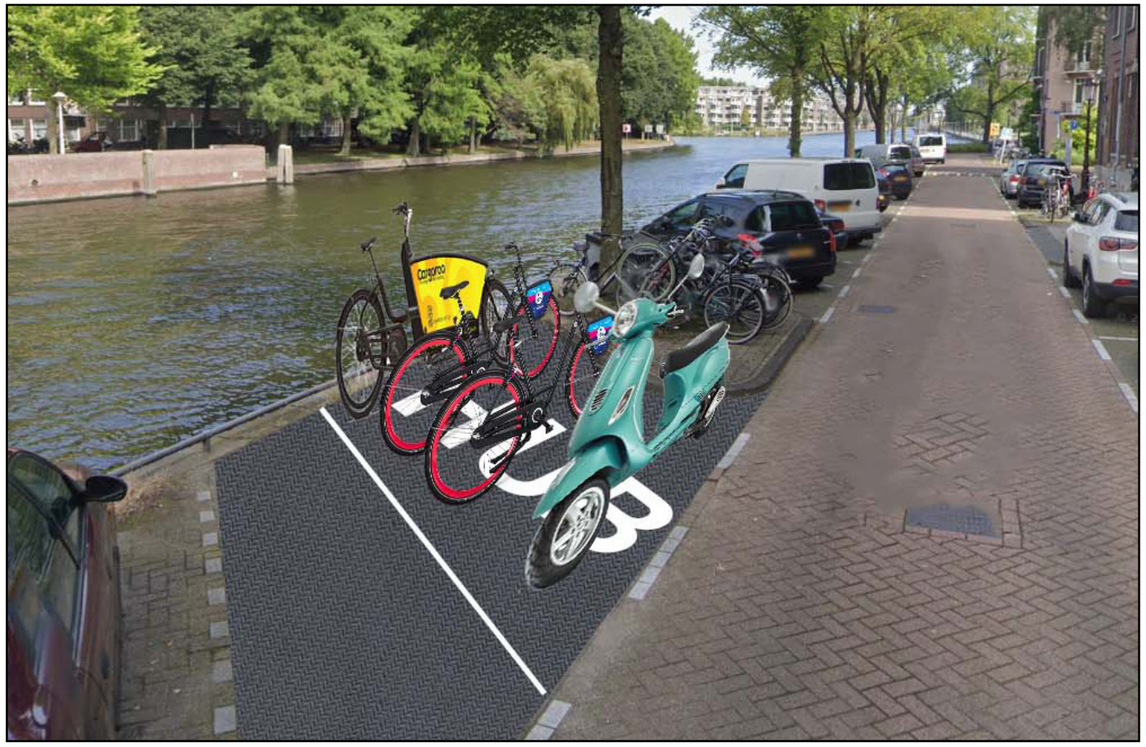
5.2.2 Types of integration in the public space

The way the hubs in the above plan are integrated into the spatial context can be categorised into four types. The figures below visualise what this would look like in these different forms.

Design 1. On wide pavement in busy street, illustrated by author

Design 2. On wide pavement in quiet street, illustrated by author

Design 3. Combined with another function, illustrated by author



Design 4. Instead of a parking space, illustrated by author

5.3 Test

In order to measure the wider support among the Bellamybuurt residents, as well as to strengthen the rationale for answering the research question, a survey was conducted. This chapter discusses various descriptive statistics and statistical tests to support this reasoning.

5.3.1 General characteristics of the survey

In addition to the general characteristics of age, education level, parenthood and car ownership as shown in 3.3.1, the figures below emphasise the diversity of the sample.

Figure 27. Occupancies of the survey respondents

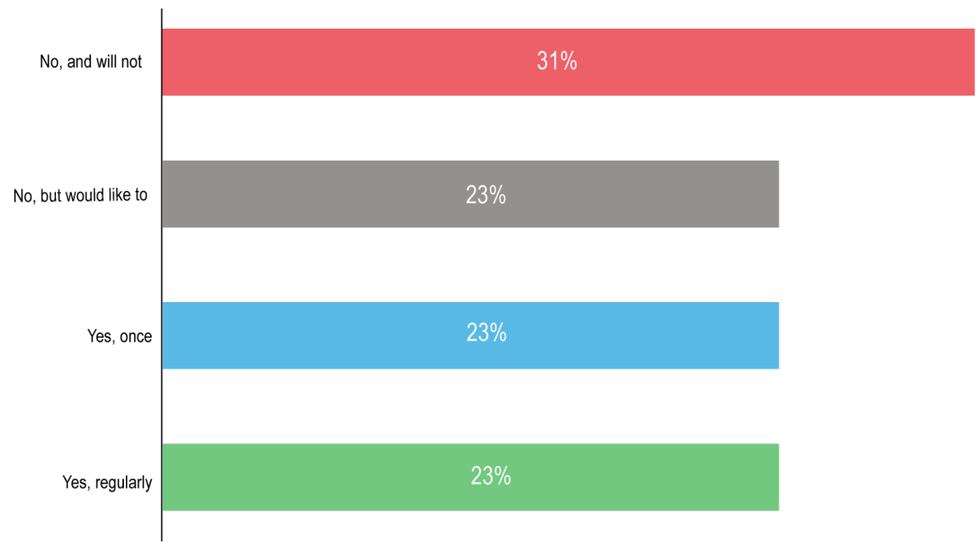


Figure 28. Earlier experience with MaaS, illustrated by author

5.3.2 Measurement of societal support

Adapted planning principles

Based on the response below, it seems that the adapted planning framework is generally well received. In fact, three quarters of the respondents indicated that they agreed or strongly agreed with the statements, while just 10% disagreed.

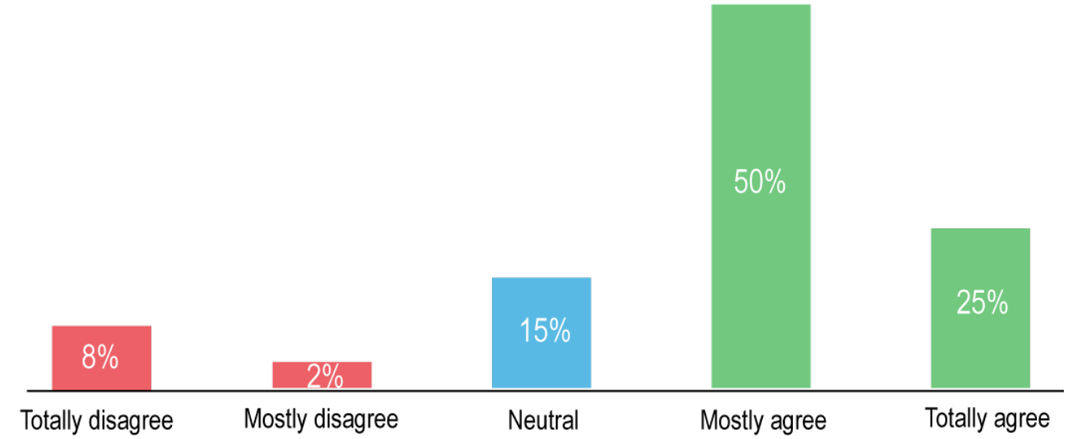


Figure 29. Perception of survey on adapted planning principles, illustrated by author

Network density

The presented location network also seems to be largely in line with the wishes of the residents. Again, 75% of the respondents said they agreed with the proposal, meaning the locations are within their maximum willingness to walk to a shared micro mobility device.

The 25% stating they would not be satisfied with the network, include a group that would not use micro mobility at all. This insists that finding an inclusive network density would be unfeasible and therefore, one always must consider a group that might not support the proposal regardless.

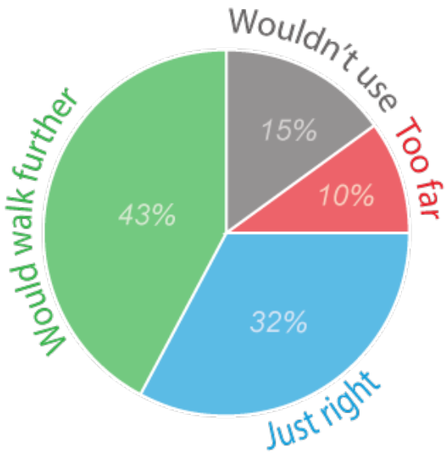


Figure 30. Perception of survey on network density, illustrated by author

Designs

Judging by the outcomes as shown in figures 31-35, the first and second design are by far the best received. This concerns the two designs on the pavements, which were also indicated as preferred locations by the adaptive planning framework. Therefore, it seems that these designs create a negative perception only in a very small number of people.

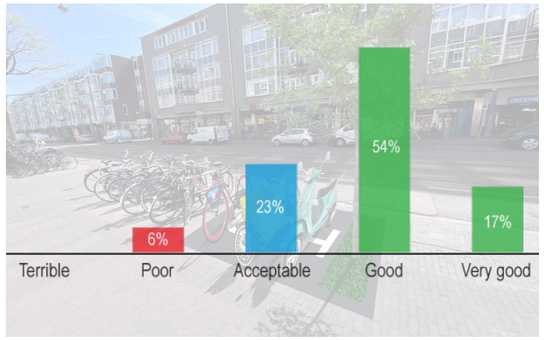


Figure 31. Perception on design 1, illustrated by author

Figure 32. Perception on design 2, illustrated by author

On the other hand, the third design seems to be the least appreciated, with only 39% saying it is a good option. This concerns the design in combination with another function. The last design (4) is also less popular. What is striking here is that there seems to be a dichotomy between a group of people who (very) like the design and a group who dislike it. Since this design concerns the implementation instead of a parking space, it seems plausible that the factor of car ownership could play a role in this.

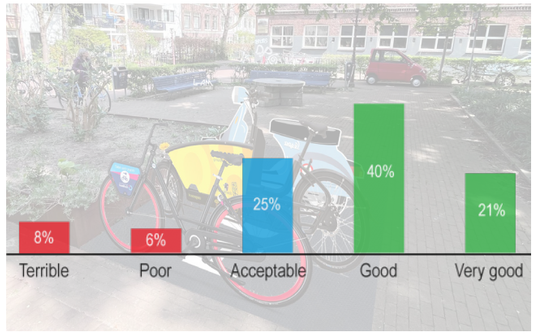


Figure 33. Perception on design 3, illustrated by author

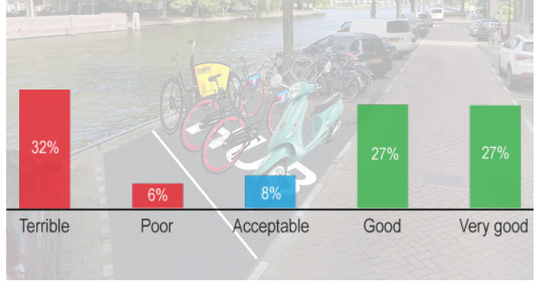


Figure 34. Perception on design 4, illustrated by author

Comparison between results

Table (7) below summarises the descriptive statistics for the responses on each of the designs. These statistics below confirm the narrative from the previous section, namely that the first two designs are best received and that the variance is particularly high in Design 4. Furthermore, the centre and dispersion measures emphasise the rather positive perceptions, also on the principles and network density.

	Principles	D1	D2	D3	D4	Network Density
N	52	52	52	52	52	52
Mean	3.83	3.83	3.62	2.94	3.10	3.29
Median	4.00	4.00	4.00	3.00	4.00	3.00
Mode	4	4	4	4	1	3
Std. Deviation	1.080	.785	1.123	1.335	1.660	1.377
Variance	1.166	.617	1.261	1.781	2.755	1.896
Minimum	1	2	1	1	1	1
Maximum	5	5	5	5	5	5

Table 7. Overview descriptive statistics survey

Through performing a Wilcoxon Signed Ranks Test, significant differences in societal support between the four different designs could be identified and in order to strengthen the narrative. Judging by the outcomes of the test in table 8, there are significant differences between D3 and D1, D4 and D1, and D3 and D2, since the two-tailed p-value is lower than 0.05 for these comparisons.

	D2 & D1	D3 & D1	D4 & D1	D3 & D2	D4 & D2	D4 & D3
P-value (2-tailed)	.215	.000	.002	.001	.067	.497

Table 8. Outcomes Wilcoxon Signed Ranks Test on different designs

The table below summarises the results of the support measurement. It shows that the general principles and network density are widely supported with 90 and 75% respectively. With regards to the designs, the majority also seems positive. As 15 out of the 22 hubs are placed in the context of design 1 and 2 in the plan, almost 70% of the locations are accepted by more than 86% of the sample. The remaining 30% are in the context of design 3 and 4, so enjoy only 62% acceptance. It should be considered whether this is sufficient, or whether another solution may have to be found for those locations.

Case	Share of respondents that express neutrality or support
Adapted Planning Framework	90%
Network Density	75%
Design 1 (Wide pavement, busy road)	94%
Design 2 (Wide pavement, local road)	86%
Design 3 (Mixed with function)	62%
Design 4 (Instead of car park)	62%

Table 9. Summary degrees of societal support

5.3.3 Factors influencing the perception

As a final part of the survey analysis, a series of Kruskall Wallis H and Mann-Whitney U tests were conducted to see if any other factors influenced the respondents' responses. For these tests, the entire sample was used, as it is not specifically important whether someone lives in the neighbourhood or not.

However, it is important to ensure there is no difference in perception between those groups. In order to test whether there was a significant difference between responses of people who live or do business in the neighbourhood and responses of people who do not live or do business in the neighbourhood, a Mann-Whitney U test was performed. Judging from the results in table x below, there are no significant differences between these two groups, since all two-tailed p-values are > 0.05. The latter justifies the choice for including the entire sample in the remainder of the statistical tests.

	P-value (2-tailed)
Visual Perception	.899
Principles	.473
D1	.820
D2	.211
D3	.323
D4	.843
Network Density	.568

Table 10. Outcomes Mann-Whitney U-test on impact of residing in the neighbourhood

After knowing this outcome, the analysis of the other factors began. These are described one by one in the following sections. However, the statistical tests on the influence of gender, age and education level appeared to be not significant. Therefore, they have not been included in this result description. The complete results of the tests can be found in chapter 3 of the data report.

Impact of having children at home

Whether or not children live at home is a factor that, based on the results in this sample, seems to influence perceptions towards the implementation of neighbourhood hubs. The two-tailed p value is < 0.01, indicating that there is a strong significant difference between the two. Based on the statistics in Table x., this significance indicates that people who do not have children are generally more positive about the implementation of micro-hubs than people who do have children. by these numbers, it seems that the parents here do not perceive a direct correlation between moving away from the car-centred regime and the promotion for child safety that is the positive consequence of this. Apparently, there are other factors that weigh more heavily on these parents, such as being able to pick up and drop off children by car.

Filter	**N**	**Mean Rank**
No children living at home	49	34.66
Children living at home	13	19.58
Total	62	

Influence on	**P-value (2-tailed)**
Total Perception	.007

Table 11. Outcomes Mann-Whitney U Test on the impact of having children at home on the total perception

Impact of owning a car

Like having children, car ownership seems to have a strong influence on the overall perception towards the implementation of neighbourhood hubs, since the two-tailed p-value is < 0.01. Based on table (x) below, car owners are much less enthusiastic than people who do not own a car. This outcome was in line with expectations, as a changing streetscape quickly comes at the expense of space for the private car.

Filter	**N**	**Mean Rank**
Does not own a car	35	38.97
Owns a car	27	21.81
Total	62	

Influence on	**P-value (2-tailed)**
Total Perception	.000

Table 12. Outcomes Mann-Whitney U-test on influence of car ownership on overall perception

Impact of having experience with shared mobility

There is no significant difference between having or not having experience with shared mobility. However, there is a significant difference in perception between the different degrees to which people have an affinity with shared mobility. Not surprisingly, people who have regular experience generally have a positive attitude towards the introduction of micro-mobility hubs. However, it is striking that people who have no experience, but would like to use them, have an almost equally high average perception. This indicates that there is a significant group that does not use shared mobility even though they have the desire to do so. This group probably belongs to the so-called late adopters, which is a great potential for the further roll-out and more inclusive adoption of shared mobility.

Filter	**N**	**Mean Rank**
Yes, regularly	15	41.97
Yes, once	12	27.38
No, but I would like to	17	37.59
No, and I will not	18	19.78
Total	62	

Influence on	**P-value (2-tailed)**
Total Perception	.002

Table 13. Outcomes Kruskal Wallis H test on influence of experience with MaaS

Impact of visual communication

As an additional part to the core of the survey, half of the respondents were shown the animation of a future street scenario of Amsterdam with more space for green, pedestrians, cyclists, playgrounds, and station-based shared mobility (Appendix III). Hereafter, they were asked about their opinion in comparison to the contemporary street layout on a Likert scale from much worse to much better. Figure x. below shows the outcomes of this question. These numbers outline an extremely positive perception, with only 15% responding moderately or negatively.

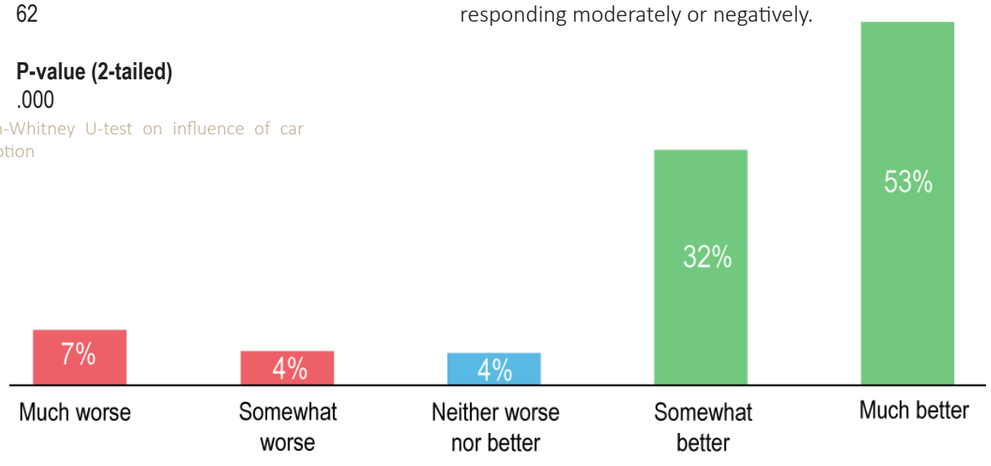


Figure 35. Perception towards future street scenario amongst sample

In order to test whether there was a significant difference in overall perception between people who have seen the video and who have not, a Mann-Whitney U Test was performed. Although the group that has watched the video is slightly more positive, the overall perception is not significantly different amongst the groups, since the two-tailed p-value is > 0.05.

Filter	**N**	**Mean Rank**
Not seen video	30	30.60
Seen video	32	32.34
Total	62	

Influence on	**P-value (2-tailed)**
Total Perception	.703

Table 14. Outcomes Mann-Whitney U Test on impact of visual communication on overall perception

Despite there is no significant difference between the two groups in general perception, there is a significant difference for certain specific designs. It is striking that people who have seen the street animation express significantly less (!) support for Design 1, while, although not statistically significant, the difference for Design 4 is the other way round. This could indicate that people who have seen the video have a better understanding of why we want to deviate from the car-based regime and therefore less support for the conflict-avoiding solution of Design 1, but more support for a more radical design such as Design 4.

	Seen Video	**N**	**Mean Rank**
Principles	No	30	30.75
	Yes	32	32.20
D1	No	30	36.23
	Yes	32	27.06
D2	No	30	33.32
	Yes	32	29.80
D3	No	30	31.93
	Yes	32	31.09
D4	No	30	28.27
	Yes	32	34.53
Network density	No	30	30.66
	Yes	32	31.49

Influence on	**P-value (2-tailed)**
Principles	.727
D1	.031
D2	.411
D3	.851
D4	.158
Network density	.693

Table 15. Outcomes Mann-Whitney U Test on impact of visual communication on individual designs.

5.4 Synthesis

This section brings together the above results and links back to the conceptual model from the theoretical framework. By interpreting the results together, a final framework of principles can be drawn up, which could be applied not only to the case of this thesis, but also to other contexts in the future.

When focus is put on the patterns that recur in the different phases of data collection, it is notable that a distinction can be made between the extent to which principles were challenged by the stakeholders of the case. For a number of principles, a kind of equilibrium seems to have been reached, whereby a general consensus prevailed that these may be starting points for further design and implementation. On the other hand, there are elements that deviated from the averages provided by existing knowledge and are therefore more likely to be context-dependent or subjective.

The framework provides guidance for developing inclusive plans in future situations with different contexts. Thus, an attempt has been made to identify which elements require the most customisation and which do not, so that maximum output can be achieved with minimum effort.

Context conditions

Conditions that, from a purely professional perspective, are essential for a mobility hub to function. If a case deviates strongly from these conditions, the potential of the intervention might already be questioned.

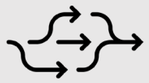
100+ housing units
The projected area should have at least 100 housing units in the immediate vicinity in order to generate sufficient demand for the use of a mobility hub

High parking pressure
The projected area must have a low parking standard and experience high parking pressure. In case of abundant parking space, mobility hubs are less likely to flourish

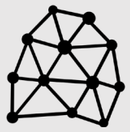
Presense of early adopters
At least part of the population of the projected area should consist of the so-called early adopters (predominantly young adults without a private car). Their presence makes the concept more likely to get off the ground quickly.

Consensual principles

Principles for which there is an acceptable degree of consensus, or which are in the common interest.



Adaptivity
Design the mobility hub in harmony with the style of the neighbourhood and ensure the mobility hub is flexible for subsequent change



Coherent network
Provide opportunity to pick-up and park shared devices in multiple places and give a certain guarantee that shared mobility is available. Furthermore, provide opportunity for external car parking in case parking spaces are removed.

Collaborating parties
Provide a diverse supply of shared modes and prevent theft and vandalism in order to ensure sound shared devices

Familiarised community
Create awareness amongst the population that the opportunity of using shared mobility exists and provide extra guidance for late adopters in order to make shared mobility passable to them

Subjective principles

Principles that are strongly context-dependent and might require tailor-made solutions

Tailor-made policies
Define the unique points of interest and examine which exceptions are relevant to them and investigate all stakeholderds and map their perspectives towards public space in order to ensure inclusivity

Choice of functions
Define the scales of hub, offer of transport modalities and desired supplemental functions

Choice of network density
Define the maximum willingness to walk and hereby the optimal density of the network

Choice of location
Define which locations are conflict-avoiding and assess the potential for multifunctional use of public space faciltiies

Suggested approach

Planning approach recommended if the aim is to achieve an inclusive plan with a high degree of public acceptance

1 Preliminary context analysis
Spatial analysis
Stakeholder analysis
Demographic analysis
Perspective mapping

2 Specify subjective principles
Data analysis
Surveying
Co-creation

3 Design the network
Mapping
Network planning
Location choice
Rendering

4 Present plans and enter the feedback loop
Surveying
Co-creation
Adressed letter

Realisation phase

Inclusive principle building

Design and planning phase

6 Discussion

This thesis has investigated the two-folded problem of realising neighbourhood mobility hubs in existing urban neighbourhoods with a lack of available space. This problem includes both the lack of knowledge about the crucial factors for a successful design of these hubs in this specific context, as well as the problem that the usual method of planning these spatial interventions generally fails to integrate the needs of the end users in the early stages of planning. The combination of these problems often makes the realisation of neighbourhood hubs in such densely populated urban areas a long-term affair, due to encountering resistance from society. Given that it is precisely these neighbourhoods that suffer significant consequences from both car traffic and global warming, it was considered important to study this metropolitan challenge.

To study this and to be able to make a broader recommendation for the planning and design approach, a mixed methods approach was used, in which part of the design and planning process was run through for a test bed in Amsterdam. This design process was put together based on existing theory, two parts of which were modified by the incorporation of co-creation based on the double diamond method. The empathy phase was carried out with a set of semi-structured interviews with a representative cross-section of the population and the final test phase with a survey amongst the entire population. The strength of this form of co-creation is that there was more time per individual and questions could be asked in more detail, as well as those participants might have been able to speak their minds more easily. On the other hand, the weakness was that no plenary discussion could take place and therefore no direct consensus could be reached during co-creation.

With regards to the survey, the strength was that a larger number of respondents could be obtained in a short period of time and that the response was relatively diverse. However, it was not diverse in every aspect. The proportion of highly educated people was clearly higher than that in the population. This confirms once again that it is not so easy to reach target groups with a migration background or with a practical education.

Furthermore, the total number of respondents to the survey during the test phase was not enough to give a statistically representative picture of the entire population. On this relatively short term, it was practically unfeasible to achieve a sample size of 364. This means that it cannot be officially said that the results are representative of the opinion of the entire neighbourhood.

Nevertheless, given the diversity in age and occupancies of the sample and the significance of the sample itself, it is plausible that the survey gave a reliable indication of the population.

All in all, this combination of methods has produced highly insightful results. After conducting the research, it turned out that additional interests and desires emerged with regards to the design principles, which had not necessarily been addressed by the theory beforehand. In terms of spatial implementation, street parking spaces for cars were expected to be the preferred locations. Considering the current phase of the emergence of mobility hubs and shared transport, i.e., that it is not yet the new normal but is mainly used by early adopters, this location choice still seems too disruptive to create public acceptance. The research has shown that these pre-expected locations are not given priority, but that more conflict-avoiding location choices are preferred by the public. In this case, these were not parking spaces, but rather stretches of wide pavement that did not have a primary function, such as the passage of a pedestrian stream.

Furthermore, the results showed that a different view on space is needed in this context. Whereas a project area with an abundance of space does not necessarily demand combined functions, multifunctional use of space in these tight urban areas should not be excluded. However, it is not necessarily a suitable choice, as was shown by the diversifying ratings for the correlating design of a neighbourhood hub in combination with a rest area for this case study. Nevertheless, there does seem to be potential for taking this into consideration during the process of location choice.
The latter also confirmed that there is no ‘one size fits all’ principle, but that a tailor-made approach and policy is crucial in order to achieve broad public acceptance. The results of this case study showed that this neighbourhood also has its own story and unique characteristics, which means that exceptions sometimes need to be made, such as excluding interventions that are directly detrimental to the market and entrepreneurs in this case.

Furthermore, it appeared that there is a demand for design and policy aimed at extra stimulation and support for late adopters. This is essential for achieving inclusiveness, because the will seems to be there, but not everyone seems to be able to get on board easily, due to barriers that vary per target group, such as the digital divide or individual purchasing power.
With regards to the methodology of planning, a number of statements on the results can also be made. The cross-section of the population that was consulted as a co-creation group proved to be an adequate reflection of the population after the plans had been tested among a wider audience. The priorities and concerns identified by this cross-sectional group were largely confirmed in the test phase. As mentioned, additional conditions and specific wishes emerged, which is a plus and does not immediately come to the fore with a more top-down strategy. The disadvantage is that this method costs a relatively large amount of time and effort, which can be a cost-benefit consideration whether to take this approach when planning to realise hubs in existing neighbourhoods.

7 Conclusion

In conclusion, it can be stated that the combination of this planning method and corresponding design principles has led to a satisfactory rate of public acceptance in this case, as the response was positive amongst the vast majority. At first glance, one might thus be inclined to conclude that this is the go-to approach for planning and designing neighbourhood hubs in existing neighbourhoods with a scarcity of public space. However, having gone through this process and putting the results into perspective, several reservations also come to the fore. First of all, this case study has once again confirmed that such issues in complex systems, and thus influenced by a wide range of factors, do not have a one-size-fits-all solution. Each country, neighbourhood and city have different parameters, and despite the further refinement of the principles into consensual and subjective principles, they cannot guarantee success in the future. This immediately brings to light the most obvious limitation of this research, namely that merely one case was scrutinised. It was, of course, a conscious choice to use a case study to investigate a wider problem and to formulate generic recommendations about it. However, they remain partly implicit or subjective principles and it would be perpendicular to the narrative of this thesis to state they would. Therefore, it remains important to approach each situation as unique and to develop tailor-made principles for each individual case.

A starting point in this could be to identify all possible perspectives beforehand and to actively seek out representatives of these perspectives. The absolute level of participation should therefore not be the yardstick, but the extent to which the voices of all these perspectives are represented in the framing of the principles for the planned, seems to be the key. A difficult point in this remains that co-creation has appeared a time-consuming method and that it stays a choice for the government or advisory body whether to adopt this method of participation. However, numerous alternative (digital) resources are available to consult for further tailoring of each individual planning framework. Hence, this thesis recommends the application of tailor-making in future plans prior to putting the first pen on paper, as this seems to be crucial for generating inclusive and publicly accepted designs.

When zooming out to the bigger picture of climate change, the mobility transition, and the domestication of public space, one could argue we should question the still ubiquitous approach of urban planning in existing dense urban neighbourhoods. This approach tends to rely on averages and to consider every situation as equal, barely involving local stakeholders' needs prior to the designing phase, resulting in the planner being not or less concerned that these averages may steer him in the wrong direction, but rather taking a wait-and-see attitude, assuming that any criticism and feedback will surface of its own accord. Hence, this thesis argues we should take a more critical approach ourselves and tailor-make every guiding principle that arises doubt during planning procedures, such as choosing the appropriate network density for mobility hubs. This research endorses this way of working as an approach that generates more acceptance and willingness to cooperate, which is exactly what we as humanity demand in our journey towards shaping a better world as so much can be achieved through behavioural change alone.

8 Reflection and recommendations

This section looks back on the thesis and reflects on several elements, except for the limitations, as they have yet been touched upon throughout the discussion and conclusion.

8.1 Implications for research and society

First and foremost, this thesis has contributed to the knowledge of how-to better tailor spatial plans to the needs of the end-user, by both developing a method and attempting to formulate as explicit as possible principles for achieving inclusive design. Furthermore, it has provided a piece of knowledge for further integration of (shared) transport in space. In terms of urban design in bringing out different perspectives towards the public space and which aspects of this space are most valued. In terms of transport planning for success factors for neighbourhood hubs in this context and the associated network planning.

With regards to implications for society, some awareness has been created in the Bellamybuurt about shared mobility and mobility hubs. Furthermore, awareness has been created regarding the disproportional allocation of public space. In this way, this research nudged the movement towards more people-oriented public spaces.

8.2 Reflection on interdisciplinarity of the research

The interdisciplinarity of this research lied in the integration of urban design and transport planning. The interrelationship between the two disciplines is evident, as maintaining accessibility is of high importance, while at the same time the overall ambience of the urban fabric needs to be improved. In this matter, it is important to maintain an integrated approach, as the design of public space has a direct effect on people's mobility behaviour.

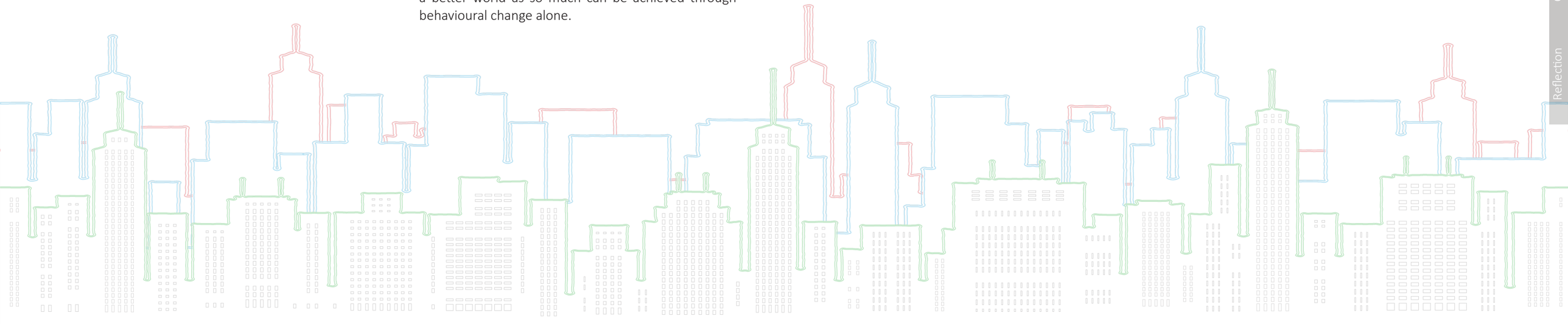
8.3 Recommendations for further research

Lastly, a couple of recommendations for further research can be made. In the short term and as a direct follow-up to this research, the design process could be completed with a new iteration, by making a final design based on the latest feedback and testing it among a group large enough to be representative of the entire population.

Furthermore, the research could be repeated in other neighbourhoods to further improve and justify the design principles in a wider context. The repetitive application of this method would iterate the principles further and further, each time providing less required input against more and more efficient output.

Alternatively, the research could be repeated with a different type of spatial intervention to further improve the method and validate its applicability for other purposes.

For a social study, research could be done on how migrants and more practically educated people can be reached more easily for participation in such projects.



9 Bibliography

9.1 List of references

Abduljabbar, R. L., Liyanage, S., & Dia, H. (2021). The role of micro-mobility in shaping sustainable cities: A systematic literature review. Transportation Research Part D: Transport and Environment, 92, 102734. https://doi.org/10.1016/j.trd.2021.102734

Aono, S. (2019). Identifying Best Practices for Mobility Hubs. UBC Sustainability Scholar. https://sustain.ubc.ca/sites/default/files/Sustainability%20Scholars/2018_Sustainability_Scholars/Reports/2018-71%20Identifying%20Best%20Practices%20for%20Mobility%20Hubs_Aono.pdf

Appleyard, B., & Riggs, W. (2021). Human rights to the street: Ethical frameworks to guide planning, design, and engineering decisions toward livability, equity, and justice. Journal of Transport and Land Use, 14(1). https://doi.org/10.5198/jtlu.2021.1918

Arup Amsterdam. (2022). Shared Mobility [Slides]. Sharepoint. https://www.arup.com

Barcelona for Climate. (2019, July 10). Climate emergency to be declared from 1 January 2020. Retrieved 4 March 2022, from https://www.barcelona.cat/barcelona-pel-clima/en/noticia/climate-emergency-to-be-declared-from-1-january-2020_837054

Bekhuis, F., Bijma, T., de Jong, M., Dommeck, S., & Homrighausen, J. (2021). Leidraad parkeren bij knooppunten en mobiliteitshubs. CROW. https://www.crow.nl/getmedia/498b31d5-cd34-4d00-8d13-16b8a84b1238/Leidraad-parkeren-bij-knooppunten-en-mobiliteitshubs.pdf.aspx?ext=.pdf

Bell, D. (2019). Intermodal Mobility Hubs and User Needs. Social Sciences, 8(2), 65. https://doi.org/10.3390/socsci8020065

Benison, M., & Anderson, M. (2021). Future Mobility Hubs. Arup & Go-Ahead.

Bergman, N., Haxeltine, A., Whitmarsh, L., Köhler, H., Schilperoord, M., & Rotmans, J. (2008). Modelling Socio-Technical Transition Patterns and Pathways. Journal of Artificial Societies and Social Simulation, 11(3), 7. https://www.jasss.org/11/3/7.html

Bösehans, G., Bell, M., Thorpe, N., Liao, F., Homem De Almeida Correia, G., & Dissanayake, D. (2021). eHUBs—Identifying the potential early and late adopters of shared electric mobility hubs. International Journal of Sustainable Transportation, 1–20. https://doi.org/10.1080/15568318.2021.2015493

Botma, H., & Papendrecht, H. (1991). Traffic operation of bicycle traffic. Transportation Research Record, 1320.

Bovenhoff, M., & Meier, S. (2015). Meer sociale cohesie door voorzieningen? Een literatuurstudie naar het verband tussen sociale cohesie en maatschappelijke voorzieningen op het platteland (Deelrapportage III). https://research.hanze.nl/en/publications/meer-sociale-cohesie-door-voorzieningen-een-literatuurstudie-naar

Boyacı, B., Zografos, K. G., & Geroliminis, N. (2015). An optimization framework for the development of efficient one-way car-sharing systems. European Journal of Operational Research, 240(3), 718–733. https://doi.org/10.1016/j.ejor.2014.07.020

Bozzi, A. D., & Aguilera, A. (2021). Shared E-Scooters: A Review of Uses, Health and Environmental Impacts, and Policy Implications of a New Micro-Mobility Service. Sustainability, 13(16), 8676. https://doi.org/10.3390/su13168676

Burghard, U., & Dütschke, E. (2019). Who wants shared mobility? Lessons from early adopters and mainstream drivers on electric carsharing in Germany. Transportation Research Part D: Transport and Environment, 71, 96–109. https://doi.org/10.1016/j.trd.2018.11.011

Center for Sustainable Systems. (2021). U.S. Cities (Factsheet). University of Michigan. https://css.umich.edu/sites/default/files/U.S.%20Cities_CSS09-06_e2021.pdf

Choi, M., Jung, H., & Lee, H. (2021). Determining the Optimum Service Area and Station Location for Personal Mobility Sharing Services. KSCE Journal of Civil Engineering, 25(10), 3966–3976. https://doi.org/10.1007/s12205-021-2060-z

Claus, S. (2019, July 31). Amsterdam wil 11.200 parkeerplaatsen opheffen. In Oost probeerden ze het een maand uit. 'Je ruikt de bloemen'. Trouw. Retrieved 20 February 2022, from https://www.trouw.nl/binnenland/amsterdam-wil-11-200-parkeerplaatsen-opheffen-in-oost-probeerden-ze-het-een-maand-uit-je-ruikt-de-bloemen~b7cb2304/

Enbel-Yan, J., & Leonard, A. (2012). Mobility Hub Guidelines: Tools for Achieving Successful Station Areas. Institute of Trandsportation Engineers Journal, 82(1), 42–47.

Geels, F. W., Kemp, R., Dudley, G., & Lyons, G. (2012). Automobility in Transition? A Socio-Technical Analysis of Sustainable Transport. Routledge. https://www.sustainabilitytransitions.com/files/Automobility%20in%20Transition%20-%20Content%20+%20Preface%20+%20Introduction.pdf

Glotz-Richter, M. (2016). Reclaim Street Space! – Exploit the European Potential of Car Sharing. Transportation Research Procedia, 14, 1296–1304. https://doi.org/10.1016/j.trpro.2016.05.202

Harteveld, M. (2020). Domestication Will Shape Future Public Spaces. A Report from Rotterdam. The Journal of Public Space, 5(3), 53–66. https://doi.org/10.32891/jps.v5i3.1379

Intergovernmental Panel on Climate Change. (2021). Climate change widespread, rapid and intensifying (Press Release). https://www.ipcc.ch/site/assets/uploads/2021/08/IPCC_WGI-AR6-Press-Release_en.pdf

Intergovernmental Panel on Climate Change. (2022). Climate Change 2022: Impacts, Adaptation and Vulnerability (Sixth Assessment Report). https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_FinalDraft_FullReport.pdf

International Energy Agency. (2021). Transport – Topics. Retrieved 10 February 2022, from https://www.iea.org/topics/transport

Klekotka, M., & Hiniker, C. (2021). Mobility Hub Planning Guide - Metropolitan Council. Metropolitan Council. Retrieved 16 February 2022, from https://metrocouncil.org/Transportation/Performance/Emerging-Trends/Mobility-Hub-Planning-Guide.aspx

Kunerth, J. (2020, March 18). Why Riding a Bike is an Ultimate Form of Freedom. Pegasus Magazine. Retrieved 11 May 2022, from https://www.ucf.edu/pegasus/why-i-ride-a-bike/

Lanzillotti, R. F., & Blair, R. D. (1973). Automobile Pollution, Externalities and Public Policy. The Antitrust Bulletin, 18(3), 431–447. https://doi.org/10.1177/0003603x7301800302

Loorbach, D., Schwanen, T., Doody, B. J., Arnfalk, P., Langeland, O., & Farstad, E. (2021). Transition governance for just, sustainable urban mobility: An experimental approach from Rotterdam, the Netherlands. Journal of Urban Mobility, 1, 100009. https://doi.org/10.1016/j.urbmob.2021.100009

Mabon, L., & Shih, W. Y. (2018). What might 'just green enough' urban development mean in the context of climate change adaptation? The case of urban greenspace planning in Taipei Metropolis, Taiwan. World Development, 107, 224–238. https://doi.org/10.1016/j.worlddev.2018.02.035

Maibach, M., Schreyer, C., Sutter, D., van Essen, H., Boon, B., Smokers, R., Schroten, A., Doll, C., Pawlowska, B., & Bak, M. (2008). Handbook on estimation of external costs in the transport sector (Version 1.1-Netherlands ed.). CE Delft.

Martens, P., & Rotmans, J. (2005). Transitions in a globalising world. Futures, 37(10), 1133–1144. https://doi.org/10.1016/j.futures.2005.02.010

Meyer, J. (2011). Automobility and Freedom. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.1911180

Milieudefensie. (2017). Van wie is de stad? https://milieudefensie.nl/actueel/van-wie-is-de-stad-pdf/@@download/file/Van%20wie%20is%20de%20stad-web.pdf

Ministry of Home Affairs and Kingdom Relations. (2020). Nationale Omgevingsvisie. Duurzaam perspectief voor onze leefomgeving. https://denationaleomgevingsvisie.nl/publicaties/novi-stukken+publicaties/handlerdownloadfiles.ashx?idnv=1760380

Ministry of Infrastructure and Water Management. (2021). Verkenning van het concept mobiliteitshub. https://www.kimnet.nl/publicaties/rapporten/2021/05/31/verkenning-van-het-concept-mobiliteitshub

MSG Group. (2022). Design Thinking Methods Catalogue. MSG Systems. Retrieved 2 June 2022, from https://www.designthinking-methods.com/en/

Municipality of Amsterdam. (2019a). Actieplan Schone Lucht (Policy Agenda).

Municipality of Amsterdam. (2019b). Programma Smart Mobiility 2019–2025 (Policy Agenda).

Municipality of Amsterdam. (2020). Agenda Amsterdam Autoluw (Policy Agenda).

Municipality of Amsterdam. (2022). Gebied in Beeld. Gebiedsgericht Werken Dashboard. Retrieved 20 March 2022, from https://gebiedinbeeld.amsterdam.nl/?code=EP

Munoz, F. (2019, September 7). Internal Combustion Engines (ICE) counted for over 90% of global car sales in H1 2019. JATO. Retrieved 10 February 2022, from https://www.jato.com/internal-combustion-engines-ice-counted-for-over-90-of-global-car-sales-in-h1-2019/

Open Info. (2022). Héél véél informatie over wijk Kinkerbuurt (update 2022!). AlleCijfers.nl. Retrieved 20 March 2022, from https://allecijfers.nl/wijk/kinkerbuurt-amsterdam/

Paris Sans Voiture. (n.d.). A Paris on veut entendre les oiseaux (et pas le moteurs). Retrieved 4 March 2022, from https://www.parissansvoiture.org/

Parry, I. W. H., Walls, M., & Harrington, W. (2007). Automobile Externalities and Policies. Journal of Economic Literature, 45(2), 373–399. https://doi.org/10.1257/jel.45.2.373.

PDOK. (2022). BGT Wegdeel [Dataset]. Basisregistratie Grootschalige Topografie. https://app.pdok.nl/lv/bgt/download-viewer/

Razzouk, R., & Shute, V. (2012). What Is Design Thinking and Why Is It Important? Review of Educational Research, 82(3), 330–348. https://doi.org/10.3102/0034654312457429

Reck, D. J., & Axhausen, K. W. (2021). Who uses shared micro-mobility services? Empirical evidence from Zurich, Switzerland. Transportation Research Part D: Transport and Environment, 94, 102803. https://doi.org/10.1016/j.trd.2021.102803

Rijkswaterstaat. (n.d.). Factsheet Deelfietssystemen. Retrieved 7 March 2022, from https://rwsduurzamemobiliteit.nl/slag/toolbox-slimme-mobiliteit/fiets/factsheet-deelfietssystemen/

Roberts, A. (2019). Mobility Hubs Guidance. CoMoUK. https://como.org.uk/wp-content/uploads/2019/10/Mobility-Hub-Guide-241019-final.pdf

Rogers, E. M. (1995). Diffusion of innovations (4th ed.). Journal of Urban Regeneration & Renewal, 10(4), 328–333.

Schemel, S., Niedenhoff, C., Ranft, G., Schnurr, M., & Soblech, C. (2020). MOBILITY HUBS OF THE FUTURE: TOWARDS A NEW MOBILITY BEHAVIOUR (Single publication). Arup/RISE. https://www.ri.se/sites/default/files/2020-12/RISE-Arup_Mobility_hubs_report_FINAL.pdf

Scholten, B., Kwantes, C., & Burmanje, T. (2021). Hoe mobiliteitshubs hoogstedelijke gebieden leefbaar én bereikbaar houden. Gebiedsontwikkeling.nu. Retrieved 7 March 2022, from https://www.gebiedsontwikkeling.nu/artikelen/mobiliteitshub-het-nieuwe-normaal-in-hoogstedelijke-gebieden/.

Sena, N., & Meesterberends, M. (2018). AMS way of working. Principles for citizen engagement (First edition). Amsterdam Institute for Advanced Metropolitan Solutions.

Shaheen, S. (1998, November 30). A SHORT HISTORY OF CARSHARING IN THE 90'S. National Academies. Retrieved 10 May 2022, from https://trid.trb.org/view/747381

Shaheen, S., Chan, N., Bansal, A., & Cohen, A. (2015). Shared Mobility: Definitions, Industry Developments, and Early Understanding (White Paper). University of California Berkeley, Transportation Sustainability Research Center. http://innovativemobility.org/wp-content/uploads/2015/11/SharedMobility_WhitePaper_FINAL.pdf

Sijtsma, M., Krumm, P., & Scholten, B. (2021). Succesvolle mobiliteitshubs: hoe brengen we alle partijen samen? Mobiliteitsplatform. Retrieved 22 February 2022, from https://www.mobiliteitsplatform.nl/nieuws/succesvolle-mobiliteitshubs-hoe-brengen-we-alle-partijen-samen

Social and Cultural Planning Agency. (2020). Onderwijs. De Sociale Staat van Nederland. https://digitaal.scp.nl/ssn2020/onderwijs/#:~:text=In%202010%20had%20ruim%2020,samen%20meer%20dan%2040%25).

Susskind, L., & Field, P. (1996). Dealing with an angry public: the mutual gains approach to resolving disputes. Choice Reviews Online, 34(01), 34–0395. https://doi.org/10.5860/choice.34-0395

Technisch Bureau Lindhout. (2022). Animation Future Street Amsterdam [Video]. Received through Personal Communication with Municipality of Amsterdam. https://www.tbl.nl

Topp, H., & Pharoah, T. (1994). Car-free city centres. Transportation, 21(3), 231–247. https://doi.org/10.1007/bf01099212

Tran, M., & Draeger, C. (2021). A data-driven complex network approach for planning sustainable and inclusive urban mobility hubs and services. Environment and Planning B: Urban Analytics and City Science, 48(9), 2726–2742. https://doi.org/10.1177/2399808320987093

UN Habitat. (2021). Global Public Space Programme (Annual Report 2021). https://unhabitat.org/sites/default/files/2022/02/20220207_annual_report_gpsp_2021.pdf

United Nations. (n.d.). THE 17 GOALS | Sustainable Development. Retrieved 19 February 2022, from https://sdgs.un.org/goals

van Essen, H., van Wijngaarden, L., Sutter, D., Bieler, C., Maffii, S., Fiorello, D., Fermi, F., Parolin, R., Schroten, A., & Brambilla, M. (2020). Handbook on the External Costs of Transport (Version 2019–1.1 ed.). CE Delft.

van Hack, F., Rijken, S., & Boon, M. (2021). Mobility as a Service: hoe realiseer je een succesvolle mobiliteitshub? Hely, BouwInvest & ParkBee. https://docplayer.nl/210459935-Case-study-mobility-as-a-service-hoe-realiseer-je-een-succesvolle-mobility-hub.html

van Rossem, V. (2013). De binnenstad belegerd. Ons Amsterdam. Retrieved 22 February 2022, from https://onsamsterdam.nl/de-binnenstad-belegerd

Villarino, S. (2021). Neighborhood Mobility Hubs: A Framework for Walkable Streets (Doctoral dissertation). University of Hawai'i at Manoa. https://www.proquest.com/openview/32a29e2da05ad413cfabbc6b8543a685/1?pq-origsite=gscholar&cbl=18750&diss=y

Virtudes, A. (2016). Benefits of Greenery in Contemporary City. IOP Conference Series: Earth and Environmental Science, 44, 032020. https://doi.org/10.1088/1755-1315/44/3/032020

World Data Bank. (2020). Population density (people per sq. km of land area) - Netherlands | Data. Retrieved 7 February 2022, from https://data.worldbank.org/indicator/EN.POP.ocations=NL&start=2020&view=map

Yanocha, D., & Allan, M. (2019). The Electric Assist: Leveraging e-bikes and e-scooters for more livable cities. Institute for Transportation and Development Policy. https://www.itdp.org/wp-content/uploads/2019/12/ITDP_The-Electric-Assist_-Leveraging-E-bikes-and-E-scooters-for-More-Livable-Cities.pdf

Zaręba, A., Krzemińska, A., & Widawski, K. (2016). Green Urbanism for the Greener Future of Metropolitan Areas. IOP Conference Series: Earth and Environmental Science, 44, 052062. https://doi.org/10.1088/1755-1315/44/5/052062

Zwikker, R., Revier, E., Shachaf, T., Agliati, S., Scholten, B., van Langevelde, C., van de Wall, R., Gerretsen, P., & Soret, L. (2021). Hubs in bestaande wijken. Sum-One, PosadMaxwan, APPM & Vereniging Deltametropool. https://issuu.com/deltametropool/docs/hubs-bestaande-wijken_rapport_issuu

9.2 List of figures

Figures

Tables

Maps

Designs

10 Appendices

10.1 Appendix I - Interview Guide Semi-structured interviews

1. Brief introduction (slide 1 on screen)

- Provide a brief introduction about the purpose of the research and the goal of enrichening the wider body of knowledge regarding planning neighbourhood hubs in space-poor neighbourhoods.
- Briefly explain what a mobility hub is, what different scales there are and what the purpose in general is.
- Explain that it is not the purpose of the research to influence local decision-making in the Bellamybuurt nor that their responses will have any direct influence on the physical space in the Bellamybuurt.
- Emphasize that participation is voluntarily, that all results will be processed anonymously and that the interviewee can drop out of the interview at any time if wanted.
- Ask permission to record and start recording

2. Introductory questions (slide 1 on screen)

- Open google form on phone and register answers to questions below

General

- o Gender (mc)
  - ☐ Male
  - ☐ Female
  - ☐ Other
- o Age group (mc)
  - ☐ <25
  - ☐ 25-45
  - ☐ 45-65
  - ☐ 65+
- o Place of birth (open, the interviewer adds)
  - ☐ metropolitan / urban environment
  - ☐ suburban environment
  - ☐ village / rural
  - ☐ native / western migrant / non-western migrant
- o Occupancy (open, the interviewer adds)
  - ☐ Student
  - ☐ Retiree
  - ☐ Yup
  - ☐ Working class
  - ☐ Entrepreneur
- o Last followed education (mc)
  - ☐ Elementary school (lagere school)
  - ☐ High school VMBO (middelbare school)
  - ☐ High school HAVO/VWO (middelbare school)
  - ☐ Professional education MBO (beroepsopleiding)
  - ☐ Professional education HBO (beroepsopleiding)
  - ☐ University BA/BSc
  - ☐ University MA/MSc
  - ☐ Academic degree (PhD)
- o Children up to 4yrs at home
  - ☐ Yes
  - ☐ No
- o Children up to 12yrs at home
  - ☐ Yes
  - ☐ No
- o Older children living at home
  - ☐ Yes
  - ☐ No

Travel behavior

- o How many days per week do you travel outside the neighbourhood? (open)
- o Why? (mc)
  - ☐ commuting, work
  - ☐ shopping/services
  - ☐ leisure, friends/family visits
- o How? (mc)
  - ☐ Walking
  - ☐ Bicycle
  - ☐ Scooter
  - ☐ Car
  - ☐ Public Transit
  - ☐ Other
- o How many days per week do you travel outside the city? (open)
  - ☐ "
- o How many days per month do you travel through the Netherlands? (open)
  - ☐ "
- o How many days per year do you travel through the Netherlands? (open)
  - ☐ "
- o Car owner with permit in neighbourhood (mc)
  - ☐ Yes
  - ☐ No
  - ☐ Yes, but parked elsewhere
- o Experience with shared mobility (mc)
  - ☐ Yes
  - ☐ No

3. Further explanation mobility hubs (slide 2 and 3)

- Explain the rationale behind mobility hubs with the support of diagrams on the slide
- Show animation of Javastraat

- o What do you think about this? (open)

4. Specific planning questions (slide 4 and 5)

- Explain the different functions of public space and that mobility hubs will come at the expense of them

- o If you would be to choose three functions to sacrifice, which ones would you choose first, second and third?
- o Which function(s) would you absolutely not sacrifice?

- Explain the necessity to find optimal fineness of network
- o How far would you be willing to walk from your home towards the closest mobility hub?

5. Planning framework questions (slide 6)

- Explain the existing principles for existing hubs based on the literature

- o Would you like to add a principle?
- o Would you like to remove a principle?
- o Do you prefer commercial or private sharing? And why?
- o Are there any other comments you would like to make on this framework?

6. Closing (slide 7)

- o Is there anything else you would like to discuss or ask?

- Stop recording
- Thank for participation

10.2 Appendix II – Supportive slides interview

Slide 1

Mobility hubs

What are they?

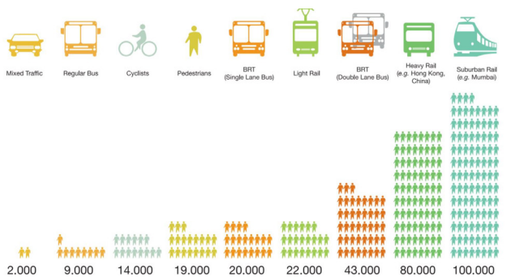
PosadMaxwan (2021)

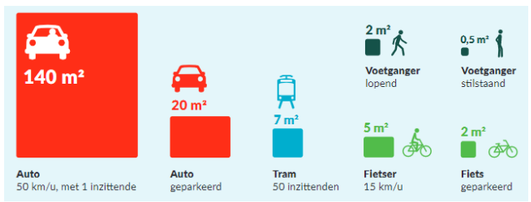
Gemeente Amsterdam (2022)

Slide 2

Background

Disproportional allocation of public space





Papendrecht et al. (1991)

Milieudefensie (2017)

Slide 3

Animation future street scenario

See Appendix III

Slide 4

Public Space

Green (in sidewalk)

Garbage collection

Bicycle rack

Parking space

Rest area

Playground

Green (in road surface)

Wide sidewalk (along busy road)

Wide sidewalk on the corner

Narrow sidewalk (in quiet street)

Wide sidewalk (on waterside)

Wide sidewalk (in quiet street)

Slide 5

Distance

Maximum willingness to walk

Rule of thumb 100 meter = 1 minute

Getekend door auteur

Slide 6

Principes for succesful hubs

Suitable context	Adaptive	Coherent network	Collaborating parties	Informed community
> surrounded by at least 100 housing units > high parking pressure > low parking norm > 'early adopters' present	> tailor-made transport offer > designed in the style of the neighbourhood > flexible for subsequent change	> to be able to leave your vehicle in several places > guarantee of availability	> divers supply of transport modes > supplemental functions	> awareness of the possibility existing

10.3 Appendix III – Animation future street scenario

This appendix shows four snapshots of the visualisation from Technisch Bureau Lindhout (2020).

Before

After

10.4 Appendix IV – Flyer Survey Invitation

Helpt u mij afstuderen?
Korte enquête

Als laatste onderdeel van mijn studie doe ik onderzoek hoe we de openbare ruimte meer in samenspraak met de bewoners kunnen ontwerpen. In het bijzonder gaat dit onderzoek over het plannen van mobiliteitshubs in stadswijken met een tekort aan beschikbare ruimte, zoals de Bellamybuurt in Amsterdam.

Deze zogeheten mobiliteitshubs zijn aangewezen plekken waar deelvervoer, zoals scooters, fietsen en bakfietsen veilig en netjes gestald kunnen worden. Enerzijds handig zodat deze niet meer zonder pardon op de stoep geknald kunnen worden, anderzijds een aanvulling op het openbaar vervoer en daarmee op de bereikbaarheid van de buurt.

In samenspraak met een groep bewoners heb ik een fictief plan gemaakt hoe dat er in de Bellamybuurt uit zou kunnen komen te zien.

Zou u zo vriendelijk willen zijn om uw mening hierover met mij te delen middels een korte enquête van meerkeuze vragen? Dit helpt mij het advies te versterken hoe daadwerkelijke plannen in de toekomst beter op de behoeften van de bewoners kunnen worden afgestemd.

De vragenlijst kunt u invullen middels onderstaande link of QR-code.

Bij voorbaat dank!

LINK shorturl.at/hFRW2

TU Delft · Wageningen University & Research · AMS · ARUP

10.5 Appendix V – Survey Setup

Korte Enquête Mobiliteithubs

Start van blok: Introduction

Bedankt dat u deelneemt aan deze enquête! Laten we beginnen met een paar korte inleidende vraagjes.

Q1 Woont of onderneemt u in de Bellamybuurt?
o Ja, ik woon in de Bellamybuurt (1)
o Ja, ik onderneem in de Bellamybuurt (2)
o Nee (3)

Q2 Wat is uw geslacht?
o Man (1)
o Vrouw (2)
o Dat zeg ik liever niet (3)

Q3 Tot welke leeftijdscategorie behoort u?
o Jonger dan 25 jaar (1)
o Tussen 25 en 45 jaar (2)
o Tussen 45 en 65 jaar (3)
o Ouder dan 65 jaar (4)

Q4 Wat is uw huidige beroep?

Q5 Wat is uw laatst genoten opleiding?
o Basisschool (1)
o Middelbare school (VMBO/MAVO) (2)
o Middelbare school (HAVO/VWO) (3)
o Professionele opleiding (MBO) (4)
o Professionele opleiding (HBO) (5)
o Universiteit (Bachelor) (6)
o Universiteit (Master) (7)
o Academische graad (PhD) (8)

Q6 Heeft u thuiswonende kinderen?
o Ja, jonger dan 4 jaar (1)
o Ja, jonger dan 12 jaar (2)
o Ja, ouder dan 12 jaar (3)
o Nee (4)

Q7 Heeft u een auto?
o Ja, die staat hier in de buurt geparkeerd (1)
o Ja, maar die staat elders geparkeerd (2)
o Nee (3)

Q8 Heeft u eerdere ervaring met deelmobiliteit?
o Ja, regelmatig (1)
o Ja, ooit een keer gebruik van gemaakt (2)
o Nee, maar ik zou het wel willen gebruiken (3)
o Nee, ik ben ook niet van plan het te gebruiken (4)

Einde blok: Introduction

Start van blok: Future Scenario

Q9a Toekomstscenario (shown to 50% of respondents)

Amsterdam wordt steeds drukker en de roep om alternatieven voor de auto neemt steeds verder toe. Slechts 30% van de huishoudens in de Bellamybuurt heeft een eigen auto, maar toch staat bijna elke kleine straat er helemaal vol mee. Een breed en divers aanbod van deelvervoer biedt voor velen een waardig alternatief en zorgt op termijn voor minder autoritjes binnen de stad. Minder autogebruik betekent dat er minder ruimte nodig is voor auto's, waardoor deze ruimte zou kunnen worden vervangen door bijvoorbeeld groen, speeltuinen of terrassen.

Hieronder ziet u een animatie van dit toekomstbeeld. Wat vindt u ervan?

Als de rustige straten in Amsterdam er in de toekomst zo uit zouden komen te zien, vind ik dit...

(Veel slechter Iets slechter Om het even Iets beter Veel beter)

Einde blok: Future Scenario

Start van blok: No Animation - Future Scenario

Q9b Toekomstscenario (shown to other 50% of respondents)

Amsterdam wordt steeds drukker en de roep om alternatieven voor de auto neemt steeds verder toe. Slechts 30% van de huishoudens in de Bellamybuurt heeft een eigen auto, maar toch staat bijna elke kleine straat er helemaal vol mee. Een breed en divers aanbod van deelvervoer biedt voor velen een waardig alternatief en zorgt op termijn voor minder autoritjes binnen de stad. Minder autogebruik betekent dat er minder ruimte nodig is voor auto's, waardoor deze ruimte zou kunnen worden vervangen door bijvoorbeeld groen, speeltuinen of terrassen.

Einde blok: No Animation - Future Scenario

Start van blok: Inhoud

Dit toekomstbeeld zal uiteraard niet hals over kop werkelijkheid worden. Een eerste stap is om het deelvervoer op een aantrekkelijke manier te integreren in de buurt, waarna weer verder gekeken kan worden hoe men verder wil.

Om een eerste plan te maken, ben ik samen met een groep bewoners uit de buurt om de tafel gegaan. Deze groep bewoners bestond uit:

- Een student
- Een werkende (jong)volwassene
- Een autobezitter
- Een ouder van een kind
- Een ondernemer
- Een gepensioneerde
- Een beroepsspecialist
- Een expat

In samenspraak met deze groep heb ik uitgangspunten opgesteld voor het realiseren van mobiliteitshubs in de Bellamybuurt.

Q10 Uitgangspunten

"Ik kan mij vinden in de bovenstaande basisuitgangspunten voor het implementeren van mobiliteitshubs in mijn buurt"

(Helemaal niet mee eens Grotendeels niet mee eens Neutraal Grotendeels mee eens Helemaal mee eens)

Q11 Op een brede stoep in drukke straat

"Een mobiliteitshub op deze plek vind ik..."

(Vreselijk Matig Acceptabel Goed Zeer goed)

Q12 Op een brede stoep in rustige straat

"Een mobiliteitshub op deze plek vind ik..."

(Vreselijk Matig Acceptabel Goed Zeer goed)

Q13 Gecombineerd met een andere functie

"Een mobiliteitshub op deze plek vind ik..."

(Vreselijk Matig Acceptabel Goed Zeer goed)

Q14 In plaats van een parkeerplaats

Vreselijk Matig Acceptabel Goed Zeer goed

"Een mobiliteitshub op deze plek vind ik..." ()

Q15 Aantal hubs

Uit samenspraak met de bewoners is gebleken dat een mobiliteitshub zich altijd binnen 250 meter (2-3 minuten lopen) moet bevinden. In de praktijk zou dat betekenen dat er op de volgende plekken hubs gerealiseerd zouden moeten worden:

"Maximaal 2 tot 3 minuten lopen om een deel(bak)fiets of scooter te gebruiken is..."

(Ik zou het überhaupt niet gebruiken Te ver Precies goed Ik zou nog wel verder lopen)

Q16 Dit is het einde van de enquête. Wilt u verder nog iets kwijt over dit onderwerp?

_____

Einde blok: Inhoud

2022