Shared Mobility Hubs in Urban Developments

A qualitative research on how developers can steer on the integration of shared mobility hubs within urban development.

Master's Thesis

Management in the Built Environment
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Colophon

Shared Mobility Hubs in Urban Developments: *a qualitative research on how developers can steer on the integration of shared mobility hubs within urban development.*

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Preface

Before you lies the master thesis "*Shared Mobility Hubs in Urban Developments"* which has been written to fulfil the graduation requirements for the master track MSc Management in the Built Environment at Delft University of Technology. Within this one-year graduation project, I have examined how developers can steer on the integration of shared mobility hubs within urban developments.

I have always been interested in mobility. Particularly, I am fascinated by the interrelation between mobility and the built environment. During my studies in the United States, I first-hand experienced this interplay: over the last century, the reliance on cars has caused widespread urban sprawl in the U.S. Being used to walking and biking everywhere, I needed to get adjust myself to large distances and car-oriented cities.

My interest for shared mobility hubs was sparked during a serendipitous conversation with a colleague during one of my internships. After having this discussion, I realized the degree of complexity of this topic. Moreover, I realized that during my studies, mobility often was not duly considered. Taking into account the challenges our society faces regarding densification and mobility, I wanted my research to contribute to this field.

I would like to thank my mentors from TU Delft, Erwin Heurkens and Paul Chan, for their great guidance during this academic year. Also. I want to thank Marcel Bilow for being the chairman of the graduation committee. Furthermore, I would like to express my gratitude towards my supervisors at Heijmans - Marco Bosch and Hans Broekman - and my colleagues from the Smart City and Real Estate department. The involvement within these departments has been extremely valuable and interesting. Lastly, I would like the participants of this research for being available to share their insights in this topic.

I hope you enjoy reading this thesis.

Yours sincerely,

Rik van den Bogaerdt

Delft, June 23rd, 2023

Abstract

Over the last decade, shared mobility has more often become a part of urban development. Studies are increasingly pointing at mobility hubs as a vehicle to deliver shared mobility, often from a viewpoint within the mobility sector. However, shared mobility hubs have to a lesser extent been studied in relation to urban development. As far as the integration of shared mobility hubs within urban development is concerned, roles are unclear, uncertainty is high, and a scientific knowledge gap exists. Therefore, this study examines the integration of shared mobility hubs within urban developments, and assesses how developers can steer on this integration. Firstly, a review of previous studies is carried out on the concepts shared mobility, mobility hubs, and management of urban development projects. Secondly, three case studies are examined to empirically assess key stakeholders' perspectives on working and steering on shared mobility hubs. It is found that the way developers can steer on mobility hubs, depends on the needs of the urban development organization and the needs of users, the purpose that the mobility hub should serve, and the eventual type of mobility hub that is steered upon. To illustrate the considerations affecting the way of steering, recommendations for practice are provided. Based on these recommendations, the management of two theoretical hub typologies is discussed within an expert panel.

Keywords: *mobility hubs, shared mobility, urban development, developer, management, mobility services, Mobility as a Service, real estate, mobility transition, energy transition.*

Executive Summary

Introduction

Context: over the last decade, shared mobility has more often become a part of urban development. Studies are increasingly pointing at mobility hubs as a vehicle to deliver shared mobility, often from a viewpoint within the mobility sector. However, shared mobility hubs have to a lesser extent been studied in relation to urban development.

Problem Statement: as far as the integration of shared mobility hubs within urban development is concerned, roles are unclear, uncertainty is high, and a scientific knowledge gap exists.

Motive 1	Motive 2	Motive 3
Unclear roles	**Uncertainty related to shared mobility and mobility hubs**	**Knowledge gap about shared mobility and mobility hubs within urban developments**

Research Objective: the objective of this study is to examine the integration of shared mobility hubs within urban developments. Its goal is to assess how developers can steer on the integration of shared mobility hubs, both in the development and user phase. The focus is on so-called *wijkhubs* (neighborhood hubs).

Research Questions

Main Question	How can developers steer on the integration of shared mobility hubs within urban developments?

SQ1	What is known about the integration of shared mobility hubs within urban development projects, and how can it be steered?
SQ2	What are the experiences of actors in collaborating on and steering upon the integration of shared mobility hubs in urban development?
SQ3	What can be learned from literature and empirical studies about the integration process of shared mobility hubs in urban development?

Review of Previous Studies

Shared Mobility	Shared Mobility Hubs	Management of Urban Development Projects

A review of previous studies is conducted to gain insights on the above topics. When it comes to the conceptualization of mobility hubs, it was found that mobility hubs can include more than just mobility (Figure 6). Based on the review of previous studies, the Mobility Hub Integration Model is constructed (Figure 21). It serves as a conceptual framework through which this thesis' topic is approached.

Figure 6: Features of Mobility Hubs (own work)

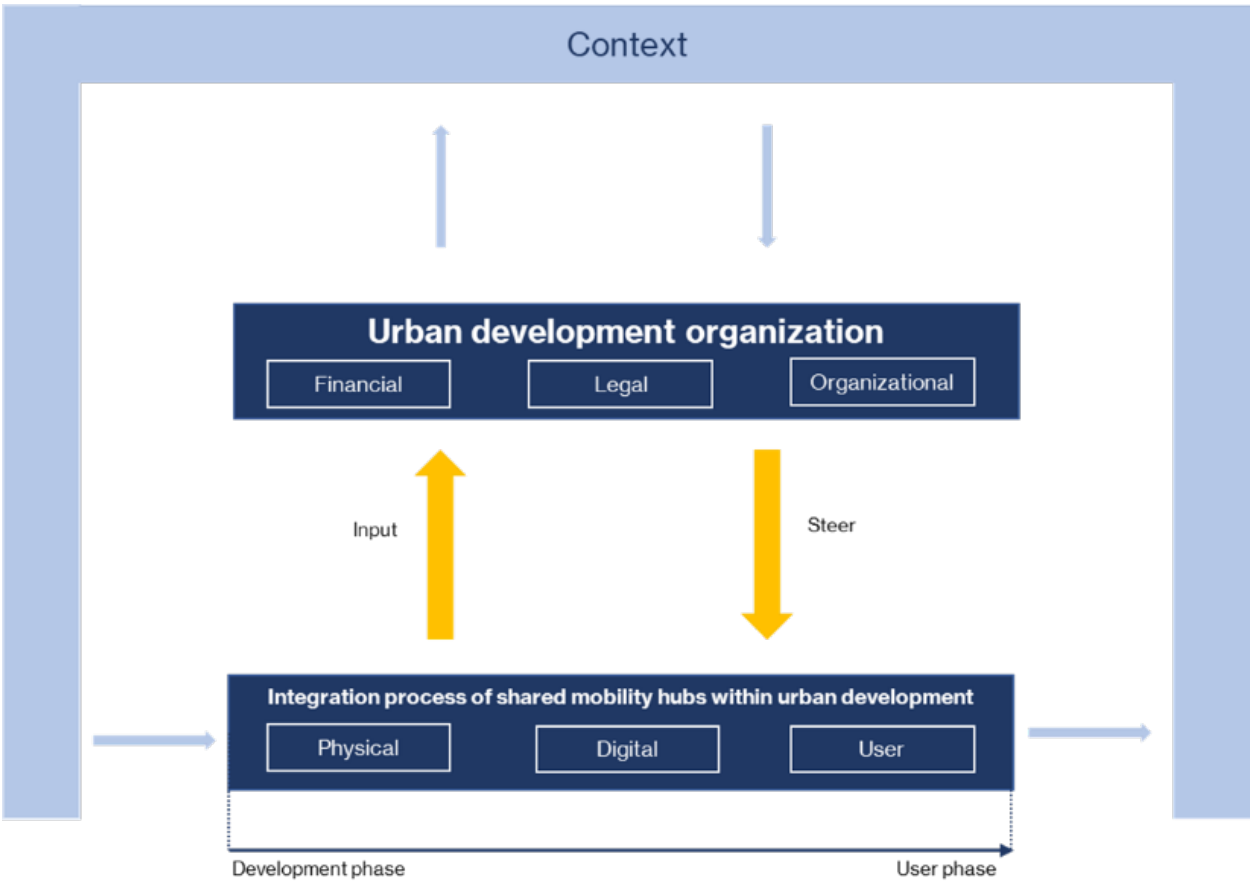


Figure 21: Mobility Hub Integration Model (own work, based on Heurkens (2012) as adapted from De Leeuw (2002))

Methodology

Next to the review of previous studies, three case studies are conducted. For each case study, participants in different roles are interviewed. The semi-structured interviews examine the experiences of actors in collaborating on and steering upon the integration of shared mobility hubs in urban development. Each of the case studies involves plans for mobility hubs. However, the cases have different contexts.

Research paradigm	**Interpretivist**	Time horizon	**Cross-sectional**
Research approach	**Abductive**	Data collection	**Theoretical background** **Document review** **Semi-structured interviews**
Data type	**Qualitative**		
Research strategy	**Case study**		
Research design	**Exploratory & Descriptive**		

Case Studies and Interviewees

Feyenoord City Rotterdam	Nieuwlandplein Schiedam	Waterlandkwartier Purmerend
• Transformation • + 3700-4000 dwellings • Located within a G4 city • Urban densification • Large-scale development with planned network of hubs	• Demolition + new construction • Located close to a G4 city • Urban densification • Smaller scale development without a network of hubs • Close to public transportation	• Transformation of an area close to down-town • + 1800 dwellings. • Plans for mobility hubs on the edge of the plan area • Partly funded with money from the WBI (*WoningBouwImpuls*) • Located close to a G4 city
Interview participants		
Developer Municipality Mobility Advisor	Developer Municipality Housing Association	Developer Municipality

Non case-study-related interviewees: Shared Mobility Provider, Shared Mobility Service Provider, Logistics Advisor.

Results

The results from the interviews are clustered into two sections that each contain related sub-topics:

• Mobility Hub Concept: everything related to the mobility hub as a product and the way it is used. This includes **physical, digital**, and **user** aspects.

• Urban Development Organization: everything related to organizational process of creating and maintaining the mobility hub. This includes **organizational, financial, legal,** and **steering** aspects.

On the next page, the key takeaways are presented for each sub-topic.

Mobility Hub Concept

Mobility Hub Concept (general): the mobility hub concept is interpreted in different ways. Descriptions differ with regard to concreteness, program and objectives, and scale and design.

Physical Design & Adaptivity: hubs can be located either within a buildings or as a stand-alone building. Hubs can have a variety of functions within the mobility, social, and the energy realm. Shared mobility is evolving, and this could potentially have spatial consequences. Therefore, adaptivity plays an important role. Adaptivity can be enhanced by using modular units, reserving space for expansion, not physically integrating the building, and building the hub as a stand-alone unit at street level.

Digital and MaaS: Participants' views differ on the necessity and (commercial) potential of Mobility as a Service. An all-encompassing MaaS application and White Label Hubs do not seem realistic in the upcoming years. However, the potential of interoperability between different hubs and providers is indicated to be hopeful yet challenging.

User and Behavior (demand): the target groups of shared mobility can be approached in two ways: those who are most prone to use shared mobility, and those that are thought of as desirable users of shared mobility. While certain visions include all people as a target group of shared mobility, there is currently no market proposition for target groups with a smaller wallet. When it comes to business use, shared cars could also serve as *pool cars*. It is indicated that shared mobility can become more attractive when it proofs itself, when it is easy to use, and when alternatives can be compared. The user perspective is important when it comes to the shift from ownership to shared mobility. This is about behavioral change and while financial incentives play a big role, other aspects, such as the car as a status symbol, should also be considered. To create awareness of shared mobility, communication about and involvement in shared mobility is of importance. Also, the hub should be recognizable and visible for users. Lastly, a staffed hub could help people use (shared) mobility and could have a social return to it as well.

Modalities and Operation: hubs can include multiple modalities, such as bikes, vans, scooters, car, and public transport. The potential of shared bikes as a first-mile solution is strongly doubted. While free-floating shared mobility is desirable to some, the financial viability of free-floating shared cars is strongly doubted. Views differ on the transfer function of hubs and in this respect, it is important to note that cars are generally not used as a first- or last-mile solution.

Energy: bi-directional charging has potential, and it can prevent overload of the electricity network by locally storing energy. Although the concept still has way to go, developments can be anticipated on in the design of hubs.

Urban Development Organization

Organization and Management: the hub can be seen as a means to an end. There is a wide variety of objectives that the hub can serve. These objectives can serve the Urban Development Organization and/or the user. Examples of objectives are preventing congestion, lowering the parking standards, lowering the amount of cars on the street, and creating more quality in the public space.

Business Case and Organization: a connection with the existing mobility concepts can be beneficial as there is already a customer base for these services. Having multiple shared mobility providers compete with each other is not desirable from a business perspective as it provides more uncertainty to the business case. While hubs can be organized by the Home Owners Association(s), this is easier when the hub is integrally part of a building than when it is a separate entity. The hub's business case can be approached in multiple ways. While it currently is not (yet) attractive from a financial perspective, one could also approach the business case through a broader scope, also including satisfaction and social return. It is paramount to determine how the shared mobility and hub concept is organized. Whether public and/or private parties are willing

to take the initiative depends on the context (e.g. market region, urban versus rural, incentive, political ambition). Ideally, this choice should be made before the project is started.

Business-to-Consumer: the importance of viewing the hub as an interplay between demand and supply is brought up in the interviews. While some participants indicate that the affordability of shared cars leaves to be desired, it seems challenging to lower the rates from a business perspective. In addition, increased accessibility is not always desired from a business perspective.

Parking: besides fewer parking spots, flanking policy related to parking could help make shared mobility a more attractive alternative. Hubs could also play a logistical role (consolidation points) to reduce the number of vans on the sidewalk and hereby increasing the quality of the public space.

Cross-case Analysis

For each three cases, the developer and the municipality take on a different approach with regard to steering. The main difference is the amount of initiative that the municipality takes as opposed to the developer. Potential explanations for these differences could be related to the amount of experience of the municipality with hubs, differences in the political approach towards mobility, demand for housing, the existing infrastructure and public transport, and the size of the development.

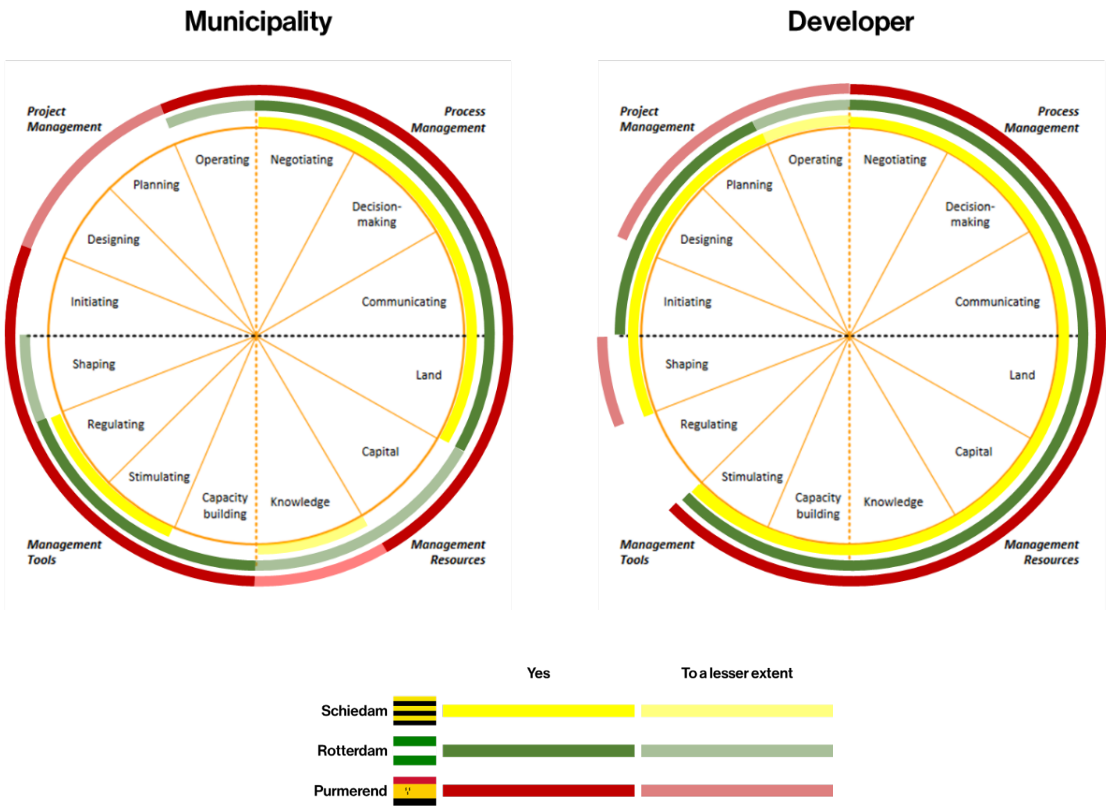


Figure 29: Management of hubs analyzed for the municipality and developer (adapted from Conceptual public-private urban management model (Heurkens, 2012))

Discussion

Contribution of the Research: this research includes both conceptual/theoretical and more practical findings about the situation as-is. The perspectives from stakeholders in different roles can be used to align inter-organizational arrangements, serve the interests of the user, and, in the end, better steer on the integration of mobility hubs in the future.

Limitations: there are certain limitations affecting the trustworthiness of this research. Firstly, the number of participants is limited and an increased number of perspectives and interviewees in different roles could have enhanced the credibility. Secondly, findings showed that the user-perspective of shared mobility is of paramount importance. Therefore, including the user-perspective in this research would enhance its credibility. Thirdly, this research is conducted within the Dutch context, affecting its transferability to other contexts. However, certain results (e.g. the design of hubs and the importance of user-aspects) are to a lesser extent context-dependent. Fourthly, the scope of this research is broad and interdisciplinary and certain sub-topics could be examined more in-depth. Lastly, the case studies are examined at one moment in time (cross-sectional). Therefore, it is hard to examine how certain decision and uncertainties have turned out over time.

Conclusion

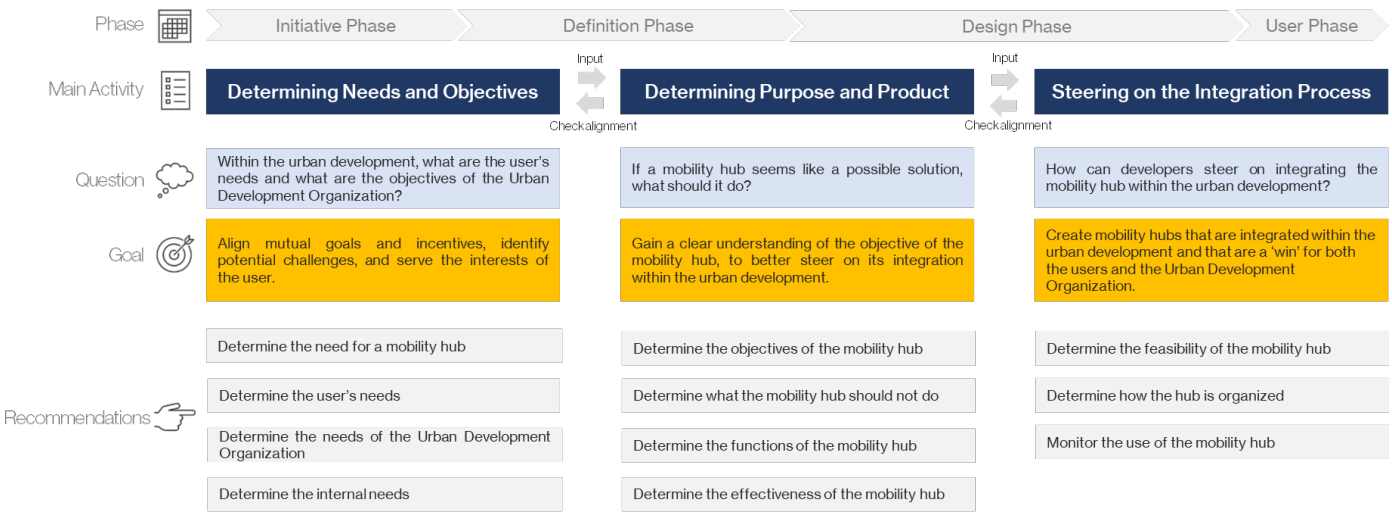
How can developers steer on the integration of shared mobility hubs within urban developments?

It can be concluded that the way developers steer on mobility hubs is dependent on the following aspects:

- **The needs of the urban development organization and the needs of users**
- **The purpose that the mobility hub should serve**
- **The eventual type of mobility hub (product)**

Recommendations for Practice

When it comes to how developers can steer on the integration of shared mobility hubs within urban developments, this thesis provides the following recommendations for practice.



Recommendations for Future Research

A number of gaps in the knowledge on mobility hubs follow from this research's findings. Therefore, future research could focus on the following realms of interest.

User aspect	The user aspect of mobility hubs turned out to be understudied. It is, however, an important topic as far as hubs and shared mobility are concerned.
Societal role	The societal objective of hubs is important to zero in on. Especially in relation to the role division of private and public parties.
Lack of precedents	Additional research could examine how certain decisions have turned out in the exploitation phase.
International context	Additional research on shared mobility hubs within an international context would be helpful to gain insights on best-practices.
Autonomous mobility	Autonomous mobility is not included in this research. Since self-driving techniques are developing quickly, the impact of autonomous mobility on shared mobility hubs is of interest.
Asset	When the hub as an asset is better defined, it would be beneficial to do further research on quantitively assessing its business model.

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01
Introduction

1. Introduction

1.1 Context

1.1.1 Emergence of Shared Mobility

Over the last decade, the Netherlands have witnessed a significant growth in shared mobility. The amount of shared cars experienced a growth from 2.853 cars in 2012 to 79.280 cars in 2021 (CROW, n.d.-b). Furthermore, there has been a rapid increase in the number of cities being serviced by shared mobility operators offering e-scooters and shared bicycles. Shared mobility is present in most high density urban areas (CROW-Fietsberaad, n.d.).

Various municipalities have put in place legislation that regulates the operation of shared mobility within the city. Mobility services operators are heavily dependent on this legislation (Schut & Broekhof, 2021., 4:44). There are multiple policy instruments that municipalities have at their disposal to regulate and propel the developing shared mobility market within the context of the Mobility Transition (Nijhof, 2020). For example, one of the important policies impacting new urban developments is that municipalities allow a lower parking standard than usual when shared mobility is available (*City Deal Elektrische Deelmobiliteit in Stedelijke Gebiedsontwikkeling*, 2018)

1.1.2 Energy and Mobility Transition

In 2015, the Dutch government signed the legally binding Paris treaty, which aims to tackle climate change and its negative impacts (United Nations, 2015). To achieve the goals in this treaty, the Dutch government aims to be (almost) fully climate neutral by the year 2050. This so-called Energy Transition aims to decrease dependency on fossil fuels and instead transition to sustainable energy sources. This transition takes place in many realms, such as *mobility*, *electricity*, and *the built environment* (RIVM, n.d.). The focus on these areas does not come as a surprise, since the mobility sector together with the built environment account for approximately 32% of all domestic greenhouse gas emissions (Centraal Bureau voor de Statistiek, n.d.-b). Furthermore, the current mobility system relies heavily on the use of privately owned fossil-fueled vehicles (Jeekel, 2013; Urry, 2004, as cited by Manders et al., 2020).

In order to meet the goals of the Dutch energy and mobility transition, shared electric mobility could be a solution. Fundamental change of the current mobility system is necessary to reduce carbon dioxide emissions and to deal with other sustainability challenges (Manders et al., 2020). Shared mobility is said to reduce greenhouse gas emissions whereas on the same time enhancing urban accessibility and livability (Goudappel, n.d.). Hence, many municipalities have put in place strategies with regard to the Mobility Transition. The association of Dutch municipalities (*Vereniging Nederlandse Gemeenten*) aims to future-proof mobility by taking into account accessibility, sustainability, livability, traffic safety, and their interdependencies (Vereniging

Nederlandse Gemeenten, n.d.). This is in line with the statement that the future of mobility asks for an integral approach (Royal Haskoning DHV, n.d.).

1.1.3 Urban Development

Dutch cities are dealing with a forecasted urban population growth of 1 million until 2035. Most of the population growth will take place in bigger and medium-sized cities (Centraal Bureau voor de Statistiek, n.d.-a). This results in a higher demand for urban housing and a higher pressure on existing urban infrastructure (Van Lohuizen & Aghina, 2018). Demand for dwellings is generally high in Dutch cities. It has been calculated that the housing shortage of 331.000 dwellings in 2020 will grow to 419.000 housing units in 2025 (Groenemeijer et al. 2020, as cited by Schilder et al., 2021). Therefore, there is a need for to ease the tight housing market. Urban densification could be one of the approaches to achieve this by generating more supply of housing.

Shared mobility is said to pose a solution to urban development challenges. For example, it helps make better use of the scarce availability of land as one shared car is said to replace 4 to 8 owned cars (Ministerie van Infrastructuur en Waterstaat, n.d.), or 4 to 6 parking spots (Over Morgen, as cited by Nijhof, 2020). Furthermore, a lower parking standard could make projects more financially feasible and leave more space for urban quality (*City Deal Elektrische Deelmobiliteit in Stedelijke Gebiedsontwikkeling*, 2018). In addition, (shared) battery electric vehicles (BEVs) could aide in the energy transition by for instance storing and delivering solar energy surplus using bidirectional charging (*Vehicle to Everything; V2X*) (ANWB, 2022).

In 2018, multiple pilot development projects commenced in which various actors are experimenting with new forms of mobility and the way they are embedded in the (new) urban fabric (City Deal Elektrische Deelmobiliteit in Stedelijke Gebiedsontwikkeling, 2018). Public and private actors together joined forces to learn from these projects, including municipalities, provinces, the national government, project development parties, and mobility service providers.

1.1.4 Mobility Hubs

Mobility hubs are increasingly taken into account when it comes to the organization of mobility services within the built environment. Mobility hubs are an option to integrate various sustainable transportation options to enhance connectivity across a region (Tran & Draeger, 2021). Mobility hubs could support shared mobility (Coenegrachts et al., 2021) and can support higher density, mixed use land development (Monzón et al. 2016, as cited by Tran & Draeger, 2021). They are said to be a way to organize mobility and spatial use in a smart way, with the goal to achieve an accessible and livable neighborhood (PosadMaxwan et al., 2019, as cited by van den Berg, 2020).

Thus, mobility hubs (and the attached mobility services) play a role in the energy transition, the mobility transition, and the challenges related to the Dutch housing shortage. Hubs are therefore intertwined with the built environment.

1.2 Research Problem

1.2.1 Unclear Roles

The emergence of shared mobility operators within the AEC (Architecture, Engineering, Construction) industry has forced the more established actors to innovate and look at novel ways of operating (*City Deal Elektrische Deelmobiliteit in Stedelijke Gebiedsontwikkeling*, 2018). For this reason, multiple pilot projects that include mobility services in urban developments are taking place. These experiments take place within a transition context, involve a broad range of actors, and therefore are practice-based and challenge-led (Sengers et al., 2016, as cited by Manders et al., 2020). Collaboration of different types of actors from multiple domains is desirable when it comes to the shift to a multi-modal mobility system (Manders et al., 2020). Furthermore, the collaboration with relatively new actors (niche) is developing and therefore not fully understood. During processes of articulation and negotiation, expectations become more specific, and more actors share the same type of expectations. Alignment of expectations is an essential condition for successful niche development (Bakker et al., as cited by Manders et al., 2020). Due to the high complexity, developing hubs is a process of learning-by-doing (Kennisinstituut voor Mobiliteitsbeleid, 2021).

Since technological advances are developing at a rapid pace, there are little precedents of the implementation of these techniques and ways of operating. Therefore, actors are still figuring out what impact new technologies, such as shared mobility and mobility hubs, have on urban development. Integration of sustainable transport modalities can be promising and valuable, but public and private parties are still uncertain about how to incorporate these modalities. For instance, project developers are struggling with their roles and responsibilities (de Koning, 2022). To successfully apply mobility hubs in the future, the role of different stakeholders during the development of these hubs needs to become clearer (van den Berg, 2020). An integral approach to urban development brings together all stakeholders (CROW, 2022b). Lack of attention for the roles and responsibilities in mobility hub development, it said to hinder the integral and future-proof design of hubs (Heezen et al., 2021).

1.2.2 Uncertainty Related to Shared Mobility and Mobility Hubs

Shared mobility is seen as promising, but the concept still needs to prove itself. For this reason, implementation should not be rigid, but ought to be adapted to future developments and insights (Mouw, 2020). Thus, short-term and long-term interests need to be linked to create long-term integration of mobility services within urban developments. Since urban developments usually take a long time, a balance between flexibility and certainty needs to be found within the collaboration. Also, the long-term success of shared mobility largely depends on the long-term operational model in the exploitation phase. Sustainable mobility options require a long commitment and guaranteeing mobility options throughout the years is important but challenging (de Koning, 2022). Hence, when it comes to the integration of mobility hubs within urban developments, this research zeroes in on both the development as well as the exploitation phase.

1.2.3 Knowledge Gap about Shared Mobility and Mobility Hubs within Urban Developments

Project developers are active within the field of shared mobility by making shared mobility part of urban developments. Shared mobility within urban developments is a relatively new phenomenon and within this realm, multiple topics are to be examined (Nijhof, 2020). The combination of urban development and mobility hubs has to a lesser extent been studied (Table 1). Tasks in the field of transport, energy, and spatial quality usually are usually seen apart from each other, but come together in urban development (CROW, 2022b). Taking into account that the role of project developers in creating hubs (van den Berg, 2020), lack of insights into these processes could hinder successful integration of the mobility hub concept in urban developments.

1.3 Research Objectives

When it comes to shared mobility hubs, the problem statement has introduced three motives that hinder the integration of mobility hubs within urban development. Therefore, the aim of this research is to provide insights into how urban developers can steer on the integration of shared mobility hubs within urban development. The focus is on the perspective of the developer, since it is noted that this stakeholder group is struggling with their roles as far as the integration of sustainable transport modalities is concerned (de Koning, 2022). Its goal is to conceptualize integration process and thereby examine which aspects affect this process. In doing so, the focus is not only on the development phase, but also on the user phase.

1.4 Research Relevance

1.4.1 Scientific Relevance

Shared mobility and mobility services are topics largely present in scientific literature. However, a lack of knowledge has been identified when it comes to *(shared) mobility hubs*. Furthermore, shared mobility and mobility hubs have to a lesser extent been studied in combination with urban development. This is shown in Table 1, which includes the number of documents found in SCOPUS and Google Scholar[1] using different key word combinations as a search query. Furthermore, in Table 2 it can be seen that the number of publications on *mobility hubs* and *shared mobility* have been increasing over the last decades, implying a growing scientific relevance of this field of research.

[1] *The amount of results in Google Scholar is an estimation given by the search engine.*

Table 1: results of search queries in Scopus and Google Scholar, as of 10-11-2022

Search query	Scopus	Google Scholar
"mobility hub"	1053	1020
"shared mobility hub"	43	37
"shared mobility"	5906	16.000
"mobility services"	45.393	29.600
("mobility hub" **OR** shared mobility hub") **AND** ("shared mobility" **OR** "mobility services")	11	18.000
("shared mobility" **OR** "mobility services") **AND** ("urban development" OR "urban redevelopment" **OR** "urban regeneration")	25	4570
("mobility hub" **OR** "shared mobility hub") **AND** ("urban development" **OR** "urban redevelopment" **OR** "urban regeneration")	3	303
("mobility hub" OR "shared mobility hub") **AND** ("urban development" **OR** "urban redevelopment" **OR** "urban regeneration") **AND** ("shared mobility" **OR** "mobility services")	0	101

Table 2: SCOPUS search results over the years, as of 10-11-2022

Years	"mobility hub" OR "shared mobility hub"	"shared mobility"
1951-1959	0	1
1960-1969	0	8
1970-1979	0	51
1980-1989	0	118
1990-1999	0	285
2000-2009	1	815
2010-2019	15	2515
2019-now	24	2664

1.4.2 Societal Relevance

The societal relevance applies to multiple scale levels, respectively to the urban development and to society as a whole.

Urban development scale

On the scale level of urban development, this research generates enhanced insights into the way mobility hubs can be organized within urban developments. This is important as AEC stakeholders can use these insights to foster more effective mobility hubs within urban developments. This applies to both the short and long term, and can add value to the residents (users) as urban areas can be densified while at the same time remaining livable and accessible. Furthermore, creating successful examples of mobility hubs integrated in urban developments could bring about a multiplier effect if concepts are proven to work and add value. At this time, lack of attention for the roles and stakeholders of the hub development process, and the limited scope with regard to domains and disciplines, is hindering integral and future-proof hub design (Heezen et al., 2021).

Societal scale

On the societal scale, effective integration of mobility hubs in urban developments can create environmental sustainability as fewer transport modalities are needed when shared, which in its turn mean less embodied energy. Additionally, proper execution of this integration helps at realizing parts of the energy transition while at the same time taking

on the urban densification challenge. Ideally, mobility hubs solve problems that go further than the mobility system (Heezen et al., 2021). Thus, integrated mobility hubs can foster sustainability in a broad sense (environmental, social, economical) throughout multiple scale levels, domains, and disciplines.

1.5 Research Questions

1.5.1 Main Research Question

Main Question	How can developers steer on the integration of shared mobility hubs within urban developments?

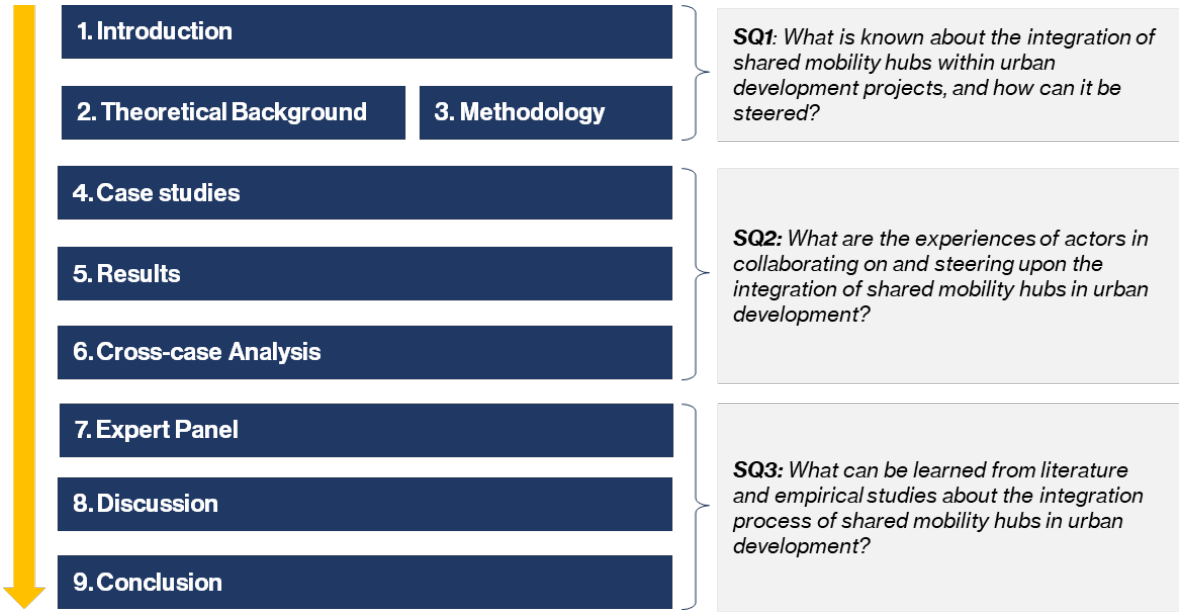
1.5.2 Sub Research Questions

SQ1	What is known about the integration of shared mobility hubs within urban development projects, and how can it be steered?
SQ2	What are the experiences of actors in collaborating on and steering upon the integration of shared mobility hubs in urban development?
SQ3	What can be learned from literature and empirical studies about the integration process of shared mobility hubs in urban development?

1.6 Personal Study Targets

For a long time I have been interested in the relationship between mobility and real estate. During a previous internship, I discovered about shared mobility strategies within urban developments and this sparked my interest. For this reason, I am excited to be writing a thesis which topic is on the cutting edge of urban development and shared mobility. Since the topic is developing rapidly, I am interested to hear different experiences on shared mobility hubs in different contexts. I hope that by writing this thesis, I will gain more insights in both the urban development process at large, and also on the phenomena shared mobility and hubs in particular. I hope that my analytical skills are enhanced by combining in-practice experience and the scientific process of writing this thesis. Lastly, I hope to provide valuable knowledge to the field by presenting new or surprising insights.

1.7 Thesis Outline



An overview of the chapters and their respective content is provided in Table 3.

Table 3: Thesis outline with description

Chapter		Main content
1.	**Introduction**	Introduction to the topic's context, problem statement, objectives, relevance, and research questions.
2.	**Theoretical background**	This chapter examines and conceptualizes the topics shared mobility, mobility hubs, and the management of urban development.
3.	**Methodology**	Methodological framework and description of the data collection and analysis methods.
4.	**Case Studies**	Review of the case studies and introduction of interviewed participants involved in the case studies.
5.	**Results**	Presentation of main findings from the empirical studies.
6.	**Cross-case Analysis**	Analysis of the differences and similarities between the case study.
7.	**Expert Panel**	Reflect on the results and discussion, validate the conclusion and recommendations for practice, discuss and explore challenges and opportunities in steering on mobility hubs.
8.	**Discussion**	Description of this research's contribution and its limitations
9.	**Conclusion**	Answer to the main research question by synthesizing the theory from desk research and empirical studies. Recommendations for practice and recommendations for future research.
8.	**References**	-
9.	**Appendix**	Reflection, informed consent form, research introduction letters, and interview protocol.

02
Theoretical Background

2. Theoretical Background

From the main research question, three concepts can be distilled:

1. Shared mobility
2. (Shared) mobility hubs
3. Management of Urban Development Projects

Before zeroing in on the interaction between shared mobility, hubs, and urban development, a study on the theoretical background of these topics is carried out. The objective is to define and conceptualize shared mobility and mobility hubs. A proper understanding of the theoretical background is needed to assess in what way the concepts are interconnected.

2.1 Shared Mobility

2.1.1 Umbrella Term

Shared mobility is seen as a loose concept that includes a number of new emerging models (Santos, 2018). Santos (2018) states that two features common to shared mobility are 1. an element of sharing an asset instead of owning it, and 2. that mobility services rely on technology (i.e. a digital platform). Karbaumer & Metz (2022, p. 19) state that shared mobility is an overarching term including a broad variety of transport options. This is in line with Shaheen et al. (2017, as cited by Machado et al., 2018) claiming that shared mobility is an umbrella term that refers to a broad array of innovative transportation modes with different use cases, business models, and travel behavior impacts.

2.1.2 Definition

Shaheen et al. (2017, as cited by Machado et al., 2018) define shared mobility as *trip alternatives that aim to maximize the utilization of the mobility resources that a society can pragmatically afford, disconnecting their usage from ownership*. Shared mobility is the short-term access to shared vehicles according to the user's needs and convenience. The phenomenon is occurring due to demographic and cultural shifts, new social attitudes on the ownership of good, and advances of mobile technology (Machado et al., 2018). Shared mobility is the shared use of a vehicle (car, bicycle, scooter, van, etc.). It is an innovative transportation strategy that enables users to have short-term access to a mode of transportation when required (Shaheen et al., 2016, as cited by Machado et al., 2018; Shaheen et al., 2018, as cited by Machado et al, 2018). Karbaumer & Metz (2022, pp. 19-27) approach shared mobility with a broader approach, ranging from abstract aspects to concrete embodiments of shared mobility.

2.1.3 Features

Based on the descriptions of Karbaumer & Metz (2022), Shaheen et al. (2018), and Santos (2018), Table 4 provides an overview of the features/aspects that the term shared mobility encompasses. The key features are shown Figure 1.

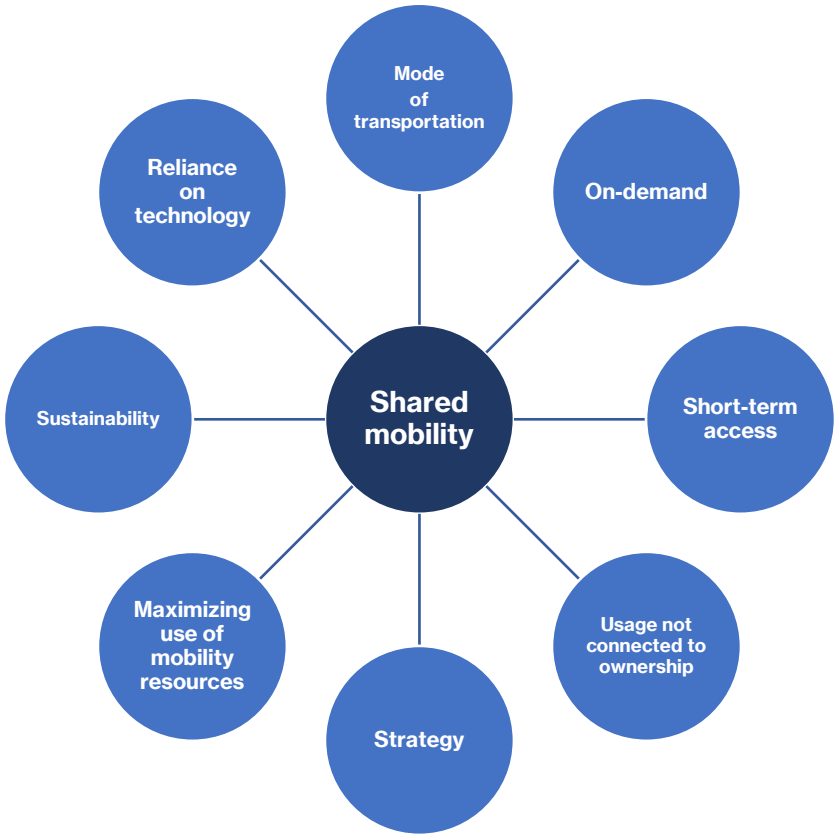


Figure 1: features of shared mobility (own work, based on Karbaumer & Metz (2022), Shaheen et al. (2018) and Santos (2018))

Table 4: overview of shared mobility features (own work, based on Karbaumer & Metz (2022, Shaheen et al. (2018) and Santos (2018)

Aspect / feature	Theory
Usage not connected to ownership	• Disconnecting usage from ownership (Machado et al. 2018) • It is an alternative for ownership, in which private vehicles and private rides are replaced by shared use, with more sustainable results (Karbaumer & Metz, 2022, p. 19) • The two features common to all of these new mobility services, is that there is an element of sharing an asset (a vehicle) instead of owning it (Santos, 2018)
Short-term access	• Short-term access to shared vehicles (Machado et al., 2018) • Shared mobility is comparable to renting, but the user experience and user patterns differ: transactions are automated and the use is for short periods (Karbaumer & Metz, 2022, p. 19)
On-demand	• Shared mobility gives users access to cars, bikes, and other vehicles when they want to use it (Karbaumer & Metz, 2022, p. 19) • Short-term access to shared vehicles *according to the user's needs and convenience* (Machado et al., 2018)
Mode of transportation	• Shared mobility is seen as a mode of transportation on itself (Karbaumer & Metz, 2022, p. 19) • Shared mobility is the shared use of a vehicle (Machado et al., 2018)

Strategy	• Shared mobility is a strategy to make better use of vehicles and space (Karbaumer & Metz, 2022) • It can among the strategies employed to help alleviate the problems caused by traffic jams and pollution by reducing the number of vehicles in circulation, congestions, and the urban emission of polluting gases (Machado et al., 2018) • The implementation of shared mobility schemes offers the potential to enhance the efficiency, competitiveness, social equity, and quality of life in cities (Machado et al., 2018)
Maximizing use of mobility resources	• Shared mobility can be defined as trip alternatives that aim to maximize the utilization of the mobility resources (Machado et al., 2018) • With shared mobility the focus is on underutilization of vehicles and seats (Karbaumer & Metz, 2022, p. 19)
Sustainability	• It is an alternative for ownership, … , with more sustainable results (Karbaumer & Metz, 2022, p. 19)
Reliance on technology	• The two features common to all of these new mobility services, … , and that they rely on technology (i.e. a digital platform) (Santos, 2018)

2.1.4 Sharing Economy

Shared mobility is often said to be part of the *sharing economy* (Nijhof, 2020; Machado et al., 2018; van den Berg, 2020; Santos, 2018). Shared mobility is even seen as synonymous with *Mobility in the Sharing Economy* (Santos, 2018). Nijhof (2020) also states that Shared Mobility can be seen as part of the sharing economy trend. To analyze shared mobility within the sharing economy context, an understanding of the *sharing economy* is needed. However, giving a definition of the *sharing economy* concept is controversial, partly due to the vast range of different sharing based practices and business models that could be classified within the sharing economy (Cherry & Pidgeon, 2018).

Nowadays, a sharing economy emerges that enables access to goods and services beyond ownership. This can be observed in the growing popularity of short-rental services of vehicles, lodging and housing and workspaces. Examples of companies in these sectors are respectively Zipcar, Airbnb and Coworking (Machado et al., 2018). Sharing economies have the potential to encourage the distribution and use of underutilized assets and to promote a more sustainable consumption, with economic, social, and environmental consequences (Cherry & Pidgeon, 2018, as cited by Machado et al., 2018).

The *sharing economy* trend is seen as a broad societal trend in which the shared use of goods becomes more important, and owning goods becomes less important (Frenken, 2016, p.4 as cited by Nijhof, 2020). Frenken (2016, as cited by Nijhof, 2020) defines the Sharing Economy as: *"the phenomenon that consumers let each other use their unused consumption good, possibly against payment*".

Looking at this definition, the *sharing economy* is explicitly about goods that are shared Consumer-to-Consumer (C2C*)*. Indeed, the Peer-to-Peer nature of the Sharing Economy is firmly agreed upon (Cherry & Pidgeon, 2018). Thus, the *sharing economy* is not about services and not about Business-to-Consumer interactions. Nijhof (2020) confirms this, and adds that Business-to-Consumer constructions can be regarded as *product-service combinations*. This is in line with Cherry & Pidgeon (2018) stating that Business-to-Consumer sharing, such as renting, leasing and service provision, are instead usually united under wider terms such as product-service systems (Tukker, 2004, as cited by Cherry & Pidgeon, 2018) or access-based services (Schaefers et al., 2016, as cited by Cherry & Pidgeon, 2018). Frenken (2016) explicitly states that the shared mobility operator

Greenwheels is not part of the Sharing Economy and instead belongs to the *Product Service Economy*: the consumer gets access to the product, but the ownership of the company remains with the company. This approach to the Sharing Economy of Frenken (2016) is in contrast with that of (Machado et al., 2018), as the latter also includes access to services beyond ownership and does in fact include service operators that own vehicles.

Taking into account that the Sharing Economy involves *Consumer-to-Consumer interactions* and *goods*, it is remarkable that shared mobility is said to be part of the sharing economy. Firstly, shared mobility is to a large extent Business-to-Consumer when shared mobility operators are involved. Secondly, it is remarkable that the term *shared mobility* is often used interchangeably with the term *mobility services* (Santos, 2018), while these very services are not included in the sharing economy and shared mobility services are to a large extent provided by private companies (Santos, 2018).

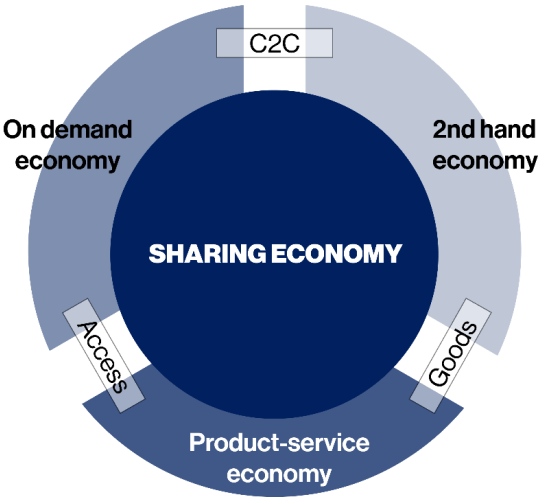


Figure 2: Sharing Economy and related forms of economy (adapted and translated from Frenken, 2015, as used by Frenken, 2016)

For this reason, this thesis does not view shared mobility in its entirety as part of the sharing economy. Only if the shared mobility concept is Consumer-to-Consumer and about goods, would it be included in the sharing economy. As will be explained later, shared mobility can encompass various forms. Each concept can be classified on the basis of variables.

2.1.5 Mobility Services

The term shared mobility is often used interchangeably with *mobility services.* Santos (2018) uses the terms *shared mobility*, *mobility in the sharing economy*, and *mobility services* in the same vein. Nijhof (2020) also does not explicitly distinguish between *shared mobility* and *mobility services.* McKenzie (2020) compares multiple (micro-)mobility services and only includes services offered by companies. Indeed, most of the shared mobility services are provided by private companies. Some of them are provided by community-based initiatives, and a very small number are purely public shared modes. In general, public initiatives of shared mobility fail because individuals tend to act in their own self-interest to the detriment of society and the environment (Cohen, 2014, as cited by Machado et al., 2018). Thus, mobility services are an important part of shared mobility but from literature it cannot be stated that all forms of shared mobility fall under mobility services.

2.1.6 Mobility as a Service (MaaS)

Mobility as a Service (MaaS) is a term that is closely related to *shared mobility* and *mobility services*. It is a system in which a broad spectrum of mobility services are delivered to customers by mobility service providers (Karbaumer & Metz, n.d., p. 8). According to the Kennisinstituut voor Mobiliteitsbeleid (2019), MaaS consists at least of 1. Services and 2. Mobility. The institute gives the following definition of MaaS:

> **Mobility as a Service**: *MaaS is a service in the field of person mobility, in which providing the service encompasses offering an online platform with possibilities to search, compare, and possibly reserve and pay for various mobility services, on the basis information that is actual and relevant for the traveler. MaaS is accessed to the customer through an application* (Kennisinstituut voor Mobiliteitsbeleid, 2019).

According to Nijhof (2020), MaaS is about bundling data from different (shared) mobility providers. The various data should communicate with each other so that the MaaS system would work optimally. This comes down to *interoperability*: the possibility of different systems to work together with each other (Enigma Consulting, 2018, p.3, as cited by Nijhof, 2020).

Table 5 important characteristics of MaaS (based on Kennisinstituut voor Mobiliteitsbeleid, 2019)

Important characteristics of MaaS	
1	App
2	Freedom of choice
3	Personalized travel advise
4	Unburdening
5	Trustworthiness
6	Costs
7	Environment
8	Safety
9	Privacy
10	Ownership

The Kennisintituut voor Mobiliteitsbeleid (2019) examined the most important characteristics of MaaS, according to experts (consultants, researchers, policy makers and service providers). This ranking is depicted in Table 5. From these characteristics, it can be concluded that MaaS is mostly about an application, related to mobility services, which provides various benefits to the customer.

The degree of MaaS can be analyzed using different levels (Opiola, 2018). The higher the level, the higher the integration of services on a platform. An integrated platform including routing, ticket, and payment for all modes is not the highest level: instead the highest level includes artificial intelligent choices based on travels preferences and a connection beyond mobility (e.g. Internet of Things, smart buildings, smart cities) (Opiola, 2018).

2.1.7 Regulation and Public Policy

The shift from “ownership” to “usership” is a critical shared mobility innovation that impacts on how the transportation system has to be ruled by regulatory agencies. Some important decisions have to be made by the local authorities in order to properly define the public good that shared modes, which are essentially rentier models, can provide. Example of these decisions are: economic regulation and taxation, assurance of an appropriate degree of social equity and non-discrimination in service access, cover area regulation, and safety issues regulation (Docherty et al. (2018), as cited by Machado et al., 2018). Municipalities can apply various measures to stimulate shared mobility (Nijhof, 2020). However, it should be noted that the municipal regulatory power could also play a role in

revoking shared mobility permits. For instance, as of 2022 the municipality of Utrecht revoked the permit for shared e-scooters (RTL Nieuws, 2022).

Interactions between Private and Public Transportation

Shared mobility schemes have involved a series of negotiations between public and private sectors, with implications for the decision-making process that remain unclear. The role of private companies in the mobility industry brings concerns over feasibility and acceptability of transport policies associated with shared modes. One aspect that still needs to be properly investigated is the implication of integrating shared mobility services, essentially provided by private firms, into current public transport networks, characterized by strong government regulation. It is important to identify synergies between established public transport networks and emerging shared mobility schemes, to make these services complementary, and to achieve the common objective of sustainability mobility (Machado et al., 2018). However, in most studies, shared mobility has been considered as an isolated system, disregarding the complexity of its interactions with other transportation modes. This makes it extremely difficult to estimate its impact of the transportation system (Machado et al., 2018).

Public Nuisance

Shared transportation has repeatedly led to complaints due to wrongly parked vehicles in the public space (RTL Nieuws, 2021). Various shared mobility operators have tried to implement user incentives aimed at encouraging uses to park correctly. For instance, the e-scooter operator Check lets users rate how a vehicle is parked before starting the trip, rewarding the feedback by giving coins/credits for discounted use. Other operators, such as Felyx and Check, forces users to make a picture of the scooter before ending the trip (Check, n.d.).

Vandalism & Moral Hazard

E-scooters have also repeatedly been the victim of vandalism. Vehicles have for instance been thrown in the water (Schie, 2022) or lit on fire (Aardoom, 2022). Pictures of wrongly parked or vandalized e-scooters have become a phenomenon in popular culture, even becoming the subject of an Instagram account (Nieuwenhuize, 2022).

2.1.8 Accessibility

In the last few decades, the importance of shared mobility has grown, as well as the need to understand how to integrate it into urban transportation systems, and make it more efficient from a social, environmental, and economic perspective (Machado et al., 2018). When it comes to accessibility, the need for a smartphone, internet access, and a credit card can exclude a portion of the population with low income that cannot afford this. Furthermore, the majority of shared mobility modes operate in central zones, citizens who live in peripheral regions face difficulties to access these services (Machado et al., 2018).

2.2 Types of Shared Mobility

Common denominators of *shared mobility* have been identified in the previous section. To classify the various concepts of shared mobility, authors have come up with different classifications. From analyzing the different models, it can be concluded that shared mobility appears in a wide variety of types. Due to this variety, it is challenging to classify each mode, as not all types of classification variables can be applied to each distinguished form of shared mobility.

Machado et al. (2018) classified some shared mobility modalities. This model is not comprehensive, as it does not, for example, include e-scooter or e-step sharing. Karbaumer & Metz (2022) created a model to classify the various types of (shared) mobility. They stress that the best way to understand these different modes of transport, is to see them on a spectrum from ownership to use. The boundaries between these ways of transportation become more and more diffuse. Karbaumer & Metz (2022) provide the *shared mobility spectrum* model. The model is fairly comprehensive, but does not clearly distinguish between types of variables used in the classification. Therefore, Figure 4 provides an overview of shared mobility concepts with categories of variables.

2.2.1 Shared Mobility Conceptualization

Based on the shared mobility classification model of Machado et al. (2018) and that of Karbaumer and Metz (2022), distinguishable variables are identified. With these variables (Figure 4) different shared mobility concepts can be classified. It is important to distinguish between *rides* and *vehicle*. Simply put, the *vehicle* category is about the use of a shared (not owned) vehicle, whereas in the *ride* category users share the *ride* with other people.

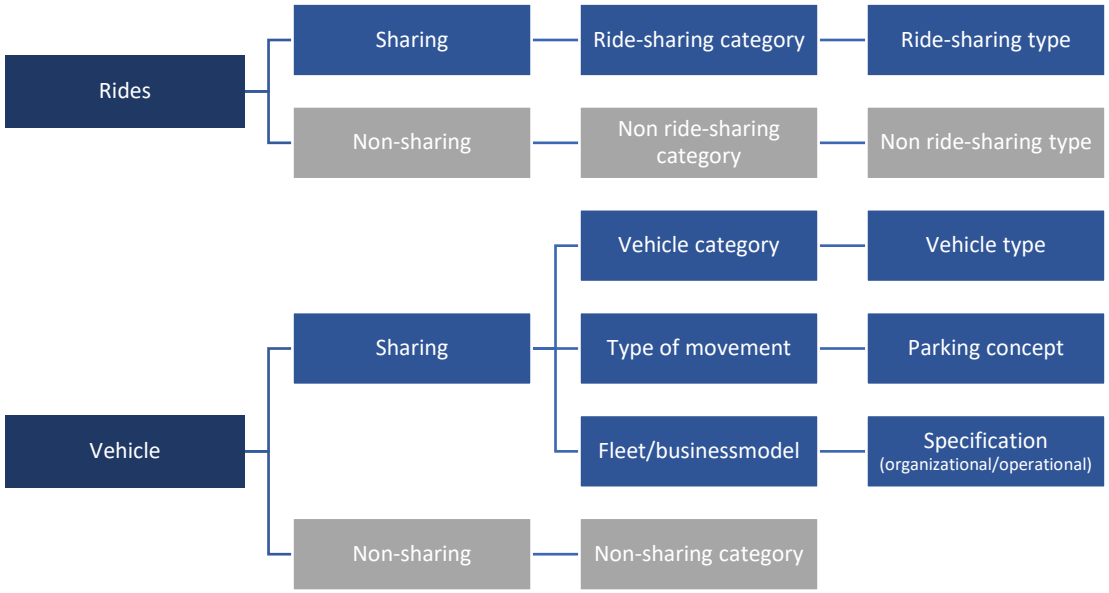


Figure 3: overview of variables with which shared mobility concepts can be distinguished (own work, based on Karbaumer & Metz, 2022; Machado et al. (2018))

2.2.2 Rides

Table 6 provides an overview of ride-sharing categories and types.

Table 6: Ride-sharing category & types (own work, based on Karbaumer & Metz, 2022; Machado et al.(2018))

Ride-sharing category & type	
Ride-sharing category	**Ride-sharing type**
Vanpooling	-
Taxi	-
Hitchhiking	-
Volunteer driver scheme	-
Microtransit	On-demand scheduling Crowdsourced scheduling Autonomous shuttle
Carpooling	Short distance carpooling (with or without payment) Long distance carpooling (with or without payment) Informal
On demand services	Real-time ridesharing Taxi-service apps Ride-splitting Ridesourcing
Collective Transport	On-demand bus Bus Tram Metro Train

2.2.3 Vehicles

When it comes to shared vehicles, the main aspect that people are driving themselves. Based on Figure 4, the following variables in the classification of shared vehicle concepts are distinguished:

- Vehicle category & vehicle type
- Type of movement & parking concept
- Fleet/business model & specification

Table 7: Vehicle categories & types (based on Karbaumer & Metz, 2022; Machado et al.(2018))

Vehicle category & type ***What kind of vehicle?***	
Vehicle category	**Vehicle type**
Car	Car
Bike	Bike; Cargo bike
Micro-mobility	E-scooter; Pram; Mobility; mobility scooter; go-kart; wagon
Other vehicles	Motor; Wheelchair-accessible vehicle; Camper; Van; Trailer; Boat; Helicopter; Plane
Movement & parking ***What type of trip does the vehicle make, and how is it parked?***	
Type of movement	**Parking concept**
Roundtrip	Station based Homezone based
Free-floating / one-way	Station based Operational area
Fleet/business model & specification ***Who owns the vehicle, who uses the vehicle, and how does this process work?***	
Fleet/businessmodel (sharing)	**Specification (operational)**
Peer-to-peer	Key swap Keyless
Owned by company	-
Communities	Closed groups Subscription Shared/fractional ownership
Informal	-
Fleet/businessmodel (rental)	**Specification (operational)**
Rental	Subscription Rental period

Type of movement & Parking concept

Roundtrip means the vehicle comes back to the starting point. This could be a *station* (fixed spot) or a *homezone*. A *homezone* is a geographic area in which the vehicle could be stationed. Certain applications make use of *geofencing*: indicating a zone on the (digital) map in which a vehicles trip can be terminated. In Figure 5, certain geofenced areas can be seen. If a users ends the trip within the blue area, this person earns certain benefits. Thus, users sometimes are incentivized to use the geofenced areas. Geofencing can be used to achieve a delicate spatial capacity allocation to maintain appropriate bicycle densities to achieve both high service level and capacity utilization. Essentially, geo-fencing technology enables an omnipresent design of virtual parking spaces in arbitrary parts of the city (He et al., 2021). For *free-floating* vehicles, the movement is essentially *one-way* as it does not need to return to its

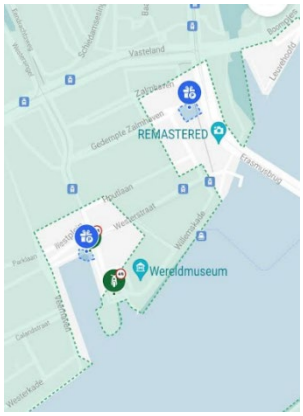


Figure 4: screenshot of the Felyx application (as of Jan. 16th, 2023)

starting point. Many e-scooters move within an *operational area* (green area in Figure 5) but free-floating vehicles can also move between various stations. For example, bike sharing companies, such as Vélib, can have a plethora of docking stations across the city (Vélib, n.d.).

Figure 5: Vélib docking station (Vélib, n.d.)

Fleet/Business Model & Specification

The vehicle's ownership and use process differs. As identified, a lot of shared vehicles are provided Business-to-Consumer. However, it is also possible to share the vehicle peer-to-peer or own it as a community. Machado et al. (2018) state that Peer-to-Peer Carsharing is about employing privately-owned vehicles. However, nowadays new models have emerged. Lynk & Co, for example, is a car brand that let users lease a car on a monthly subscription. Additionally, they can share this leased car with users that do not own a Lynk & Co. In this way, leasers can get a discount on their monthly lease (subscription) fee. Besides lease contracts, the operator earns money by keeping a percentage of the rental fee. The person leasing the car and renting it out, can decide the price and the location where the car needs to be handed in (Lynk & Co, n.d.).

2.3 Mobility Hubs

2.3.1 Definition

Over the last years, the mobility hub concept has gained attention. The concept is still developing and is interpreted in different ways (Kennisinstituut voor Mobiliteitsbeleid, 2021). TNO defines hub as a transfer point, handling point, and/or node consisting of different activities, services, and facilities (Heezen et al., 2021). It is also defined as a physical link between transport modalities, that besides its mobility function also serves as a concentration point for spatial development (Kennisinstituut voor Mobiliteitsbeleid, 2021). Karbaumer & Metz (2022) use the term *mobipunt* interchangeably with mobility hub and define it as a transport hub at neighborhood scale, in which different sustainable shared transport modalities are connected with each other. Hubs are also defined as a physical location that makes the transfer to the most optimal modality possible for the onward travel (Mobiliteitsalliantie, 2020, as cited by Karbaumer & Metz, n.d.). The concept of a mobility hub remains ambiguous, with a lack of consensus on its definition (Rongen et al., 2022). Thus, to truly understand the concept of mobility hubs, it is important the conceptualize this term.

2.3.2 Characteristics

Table 8 shows important features of mobility hubs. It shows that mobility hubs include more than only mobility. Instead, a wide variety of other disciplines are included in mobility hubs. The main features identified are shown in Figure 6.

Figure 6: Features of Mobility Hubs (own work)

Table 8: Characteristics of Mobility Hubs

Aspect/feature	Explanation
Connected to a physical network	• TNO defines hub defined as a transfer point, handling point, and/or node consisting of different activities, services, and facilities (Heezen et al., 2021). • In a hub, multiple transport modalities and their infrastructure, size and scale levels come together (CROW, 2022b).
Connected to a digital network	• A mobility hub can be seen as the physical equivalent of MaaS in the public space (Nijhof, 2020). • Hubs could include shared mobility, and in the previous section in has been identified that shared mobility is connected strongly to a digital network.
Focus on persons and/or goods	• The Mobiliteitsalliantie (2020, as cited by Kennisinstituut voor Mobiliteitsbeleid (2021)) distinguishes three main categories of hubs: goods hubs, persons hubs, and combination hubs.
Cluster of functions & facilities	• A mobility hub's right to exist stems from multiple societal objectives that the hub can contribute to (Kennisinstituut voor Mobiliteitsbeleid, 2021). • A mobility hub is a physical location where a selection of services is offered in a cluster (Kennisinstituut voor Mobiliteitsbeleid, 2021). • Activities, subactivities, services & facilities (Heezen et al., 2021) . • [...] healthy, livable and agreeable places with sufficient facilities to stay (for a longer time) (CROW, 2022b). • The use of mobility hubs becomes more attractive when mobility comes together with societal and commercial facilities that connect to the (travel) needs of travellers. It can be about shops, workplaces, a parcel service point, et cetera (Mobiliteitsalliantie, 2019, as cited by Nijhof, 2020).
Facilitating (shared) mobility	• With mobility hubs in the existing city and with new hubs that are integrated in urban development, users can choice between different forms of shared transportation (Nijhof, 2020). • Mobility hubs are hubs in a city where different types of (shared) mobility come together (Nijhof, 2020). • Facilitating shared mobility (Kennisinstituut voor Mobiliteitsbeleid, 2021).
Embedded in the urban fabric	• The area that is serviced by the hub and the area in which the effects of the hub are visible (Janjevic & Winkenback, 2020, as cited by Heezen et al., 2021). • They are places where in the future the function living, working and recreations come together, more than is the case right now (CROW, 2022b). • Besides spatial gains, hubs provide concentration in function, visitors, et cetera, and thereby can add to a high quality spatial design (CROW, 2022b). • The pressure on urban areas is high and the hub is often seen as a space-saving measure to fit in mobility differently (Heezen et al., 2021). • Besides the transport function, the quality of stay and experiences is central (CROW, 2022b). • Hubs can be classified on the basis of different characteristics, amongst others (geographic) scale (the area that is served by the hub and the area on which the effects of the hub are visible) (Heezen et al., 2021). • [...] or give the hub an important role in the road to sustainable urban development (CROW, 2022b)
Governance	• Governance aspects such as ownership, exploitation, and collaboration model (Janjevic & Winkenback, 2020, as cited by Heezen et al., 2021) • Conditions are partly created by stakeholders that from different roles (for instance financier, director... or concession holder) have influence on the success of failure of the hub (Kennisinstituut voor Mobiliteitsbeleid, 2021)
Social	• Hubs can include social functions. Some concepts include a social program, in which the community-hub can be come the living room of the neighborhood (CROW, 2022a). • Functions like a library, bar, central meeting place, or day care can be part of a mobility hub too (Heezen et al., 2021).
Energy	• There are chances to connect the mobility function of the hub with the energy transition (for example offering cleaner transport and generating clean energy) (CROW, 2022b) • Facilitating electrification (Kennisinstituut voor Mobiliteitsbeleid, 2021)
(Physical) design	• The design of hubs therefore plays an even bigger role in connecting the various components of the hubs (Kennisinstituut voor Mobiliteitsbeleid, 2021)

2.3.3 Types

CROW (2022a) has identified that there are a plethora of definitions for a hub. Therefore, it defines hub by providing certain characteristics by which a hub can be classified (Figure 7. Using this model, a description of the hub typology can be created (CROW, 2022a). For instance:

A **multifunctional** hub in a **new district** for **multiple users** in the **public space**.

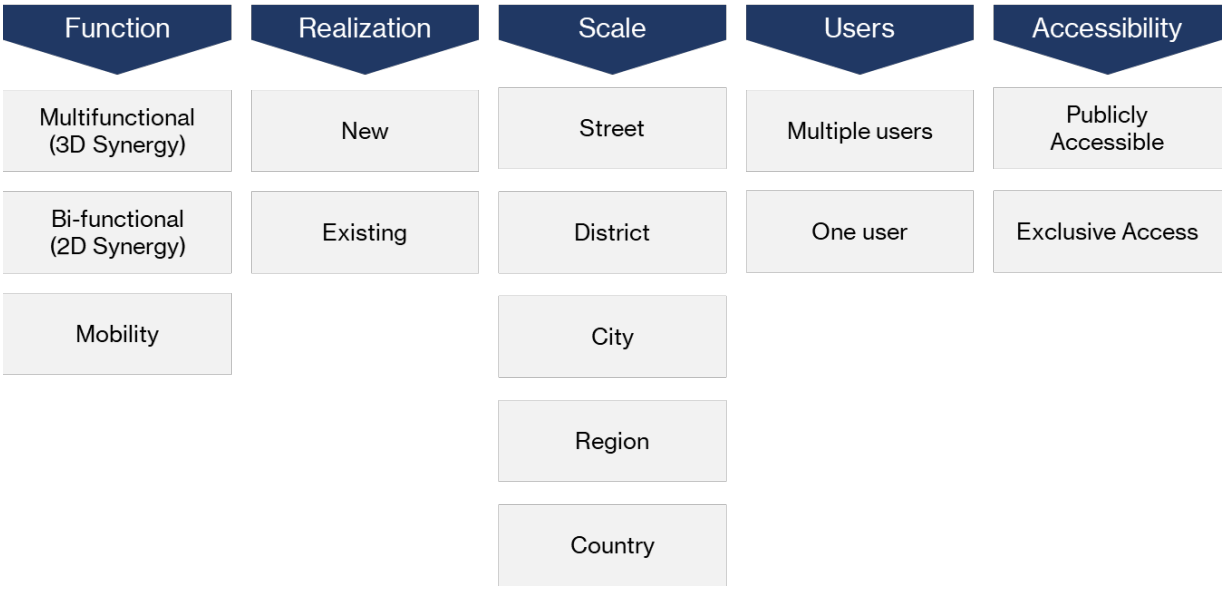


Figure 7: Classification of hubs (translated and adapted from CROW, 2022a)

2.3.4 Functions and Objectives

A mobility hub derives its right to exist from one or multiple societal objectives that it can add to. Its functions are related to the objectives that it serves (Kennisinstituut voor Mobiliteitsbeleid, 2021). For example:

> **Functions:** *reduce friction against multi-modal transfer; facilitate alternative first- and last-mile solutions, facilitating bundling of thin transport streams, facilitate shared mobility, clustering facilities, facilitate electrification*
>
> **Societal objectives:** *strengthen accessibility; cost-efficiency of mobility system; decreasing harm (to health) caused by mobility; livability of the living environment; livability inner-city; reducing congestion; reducing emissions. (Kennisinstituut voor Mobiliteitsbeleid, 2021)*

In the following sections, multiple possible functions of the mobility hub are elaborated upon.

Mobility & MaaS

A motivation to develop mobility hubs is the possibility to facilitate scaling up shared mobility. Hubs can reserve space to offer shared vehicles. The concentration and the design of the hub lead to recognizable locations at which shared mobility can be accessed.

Because using shared vehicles can lead to less owned vehicles over time, developing hubs would in the end save more public space than it will costs at first (Kennisinstituut voor Mobiliteitsbeleid, 2021). Physical synergy through shared mobility hubs is essential to make shared mobility visible. Digital synergy with Mobility as a Service strengthens the connectivity and increases the appeal (Karbaumer & Metz, n.d.).

The mobility hub can be seen as a physical counterpart of digital Mobility as a Service (MaaS) applications. While MaaS is about the access to a digital platform that brings together the mobility services (Kennisinstituut voor Mobiliteitsbeleid, 2019), hubs can be regarded the physical platform (Kennisinstituut voor Mobiliteitsbeleid, 2021). Hubs can also be used to share rides. If passengers wait at concentrated locations, the passenger density can be higher and the routing more efficient (Kennisinstituut voor Mobiliteitsbeleid, 2021).

Energy

Hubs can offer a positive contribution to the energy system when energy is integrally taken into account in the design. Solar panels at a mobility hub, in combination with a battery, are a costly alternative compared to a connection to the energy grid. When examining how hubs affect the electricity grid, it is important to look at peak demand throughout the day and for example take into account smart charging (CROW, 2022b). It is important to note that Mobility as a Service asks for a high demand for charging, because of short-time peaks in demand. This increases the electrical load on energy infrastructure. Private cars offer more possibilities to support the power grid because they are connected to a charger for a longer time (CROW, 2022b).

Social

Hubs can include social functions. Some concepts include a social program, in which the community-hub can be come the *living room of the neighborhood* (CROW, 2022a). Functions like a library, bar, central meeting place, or day care can be part of a mobility hub too (Heezen et al., 2021).

Behavior & User-Perspective

The success of mobility hubs ask for a relative strong change of behavior by end-users (Kennisinstituut voor Mobiliteitsbeleid, 2021). Selection behavior (of a travel mode) is affected by habitual behavior and by external factors that affect behavior. The latter includes psychological factors, socio-economical factors, physical environment, rules and regulations, and social context (van der Linden & de Geeter, 2021). The urban development and the organization of mobility therefore affect travel behavior. In this context, the *STOMP principle* indicates the priority of use for different transport modalities. STOMP forms the basis for spatially embedding mobility. It consists of *stappen, trappen, OV, MaaS, Privé-auto* (*walking, biking, public transport, MaaS, private car*). The use of a private car therefore should only be a choice when the other modalities do not suffice. (CROW, n.d.-a).

Adaptability

Developments, such as the rise of MaaS, are hard to predict. This causes uncertainty and therefore adaptable development of hubs becomes attractive (Kennisinstituut voor Mobiliteitsbeleid, 2021). Trends and developments can be taken into account in the design

of a hub to make it future-proof (Heezen et al., 2021). Implementation should not be rigid, but ought to be adapted to future developments and insights (Mouw, 2020).

2.3.5 Scale

In Figure 7 various scale levels of hubs are identified. In Table 9, a more comprehensive overview of scale levels is given. It should be noted that hubs can be distinguished based on persons or goods. Furthermore, in addition to Figure 7, a neighborhoods hub and ward hub are distinguished (Kennisinstituut voor Mobiliteitsbeleid, 2021). On the scale of urban development, this difference and the relationship between these types is important.

Table 9: overview of hub typologies (Kennisinstituut voor Mobiliteitsbeleid, 2021)

Transportation of persons	Transportation of goods
Neighborhood hub *(buurt)*	City distribution center
Ward hub *(wijk)*	Regional distribution center
Regional hub	(inter)national goods hub
Hubs on outskirts city / beltway	
City hub	
International hub	

2.3.6 Ownership and Exploitation

White Label Hubs

Mobility hubs can form a neutral linkage in a mobility system in which more public and private parties are active. For the functioning of MaaS it is paramount that travelers do not experience barriers while using mobility services of different providers, even if these are competing with each other. Mobility hubs can be designed neutrally as *white label*: this would mean that all mobility service providers can use it and therefore the coverage and density of the mobility services would increase (Kennisinstituut voor Mobiliteitsbeleid, 2021). If mobility hubs are not *white label*, each company would have its own network.

Mobility Hub Processes

To map the underlying processes of mobility hubs, the Framework for the Sharing Economy (Puschmann & Alt, 2016) is adapted. This framework may serve to map different approaches and provide guidance (Puschmann & Alt, 2016). It distinguishes between *service consumers* (user), *service providers* (provider), and *intermediaries*. Furthermore, it distinguishes between different layers, namely *Strategy*, *Processes*, and *Systems*. Multiple categories of processes can be identified (legal, financial, and organizational). These processes take place with an underlying digital system. Thus, the processes in the exploitation of mobility hubs take place both physically and digitally. Although the framework serves to map C2C interactions, this thesis uses it to map B2C interactions.

> **Strategy:** the strategy layer is about the way the shared mobility provider and shared mobility consumer are connected. Based on the previously identified shared mobility concept, this can be Consumer-to-Consumer or Business-to-Consumer. Also, there can be an intermediary party. In the case of MaaS, the MaaS platform would be the intermediary that connects consumer and provider.

Processes: aspects involved in the shared mobility process.

Systems: the underlying digital systems that facilitate the process.

A mobility hub is a physical objects, but has underlying digital processes taking place. Integration of mobility hubs within urban developments therefore has a **physical** & **digital** dimension and the nature of the processes can be **Legal**, **Financial**, or **Organizational**

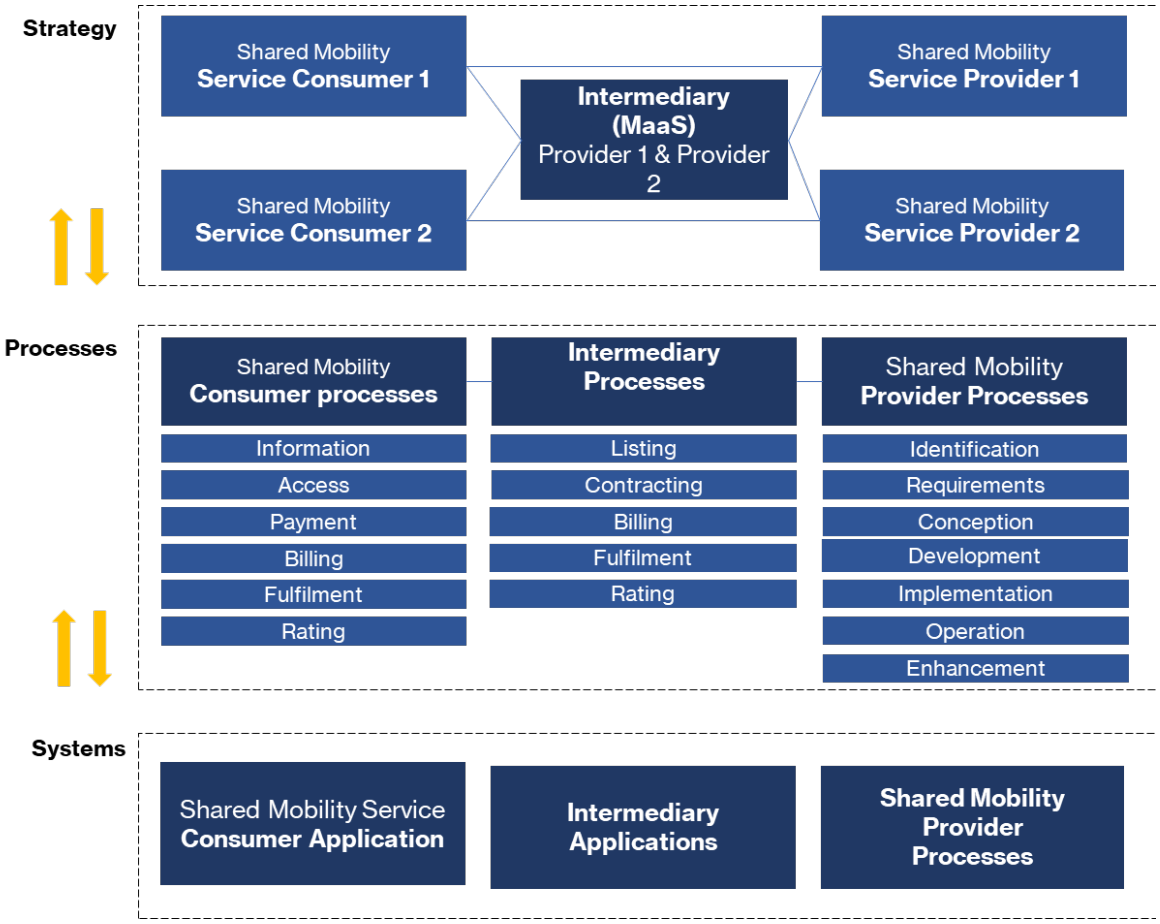


Figure 8: Mobility Hub Processes Framework (adapted from The framework for the Sharing Economy (Puschmann & Alt, 2016))

Table 10: categories of mobility hub exploitation processes

Legal	Financial	Organizational
Contracting	Payment	Access
Identification	Billing	Usage
Requirements		Rating
		Information
		Development & implementation
		Operation

2.3.7 Mobility Hub Actors

Nijhof (2020) distinguishes between *shared mobility providers* and *shared mobility users*. Furthermore, he adds to these stakeholders *government* and *project developers.* Nijhof (2020) distinguishes between *shared modality providers* and *service providing institutions in the field of shared mobility.* The latter would include for instance MaaS platforms, mobility hub operators, and car sharing cooperations. Table 1 shows important actors involved with regard to shared mobility hubs. When it comes to energy, the energy supply and management companies play a role as well. The exploitation phase brings in new roles, such as settling complaints, enforcement (*handhaving*), and technical management (CROW, 2022a).

Table 11: Mobility hub actors (based on Nijhof (2020), CROW (2022a), Kennisinstituut voor Mobiliteitsbeleid, (2021))

Actor category	Example
Shared Modality Provider	Shared mobility operator
Service providing institutions in the field of shared mobility	MaaS platform Mobility hub operators Concessionaire Charging facilities operator Car sharing cooperations Consultancy firms Energy-related organizations
Shared Mobility user	Business users Private users
Government	Politicians Policy makers (civil servants)
Project development	Project developer Delegated project developer Financier Director (*regisseur)*

2.3.8 Design

The design of hubs plays a role in connecting the various components of the hubs (Kennisinstituut voor Mobiliteitsbeleid, 2021). The concept *Wijkhub* can include various functions. An example of a *wijkhub* design (Hamburg, 2022) is analyzed. It can be seen that the hub brings together multiple domains in a physical design (e.g. social, digital, mobility, cargo, urban design)

This design concept consists of:
- Shared e-scooters, cars and cargo bikes
- Parcel services
- Place to load and unload, that can transform to a kiss-and-ride or a market
- Elevated parking deck
- Digital application to show, reserve and pay for sustainable travel options
- E-vans that supply bars and restaurants
- Data-driven and monitored use
- Smart adaptable traffic signs
- Solar panels on the roof
- Located at the edge of a neighborhood

(Hamburg, 2022)

Figure 9: wijkhub (ward hub) design concept (Hamburg, 2022)

2.4 Management of Urban Development Projects

Within the urban development project, four major components can be distinguished (Heurkens, 2012). This chapter will zero in on each aspect and their interrelations.

Actor | Roles | Project | Management

2.4.1 Actors and Roles

In this thesis, the following definition of actor is adapted.

> **Actor:** *An organization or representative individual actively involved in urban development projects* (Heurkens, 2012).

It is worth noting that *actor* is not synonymous with *stakeholder*:

> **Stakeholders:** *those actors which will incur – or perceive they will incur – a direct benefit or loss as a result of the project* (Winch, 2010, p. 74).

From these definitions it can be derived that all actors are stakeholders, but not all stakeholders are actors. Winch (2010, p. 75) distinguishes between stakeholders internal to the project (demand and supply) and stakeholders external to the projects (private and public). This difference is useful with regard to mobility hubs. For example: residents from outside the urban development (external) can become internal stakeholders when using the hub.

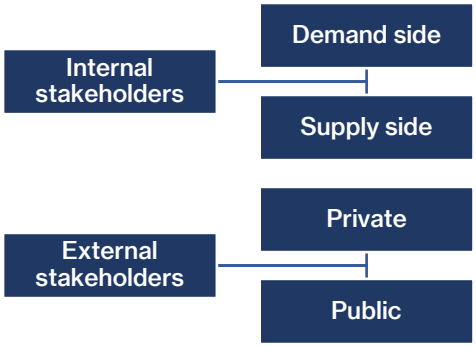


Figure 10: project stakeholders (Winch, 2010, p. 75)

Actors within urban development play a certain interdependent role (Heurkens , 2012).

> **Role:** *A coherent set of organizational tasks and related management measures carried out by actors involved in urban development projects* (Heurkens , 2012).

2.4.2 Urban Development

As identified in the previous section, actors within an urban development project play a role consisting of organizational tasks and management measures. However, a clear definition of urban development and urban development projects is yet to be given.

> **(Urban) area development** (*gebiedsontwikkeling*): *a way of working, in which government bodies, private parties, and other actors involved reach an integration of planning activities and spatial investments, eventually resulting in the implementation of spatial projects* (Daamen, 2010).

Daamen (2010) refers to urban development project as *a framework of concrete material interventions inside a geographically distinct urban area*. Although this means that the concrete realization of material products like buildings, infrastructures, and public spaces is a fundamental feature of urban development projects (Daamen, 2010), it does not clearly specify whether or not the process leading up to these interventions is also included in the urban development project. Blokpoel et al. (2005) does imply that various processes are part of an overarching project. This is in line with Heurkens (2012) stating that urban development projects are developed over time and thus can be considered as a process of interlinked stages. Van der Ven (2009, p.17) states that labels (e.g. project) are only meaningful within a specific context. Therefore, this thesis does not provide one single definition, but provides the following features urban development projects consist of:

- Processes
- Phases/stages
- Actors & relationships
- Concrete realization of material products (interventions)
    - Inside a geographically distinct urban area

Integration

This thesis is about the integration of mobility hubs within urban development. An integrated approach implies that technical, legal, political, economic, demographic, ecological, and socio-cultural aspects of a project all have to be consciously taken into account if qualitative results are to be realized (Bruil et al., 2004, Peek, 2006, as cited by Daamen, 2010). This is important to note, as it has been identified that mobility hubs can include more than only mobility. According to Heezen (2021), a future-proof integrally designed hub includes domains, functions, target audiences (quadruple helix), objectives, and spatial claims for now and later.

Phasing

The traditional development process consists of different phases. Each phase is concluded with a decision at the end. In Figure 12 it can be seen that the design process consists of various phases of the development process (Blokpoel et al., 2005).

Uncertainty

All organizations are, in essence, information processing systems (Winch, 2010, p. 6). This is in line with Heurkens (2012) showing a transfer of information between the Process System and Organizational System. The more information is available, the lower the uncertainty (Galbraith, 1977, as cited by Winch, 2010, p.6). As time advances in a project,

the amount of certainty decreases as more information has been processed (Figure 13). Figure 13 implies that upon completion, there is no mission certainty anymore. However, when it comes to mobility hub projects, this does not hold true: the exploitation phase (referred to as *renting and maintenance* in Figure 12) is still uncertain as not all information is available. For instance, the intensity and way the hub is used remains to be seen. The further a project advances, however, the fewer possibilities to steer (van den Brink, 2022). This is in line with Figure 13, indicating that the further in the process, the lower the influence on the end result. It also shows that the the more interdisciplinary the design trajectory is, the earlier the interdisciplinary part of the design process should start.

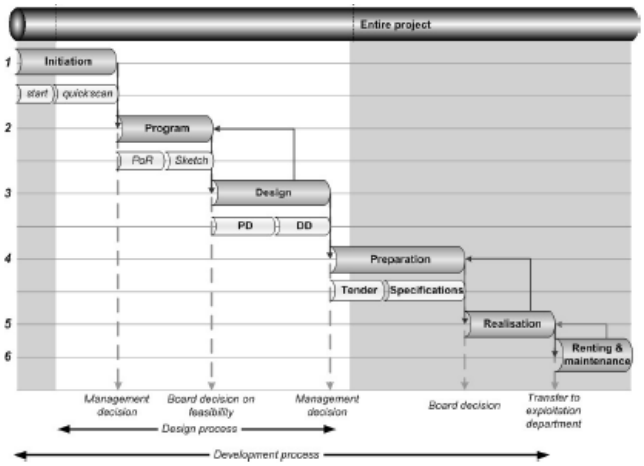


Figure 11: different phases of a (traditional) development process (Blokpoel et al., 2005)

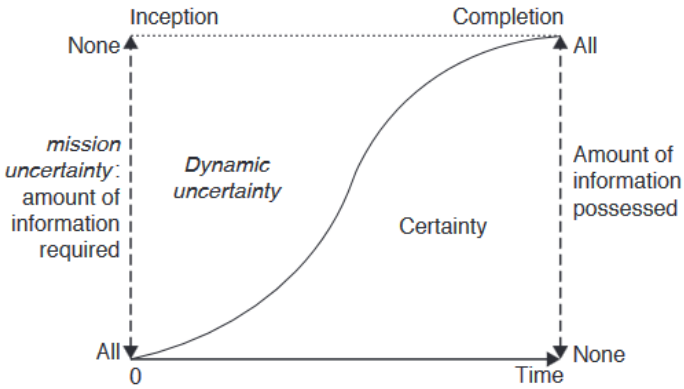


Figure 12: the project process as the dynamic reduction of uncertainty through time (developed from Winch et al., 1998, as used by Winch, 2010, p. 7)

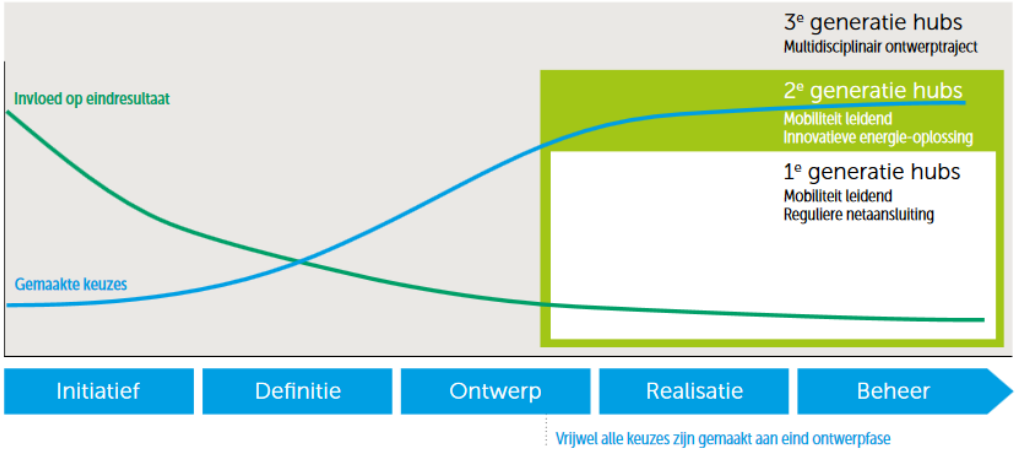


Figure 13: Overview of the Integration of Design Phases (CROW, 2022b)

2.4.3 Management and Steering

The following definitions of management and steering are used within this thesis.

> **Steering:** *any form of directive influencing* (De Leeuw, 2002, p. 151 as cited by Heurkens, 2012).
>
> **Management:** *Management consists of any type of directive influencing the realization or urban development projects* (Heurkens, 2012).

In practice, it is hard to distinguish project from process management. However, they are complimentary and essentially both needed to realize projects (Heurkens, 2012)

2.4.4 Conceptual Steering Model

According to Heurkens (2012) an urban development project is embedded within a context. The project consists of an *urban development project (UDP) Organization* and an *UDP Process.* These are all interrelated. This thesis focuses op the interactions between the *UDP Organization* and *UDP Process*. Therefore, the context external to the urban development project falls beyond the scope of this research.

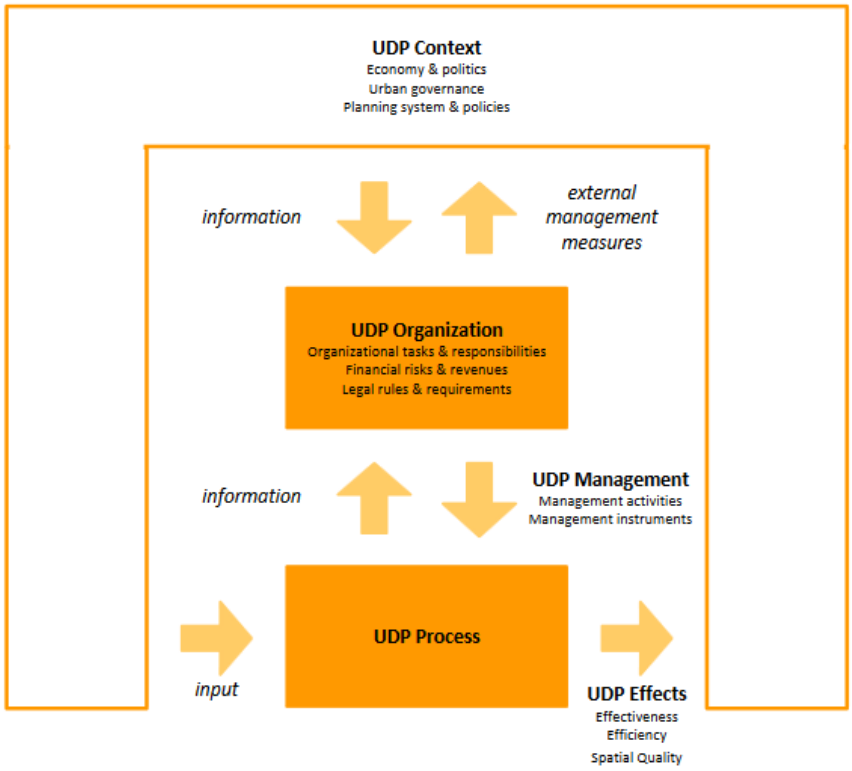


Figure 14: Conceptual steering model (Heurkens, 2012, as adapted from De Leeuw, 2002)

Table 12: Explanation of Conceptual steering model (based on Heurkens, 2012)

Aspect	Explanation
UDP Organization	• Organization consisting of internal stakeholders. • Consisting of interorganizational relations (organizational, financial, and legal) • Manages the UDP Process
UDP Process	• The UDP Process which is managed by the UDP Organization
UDP Management	• Internal management of the UDP Process by applying management activities and management instruments. • Aimed at influencing the structure or objectives of the project.
Information	• Information about the UDP Process is processed by the UDP Organization

2.4.5 Management Activities and Instruments

Management activities and instruments are used by the UDP organization to steer the UDP Process. In Figure 15 and Table 13 the activities and instruments are elaborated upon.

Figure 15: Conceptual public-private urban management model (Heurkens, 2012)

Table 13: Explanation of the conceptual public-private urban management model (based on Heurkens, 2012)

Type	Explanation
Project Management Activities	How actors influence projects by carrying out project activities
Process Management Activities	How actors influence projects by carrying out process activities
Management Tools	How actors use tools to influence projects
Management Resources	How actors use resources to influence projects

03
Methodology

3. Methodology

3.1 Type of Study

The main topic of this research is the integration of shared mobility hubs within urban developments. This topic is still developing. Despite the wide variety of literature available on shared mobility and mobility hubs, the impact on urban developments has to a lesser extent been studied scientifically. As can be seen in *Table 2: SCOPUS search results over the years, as of 10-11-2022*, it can be regarded as a fairly recent phenomenon. A qualitative approach is chosen because it is suitable for investigating a contemporary phenomenon in depth and within its real-life context. Furthermore, it is perfectly suitable to answer 'how' questions (Yin, 2009, p. 47).

This thesis examines a range of documents on shared mobility, mobility hubs, and the latter's integration process within urban developments. These data are used for synthesis with the results of the empirical studies. The empirical part of this research consists of cross-case analysis. This method is suitable for gaining knowledge from individual case studies within different contexts (Yin, 2012, p. 8). In Table 14 the underlying principles of the research methodology are shown, based on the *Research Onion model* (Saunders et al., 2009, p. 130).

Table 14: Study type description (own work, based on the Research Onion model of Saunders et al. (2009, p. 130)

Research paradigm	**Interpretivist**	
Research approach	**Abductive**	*The original framework is based on the review of previous studies, but can be modified as a result of unanticipated empirical findings and/or theoretical insights gained during the process* (Dubois & Gadde, 2002).
Data type	**Qualitative**	*Understanding the concept of and experiences with shared mobility hubs within urban development. This topic is not well-understood and is still developing.*
Research strategy	**Case study**	*Data is collected from case studies involving shared mobility hubs.*
Research design	**Exploratory** **Descriptive**	*Exploratory: shared mobility are a recent phenomenon.* *Descriptive: describing the phenomenon of shared mobility hubs within urban development.*
Time horizon	**Cross-sectional**	*Data is collected at one point in time. Data is not collected at different points in time to examine changes.*
Data collection	**Theoretical background** **Document review** **Semi-structured interviews**	*Theoretical background: review of previous studies on shared mobility, hubs, and the management of urban developments* *Document review: case study documentation to analyze case studies in advance of interviews.* *Semi-structured interviews: purposive sampling ; aim to gather experiences from stakeholders involved in the case study.*

3.2 Methods and Techniques

In Table 14 the underlying principles concerning the research design are laid out with their corresponding research questions. As can be seen in Table 15, each research phase is dedicated to a sub question. These phases are respectively: *Desk research*, *Empirical research*, and *Synthesis & Validation*.

Table 15: Main research question and sub research questions

How can developers steer on the integration of shared mobility hubs within urban developments?
Desk Research
SQ1: What is known about the integration of shared mobility hubs within urban development projects, and how can it be steered?
Empirical Studies
SQ2: What are the experiences of actors in collaborating on and steering upon the integration of shared mobility hubs in urban development?
Synthesis & Validation
SQ3: What can be learned from literature and empirical studies about the integration process of shared mobility hubs in urban development?

3.2.1 Trustworthiness

In order to make the results of this study more trustworthy, the criteria from Lincoln & Guba (1985, as presented by Shenton, 2004) are borne in mind throughout the research process. The criteria and their respective descriptions are presented in Table 16 and their subsequent applications/provisions are taken into account.

Table 16: criteria for ensuring trustworthiness in qualitative research projects (based on Shenton, 2004)

Aspect	Description
Credibility	Congruency of findings with reality.
Dependability	Similar results would be obtained if the work were repeated in the same context.
Confirmability	Investigator's concern to objectivity.
Transferability	Extent to which the findings of one study can be applied to other situations (Merriam, as cited by Shenton, 2014)

3.2.2 Methodological Framework

The methodological framework is presented in Figure 16. It shows the various stages of the research (i.e. desk research, empirical studies, synthesis, and validation) with their corresponding method, goal, and output.

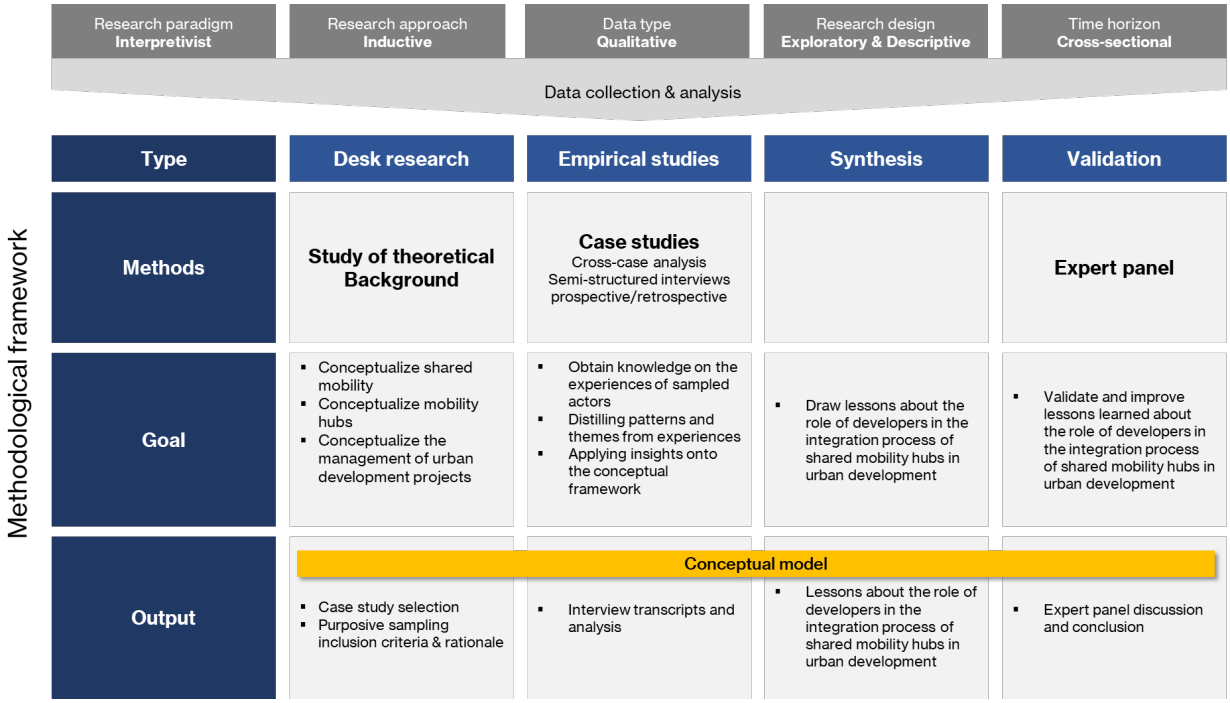


Figure 16: methodological framework (own work)

3.3 Data Collection & Analysis

3.3.1 Data Types and Forms

In order to answer the main research question of this thesis, three phases are carried out.

- **Phase 1 (P2):** examination of theoretical background on key topics: examining and conceptualizing shared mobility, shared mobility hubs, and the management of urban development projects.
- **Phase 2 (P3):** empirical examination of case studies (semi-structured interviews) and case study document analysis in order to carry out a cross-case analysis.
- **Phase 3 (P4):** answering main question by synthesizing the knowledge from theory and the results from the empirical studies and validating the results.

3.3.2 Data Plan

Good data management and stewardship is not a goal in itself, but rather a pre-condition supporting knowledge discovery and innovation (Wilkinson et al., 2016). To enhance the reusability of scientific data from this thesis, the four foundational FAIR Data Principles (Wilkinson et al., 2016) are taken into account in the process of creating thesis. These four principles have been created by a diverse set of stakeholders, including academia, industry, funding agencies, and scholarly publishers, in order to improve the infrastructure

supporting the reuse of scholarly data. These principles are: *Findability*, *Accessibility*, *Interoperability*, and *Reusability*. In Table 17, the application of these principles within this thesis is described.

Table 17: FAIR Data Principles applied to this thesis (based on Wilkinson et al., 2016)

Principle	Explanation
Findability & Accessibility	In its final form, this thesis is published on the TU Delft repository and will therefore publicly accessible. Additionally, the contents of the repository are indexed by search engines. Thus, the thesis will be findable and accessible
Interoperability	Although the examined topic is embedded in the Dutch context, it is written in the English language as lingua franca. Its interoperability is therefore increased by being accessible to a broader audience.
Reusability	The methodology of this research is described as specific as possible, so that it is possible to carry out the same research within, different contexts. Furthermore, the commonly used APA7 writing style and format is used, which is well-known to scholars in the field of qualitative research.

3.3.3 Desk Research

Theoretical Background

Previous studies and reports are reviewed to provide an overview on the topics of shared mobility, mobility hubs, and the management of the latter within urban development.

Conceptual Models

Previous studies are used to conceptualize the above topics. From literature, a conceptual model is created which serves as the lens through which this research is approached. This model is not set in stone and it is possible that findings from the empirical studies alter the conceptual model (abductive approach).

3.3.4 Empirical Studies

Exploratory Interviews

An exploratory interview has been carried out with a professional in the field of urban development and shared mobility. The purpose of this interview was to gain enhanced insights into the field of shared mobility hubs within urban developments. Initial conversations regarding the topic helped in creating more focus within the research in its initial phase. Additionally, conversations with professionals in the graduation internship company have provided insights and guidance in narrowing down the topic.

Table 18: List of persons participating in exploratory interviews

Professional's function	Organization	Description
Consultant	Consultancy firm related to shared mobility	Consultant specialized in innovative mobility concepts.

Case Selection Strategy

• **Mobility Hub Typology:** From practice, a focus on the district hub (*wijkhub*) seemed to be most appropriate for this research. The choice for district hubs is due to the fact that on this scale level, the developer is not sure how position itself and to determine its role and that of other stakeholders. Furthermore, zeroing in on this hub typology is interesting in relation to urban development: the function of a neighborhood hub (a small scale hub consisting of a few cars) is to a large extent only related to mobility, whereas district hubs are related to the urban area in more ways as it can include central facilities and other functions. Lastly, it serves more dwelling units than a neighborhood hub and its design is more embedded in the whole urban planning concept.

• **Mobility Hub Context:** The unit of analysis is the district hub. However, as can be seen in the conceptual model (Figure 21), the mobility hub is embedded in a context. Therefore, three case studies are selected that are all located in different urban development contexts (see Table 19). The strategy applied for selecting these case studies is 'maximum variation cases', which is suitable to determine information about the significance of various circumstances for case process and outcome (Flyvbjerg, 2006). The cases differ on one dimension, namely context of the urban area (re)development (Flyvbjerg, 2006). Aspects of this context are for instance the geographically distinct urban area and its (future) land use.

Table 19: case selection; urban development types

Case Study	Urban development type	Case description
Feyenoord City Rotterdam	***Transformation area*** around downtown area of large city	• Large scale city district transformation from mostly industrial estate to housing (+3700-4000 dwellings). • Plans for new construction and a mobility hub network consisting of various typologies initiated by private parties. • Located in a G4 City.
Nieuwlandplein Schiedam	Post-war neighborhood redevelopment (***herstructurering***)	• Post-war neighborhood mostly consisting of 3-4 story apartments buildings. • Plans for demolition & new development. • Exploration of hub concept within the mobility concept. • Located in the vicinity of a G4 city.
Waterlandkwartier Purmerend	***Transformation area*** close to the train station	• Transformation of an area. Construction of 1800 dwellings and a mixed-use program. • Plans for mobility hubs on the edge of the plan area. • Partly funded with money from the WBI (*WoningBouwImpuls)*. • Located in the vicinity of a G4 city.

• **Project Phase:** it has been identified that the further in the development process, the fewer possibilities to steer. Thus, when it comes to the integration of mobility hubs it is valuable to zero in on the initiative phase in particular.

Document Review

Before carrying out the interview on the different case studies, documents related to the case studies are reviewed. In this way, both qualitative and quantitative data can be gathered on for example the urban plans, the mobility concepts, and the overall vision for the development. This information is used to compare the various cases, to distill remarkable differences, and to prepare for in-depth question in the interviews. A more in-depth context on the cases is created in this way. Furthermore, these documents are also used to determine the actors/parties to be interviewed. Depending on the availability, the following documents are to be reviewed:

- **Urban planning documents**
  - Qualitative data (e.g. urban vision, target groups)
  - Quantitative data (e.g. data on planned housing units, target groups, data related to mobility)
- **Municipal visions**
  - Related to mobility
  - Related to the urban area

Semi-structured Interviews

Semi-structured interviews are carried out to gather empirical data on the integration process of shared mobility hubs within urban development. This data is cross-sectional: interviewees are interviewed at one point in time and there are no follow-up interviews. Furthermore, since the selected case studies are in the design phase, the interview will mostly be about the actor's experiences in this phase. However, the interviews do have a retrospective character too, as the interviewee could bring up previous experiences with other projects. The interviews have a prospective character as well. Especially taking into account the entire real estate life cycle and guaranteeing shared mobility in the long term, the realization and exploitation phase is a topic of interest because most choices affecting these phases are already made in the design phase. Lessons drawn from the interviews can therefore be about the current situation, but also looking forward to the future.

Figure 17: visualization of the temporal aspects related to the interview (own work)

Actor Sampling

In terms of interviewees, purposive sampling takes place. The prerequisite for interviewees is that the person is involved in the decision-making process of the project, and is involved with the shared mobility concept of the project. Table 20 provides the type of interviewees which will be asked to participate in this research.

Table 20: actor sampling; overview for each case

Organization	Actor	Inclusion rationale
Development Company	**Developer**	Involvement in decision-making process of the project, in ways that are relevant to mobility and/or mobility hubs.
Consultancy Firm	**Consultant**	
Social Housing Association	**Project Manager** *(or similar)*	
Municipality	**Civil Servant** *(or similar)*	
Shared Mobility Provider	**Project Manager** *(or similar)*	

There is a possibility that not all of the above stakeholders are to the same extent involved within the case studies. There may be stakeholders with a relevant expertise which are not connected to one case study in particular. These stakeholders will be included within the category *general stakeholders*.

Interview Procedure

• **Participation and consent form:** Interviewees will be made aware of this research by people from the internship company. Thereafter, they will formally be asked to participate in the research. If willing and able, an interview consent form is sent in which the research is also briefly described.

• **Interview protocol:** digital interviews will be recorded by video-conferencing software. Physical interviews are preferred and will be recorded on two devices to prevent technical errors.

• **Interview techniques:** to receive the data needed, rapport will be nurtured and different probing techniques will be used (Moerman, 2016).

More information on the interviews can be found in the appendices.

Expected Findings

It is expected that participants will have a multitude of approaches to the mobility hub concept. Therefore, participants probably have varying experiences with regard to mobility hubs within urban developments. Furthermore, based on their expertise and role, participants will probably have different focus area's. Having different approaches, focus areas, and roles is expected to provide a more comprehensive overview of the context and therefore a more generalizable answer to the main research question.

Interview Analysis

Interviews will be transcribed in Dutch and summarized in English. During the summarizing process, findings are categorized in certain topics. This could be regarded as open coding. The topics, which are brought up by the interviewees, are then clustered within the conceptual framework (Mobility Hub Integration Model). It might be possible that the conceptual framework needs to be adjusted (abductive reasoning) as a result of the interview findings.

Figure 18: Interview Analysis (own work)

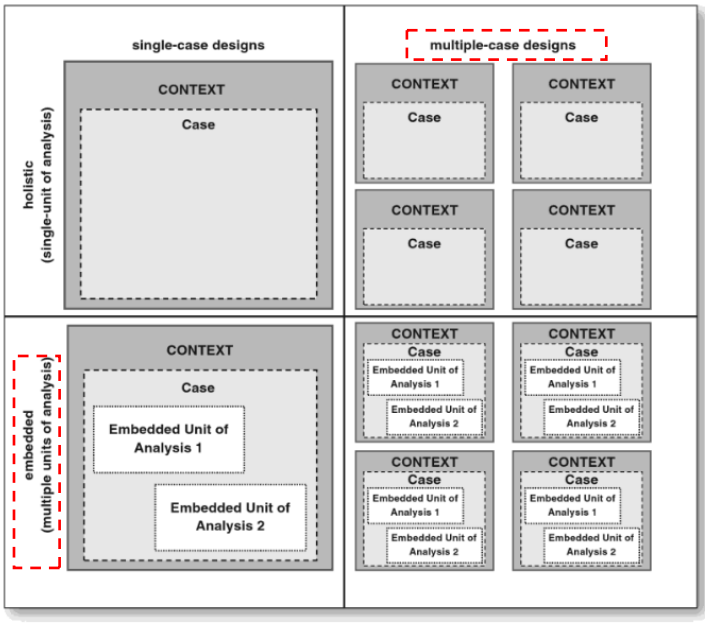
Lessons

Lessons are drawn from the analyzed interviews in the multiple ways. Firstly, if certain views come forward more often. Secondly, if certain views are in contrast with or complement each other. Thirdly, if certain insights add more in-depth insights about a topic. Lastly, if insights are case study specific and therefore worth mentioning in relation to other case studies. Furthermore, the expert panel functions as a way to validate the lessons drawn from the interviews, thereby increasing the generalizability.

3.3.5 Cross-case Analysis

Case Study Design

In this research, multiple 'embedded units of analysis' are examined within cases that are embedded in different context. The research can be classified as multiple-case and embedded (Figure 19).



Context:
Differs for each project

Unit of analysis:
Multiple units of analysis are identified in literature and presented in this research's conceptual model.

Figure 19: case study designs (adapted from COSMOS Corporation, as used by Yin, 2012, p.8)

3.4 Synthesis and Validation

3.4.1 Synthesis

Insights from desk and empirical studies are synthesized using the Mobility Hub Integration Model (Figure 21). This framework is used to structure the results from the interviews.

3.4.2 Validation

Expert Panel

The conclusion and recommendations for practice are validated by an expert panel. To enhance objectivism, one expert is from inside and the other from outside the graduation internship company. The expert panel does not include participants of the main interviews. A more detailed explanation of the expert panel approach can be found in chapter 7.

Table 21: expert panel participants

Professional's function	Organization	Description
Consultant (external)	Consultancy firm related to shared mobility	Consultant specialized in innovative mobility concepts.
Developer	Development Company	Developer with expertise in complex urban developments that include shared mobility.

3.5 Theoretical Concepts

3.5.1 Mobility Hubs within Urban Development

At its core, the function of the mobility hub is to bring together the shared mobility providers and users. The physical mobility hub is located within the urban development. Besides mobility, the hub can consist of other functions. For example, a social function or a function related to energy. As identified, there is usually a (digital) intermediary between user and provider. The integration process of mobility hubs within the urban development takes place over different phases. Figure 21 shows this concept.

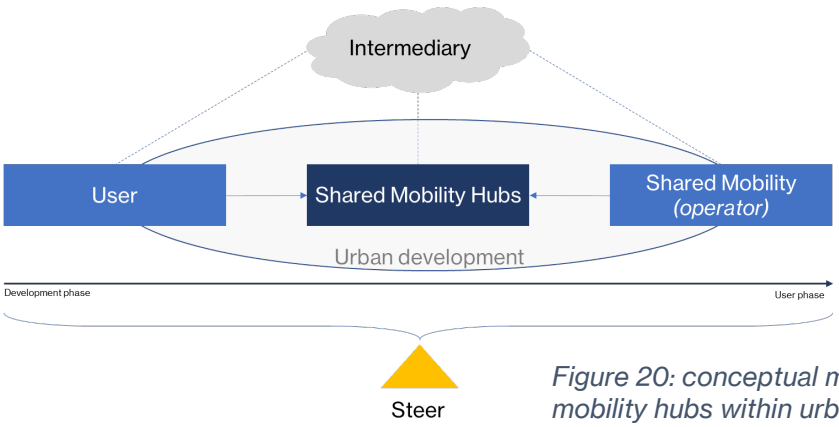


Figure 20: conceptual model of mobility hubs within urban developments (own work)

3.5.2 Mobility Hub Integration Model

To answer the main research question, a conceptual model is created (Figure 21). The model functions as a lens through which to approach the integration of shared mobility hubs within urban developments. It zeroes in in the interaction between the *Urban Development Organization* and the *Integration process of mobility hubs within urban development.* As a result of the interview findings, the user aspect has been added to the integration process of shared mobility hubs within urban development (abductive approach).

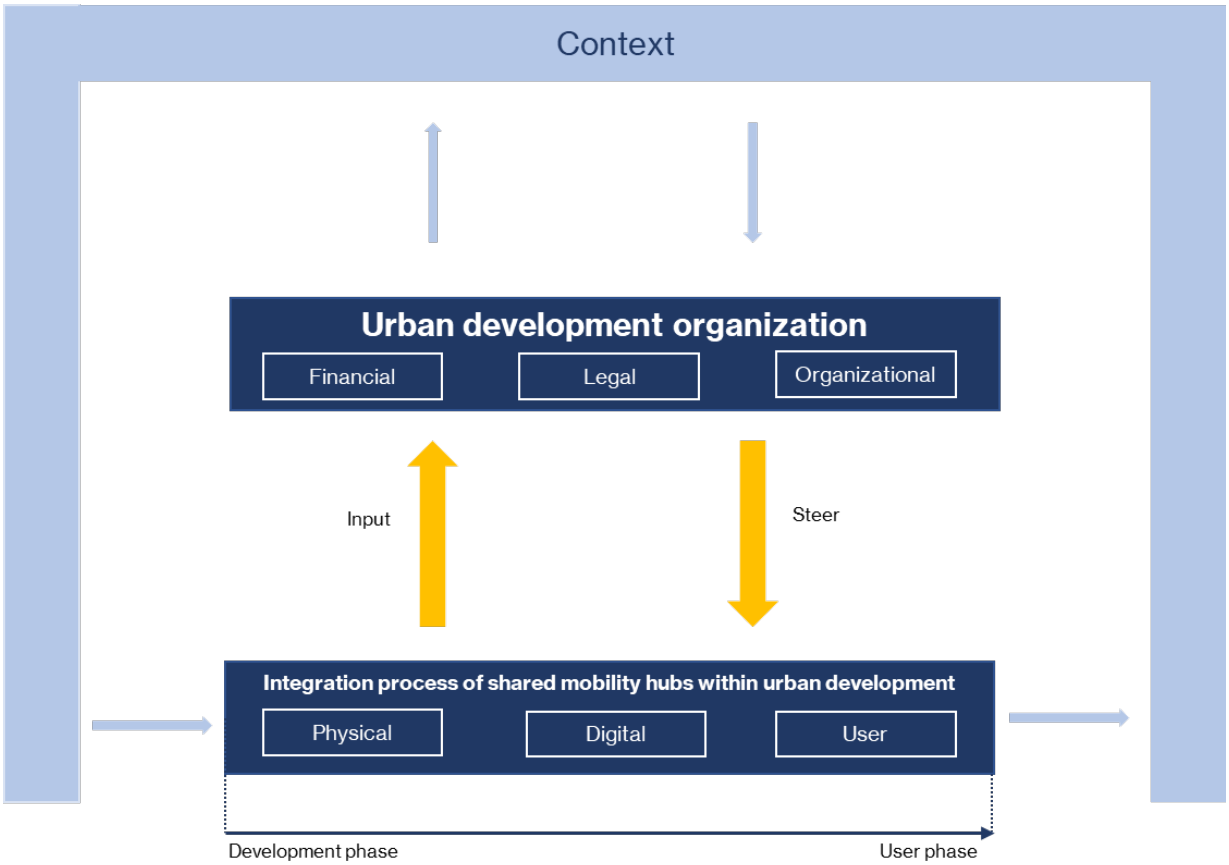


Figure 21: Mobility Hub Integration Model (own work, based on Heurkens (2012) as adapted from De Leeuw (2002))

3.6 Research Scope

The focus of this study is on the way developers can steer at the integration of shared mobility hubs within urban developments. In particular:

- Within the interorganizational collaboration strategy (organizational system) of the urban development.
- In both the development and exploitation phase.
- Examined from the urban developer's perspective.

Although users play a big role in the way shared mobility functions, empirical assessment of first-hand user experiences fall beyond the scope of this research. The focus is on the interorganizational aspects and on the urban development organization. Nonetheless, topics related to user experiences (such as social aspects, behavior, and attitudes) are brought up during interviews and are included in the results.

3.7 Dissemination and Audiences

This study is aimed at organizations that would like to gain more insights about shared mobility hubs in urban developments. Its insights can guide professionals in the AEC industry on the integration of shared mobility hubs, focusing on both the interorganizational aspects of this process as well as the use of hubs. Notwithstanding the main research question's focus on the role of the developer, its outcomes can also be used by other organizations. For instance: consultancy firms, social housing associations, government organizations, and governmental agencies related to the topic.

3.8 Miscellaneous

3.8.1 Graduation Internship

This thesis is written in collaboration with Heijmans N.V. in the role of graduation internship company. Guidance is provided by multiple professionals of the department Smart City, Real Estate, and Urban Development. The choice for this company stems from its role as a developer of and its concern with smart mobility and mobility hubs (Heijmans, 2021). Due to a variety of ongoing projects that include shared mobility and mobility hubs, the company is regarded as suitable for this research. The company values this research as gained knowledge can aide their shared mobility hub endeavor.

3.8.2 Ethical Considerations

This thesis will be published on the TU Delft Repository. Therefore, it is of great importance that no participants in this research experience any negative effects whatsoever due to the publication of this research. To this end, interviewees receive a letter concerning the purpose of this research, the voluntary nature of participating in the interview, and the right to not answer a question. Furthermore, in the letter the interviewee is asked if the interview

can be recorded. Interviews will only be recorded with permission of the interviewee and even after written permission to record the interview, this very question is asked again verbally at the beginning of each interview. Statements made by interviewee are validated by the interviewee to ensure the correct interpretation. In addition, all statements made by interviewees will be anonymized in this publication.

04
Case Studies

4. Case Studies

4.1 Feyenoord City, Rotterdam

4.1.1 Introduction

Feijenoord is a neighborhood located south of the river Meuse in Rotterdam. The area is strongly connected to the Feyenoord soccer club and its stadium: de Kuip. A large part of the existing dwellings has been constructed or renovated during the urban renewal in the 1970s and 1980s Due to the rail tracks and the river, the neighborhood can be considered isolated (NPRZ, 2013).

After the construction of the Erasmus Bridge in 1996 , the southern part of Rotterdam became more accessible and areas that were formerly used for port functions underwent a transformation. A well-known example is de Kop van Zuid, which has transformed to a mixed-use and highly densified urban neighborhood.

As can be seen in Table 22, Feyenoord on average has a higher amount of social housing and a lower income compared to Rotterdam on average. In 2013, the Nationaal Programma Rotterdam Zuid (NPRZ) has started. In this program, multiple institutions together aim to enhance the quality of life in the South of Rotterdam. It this way, job participation, education, and quality of life should increase (NOS, 2022).

Table 22: Statistics of Feyenoord and the Municipality of Rotterdam)

	Feyenoord	Rotterdam (municipality)
Population	77.935	655.468
Number of dwellings	37.190	319.210
Years of construction	Majority before 1950 or after 1980	-
Division ownership/rental	60% social housing (rental) 19% rental 21% owned	44% social housing (rental) 21% rental 35% owned
Average income	€23.200	€27.200

4.1.2 Developments

According to the Feyenoord City masterplan, 8 separate areas will be developed in about 10-15 years. These areas together will form a coherent entity. The plans consist of new construction of dwellings to rent or purchase. Furthermore, the neighborhood will also include a mix of various functions, such as health, sport, retail, a cinema, and cafeteria. The neighborhood aims to be for all people of Rotterdam, where the emphasis is on vitality, relaxation, and sustainability (OMA, 2019). The large-scale development has been a topic of discussion and has frequently been on the news. The plan in its original form has been adjusted and it has been decided that the new stadium for Feyenoord is not anymore part of the plans (Rijnmond, 2022).

Figure 22: Area boundaries of the Feyenoord City Development (Gemeente Rotterdam, 2017)

Mobility Vision

In the Position Paper of the Municipality of Rotterdam, it is indicated that the mobility strategy needs to aim for sustainable transport and spreading the traffic flow in time and place. Furthermore, organizing mobility the right way during both regular situations as well as during events is crucially important to the Municipality of Rotterdam (Gemeente Rotterdam, 2017). Additionally, the municipality of Rotterdam is willing to implement flanking policy, such as dynamic traffic management and parking policy in surrounding areas (OMA, 2019).

4.2 Nieuwlandplein, Schiedam

4.2.1 Introduction

The Nolensbuurt is part of Schiedam Nieuwland. Nieuwland is an area that has been constructed in the post-war years. The architecture of the 4 story apartment blocks is characteristic for this era (Nieuwland Schiedam, n.d.). The Nolenslaan is a relevant shopping street of the neighborhood and functions as a shopping district separate from the inner-city stores. The neighborhood is close to both a light rail station (Hoekse Lijn) which directly goes to either Hoek van Holland (beach) as well as downtown Rotterdam. Furthermore, there is a tram station in near vicinity which connects to the north of Schiedam, Vlaardingen, and downtown Rotterdam. Nieuwland has been named a 'Vogelaarwijk', which means that the neighborhood has been regarded as a 'problem neighborhood' and hence received funding from the national government to enhance the situation (Roerdink, 2016). As can bee seen in Table 23, the area has a relatively high amount of social housing and a lower-than-average income.

Figure 23: plan area of Nieuwlandplein development (own work, based on Google Earth, n.d.)

Table 23: Statistics of the Nolensbuurt and the Municipality of Schiedam (Allecijfers, 2023d) & (Allecijfers, 2023b)

	Nolensbuurt	Schiedam (municipality)
Population	1.475	79.644
Number of dwellings	694	37.749
Years of construction	Majority built 1950-1970	-
Division ownership/rental	46% social housing (rental) 22% rent 32% owned	31% social housing (rental) 19% rent 49% owned
Average income	€21.100	€26.800

4.2.2 Developments

The (re)development consists of two building masses. One of about 35.000 m^2 and one of about 19.000 m^2. The development includes housing, retail (supermarket) located at street level and parking and storage. The mission of the Nieuwlandplein development is to create a vital neighborhood that is in balance and lively. Furthermore, qualitative green environment should be created. It aims to add about 400 accessible dwellings. Adjacent to the new developments is the Nieuwe Damlaan (lane) which should become an entry to Schiedam. The area should become more permeable. Accessibility and clustering of facilities is key. Currently there are buildings blocks located on the development plot. These plot will be restructured due to the new development.

Mobility Vision

The plan aims to use and strengthen public transport to foster a decrease in car-use. The Nolenslaan (shopping street) should become more attractive to pedestrians and cyclists and parking solutions should become compact. One of the tasks is to create mobility for everyone in the urban renewal. Furthermore, a mobility hub next to the light rail station is indicated in the conceptual plan. Parking will be organized within the building blocks in a parking garage that is partly underground. On top of the parking garage, an inner courtyard is shown in the impressions (personal communication).

4.3 Waterlandkwartier, Purmerend

4.3.1 Introduction

The Waterlandkwartier is located north and south of the Waterlandlaan. The north side is delimited by the Where. The area is approximately 27 hectares and is used for both living and working. As can be seen in Figure 25, the area is close to the Purmerend station and the historic inner city (Gemeente Purmerend, 2021) Since the Waterlandkwartier urban development falls within the area boundaries of Gors-Noord, the statistics of the latter are shown in Table 24: Table 24. Looking at the division of ownership/rental and average income, it can be seen that the area is fairly representative of Purmerend's average.

Table 24: statistics of Gors-Noord and the Municipality of Purmerend (Allecijfers, 2023a) & (Allecijfers, 2023c).

	Gors-Noord	Purmerend (municipality)
Population	9.590	92.240
Number of dwellings	4.475	42.039
Years of construction	Majority during 1970-1990	-
Division ownership/rental	61% owned 31% social housing (rental) 8% rental	59% owned 34% social housing (rental) 7 rental
Average income	€27.900	€28.300

4.3.2 Developments

The Municipality of Purmerend aims to add 10.000 dwellings by 2040. 1.800 of those are planned in the Waterlandkwartier (formerly named Stationsgebied). The transformation of the area should make the Waterlandkwartier a mixed area to live and work in: a lively area where living, working and recreation come together (Gemeente Purmerend, n.d.-c). The new development, together with the historic inner city, should become one central area (Gemeente Purmerend, 2021). The area's masterplan indicates that for every new development, the division of dwellings should be 30% social housing, 30% purchasable homes and mid-segment rental, and 40% private sector. In January 2020, a vision for the Waterlandkwartier area has been determined (Gemeente Purmerend, n.d.-a). The Municipality of Purmerend gets €5,1 million from the national government to accelerate the construction of new and affordable dwellings in the Waterlandkwartier (NH Nieuws, n.d.).

Figure 24: Waterlandkwartier boundaries (Bura urbanism, as used by Gemeente Purmerend, 2019)

Mobility Vision

Due to an increased number of dwellings and places to work, the neighborhood gets more busy. The Purmerend municipality states that there is more space needed for pedestrians and cyclists (Gemeente Purmerend, n.d.-b). Around the station a public transport hub is created for trains and buses and the current network of bike paths is extended. Facilities in the neighborhood are located in such a way that they can easily be reached by bike or on foot. The municipality expects that the use of shared cars will increase in the future (Gemeente Purmerend, n.d.-b). In the area vision for the Waterlandkwartier, it is stated that the mobility transition can be used to invest in more sustainable and future-oriented solutions. Furthermore, a so-called *transfer machine* at the Waterlandlaan creates the possibility for Mobility as a Service. With a hub of different modalities at the station, shared mobility can optimally be used to make residents as well as visitors less dependent on car ownership (Gemeente Purmerend, 2019). The masterplan includes 6 mobility hubs in the area. The hubs are depicted as a multi-story building containing shared cars and a mobility store at ground level (see Figure 25). The hubs are said to contain multiple forms of shared mobility. Additionally the STOMP principles (Stappen-Trappen-OV-MaaS-Privéauto) is

leading and a lower parking standard can be used with residents depending less on car ownership (Gemeente Purmerend, 2021)

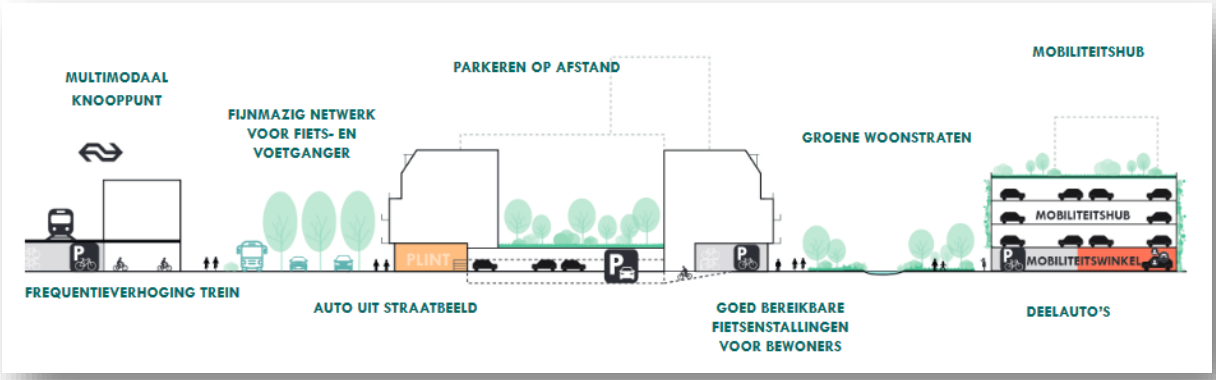


Figure 25: Schematic overview of the Waterlandkwartier mobility concept (Bura urbanism in collaboration with LOLA landscape architects, as used by Gemeente Purmerend, 2021)

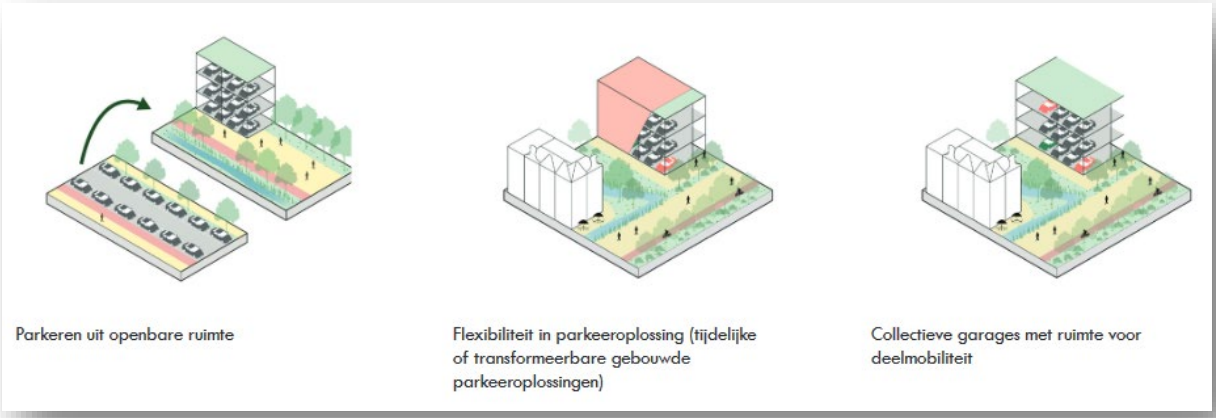


Figure 26: schematic overview of parking solutions (Bura urbanism in collaboration with LOLA landscape architects, as used by Gemeente Purmerend, 2021)

4.4 Interviewees

Table 25 provides an overview of all interviewed stakeholders and the corresponding case studies. The abbreviations are used in the Results section.

In addition to the interviewees related to particular case studies, there are also interviewees that are not related to one particular case study. These interviews are valuable to this research as they have experience related to shared mobility and/or hubs in urban developments.

Table 25: Overview of stakeholders, abbreviations, and case studies.

	Stakeholder	Case Study
A	Developer	Feyenoord City, Rotterdam
B	Municipality	Feyenoord City, Rotterdam
C	Municipality	
D	Mobility Advisor	Feyenoord City, Rotterdam
E	Developer	Nieuwlandplein, Schiedam
F	Municipality	Nieuwlandplein, Schiedam
G	Housing Association	Nieuwlandplein, Schiedam
H	Developer	Waterlandkwartier, Purmerend
I	Municipality	Waterlandkwartier, Purmerend
J	Shared Mobility Provider	Not case study-related
K	Shared Mobility Service Provider	Not case study-related
L	Logistics Advisor	Not case study-related

Feyenoord City, Rotterdam

Developer (A): Participant is involved in the development from the very beginning until the key is handed over to the buyer. For a part of the project, participant is in the lead as a developer and during the entire project, the participant bears final responsibility. Responsible for the product from the very beginning, but when construction start this responsibility is handed over the Construction. However, the developer keeps the final responsibility. Within Feyenoord City, there is a development combination (ontwikkelcombinatie) consisting of two parties joining forces in the OCFC (Ontwikkelcombinatie Feyenoord City). So on each plot, there are two developers from this combination and every decision is made in agreement with both parties.

Municipality (B): area advisor (*gebiedsadviseur*) for urban development projects in the south of Rotterdam. Participant has been working for the Municipality for about 20 years and is involved in the Feyenoord City project.

Municipality (C): Mobility advisor involved in mobility hubs on the municipal scale. Therefore, participant is not involved in urban development meetings. However, from time to time participant advises on Feyenoord City from the mobility hub perspective.

Mobility Advisor (D): Participant is a program manager mobility within the business development department of a construction company active in Feyenoord City. Within this function, participant is involved in the concept of shared mobility and mobility hubs.

Nieuwlandplein, Schiedam

Developer (E): Participant is a development manager, which includes several roles. For urban developments, participant is responsible for the project underneath the board level. This involves steering the team to get the project off the ground, securing the progress and properly finishing the project. Within this role, the urban development is approached integrally and is about combining various objectives and visions.

Municipality (F): Participant is involved in the entire task of constructing about 6.000 dwellings in Schiedam as *Woningbouwregisseur/senior beleidsmedewerker wonen.* These involve projects of different scales, the smaller ranging from 1-300 units and the larger ones are 3 main urban developments. Participant is involved from the initiative phase of a project, until the permit is issued. It involves planning the housing program, setting up the tender and selecting a market party. Stakeholder is involved from the perspective of housing: quality of housing, outdoor space, storage, mobility. Within the municipality, there is the department of City Development. This involves different teams: Real Estate, Economy, Spatial Development and Policy. Spatial Development and Policy is concerned with the topics Environment, Sustainability, Mobility, Housing. Together an integral advice is formed for a project of urban development.

Housing Corporation (G): Participant is a program manager within the housing association which is involved in the Nieuwlandplein project. Interviewee G has previous experiences within urban development and as an asset manager at various housing associations. As a program manager, participant is involved in realizing programs to reach long-term objectives. The involvement is about securing the process from the very beginning (vision) until realization.

Waterlandkwartier, Purmerend

Developer (H): Participant is a developer (since November 2022) and is involved in a Smart City team within the development company . Before becoming a developer, participant has worked as an urban development consultant. Firstly as an advisor at a more traditional urban development consultancy company and later at a consultancy firm within the field of mobility. Participant has advised on multiple urban developments that included novel mobility concepts and hub developments.

Municipality (I): Participant is a strategic advisor mobility. Within this role, the objective is to better involve mobility within urban development plans, and already include it from the very beginning. Additionally, within this role this participant works on having a proper stakeholder network so that the municipality can have the right conversations with the right stakeholder.

Not Case Study-Related

Shared Mobility Provider (J): This stakeholder is the owner and founder of a company involved in shared mobility and the energy transition. The company offers shared cars (subscriptions). It provides shared electric cars to both individual customers as well as companies. The company works together with project developers and real estate investors in lowering parking standards, making mobility more sustainable, and to use sustainable energy in a smart way.

Shared Mobility Service Provider (K): Participant has an automotive background and is active in the role of owner of a company that provides technological solutions in the form of an app, platform, and hardware for shared cars. Participant is a pioneer for everything having to do with shared mobility. Firstly, participant was active in the public domain regarding B2C propositions for the consumer to use shared cars. During this time, the participant turned the focus to the technical solution to facilitate the operation of shared cars. Because at that time, from a technological perspective (apps, platform, hardware for cars) there was not enough to fulfil the demand. Sharing concepts do not work when the technology does not function. Participant was active in gaining user-feedback from multiple locations in collaboration with a car company franchise. The company is part of an overarching group of which the main activity is facilitating business travel through public transport and combining and settling all transactions between employer and employee.

Logistics Advisor (L): Participant is active within a development and construction company. Participant's role is about developing new products, services, and ideas in addition to the company's core business. These developments take place within the context of a changing society. Important themes are energy, circularity, livability of cities, equal opportunities, diversity. Participant's role is about creating something and exploring 'off the beaten track.'

05
Results

5. Results

The *Mobility Hub Integration Model* (Figure 21) functions as a guideline to structure the results of the interviews. The results are separated into two sections:

Mobility Hub Concept: everything related to the mobility hub as a product and the way it is used. This includes **physical, digital**, and **user** aspects.

Urban Development Organization: everything related to organizational process of creating and maintaining the mobility hub. This includes **organizational, financial, legal,** and **steering** aspects.

Figure 27: structure of results, based on the Mobility Hub Integration Model (own work)

Findings & Key Takeaways: for each of the sub-topics mentioned in Figure 27, interview findings are presented and followed by a key takeaways section. As mentioned in chapter 3 (methodology) lessons are drawn from the interviews when insights/remarks are.

Insights are mentioned by multiple participants	Insights are in contrast with or complementing each other	Insights are in-depth or adding further nuance	Insights are case study specific

5.1 Mobility Hub Concept

5.1.1 Mobility Hub Concept (general)

→ Participants' views on what a mobility hub entails in a broader sense.

The mobility hub concept is interpreted in different ways. Results mainly included descriptions of what the mobility is (i.e. product) and what it is used for (i.e. objective). It was indicated that there might not be one universal definition, as it is more of a buzzword (K). The description of what a mobility hub entails differs on the following aspects:

Concreteness:

- Hubs are about things coming together in an area (A).
- A hub consists more of options, than one description of how it physically looks (D).
- A hub is more of a conceptual model than one single object (L).
- A mobility hub is not a physical object, but rather an embedded mobility solution for the entire neighborhood (F).

> **"To me, the hub is much more of a conceptual model than one single object."**
> (L) Advisor Logistics

Program & Objective:

- A place where different mobility services, but also other services, are offered for a broad target group (A).
- A central location within an area, in which mobility in the broadest sense is offered (E).
- It is about integrally disclosing mobility within an area, so that mobility is an integral part of housing, working, and living (K).
- A mobility hub is about making a location within an area, where you can come in a car and continue in a different way. So one central spot, to relieve the area surrounding it (G).
- Hubs are a combinations of mobility in the first place, they have a social aspect, and an energy component (D).
- It could possibly involve a package hub, but at its core it is about mobility (J).
- It is more of a blueprint, it often comes down to the same (H)
- Within the context of urban development, a hub is mainly a glorified parking garage at a distance, to stimulate active mobility (H).
- A physical location where different transport modalities are offered, including at least one form of shared mobility and sometimes public transport (B).

- It is a mobility location where multiple modalities come together and where people with a mobility demand can change modalities (I).

> **"I do not think of it** [mobility hub] **as one built object, but more as embedded in the area. And not for one project, but for the entire neighborhood."**
> (F) Municipality

Scale & Design:

- A mobility hub includes 2 or 3 electric shared cars for (local) residents living in and around the urban development (J).
- There are multiple hub typologies (B, I).
- The Municipality of Rotterdam has 5 levels of hubs (D).
- There are multiple degrees of hubs (H).
- It could be as small and organized, or as big and complex as one wants (I).

> **"My statement often is: a hub is a glorified parking garage, complemented by space for shared cars or other modes of shared mobility. That's it, in essence"**
> (H) Developer

KEY TAKEAWAYS

Mobility Hub Concept (general)

Participants interpret the mobility hub concept in different ways. The descriptions differ on the following interrelated aspects:

- **Concreteness**: from more of a conceptual description to more concrete descriptions of the mobility hub.
- **Program & Objective:** many descriptions included the objective of the hub and how this objective is achieved (program).
- **Scale & Design:** related to the Program & Objective, the hub descriptions differed with regard to the Scale & Design within the urban development.

5.1.2 Physical Design, Adaptivity & Functions

→ Participant's views on how the hub can be physically designed, in what way it can be adaptable, and the functions that could be included in a hub.

Scale & Location

Results imply that there is a relationship between the scale of the hub and its location. Both the scale and the location of the hub are affected by its function and objective and vice versa.

The **Municipality of Rotterdam** has a framework for different scales of hubs. These include (A, B, C, D):

• **Mini-hub / Private hub** - Included in a plot development in a garage (e.g. Timmerhuis).
• **Buurthub** - Public terrain mostly for small shared mobility 'two wheelers'. It mainly consists of a sign and some information tiles (C).
• **Wijkhub -** bigger hubs consisting of multiple cars (B). In Feyenoord City, approximately 2 or 3 wijkhubs are needed because of the number of dwellings that are going to be constructed (3700-4000) (A).
• **OV-hub** – Public transport hub at 9 public transport locations (like Beurs, Blaak, Slinge, Central Station) (B).
• **Region hub** - More of a Park and Ride location. Aimed at facilitating traffic coming from outside the city (B)

In **Waterlandkwartier** the hubs are located on the edge of the area. The area is only accessible for cyclists and pedestrians. For logistics there is room to load and unload, but residents and visitors should park in the parking hubs (H). Currently, the bus network in Purmerend is not the most convenient way to get around. The hub should help in offering last-mile solutions (I).

When it comes to the term location, two categories can be distinguished:

• **Location in relation to the surrounding buildings:** hubs can be located within a building (B, D, H, G) at ground level (A), they can be created as a stand-alone building (A, B, D, H, G), they can be at street level (J) (not in a building) or underneath infrastructure (e.g. an overpass) (A)

• **Location within the city and area:** the hub can be located at different locations within the city/neighborhood (A, B, D, H, I). This location affects its function. Within a neighborhood,

In **Feyenoord City**, there are 4 potential variants regarding the hub's location (A)
• *Hub on street level (not in a building)*
• *Hub in a stand-alone building*
• *Hub within a building at ground level*
• *Hub underneath an overpass*
Space underneath an overpass is not an attractive place to build housing, so a mobility hub can make it lively. However, it is indicated that 'eyes' are needed.

when it comes to the shape and form, it often comes down to parking at a distance for the current residents, and 5-10% for shared cars (H). It depends on the location if function can be successful and if a hub can become a hotspot (A).

Adaptivity

It is indicated that the market for shared mobility is not yet grown-up (A, J). Small aspects of the shared mobility concepts often change, having spatial consequences for the environment (A). In a broader sense, society is always changing and the hub should be able to transform (E). Looking ahead, participant I mentions that if self-driving cars become a reality, it is over with hubs (I).

> **"In a best-case scenario, a building exists for more than 100 years. I think we cannot predict what the shared mobility sector will be doing in 5 years."**
> (A) Developer

As far as the adaptivity of the mobility hub is concerned, it is firstly important to determine if the hub is temporary or permanent, and physically integrated or stand-alone (D). Participant L mentions that the hub should not be cast in concrete from day 1 and that it can be rolled out over multiple locations, objects, and functions. Making the hub future-proof is also a form of sustainability (E). Adaptivity can be created using the following:

- Modular units (D)
- Reserving space for extra expansion (D, F)
- Not making the hub integrally part of the building (H)
    - However, indoor is better for the spatial quality (B).
- Not constructing underground (H) - which is very expensive (G) -but instead building on ground level (B, C)
    - Then it still is flexible and possible to change (C)
    - Then it is easier to construct and deconstruct (B).
- Making it possible to reprogram the building's functions (I)
- Creating ownership, connecting the hub to a group or community (E).
- Making the hub simple and effective (I).

In terms of adaptivity, participant I mentions that including adaptivity makes the hub even more expensive and that adaptivity could also be found in simplicity and effectiveness (I). In this way, it is cheaper, easier to remove the hub, and free up space after 15 years. However, this will not make a location of good quality (I).

> **"Maybe we should do it the other way around: future-proofing in simplicity and effectiveness. But that is at odds with a qualitative location"**
> (I) Municipality

Participant L indicates that there is a dividing line between what needs to be solved from the beginning, because it would otherwise not fit anymore, and things that are given space and adaptivity so that it can grow for the first generation. This is in line with participant F noting that adaptivity should be taken into account by having enough space for the car,

In **Feyenoord City,** the Roseknoop hub is temporary. It is in function for two years and then the plot will be built upon (D).

bike, and walking. When allowing densification, the public space should not be reduced (F). Adaptivity in the future can therefore be created by having enough public space (F).

Functions

During the interviews, multiple potential functions of hubs were brought up. These are:

- (Flex) Working places (A, H, D)
- Offices (G)
- Cafeteria (A, D, F)
- Retail (H)
- Service shop (H)
- Community Space (D)
- Bike storage (D)
- Logistics (L)
    - Package Service (D, E)
- Charging poles (D, J, I)
- Nursery (I)
- Dry cleaner (I)

When it comes to the location of each function, it is noted that some shared mobility providers want to be visible at street level, where there is usually cafeteria at the visible locations (A). Participant F also mentions that the plinth of a building should be lively, which does not seem the case with bike storages at plinth level. Additionally, it depends on the place if services are to be added to the hub (A). This is in line with participant C mentioning that the context is important in deciding what to offer in the hub. Mobility hubs are about customization and its functions depend on the task that needs to be solved (G). Participant F also notes that the municipality is alert on the functions, so that it does not compete with, for example, a shopping street. Furthermore, it is noted that energy production and greenery are not a precondition when it comes to mobility (H). With regard to different functions, mobility is said to be an integral part that should not be viewed separately from other interrelated aspects and disciplines (E).

Efficiency: participant L is critical towards the efficiency of mobility hubs, which is not an objective in itself. Instead, livability in the city should come first (L). Despite the fact that a mobility hub could be a solution in a technocratic way, it does not necessarily create a neighborhood that can grow in the long-term. If all functions are clustered, everybody needs to go the same building for everything he/she needs and this will not enhance coincidental meetings and livelihood of the neighborhood (L). Participant L notes that efficiency is not the objective. Instead, livability in the city comes first. When adding functions, the effects on other functions in the area should also be taken into account. For example: if the mobility hub has a parcel point, it could mean the bankruptcy of tobacconists in the area (L).

> **"The mobility hub concept is too clinical, too pure, too nice. I think that with inner-city construction, you need to make use of what is already there."**
>
> **"Why can't you divide the hub? With all due respect, this is the real estate way of thinking. "**
>
> (L) Logistics Advisor

KEY TAKEAWAYS

Physical Design & Adaptivity

• **Scale & Location**: results showed that hubs can come in all shapes and sizes. The scale depends on what role the hub plays within the network of the city. Furthermore, hubs can be located either within buildings or as a stand-alone building.

• **Adaptivity:** shared mobility is evolving and this could potentially have spatial consequences. Adaptivity helps in being able to carry out desired changes. Adaptivity can be enhanced by using modular units, reserving space for expansion, not physically integrating the hub within a building, and building the hub as a stand-alone unit at street level.

• **Functions:** during the interviews a plethora of functions that hubs could fulfil were brought up. The common denominator in these function are that they all can be categorized in one of the following classifications: mobility, social, energy.

5.1.3 Digital & MaaS

→ Participants' views on the digital aspects (e.g. Mobility as a Service) of hubs and shared mobility.

MaaS

It is indicated that ideally, there is a network in a city and cars can be transferred and exchanged between cities (H). MaaS is about hubs that are accessible to everybody and it is about exchanging spaces (H). It is stated that shared mobility all needs to be connected to be successful (A). In addition, it is mentioned that a network is needed for *wijkhubs* to have everything at the right distance, and that separate hubs are not really of use (C).

> **"Our vision says that *wijkhubs* cannot really function on their own, because a network is needed to have everything at the right distance. In addition, it is necessary to have *buurthubs* that are easily accessible. In this way, the network is city-wide. Separate hubs are not really of use.**
> (C) Municipality

Mobility as a Service used to be hopeful and ambitious, but looking at the outcomes of pilots it can be seen that most stakeholders do not see a chance to generate income (H). There is a lot of development time and therefore costs related to connecting multiple platforms. Connecting two operators costs about €50.000-€100.000, so for 4 to 5 operators this will add up to €300.000. This money should be earned back by disclosing the supply (K). There needs to be an incentive that for all stakeholders income will increase. Market circumstances are expected to wreak havoc with MaaS (K). Besides the

> **"I do not see large-scale partnerships happen."**
> (E) Developer

digital link, it is also about servicing: different brands and responsibilities. Thus, it is also about linking different layers of various organizations (e.g. support, servicing) (K).

Additionally, it is mentioned that in Holland, a trip does not consist of a lot of modalities or transfers. It often is about biking to the train or bus stop, but apps to figure that out already exist (H). Participant C indicates that preferably, MaaS is organized at a national level, because it is not desirable to organize this as a municipality. When it comes to the role of the government, two dilemmas are mentioned by participant I: firstly, it needs to be discussed what underlying values influences the travel recommendations. Secondly, it should be carefully considered if the government should share data with private parties that monetarize data (I).

Shared mobility providers are not keen on having one application to offer all forms of shared mobility (K, J). Reasons for having an own application could be a user experience that is thought to be superior (K), and the need to know the customers of the company (J). However, shared mobility providers could potentially collaborate with individual services, such as a cargo bike company (J). It Is expected that there will not be 1 system offering all services, but that users will have 3-5 apps (D).

When it comes to the role of developers, mobility is a not a core business (E, H). It is about offering housing products and a part of that includes organizing or guaranteeing mobility. 900.000 dwellings need to be built and in the upcoming years something concrete needs to be offered. When MaaS or the municipal network is insufficiently worked out, a developer cannot do a lot of things with that (H).

> **"You cannot realize all ambitions that you have projected 30 years later and already integrate it in an urban development"**
> (H) Developer

White Label Hubs & Interoperability

Results indicate that white label hubs are not to be expected in the near future. It is noted that there are too many things changing in the mobility sector to create one united concept that has all car providers in one hub for one rate (A). With regard to the ownership of parking spots, it should not be fragmented to guarantee long-term commitment within the hub (K). Notwithstanding the expectation that white label hubs are not realistic in the short-term, participants A and D are positive towards interoperability between hubs within one urban development. In contrast to the 'white label' concept, participant D indicates that the hub should house partner identity.

Feyenoord City: in Feyenoord City the *buurthubs* might complement the *wijkhub*, so that the supply of cars in guaranteed with a sort of integral booking system. However, this is challenging if there are multiple shared mobility providers (A, D).The bigger the fleet, the better peaks can be managed (D). Operators exchanging cars between each other could be interesting for the business case (D).

Digital & MaaS

• **MaaS:** results indicate that when it comes to Mobility as a Service, views differ on its necessity and potential. Some mention that ideally, hubs and shared mobility should be interconnected, but others do not really see the point of shared mobility within a chain of modalities/transfers. From a commercial perspective the potential of MaaS as one application involving all modes of (shared) mobility is doubted. This is due to the lack of incentives for shared mobility providers to invest in MaaS and the fact that accessibility is not always the goal for mobility providers. Thus, a dividing line between reality and ambition is identified.

• **White Label Hubs & Interoperability:** it is indicated that one all-encompassing MaaS application does not seem realistic in the upcoming years. When it comes to White Label Hubs, the concept does also not seem realistic because it about connecting more than only a digital linkage (also about servicing). However, the potential of interoperability between different hubs and providers is indicated to be hopeful yet challenging.

5.1.4 User & Behavior (Demand)

→ *Participants' views on the user-related aspects of shared mobility hubs.*

Target groups

The target group is about the demand (A). When it comes to shared mobility, the most important aspect is that the user wants it (K). Participant H states that the target group depends on the objective of the mobility hub. The importance of the user is stressed by multiple participants and is said to be understudied (K).

> **"If you listen to your customer, then it is going to work. If you don't, then you're gone."**
> (K) Shared Mobility Service Provider

Age: It is indicated that people under the age of 30 are more open to shared mobility and that the older generation wants to have a car in front of their door (A). Participant F also mentions that it depends on the person and the phase of life it the use of shared cars is suitable. When it comes to elderly people, a transition to shared cars is not really realistic as many value having an own car (G). However, certain people do not always need a car and those can rely on public transport, a bike, and sporadically rent a shared car (E).

> **"When you are 80 years-old, you are not getting into a shared car anymore."**
> (G) Housing Association

Income and/or Education: When it comes to the target groups, it is indicated that, in general and simply put, the target groups are more highly educated people that earn enough money. Customers that formerly had 2 or 3 cars, or 1, and said goodbye to that

car (J). This is in the same line as participant H stating that when one wants to reduce car ownership, the target groups are middle and higher incomes. Higher income groups usually have a car ownership of 2 per household: shared mobility could potentially replace the second car (H, I).

Current / Future Residents: it is desirable to make shared cars available not only to the residents of a new development, but also to residents living around it (J). Participant F mentions the friction between shared mobility just for the building or for the entire neighborhood. It is mentioned that shared mobility should become an attractive alternative to use in one's life if someone can organize one's life around it (F). This should apply also to current residents, and not only to newcomers (F).

The **Nieuwlandplein** project is aimed at climbing the housing ladder (*wooncarrière maken*) within Schiedam. In Schieveste (a big development close to the Schiedam train station) the construction is for the entire region (F). Participant F notes that many people living in Schiedam are simply dependent on their car, so they should reach the place where they need to be.

Social target groups and Affordability

For municipalities, the target group often includes everybody (H). This is also indicated by the municipality (C) which indicates that it is a political choice whether or not to subsidize shared mobility to make it affordable for everybody (B). For social target groups the parking standard is already very low and it is challenging to offer shared mobility to people with a small wallet, as there currently is not yet a market proposition to do this (H). Affordability of shared mobility is doubted (L). Furthermore, it is mentioned that customers from social housing are not very helpful/useful customers for a shared mobility provider, as the company needs customers that would normally have money for 1 or 2 cars and understand the shared car concept (J). As far as social housing is concerned, it is mentioned that tenants of social housing should not be obliged to use shared mobility (G).

> **"I think it is very important for our tenants that it** [using shared mobility] **is not an obligation but a choice."**
> (G) Housing Association

> **"Development takes place from utopian ideals than in practice exclude many people."**
> (L) Advisor Logistics

Participant E and L note that many people simply rely on their car to go to their jobs and that not all people have the choice to work remotely (L). Regarding affordability, Participant D indicates that for certain target groups, something should be added. For example, people with a distance to the labor market, people with a handicap or people looking for a job. The connected system should provide the possibility of receiving a

> **"People can barely pay their energy bills, let alone a shared car. They are driving a 20 -year-old car"**
> (L) Advisor Logistics

> **"I certainly think that shared cars are a solution for social target groups, but then the financial component is way more important. "**
> (E) Developer

budget from the municipality. For example, a person could get €100 a month to rent a shared bike. This compensation should be arranged back-end. (D).

Business Use

Shared cars could also serve as pool cars of a company (A, J). However, the scale of the company could have an influence on this choice (A). When companies offer lease cars, it is hard for shared mobility to compete or be supplemental (H). There is a trend that companies offer mobility instead of offering lease cars. An employer could steer by doing away with lease cars and introducing a budget that can be used for public transport, bus, or shared car (H).

Attractiveness

Proof: It is indicated that shared mobility can become more attractive when it proves itself by being available and functioning well (A). It then achieves the customers' trust (A). Receiving trust and shared mobility proving itself is a process (A). The product should grow in phases with the residents, so that it can be discovered what works best with the residents (K). Participant F indicates that there need to be successful projects in which shared mobility functions well for a couple of years and wonders if Schiedam needs to pioneer in this.

Ease of Use: It is indicated that shared mobility can be made more attractive by making it easy to use (A, K). The following aspects can make it easy to use:

- Only having to use 1 application in which you can compare and book mobility (A).
- Ease of use, so that it feels like one has a car key (K).
- Having 1 application to get an overview of mobility, and then be redirected to another app for payment (A).
    - Connecting the hub with an application (E).
- 100% reliability of operation (K).
- Recognizable (J, D), close (G) and fitting location (J).
    - Flexibility in where to park (G).
- Good accessibility (B, E, I)

> **"Under the surface it is complex, but it must be super easy for the customer. It should feel like he has his own car key in his pocket, but then it is an app"**
> (K) Shared Mobility Service Provider

Comparing Alternatives: Results indicate that affordability plays a role when it comes to (the transition of ownership to) shared mobility (A, B, D, E, F, G, I, K, L). In order for people to use shared mobility, the financial incentive needs to be made clear. This includes making clear what the costs of owning a car versus sharing a car are (A, K). Participant C notes that in most cases, when one does not make a lot of trips, shared cars are often cheaper

In **Feyenoord City** the temporary hub is used to learn and experiment. The process will be monitored by a university using interviews, surveys and focus groups. This research consists of two phases. Phase 1 is before construction and Phase 2 is about the use of the hub. A *wijkhub* with all the functions included does not yet exist, so the hub has been positioned towards the Municipality as *learning and experimenting*. (D).

than owning a car. It needs to be made clear that owning a car costs more money than just fuel (K). When the shared car concept does not work for people, it is mainly due to those people having either too much money and therefore choosing to own a car, or people having too little money so that they cannot afford shared cars (J). It is also noted that for some people, shared mobility does not work. For example people that work in the Port of Rotterdam (C).

> **"If you take a shared car and it costs a fortune, you rather request an Uber."**
> (E) Developer

Change of Behavior

People doing away with their own car and replacing it with shared mobility is a long process (A). It is about trial and error (A). Participant K indicates that a change of behavior only works when the government financially stimulates it (K). Participant K remarks that the user-experience is underexposed in many report (K). Participant F also notes that mobility is about how one organizes his/her life and that it is about time, trust, and certainty. Related to the latter, participant B mentions that it is easier to make shared mobility more attractive for new residents than for current residents. Participant G is of the opinion that during this transition, one should start with the 'low hanging fruit'; those people for whom it is most easy to make the transition.

In **Purmerend,** car ownership is high (H). The car is often used to daily trips and for distances <15km. These distances can be traveled by other modes (e.g. bus, scooter, bike). Many people in Purmerend work in Amsterdam, so the traffic consists to a large extent of commuters. Upgrading train and bus could decreases car dependency (H).

Status symbol: For certain groups, the car is a social norm or status symbol (G, H). For social target groups it needs to be properly investigated how people can maintain a status symbol as an alternative to hand in your car, which is quite challenging (H). Offering shared bikes, just like public transport, has no status at all for certain ethnic groups. The car is a symbol to show that people have climbed the economic ladder (H). Participant F also notes that for some, car ownership gives a certain comfort and offers luxury and status.

Communication

Participant E and H mention that it is crucial to include shared mobility from the very beginning, partly because people take a lot for granted in the process of findings a home (K). People do not realize what it means to not have a car or not be able to park anymore (K). A lot of people are enthusiastic until to need to do away with their second car (K). During the development phase, future residents are actively involved in the shared mobility concept and this works well (J). This is in line with participant A stating that shared mobility providers are in charge of the communication and marketing by themselves. When it comes to the location of shared mobility, it is important for customers that there is a

> **"And then you just need to produce a good product that does not arrive overnight, but which basically expands in phases with the residents that come to live there."**
> (K) Shared Mobility Service Provider

location where they get their cars and that this location is recognizable and fitting (J). Participant D also indicates that the hub needs to have a recognizable identity (D). When it comes to communication, participant C mentions the importance of awareness: making visible and the communication campaign for current and existing residents. Related to this, participant E mentions that there are certain trends which will happen anyway, and other trends on which you can steer. When it comes to mobility solutions that are different from parking the car in front of one's home, it is exciting (*spannend*) to actively steer on this trend (E).

Customer Attention

Participant D mentions that when choosing a hub, it is important to determine if the hub is staffed. This is in line with participant K stating that shared mobility is about genuine attention for the customers, which is human work (K). People should feel like they are guaranteed of mobility and that it is a good service, a kind of luxury (K). Therefore, a hub needs a local manager, who might be visible to wash the bike or car, fix the malfunctioning charging pole or inflate the tire (K). Having a staffed hub (for information or repairs) has a social return to it (D).

KEY TAKEAWAYS

User & Behavior (Demand) 1/2

• **Target groups:** target groups of shared mobility can be approached in different ways.

Most prone to use shared mobility: these are people that (most easily) can build their life around the use of shared mobility. This is generally easier to achieve with new and younger residents. Also, it is indicated that these people, generally and simply put, have a higher education, earn enough money, and use shared cars to replace their own car.

Desirable to use shared mobility: a dividing line is identified when it comes to the target groups who are thought of as desirable users of shared mobility. While visions and ambition documents sometimes include *all people* as a target group, it is indicated that currently no market proposition exists for target groups with a smaller wallet. Furthermore, shared mobility providers could prefer customers with a higher spending power. From a customer perspective, some participants note that shared mobility is on the pricey side. However, form a business perspective it seems challenging to lower the current prices looking at the actual costs. Subsidizing shared mobility is brought up, but views differ on whether or not this is a good idea.

• **Business Use:** businesses can be seen as customers of shared mobility as they can use it as *pool* cars. However, the scale of the company could affect the attractiveness of business use and for the user itself, flanking policy by the company does also affect the potential: if lease cars are also offered, it is hard for shared cars to compete.

KEY TAKEAWAYS

User & Behavior (Demand) 2/2

• **Attractiveness:** the attractiveness of shared mobility is affected by a wide variety of factors. Proof: Firstly, it was brought up that shared mobility should prove itself to become more attractive. If there are good examples and people gain trust, attractiveness can increase. Ease of Use: secondly, ease of use is brought up as a way to make shared mobility more attractive. The ease of use can, for instance, be improved by the following: having only one application for all mobility, application that feels and is as easy as a car key, 100% reliability, recognizable and fitting locations for shared mobility, and close accessibility. Comparing Alternatives: lastly, providing insights of the costs of owning versus sharing mobility is important if people should transition to shared mobility.

• **Change of Behavior:** taking into account the user perspective is important in the process of shifting from ownership to shared mobility. While financial incentives are a rational incentive, it must be noted that cars are a status symbol to some and this does not apply to other modes of mobility. Also, some people want to have the feeling of having a car at their disposal at all times.

• **Communication:** in order to create awareness of shared mobility, communication is key. Involving people in the process early-on and making the hubs recognizable and visible can enhance the awareness.

• **Customer Attention:** a staffed hub could help people use (shared) mobility and can have a social return to it as well.

5.1.5 Modalities & Operation

→ Participant's stances on the various modalities that can be included in a hub, and their means of operation.

Modalities

During the interviews, multiple modalities that can be in a hub were brought up:

Modality	Brought up by participant
Bikes	A, D, E, F, J
OV-fiets	J
Cargo bikes	H, I, J
(Moving) vans	A
Scooter	A, B, D, E, J, H
Car	A, B, E, G, H, I, J, K
Public Transport	A
Train	A
Metro	B
Tram	A
Bus	A, I

The potential of shared bikes in neighborhoods (this does not include the *OV-fiets* as a last-mile solution) is doubted (A, H, J), mainly because many people have a bike (H, J). However, it is noted that shared cargo bikes can be a successful service in neighborhoods, as people do not quickly buy those (J). Nonetheless, bike storage is something that should be properly solved (E).

If somebody lives further away from the hub, the smaller forms of shared mobility are organized close to the dwelling (H). Biking (including OV-fiets) and scooters are used for first and last-mile (J). Participant F also indicates that bikes need to be organized as close to one's home as possible. 5 years ago, the idea used to be to offer all mobility centrally. However, for smaller modalities (e.g. scooters) one is not going to walk 300 meter and operators want to offer it closer to home (H).

> **"We all bike here, right? And it works. Finally, hundreds of millions are invested in bike infrastructure, that is what needs to happen** [...] **But shared bicycles in a neighborhood: no."**
> (J) Shared Mobility Provider

Free-Floating & Station-Based

It is indicated that one-way trips with shared mobility (A to B) have the biggest market within cities, as you can always come back to A (A). It is indicated that outside of the city, A to B to A trips (e.g. station-based) are more useful (A). Participant H states that in Amsterdam free-floating cars are used more often than station-based cars, but that they are aimed to shorter distance trips (H).

The concept of free-floating shared cars is doubted (J, K) as it costs a lot of money, because it is expensive to redivide all modalities and monitor and manage the process (K). It is easier to include station-based mobility in a hub, because of the certainty that the modality will return (H). Even with a lot of customers, the free-floating concept is not financially viable (J). Also, it is noted that shared mobility is not a throw-away product that you can leave anywhere (J).

In **Rotterdam-Zuid,** there is a need to station-based bikes and scooters. This is due to free-floating modalities breaking down and clutter (D).

Free-floating bikes and e-scooters are focused on random (*willekeurige*) users in the neighborhood. When it is about giving substance to a hub, it is focused on future residents of new dwellings (H). On the contrary, participant D indicates that free-floating operators could potentially benefit from clustering everything at one station. The hub should be a place where there is supervision and where one can do maintenance and repair (D). Participant C also is of the opinion that different systems are necessary because every person has different needs. This would imply a combination of station-based, free-floating, and back-to-many, and that they can be parked in hubs (C).

Participant C wonders if it is possible if shared cars can share parking spots when they are all electric. Regarding this, participant J stresses that having one car at one charging

> **"Ideally, you want a mix of free-floating and station-based."**
> (D) Mobility Advisor

spot guarantees parking upon return; leaving shared cars at a public charging pole is challenging (J). The last concept has been created on paper and sticking to it in practice will result in the practice disappearing (J). There is a shortage of public parking space where you can charge a car, so participant J regards it as a bad idea to add shared cars to that.

Transfer

Due to the different conceptualizations of what a mobility hub entails, views differ on whether a hub is a transfer location. Participant J states that a hub is not a transfer location, but a place where one goes to get a shared car (J). If a shared car is located at a train station, it is because they are used by people that work and live there. Not by people arriving at the station, because they often only have to travel a couple of kilometers (first- or last-mile) which is not useful to use a car for (J). However, participant D explains that people can stay at a hub for three reasons: a brief stay, a transfer or a longer stay. During this longer stay, they could wait, get a coffee, or stay while it is raining (D). This quality of stay is also express by participant I: when functions are clustered and a transfer is possible, people are incentivized to use the hub. Although simple forms of hubs already exist, connecting multiple modalities in this way is new (I).

KEY TAKEAWAYS

Modalities & Operation

• **Modalities:** multiple modalities that can be included in a hub were brought up. These include: bikes, (moving) vans, scooter, car, and public transport. Important to note that smaller modalities should be organized closer to home and that not all mobility should be organized centrally. Also, the potential of shared bicycles as a first-mile solution is strongly doubted.

• **Free-Floating & Station-Based:** though some participants express the desire to have one-way trips (free-floating), the potential and financial viability of free-floating shared cars is strongly doubted. Station-based modalities can be beneficial to guarantee parking space and charging possibilities, and not treat mobility as a throw-away product. Additionally, in some cases, station-based might be desirable in order to have supervision and prevent clutter within the public space. However, including free-floating mobility within a hub might be beneficial for mobility operators to have one location for maintenance and repairs.

• **Transfer:** due to the different views on what a hub entails, participants' views differ on whether or not a hub has a transfer function. The difference lies within the fact that some participants imagine more functions within a hub than others. In this respect, it is also important to note that cars are generally not used as a first- or last-mile solution.

5.1.6 Energy

→ Insights from participants on the energy related aspects of hubs.

One of the functions of hubs can be energy production and storage. When constructing a hub, the right charging infrastructure should be constructed (e.g. charging poles that can be used for bi-directional charging) (H). Looking at the future, certain design choices, such as empty pipes, can already be included (F). Related to the hub's energy concept, participant F indicates that the concept of batteries in garages is still in its infancy.

It is indicated that bi-directional charging is at the eve of becoming more scalable but for the coming 5 years, it is too primitive (K). However, the current energy grid cannot handle a high increase in charging infrastructure (I). Participant E also mentions that, despite the opportunities in connecting mobility and energy, the question remains whether it is going to be realized (E). At this moment, a lot of cars do not support bi-directional charging (K). It still is questionable whether it is possible to use somebody else's car when it comes to using electricity for your own house (H). Smart-to-Grid is seen as more of a beautiful story by participant K. It is interesting to note that participant F mentions that importance of letting the fire department join the process if implementing batteries in a parking garage.

In **Feyenoord City,** before the new Feyenoord Stadium was left out of the Feyenoord City plans, there was an overarching energy concept. The energy concept currently is not integral anymore, but the mobility hub concept is intended to be integral (A).

Participant J mentions that new developments all include a lot of solar panels and that a smart solution has to be come up with, as currently so much energy is produced that the grid cannot handle it. There is a financial component to bi-directional charging: if you charge your car at the right moment, you can charge your car for cheaper or make money by discharging if the price is high (J).

KEY TAKEAWAYS

Energy

Bi-directional charging has potential and the technical solutions to implement it exist. It can prevent overload of the electricity network by locally storing energy. However, not all BEVs currently support bi-directional charging and at this moment the Smart-to-Grid concept still has a way to go. Nonetheless, anticipating these developments in the design of hubs can facilitate implementation of new energy concepts later on.

5.2 Urban Development Organization

5.2.1 Organization and Management

→ The views of participants on the organizational and management aspects of mobility hubs.

When organizing mobility concepts, it important to consider in what way the urban development is organized. This includes land ownership and the collaboration between different parties (roles).

In **Feyenoord City**, three parties are active. The Municipality, the Stichting Gebiedsontwikkeling aan de Maas (STIGAM) and the Ontwikkelcombinatie Feyenoord City (OCFC). The municipality is responsible to test the development to the municipal framework. STIGAM is responsible for buying the land, site preparation and issuing the land and everything connected to that (e.g. masterplan and architectural requirements). STIGAM looks at the entire area. OCFC is the developer of the plots (A).

For **Nieuwlandplein,** the new Omgevingswet will apply. This means that mobility is already included and considered from the very beginning. From different disciplines, a framework is created by the municipality regarding sustainability, housing, mobility, and urbanism. The advice is given to the developer that submitted its concept plan (F). There are many developments in Nieuwland, so one could have a collaboration and generate value by also making shared cars accessible to residents already living in the area (F).

In **Waterlandkwartier,** the developer is collaborating with the municipality to reach a cooperation agreement (SOK; Samenwerkingsovereenkomst). The development company has been selected as a partner two years ago and thinks about how to take the area to the next level. In doing this, the development company has received a sort of right to developer a part of the program. Knowledge is brought in on a variety of themes, and in exchange the developer is entitled for the construction of a part of the plan. Together with external advisor, it has been examined how to make the area car-free (*autoluw*). There is an investment from the national government (Rijk) for the train station area. It gets upgraded and thereby increases the city's accessibility for commuters and gets less dependent on car traffic (H)

Objectives

When it comes to shared mobility and mobility hubs, there are multiple underlying motivations which depend on the stakeholders' perspective. These can be divided into the objectives that serve the users and objectives that serve the Urban Development Organization.

- Lowering the amount of parking spots that need to be built (D, I)
  - Solving parking themes (G)
  - To make project developments financially feasible (A, K)
    - Sell the land position as a municipality and have dwellings realized on it (K).
- Reduce the number of cars on the streets (B)

- Lowering the footprint of mobility (I)
- Reduce the amount of car trips (B) / preventing congestion (K)
    - Preventing loading and unloading wholesaler vans parked on the sidewalk (L)
- Stimulate active mobility (H)
- Create quality in the public space (F, I); add to a healthy living environment (E).
- Livability (L)
    - Livability is more important than efficiency (L)
- User's motivation
    - Sustainable motivation (e.g. residents of an eco-neighborhood) (K)
    - Financial incentive (A, K)

Challenges

One of the challenges regarding mobility hubs is the novelty (A, G). There is not yet a proven variant of the mobility hub that you can copy-paste (A). Furthermore, the exact demand is hard to predict (A). Additionally, it is challenging that it sometimes takes 3 to 4 years before dwellings are completed and during this period, a lot of things can change, and shared mobility is fully in motion (J). The shared mobility provider (J) indicates that the conversation with the developer is different every year. By regularly monitoring and keeping each other updated, the company tries to secure this (J). Mobility is always changing and innovating, which makes communication about mobility hubs challenging; when talking about mobility hubs, you never know if one is talking about the same level or scale (A). Participant G always asks what people mean when they use the word *mobility hub*.

> In **Feyenoord City**, it was challenging to find a provider for 50 shared mobility spots for 1200 dwellings. This was the developer's problem, but it was discussed with the STIGAM which said that mobility should be approached from an area level (A). OCFC provides input to STIGAM, and STIGAM is in the lead. After discussing this problem with a team of experts, it was decided that mobility hubs in 3 scales could be the solution. One needs to look at the different scale levels to see what fits best, so that it all fits together and one has one mobility concept for the entire urban development (A).

Participant D mentions that the biggest challenges are Location, Capex, and Opex. Participant D explains that sometimes, the interrelation between Location, Capex and Opex becomes a circular argument. Target group X might be in a different location than target group Y. Capex depends on what one wants to do, and Opex depends on the location. It is challenging to pin that down right at the beginning (D). When it comes to steering, it should be from the early phases onwards (A). The later in the project, the lower the influence (A).

> **"The biggest challenges are Location, Capex, and Opex."**
> (D) Mobility Advisor

- **Location**: ownership of the location (private/public).
  - It is challenging to decide where to build the hub (I).
- **Capex**: initial investments without a business model.
  - It is challenging to decide who finances the pre-investment (I).
- **Opex**: the expected yearly costs and benefits.
  - It is challenging to find a structural exploitation model (I).

In **Waterlandkwartier,** the vision for the area has been elaborated upon in a Program of Requirements for Mobility (*MPvE; Mobiliteits Programma van Eisen*). This vision is based on the STOMP principle (Stappen, Trappen, OV, MaaS, Privé-auto). The vision has been translated to concrete principles that have led to specific hubs and other conditions (H). MPvEs were not conventional, but in the last 3-4 years they have become more common. They are used to give more substance to the vision of sustainable mobility and to provide spatial principles that stem from ambitions (H). Certain pilots have taken place, for example in Utrecht, to better steer spatial design, which often leads to implementing central hubs, more space for walking paths, bike connections, and the area's access to reach these hubs (H). A MPvE makes it clearer what is expected in terms of mobility and prevents mobility from becoming a hiccup later in the process (I).

KEY TAKEAWAYS

Organization & Management

• **Objectives:** hubs can be seen as a means to an end. There is a wide variety of objectives (ends) that hubs can serve. These objectives can be divided in objectives serving the Urban Development Organization and/or objectives serving the user. One of the main objectives often includes lowering the parking standard. This can make the project financially feasible. However, it should be noted that lowering the parking standard is also related to livability in the neighborhood. The objectives can also include preventing congestion, lowering the number of cars on the street, and creating more quality in the public space. Additionally, from the user there could be a sustainability or financial objective.

• **Challenges:** the novelty of the hub phenomenon is a challenge. There are many aspects that are hard to predict, causing uncertainty. Furthermore, over the duration of development projects, many changes occur. Furthermore, communication is said to be challenging. Lastly, the interrelation between Capital Expenditures, Operational Expenditures, and Location is said to be challenging and this sometimes becomes a circular argument.

5.2.2 Business Case and Exploitation

→ Insights from participants on aspects related to the hub's business case and its exploitation.

Existing Concepts

It is indicated that a connection with existing successful concepts is desirable. In this way there is already a customer base that is going to use the services (A). In order to connect with existing concepts, a collaboration between private parties is certainly needed (A). Participant D implies that the municipality is in control of the public space and that it should determine the conditions under which market parties agree to operate (D).

> **"Look for the connection with concepts that are already successful to bring it all together, so that you get a concept which is innovative at certain aspects, needs to invent itself, but also has a certain clientele that is going to use the services**
> (A) Developer

Competition

Shared mobility providers do not want to be at a place where there is fierce competition (A). It is hard to find shared mobility providers for large developments that include a large amount of shared mobility (e.g. 30-80 shared cars), as the business case is not certain enough (A). Participant K mentions that shared mobility is a dynamic demand-supply game, with preferably as little assets as possible (K), which fully meets the user's demand (K). When it comes to a hub, all parties should benefit from it (D).

HOA

Shared mobility could theoretically be organized at the level of the Home Owners Association (HOA). However, asking residents a contribution for shared mobility through the HOA is challenging (A). It will increase the HOA fee and it is also paid by people not using shared mobility (A). Furthermore, there is a lot involved in the organization of shared mobility as a HOA, which makes it challenging (H). Parking used to be organized by the HOA (e.g. parking below and apartment building) but now it is organized centrally with owners at a distance (H). The question is whether 300-400 dwellings are joining one entity (H).

> In **Feyenoord City**, certain parking spots that are owned by the HOA are used by a shared mobility provider during the 10-year mobility guarantee. The development organization of Feyenoord City (OFCF) has an agreement to secure the 10-year mobility guarantee. Afterwards, the development organization does not have influence on the parking spot anymore as it is owned by the HOA (A).

(Positive) Business Case

The business case can be examined from multiple perspectives. The business case of a mobility hub could be examined from solely a financial perspective. However, it is indicated that from a financial perspective business case is not very attractive for market parties at

> **"Looking solely at the hub's business case, it is not very attractive for market parties."**
> (H) Developer

the moment (D, E, H). Also, despite the fact that shared mobility can results in fewer parking spots, shared mobility is not profitable for developers (A).

The business case can also be examined from a broader perspective, taking into account both quantitative and qualitative aspects. It is indicated that the satisfaction of all stakeholders can result in a positive business case (K). If the business case is positive for the developer, provider, user, and government, there is a win-win-win and then it always works (K). When a hub becomes a success, one can get the message out (B). According to the municipality (C), the hub is a success when it is well-used.

> **"The hub is a success when it is well-used."**
> (C) Municipality

Exploitation and Responsibility

Participant K stresses that before the project is started, certain questions need to be tackled. These include determining who bears the exploitation risk, determining the number of cars, determining how the charging infrastructure is organized, determining the current rates, and determining how to keep it affordable (K).

Private and public initiative: if the HOA or a joint entity are not organizing the mobility hub, then it should be examined if market parties are interested to exploit hubs in a rental contract (H). However it is more attractive for market parties to have a downtown parking garage with an hourly ticket rate compared to renting out parking spots to residents (H). When it comes to private actors, both participant A and D indicate that the market should take care of certain functions of the hub. Participant D is of the opinion that a certain set of arrangements should be made, so that incentives are headed the right way. All parties should benefit from the use of the hub (D). This is in line with participant A stating that there will be a mix between public and private actors and that this mix should be aligned (A). Participant B indicates that there should be a certain gradation in the kind of hub, from leaving it to the market or taking control as a municipality. Participant C is wondering whether or not the municipality should subsidize wijkhubs or leave it to the market. It might be possible to have a tender for a wijkhub that can be won by a shared mobility provider (C). The municipality is still weighing the options of owning and exploiting the hub versus leaving it to the market (B). Participant E mentions that municipalities are not eager to take on the exploitation of hubs, although the municipality does exploit parking garages (E). It is indicated that other municipalities are also looking at how to take control (*regie*), but

> **"In my opinion, a certain set of arrangements should be made, so that incentives are headed the right way."**
> (D) Mobility Advisor

> **"I think you should have a certain gradation in the kind of hub, from leaving it to the market or taking control as a municipality. From no control (*regie*) to 100% control and everything in between."**
> (B) Municipality

> **"The question always remains who is going to exploit and own the mobility hub** [...] **Who is going to step forward?"**
> (G) Housing Association

that it is hard to make a choice because it is unknown (B). Municipalities can also choose to tender both the construction of housing and the hub together (H).

Participant J is critical towards more control (*regie*) in the sense of more requirements and thinks there is too much being steered. Since the market for shared mobility is far from grown-up and many shared mobility companies have gone bankrupt, more *regie* could mean that shared mobility providers do not want to join in certain situations (J).

> **"Do you know how well-filled the cemetery of car-sharing companies is? 90% of all car sharing companies ever started, are in the cemetery. If you steer a little more and take charge, then we will soon be there too. And then there will be 2 or 3 companies in the Netherlands, which simply have a monopoly"**
> (J) Shared Mobility Provider

Risk: it is more attractive to put a parking garage on the market when the dwellings (with potential customers) are already constructed. One could take on the risk upfront by making a pre-investment and put the parking garage on the market later on, when there is more certainty for the parking operator (H). Mobility providers do not want to be inside a parking garage and offer mobility to the residents exclusively unless the exploitation risk is covered (D). Developers are hesitant to cover the exploitation risk, because then there is no incentive (D). For example: if mobility providers get €10.000 a month to staff the hub, there is no incentive to rent much out. A location in the public space is more interesting for shared mobility providers, compared to a parking garage (D). Participant I mentions that, unless the developer keeps the portfolio of newly constructed dwellings, the government is the stakeholder with long-term commitment and should therefore take the initiative (I).

> **"In my opinion, the government should take the initiative (regie). Why? Because the government is a stakeholder with long-term commitment**
> (I) Municipality

Despite the fact that there currently are examples of hubs, such as Merwedekanaalzone, one cannot look back at how it works. A choice need to be made now, but it is uncertain how it is going to be in 5, 10, 20 years (B). This is in line with participant A stating that the municipality can be convinced by a developer if there a good examples. Concepts need to prove themselves by trial and error (A)

In **Feyenoord City**, the OCFC and STIGAM approached the municipality about hubs. The municipality did not offer this idea, but instead it was the other way around. In another development close to the current development, hubs are not included at all. It is indicated that the municipality could steer better on the way developers should implement mobility hubs (A).

In **Waterlandkwartier**, the municipality is the ground operator (*grondexploitant*) and thereby takes the lead (*regie*). The municipality invests in the hubs at their own expense and risk. The municipality is responsible for construction and maintenance (*beheer*). The hub has a financial gap (*onrendabele top*), so the question is whether market parties are interested if it is placed on the market (H). It can also be organized differently: in Amsterdam, there has been a project where the construction of housing and a hub where together brought on the market as 1 task (H).

Housing market region: the housing market regions play a role in making shared mobility more attractive (H). It is easier to convince people to use shared cars in the G4 regions, where there is a high demand for housing and space is scarce (H). Those people can be convinced to compromise and there always are more alternative modes of transportation available in urban areas (H). However, this does not account of cities outside the *Randstad*, where there is plenty of space (H). Participant A mentions that rural and urban areas cannot be compared. From a spatial and technical perspective, there is no incentive to reduce the household to one car in more rural parts (H). In relation to G4 cities as opposed to smaller cities, participant F indicates that learning from other developments is important, as Schiedam is not like downtown Rotterdam. Also, people in more urban areas are already focused more on other modes of transportation (G). The opportunities for hubs are, however, not fully dependent on the housing market region: if there is a good existing infrastructure, there is more potential (E). Participant I also mentions that currently, developers can relatively well comply with all requirements for urban developments (e.g. building social housing, greenery, design quality). However, when the market deteriorates this will become more difficult and the choice will either be less cars in the development or not building at all: building a parking garage underground is too expensive (I).

Scale Level: it is indicated that there will always be a need for 5 shared cars in a building of 600 dwellings (private *buurthub*). However, the *wijkhub* should have separate *regie* (plot level) (D). Participant A thinks the municipality is the right scale level to organize hubs. Certain rules should be put in place by the national government, but the real policy implementation for hubs should be at a municipal level (A). Participant F mentions that if forced are joint in a bigger urban development, the mobility concept can become beneficial for the residents (F).

> **"But in the end, the government is in control of public space. It should determine the conditions under which market parties agree to operate."**
> (D) Mobility Advisor

Mobility Guarantee

Participant F wonders how the concept sustains when the developer is gone after 5 years. The municipality wants to have a kind of certainty and wants to know how to deal with it if it turns out to not be financially viable (F). This certainty should be offered by the market, as the municipality does not offer shared cars (F). One of the solutions can be guaranteeing that a shared car for a certain price and certain number of years is guaranteed in a development (F). This is in line with participant B stating that when somebody gets rid of his/her car, this person should be guaranteed availability (B). According to the Municipality of Rotterdam, a mobility guarantee is needed for 10 years (A). Parking spots cannot be added afterwards, so operators need to have a long-term commitment (K). Although a mobility guarantee could make sure that mobility is properly organized in the upcoming years, participant I is critical: if the exploitation does not work out after a guarantee period, the mobility provider is gone. Thus, a business model should

> **"Municipalities are making deals** [i.e. mobility guarantee] **with the developer for 10 years. However, don't you create a future problem in this way?** [...] **I think we should look for a business model that will work forever"**
> (I) Municipality

be created that works forever. This probably involves that the government pays for it (I). Should the government choose to subsidize, if is important that the returns are social gains, and that the money does not go into the developer's pocket (I).

Long-term commitment is needed when it comes to shared mobility providers, and in this market these are scarce (K). Ownership should not be fragmented: in order to secure the supply of shared mobility, it is necessary that there is one manager in charge of the hub (K). Participant I mentions that the government in the stakeholder with long-term commitment and therefore there is a role for the municipality if it is socially desirable to guarantee mobility (I). However, if developers keep the constructed dwellings in their own portfolio, there is also an incentive for the developer to make sure the mobility solutions are organized the right way after completion (I).

> **"In my view, when something has social value, it may cost public money. However, it should not go into the developer's pockets."**
> (I) Municipality

KEY TAKEAWAYS

Business Case & Organization 1/2

- **Existing Concepts:** when it comes to hubs, connection with existing mobility concepts can be beneficial as there is already a customer base for these services. To organize this, a public-private collaboration should be organized and if public space is involved.
- **Competition:** having multiple shared mobility providers competing with each other within an urban development is not desirable from a business perspective as it provides more uncertainty to the business case. When it comes to parties involved in a hub, it is important that all parties should benefit from it.
- **HOA:** hubs can be organized by a Home Owners Association, but this is easier when the hub is integrally part of the building. If hubs are organized more centrally and are bigger in size, it is not certain if residents, at a distance, are joining a bigger overarching entity for the operation of mobility hubs.
- **(Positive) Business Case:** the business case of the mobility hub can be viewed in different ways. From a financial perspective, it is indicated that the business case is not (yet) attractive. However, one could also view the business case through a broader scope, also including satisfaction and social return.
- **Exploitation and Responsibility:** determining how the shared mobility and hub concept is organized with regard to exploitation risk is paramount. This should be determined before the project is started. Taking the lead in organizing the hub can either come from private or public parties. This choice is context dependent (market region, urban versus rural, incentive, political ambition). There is uncertainty involved in the exploitation of hubs: there is a lack of precedents and the business case is not (yet) very attractive to market parties. Also, whether or not parties are willing to take initiative depends on the scale of the hub: the organization of *wijkhubs* is more complex than for private *buurthubs*.

KEY TAKEAWAYS

Business Case & Organization 2/2

• **Mobility Guarantee:** for municipalities, the uncertainty related to shared mobility can be addressed by implementing a mobility guarantee. Long-term commitment is said to be important as it is difficult to add parking spots afterwards if the concept turns out not to work. Long-term commitment could be enhanced by having one manager of the hub, and not have fragmented ownership.

5.2.3 Business-to-Consumer

→ Interview findings on shared mobility hubs as seen from the Business-to-Consumer perspective.

From the interviews it can be derived that hubs and the corresponding shared mobility should be viewed more as an interplay between supply and demand (market). Therefore, this subchapter focuses on the Business-to-Consumer part, focusing on the user from a business perspective.

Customer Base

Demand is needed to decide what custom product is offered within the hub. A thorough demand-supply analysis is needed on each location to make sure that the hub is going the be used and for the hub to succeed (A). The demand differs in what modalities people use and how often (A). This is in line with participant D stating that the need for mobility is to be determined for all target groups. Not only the amount, but also how this need can best be fulfilled (D). Participant K stresses that involving people from the initiative phase onwards is a way to influence (K). The shared mobility provider mentions that, as agreed with the developer, the developer in an early phase pays attention to the fact that there are going to be shared cars (J). Participant K brings up that everything being implemented needs to be of the highest quality and connect to the user's demands and needs. All other stuff should already be done the right way (distance, clean, safety, lighting, affordability, accessibility) (K). As a developer, one has to sell a housing product to the intended target groups. Therefore, it should be examined whether the product has the right price-quality ratio (when including hubs) (H).

Rotterdam-Zuid currently has *buurthubs*, but the *wijkhub* or mobility hub is not yet there. While it works well in the North of Rotterdam, the people that need it have not yet been found in Rotterdam-Zuid (A). The new construction of housing in Feyenoord City could boost the implementation of the mobility hub with people from inside and outside the development (A).

Purmerend is said not to be a very attractive market for shared mobility providers at the moment (I). If the target group are people with are car ownership of more than 1, the second car can be replaced by a shared car and thereby increase the business case (I). However, in the transition phase the business case might not be viable and therefore the government could fill this gap (I).

Pricing, Subscriptions & Accessibility

In some new developments, there is an introductory subscription for shared cars. This works well, but not all customers keep on using the subscriptions afterwards (J). Not all residents within the apartment become customers of the shared mobility provider (A). When the shared car concept does not work for some people, it mainly is about people having either too much money and therefore choosing to own a car, or too little so that they cannot afford shared cars (J). Participant K mentions that shared mobility needs to be cheaper than the users currently pay (K). However, participant J (shared mobility provider) indicates that it is not really possible and desirable to offer shared mobility against a lower prices. Participant E mentions that it oftentimes a problem for shared mobility providers to finance their operation and also make it attractive for the customer (E).

The shared mobility provider indicates that approachable/accessible (*laagdrempelige*) customers are not desired, because on average they make more damage and use it without care. If customers damage the car a couple of times, the lease company will raise the insurance fee of the entire fleet (J) For this reason, there is a threshold with a €99/month subscription and a €99 deductible and a minimum of 3 months. In this way, there is a €400 commitment upfront.

Costs of Electric Cars (J)

Electric cars on average cost €35.000-€50.000. Leasing an electric car on average costs €600-€700 a month. Additionally, there are system costs, which drive the price up to €800-€900 a month. Divided by 30 days, that is €30/day operational expenditures. With the subscription of €99, the customer can drive 4 days. This would mean €25/day. On top of that, costs of electricity have increased (J). So, the price (of shared cars) cannot be lowered, and participant J thinks it is a bad idea to subsidize shared cars (J). To be profitable, the prices to use shared cars should actually be twice as high (J).

Increased accessibility of shared cars also means more risk. With easy registration and access, it also means that it is easier for criminals to use shared cars (J). The company would like its cars to be used for longer trips to places that cannot be reached well by bike or public transport (J). It is preferred not to have a car booked for only 1 hours, because then there is no business case for the rest of the day (J). The company's goal is not to offer people cheap mobility, but to get people out of their combustion engine cars. The project is not really financially viable, so a contribution from developers is asked to cover the unprofitable part and pay for an introductory subscription (J). These findings are in line with participant D explaining that with electric transport, it is hard to offer it against a lower price.

KEY TAKEAWAYS

Business-to-Consumer

• **Customer Base:** the importance of viewing the hub as an interplay between demand and supply is brought up in the interviews. From a business perspective, this means that it is important to gain insights in the customer base and figuring out what and how much shared mobility is desired, and how this can best be fulfilled.

• **Pricing, Subscriptions & Accessibility:** in new developments, residents can receive an introductory subscription for shared mobility for a certain period of time. However, not all people remain customers afterwards, as some have the money for and prefer to have an own car, and others cannot really afford it. While some participants indicate that affordability of shared cars leaves to be desired, from a business perspective it seems challenging to lower the prices. From a business perspective, increased accessibility is not always regarded as desirable.

5.2.4 Parking

→ *Interview results having to do with the interrelation between mobility hubs and parking.*

Parking Standards

Meeting the parking standards is challenging (B, E, F, G). Since construction costs are currently sky-high, this drives up the costs of constructing parking spots (E). Using default parking standard makes the development very unfeasible from a financial perspective (E). The ambition is to lower the parking standard: to have less cars on the street and a lower use of cars (D). Although the parking standard can be lowered if (bike) storage or mobility scooter spaces are built, residents need to be offered qualitative adjustments of spaces. This is challenging as there are not enough examples that have been successful for a couple of years (F). The challenges lies in how the public space can gain more quality that it currently has, while at the same time organizing enough parking spaces. One needs to consider how to integrate a parking garage in such a way that it does not hinder the traffic flow (F). For the housing association, shared mobility is not the starting point. However, the topic of mobility should be solved in a good way to create a good urban development (G).

In **Rotterdam**, there is a 1 to 5 discount on the parking standards when offering shared mobility.

In **Nieuwland**, there is a *10-minute city*. Pedestrians are central, there are good walking routes to schools, shops, public transport. Nieuwland already has the infrastructure for a 10-minute city, but it is not used to the full extent. When it comes to mobility and the density that can be created with the current infrastructure, Nieuwland has more potential. There is a luxurious infrastructure compared to what is already built. Currently, the neighborhood is car-oriented, but the ease of crossing over should be enhanced. In Nieuwland, the infrastructure is ready for the future, but the buildings should join.

Parking Spots

Although a maximum discount on the parking standard can be achieved by maximizing the amount of shared mobility, one should also take into account the amount of parking spots when it comes to selling the dwelling (A). Parking spots are a source of income for the municipality, but the municipality could also prefer ownership of parking spots as it can help in steering car policy (C). It is indicated, that ideally shared mobility is available at street level (B). Furthermore, parking on the street is easier than a hub for shared mobility providers, and more flexible for the users (H). It should also be mentioned that participant G has experience with building parking spots according to the requirements, but that it led to undesirable overcapacity: the parking spots were underused (G).

Flanking Policy

It is mentioned that if there are sufficient parking spots, the transfer to shared mobility is not stimulated (A). The success of the hub depends on whether or not paid parking is put in place (C). Flanking policy, such as a limited amount of parking spots and expensive parking permits, are needed to let shared mobility providers succeed (J).

> **"On the one hand, it** [shared mobility] **should become more attractive. On the other hand, it should be discouraged to own a car."**
> (B) Municipality

What also plays a role, is that a square meter of housing is 10 times as expensive as a parking spot (J). Shared mobility should not become cheaper and a better app is not needed. The issue is: one can leave a cheap car in the middle of the city for not a lot of money (J). Participant E mentions that there are plenty of mobility visions, but the implementation and realization of vision (for instance paid parking) does not, or very late, go through. This could be due to political support: if everybody wants to park their car in front of their homes, politicians are less likely to implement policy contrary to that (E). Participant I expresses that you could either prevent parking problems or solve it afterwards. In both cases, these choices are difficult (I).

Participant F mentions that when there is no paid parking in an area, which is a political choice, it is difficult to manage mobility and steer on adding shared mobility. The most important role of the municipality is to facilitate and minimize nuisance (F).

> **"Residents should not be required** [to use shared mobility], **but tempted to use something more attractive. And then, in the end, people will be persuaded. And that will take time"**
> (F) Municipality

The car infrastructure in the Netherlands is of great quality (I). Therefore, alternatives modes of mobility can either be stimulated (which will cost a lot of money) or car ownership can be discouraged (I). However, in steering on behavior with financial incentives, there is a risk of making all travel modes too expensive. Therefore, if the car gets more expensive, train fares should be lowered (I).

Logistics

Participant L believes in the consolidation of logistic flows, which can be organized bottom-up. The municipality could facilitate initiatives by private parties. If there is one package point for all dark store deliveries, traffic is reduced. When it comes to the supply of stores, a consolidation point can pose a solution to multiple wholesaler vans parked on the sidewalk and/or empty returns (L).

KEY TAKEAWAYS

Parking

Developers can receive a discount on the parking standard if, for example, shared mobility or bike storages are implemented in the plans. Besides fewer parking spots, flanking policy related to parking (e.g. paid parking) can help making shared mobility a more attractive alternative. However, it should be noted that the implementation of (flanking) policies related to parking are political choices. As for as logistics are concerned, package points (consolidation points) can reduce the amount of parked vans on the sidewalk thereby increasing the quality of the public space.

06

Cross-case Analysis

6. Cross-case Analysis

While a more general analysis is presented in the key takeaways of each sub-theme, this chapter focuses on the underlying reasons for similarities and differences. Based on the Mobility Hub Integration Model (Figure 28), as cross-case analysis is conducted to distill differences between the three analyzed developments. Afterwards, potential explanations of these differences are presented.

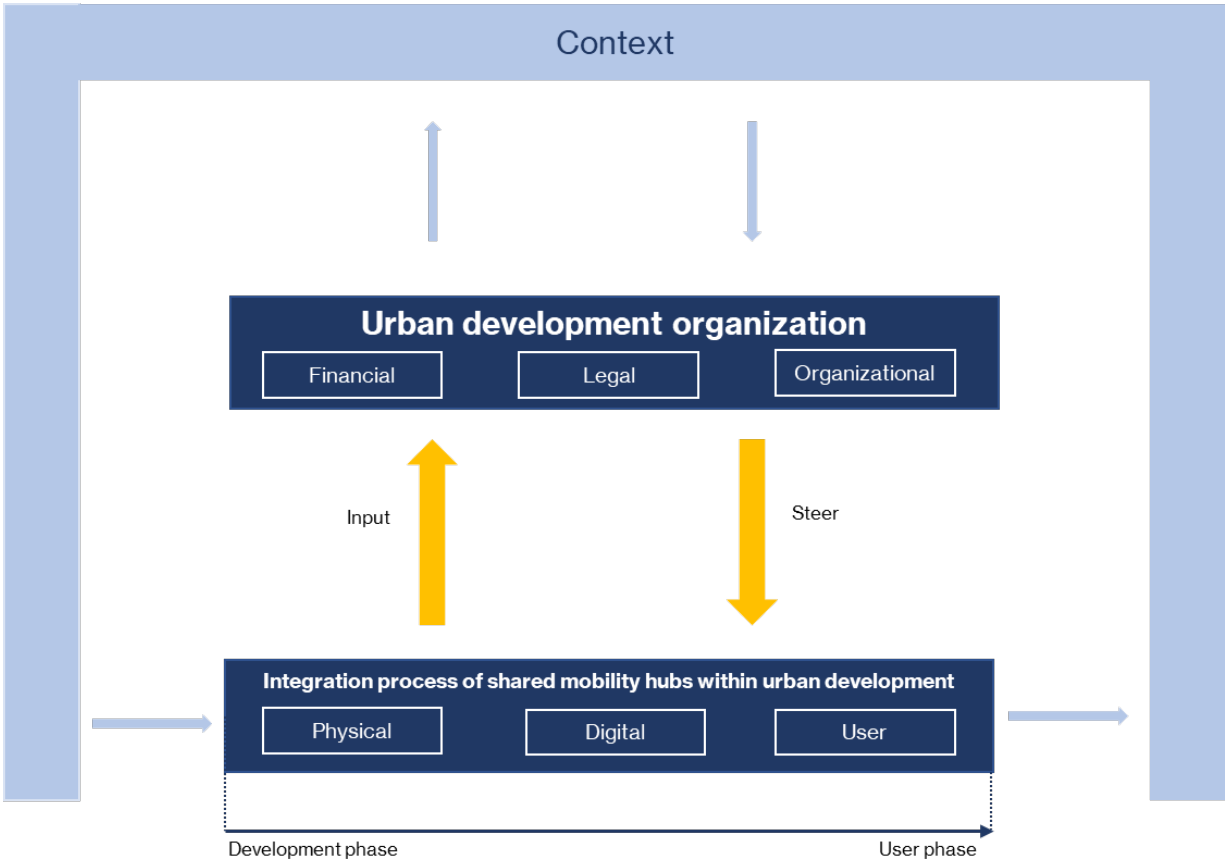


Figure 28: Mobility Hub Integration Model (cross-case analysis) (own work, based on Heurkens 2012 as adapted from De Leeuw (2002)).

In terms of the **Integration process of shared mobility hub s within urban development**, the general plans are firstly compared. Afterwards, the focus of the cross-case analysis mostly lies on the role division between the developer and municipality (**urban development organization**), how these parties manage the mobility hubs integration process within the plans, and for what reasons (**steer**). In this regard, both the development and user phase are analyzed since the adapted *Conceptual public-private urban management model* (Figure 29*)* views *operating* as part of the project. Thus, the *process management* aspects, *management tools*, and *management resources* apply to both the development and user-phase.

6.1 Plans

Table 26: Case study plan comparison

Plans			
Aspect	**Feyenoord City**	**Nieuwlandplein**	**Waterlandkwartier**
Located within G4 city	Yes	No	No
Number of dwellings to be added	3.700-4.000	400	10.000
Transformation	Yes	Yes	Yes
Densification	Yes	Yes	Yes

Table 27: Case study hub plans comparison

Hub plans			
Aspect	**Feyenoord City**	**Nieuwlandplein**	**Waterlandkwartier**
Mobility hub(s) considered a potential solution	Yes	Yes	Yes
Wijkhub(s) included in plans	Yes		Yes
Buurthub(s) included in plans	Yes		
Planned hub network	Yes		

All cases are transformations of an urban area and densification will take place. The size of the cases differs: while Nieuwlandplein is significantly smaller than the developments of Feyenoord City and Waterlandkwartier. The extent to which hubs are included in the plans differs.

6.2 Management Approach

6.2.1 Comparison

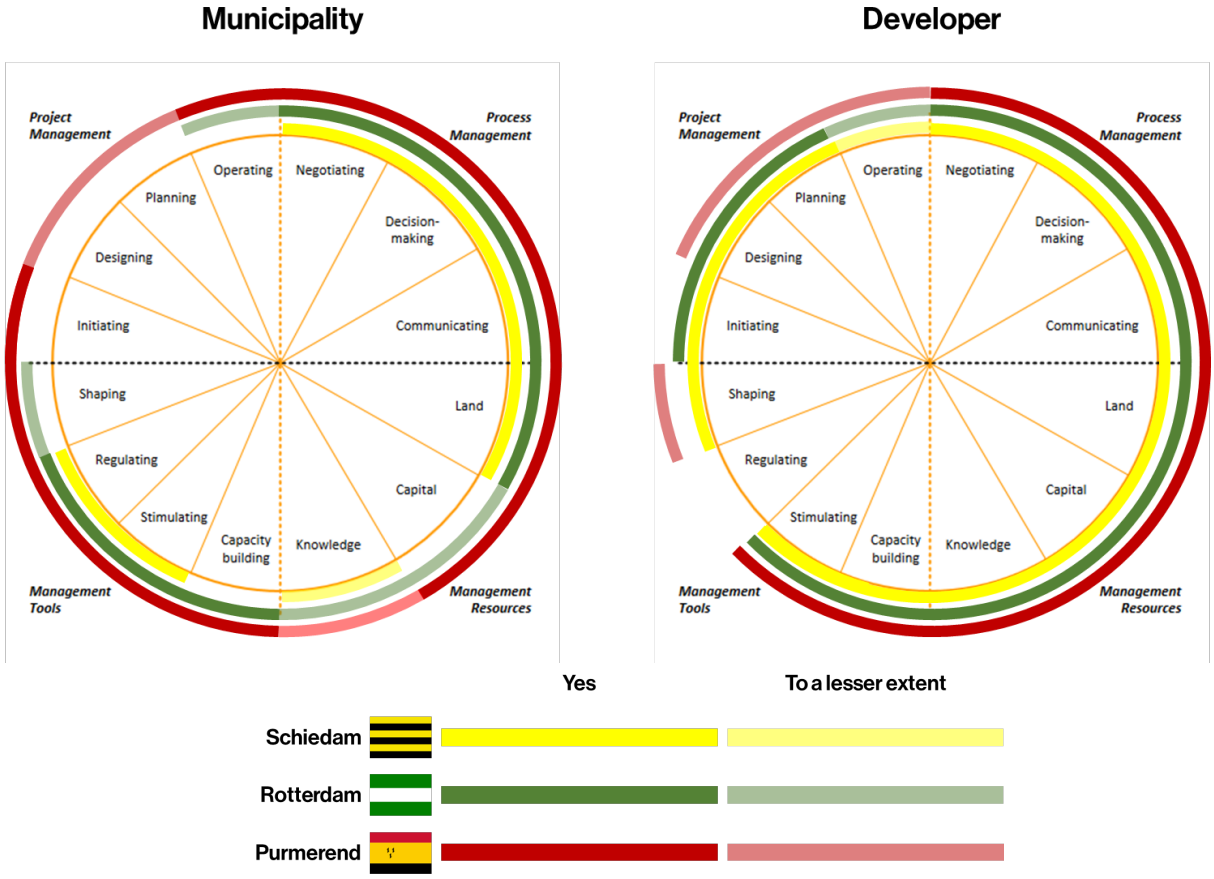


Figure 29: Management of hubs analyzed for the municipality and developer (adapted from Conceptual public-private urban management model (Heurkens, 2012))

Management Resources

Municipality: land is the most important management resource of the municipality. It can determine the development conditions through the zoning plan. With regard to hubs, the parking standard is an important instrument in all cases. It can be seen that the municipality of Purmerend wants to take initiative in the organization of hubs (risk and expense) and therefore capital is an additional management. For the municipality of Rotterdam, it is to be determined how the hub is to be exploited (*wijkhubs* and *buurthubs* have different exploitation models).

Developer: for the developer, both land and capital are important management resources. Furthermore, the developer possess knowledge about hubs and from experiences in other projects as well.

Management Tools

Municipality: the municipality of Rotterdam and Purmerend are proactive when it comes to capacity building with regard to hubs. They view hubs as a mobility solution within urban developments. The municipalities have a vision regarding the implementation of (types of) hubs. The municipality of Purmerend includes *wijkhubs* in the urban development vision, while Rotterdam has a hub typology framework that serves as a guideline for hub development. These municipalities hereby shape the hub product to a larger extent than the municipality of Schiedam, which, to a larger extent, is expecting the initiative from market parties. All municipalities stimulate shared mobility and regulate the mobility solutions using visions and zoning.

Developer: the developer has been working on capacity building regarding shared mobility and hubs (e.g. knowledge building and having shared mobility partners). Additionally, the developer can stimulate shared mobility by involving residents in shared mobility. This task is usually outsourced to the shared mobility provider. Stimulating shared mobility is in the interest of the developer since it allows for the projects to become (more) financially feasible and could help in creating a healthy living environment. When it comes to regulation, the role of the developer is more complex: while the municipality clearly is regulating mobility (regulating by law), one could say that the developer is also regulating by, for instance, not making a hub or shared cars accessible for people outside the development. However, accessibility of parking is mostly *regulated by law* (parking policy for residents and visitors) and when it comes to using shared modalities, this is about *regulation by contract* and these conditions can be set by the shared mobility provider or hub operator.

Project Management

Municipality: the municipality of Purmerend is the most proactive in taking the initiative for hubs. Where the developing parties of Feyenoord City reached out to the municipality with the idea for hubs, Purmerend already included it in the vision for the Waterlandkwartier. Hereby, Purmerend already designs and plans the hub to a larger extent. Also, the municipality is not excluding bearing (a part of) the exploitation risks and costs. For all cases, the exact exploitation model is to be determined. However, in Feyenoord City hubs inside the building are going to be for residents exclusively while the *wijkhubs* have a more public nature. The mobility guarantee for *buurthub* is organized with partners of the developer.

Developer: while the municipality initiates hubs in Purmerend, this is the developer's choice/responsibility for Feyenoord City and Nieuwlandplein. Determining the design and planning therefore is to a larger extent a task for the developer. However, the exploitation model is to be determined in collaboration with the municipality as well. The mobility guarantee is provided by (the shared mobility partner of) the developer.

Process Management

Negotiating, communicating and decision-making are included in the interaction between the developer and municipality. In all cases, there are challenges that need to be figured out. For instance, what target groups the hub should serve and who bears certain risks and expenses.

6.2.2 Analysis

The most notable difference between these case study is the amount of initiative that the municipality takes as opposed to the developer. This difference could potentially be explained by the following aspects:

Experience: mobility hubs are novel and a best-practice is yet to be created. Therefore, the amount of risk that municipalities want to take could be explained by the experiences with hubs. While Rotterdam already has had a variety of shared mobility projects (and pilots), this does to a lesser extent apply to Schiedam.

Politics: the political approach regarding mobility and parking could affect the amount of initiative that municipalities prefer to take. This is an interaction by, on the one hand, the desire to develop dwellings (make projects feasible) and on the other hand the political support for alternative mobility solutions. Also, groups that the municipality aims to target and the corresponding objective could affect its stance: since there is no proposition from market parties to provide shared mobility to social target groups, subsidies might be needed. On the other hand, if the goal is to reduce car ownership the municipality could aim for households with a car ownership of more than 1. Also, the *Woningbouwimpuls* might bring the municipality of Purmerend in a better financial position to take on certain risks.

Market: while Rotterdam is a G4 city, demand for housing is higher than in Schiedam or Purmerend. This could be one of the reasons why people to a lesser extent would mind a lower parking standard.

Existing infrastructure and public transport: the quality and proximity of public transport could affect the desire to focus on mobility hubs. Rotterdam and Schiedam have a high-quality public transport network. While the Waterlandkwartier is close to the train station, it is indicated that the bus network leaves to be desired. The mobility hub could potentially enhance the existing network.

Size of the development: a bigger sized development could provide a scale advantage, both in the sense of users (business case) as in the sense of creating an integrally embedded urban plan. When developing a higher number of dwellings, creating a public hub could also become more feasible than with a smaller development. On the total number of dwellings to be developer, the amount of capital expenditures for the hub could decrease per dwelling. Additionally, a larger development includes more potential users/customers of the hub.

07

Expert Panel

7. Expert Panel

7.1 Purpose and Approach

7.1.1 Objectives

The objective of the expert panel is to reflect on the results of the interview. Furthermore, the discussion is reflected upon and enriched. The conclusions and recommendations for practice are validated and enhanced. Two hub typologies are used to discuss challenges and opportunities in steering on two theoretical types of hubs. Additionally, specific challenges that have come out of the interviews are discussed (see Table 28).

Table 28: specific challenges discussed in the expert panel

Specific challenges
How to include adaptivity in the mobility hub?
In what way can incentives of all stakeholders be maximized?
How to deal with the target groups of shared mobility: should everybody be a target group, or only certain groups?

Table 29: Expert panel approach

Action	Description
Reflect	Reflect on the results and discussion
Validate	Validate the conclusion and recommendations for practice
Discuss	Discuss challenges and opportunities in steering on two types of hubs.
Explore	Explore specific challenges

7.1.2 Participants

Table 30: expert panel participants

	Professional's function	Organization	Description
(M)	**Consultant (external)**	Consultancy firm related to shared mobility	Consultant specialized in innovative mobility concepts.
(N)	**Developer**	Development Company	Developer with expertise in complex urban developments which include shared mobility.

7.1.3 Typologies

Findings show that the way of steering is dependent on the product that is steered upon. For this reason, this thesis provides two theoretical variants of the mobility hub that fall on the opposite sides of the spectrum. Since mobility hubs (*wijkhubs*) can come in all shapes and sizes, the idea underlying this choice is that other types of mobility hubs theoretically fall within this spectrum.

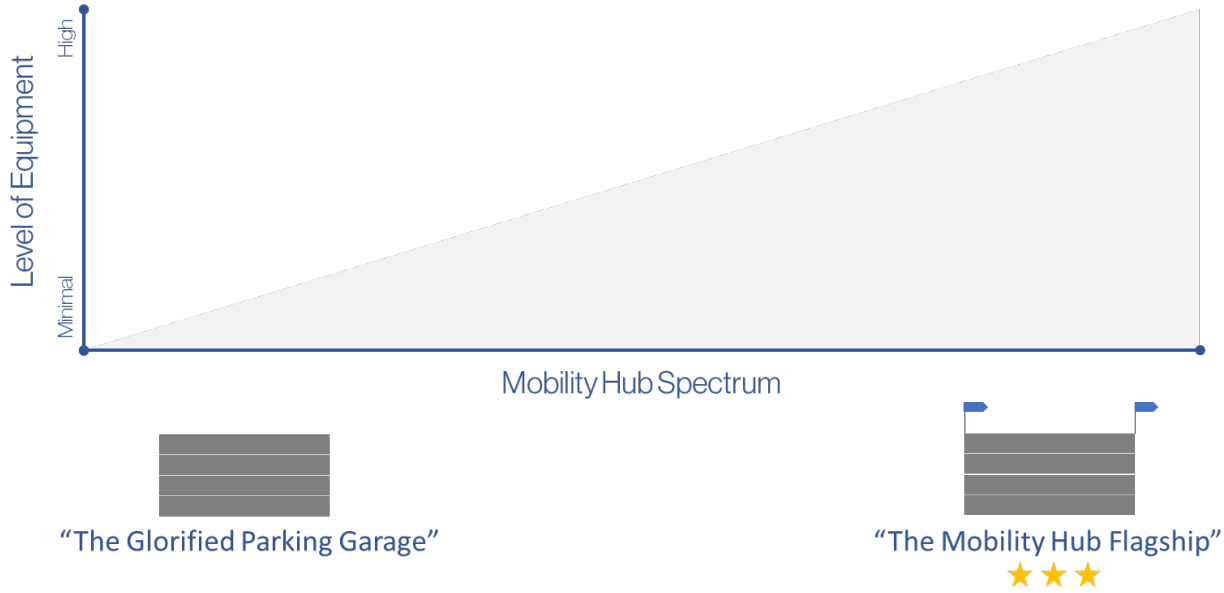


Figure 30: Mobility Hub Spectrum (own work)

"The Glorified Parking Garage"

This type has the minimal equipment needed to be called a mobility hub. This stand-alone building is located at the outskirts of an urban development and serves to centrally organize parking. Its looks do not particularly stand out. It has several stories, and the majority of the building consists of private parking spots. Additionally, a handful of station-based shared cars are offered. Some parking spots are equipped with charging poles. Entrance to the building is restricted to residents only. The building is not easily transformable. Functionality is the key word and residents do not come to the building for other reasons than to get a car.

"The Mobility Hub Flagship"

This type of mobility hub is state-of-the-art. It aims to push the envelope in several areas. It is the beating heart of the neighborhood. When it comes to shared mobility, the hub offers multiple shared modalities: shared e-scooters, shared bikes, and shared cars. These modalities are available for everybody. All modalities can be booked and unlocked using 1 application. This *wijkhub* is connected to several *buurthubs:* interoperability secures adequate supply. The hub's construction is modular and transformable: it is able to scale up and down over time. The hub is staffed: a mobility coach is the friendly face of the area. Besides mobility advise, this person aims to enhance the social cohesion in the neighborhood. As far as energy is concerned, the roof is covered with solar panels and locally generated energy is stored in a neighborhood battery. Additionally, bi-directional charging poles allow for BEVs to serve as batteries as well.

7.2 Discussion

7.2.1 Feedback

Expert M thinks that the results and insights from this research are recognizable, especially the challenges regarding the business case and the question which party is going to be the owner of the mobility hub. Expert N also agrees with the recommendations, but mentions that they could become more specific. Although both experts did not express disagreement about the discussion, conclusion or recommendations for practice, participant N stressed forward the following point that should be taken into account:

Broader social and historical context: the phenomenon mobility hub is an old concept that can be analyzed over a larger period of time in a broader social and historical context. Besides a technological phenomenon, it has a very important social element. The position, architectural appearance, and the way it is embedded in the city is valuable. It is important to view the hub in relation to the historical context: stations could start a new city back in the days. If done right, the hub can define the identity of the neighborhood (N).

7.2.2 In-depth Discussion

During the discussions about the outcomes of this research, several topics of interest came forward. The most important aspects are discussed below.

Hub typologies: expert M mentions that the *glorified parking garage* should not be a results of only wanting to lower the parking standards. Expert N views the *wijkhub* on a range between a *buurthub* and a train station. It should have public transport and it can boost the development. The *wijkhub* is the heart of the development and it should be able to transform (for example by having higher ceiling heights). According to expert N, the *wijkhub* should focus on high quality public transport, first and last mile solutions, shared cars, and facilities. However, parking spots for owned cars do not have priority. A hub that is like the *glorified parking garage* is something else: this basically entails a stacked *buurthub* and has less quality of stay. Expert N also mentions that is most adaptive to organize parking on green tiles at ground level.

Trade-off: Participant M mentions that it might be beneficial to get an overview of expenditures that do not need to be made as a results of not making parking spots, and see how this relates to the costs of creating a mobility hub.

Public-private role division: participant M thinks that the municipality/region could potentially take on a bigger role. The municipality could both stimulate sustainable mobility and guarantee mobility. The municipality could include more detailed requirements/ criteria/constraints in tenders, so that mobility better connects to the target groups. To do this, the municipality should also have more insights in how target groups use shared mobility Additionally, it is important that the municipality keeps certain steering instruments, and having privately exploited garages could decreases the municipality's influence to steer on mobility. Participant M sees the National Hub Standard by the Ministry of Infrastructure and Water Management as a good incentive: if municipalities use this standard, they receive subsidies for the mobility hub.

Participant N mentions that public transport station are fully paid by the government. Therefore, if a *wijkhub* has a societal value it will always be a collaboration between private and public parties. In addition, sharing knowledge is important for both public and private parties in this high complexity topic: in this way parties can better solve the puzzle.

Mobility guarantee: participant M holds the opinion that 10 years is a fairly long time for a mobility guarantee. Looking at how quickly shared mobility is developing, this expert puts forward the idea of phased mobility guarantees: in this way evaluation moments could take places and it can be examined if/how new developments (e.g. vehicle-to-grid) can be implemented.

Modalities: participant M that the focus within urban development is mostly on (shared) cars as compared to shared bikes and scooters. On the one hand, this seems logical as cars take up more space and parking spots are expensive, but when looking at the implementation of both *wijkhubs* and *buurthubs,* both should be examined.

Interoperability and MaaS: expert M does not view MaaS as a prerequisite for hubs, but thinks interoperability could help in guaranteeing mobility for the residents.

Autonomous mobility: expert M mentions that hubs could still play a role if mobility becomes autonomous. Distribution locations are probably still necessary and with regard to the smart-to-grid concept, electric autonomous vehicles could still play a role. However, the lay-out of garages could potentially be adjusted: less space is necessary as autonomous cars can do with a smaller footprint. In addition, autonomous vehicles could play a role in facilitating mobility for peak demands, for example when there are events with many people.

7.3 Expert Panel Conclusion

As described in the previous section, the expert panel interviews have brought forward new approaches to the topics. Table 31 presents how to input is processed to enhance the research. Since it was mentioned that the *Recommendations for practice* could become more specific, this feedback has been processed. When it comes to the additional findings from the expert panel, generalizability leaves to be desired. Therefore, these findings are used to enrich the discussion and recommendations for practice they add to a more nuanced or different way of approaching certain topics.

Table 31: expert panel input and adjustments

Input	Adjustment
Recommendations for practice could become more specific.	Examples for the particular hub typology are added to the recommendations for practice.
Additional findings from in-depth discussion	Newly gained insights on sub-topics are used to enrich the discussion and recommendations for future research.

08
Discussion

8. Discussion

8.1 Contribution of the Research

This research's problem statement includes three main problems related to mobility hubs:

- **Unclear roles**
- **Uncertainty related to shared mobility and mobility hubs**
- **Knowledge gap about shared mobility and mobility hubs within urban developments**

When it comes to (the organization of) mobility hubs within urban development, the results section includes both conceptual/theoretical and more practical findings. Within this context, insights are provided on the role of stakeholders and why there is uncertainty in the integration process of hubs. Findings show the multifaceted nature of the hub, in what way various disciplines are interconnected, and the potential challenges and opportunities stakeholders come across. Since the topic is continuously developing and due to the lack of precedents, there are no best-practices to reflect upon. However, this research provides insights and draws lessons from the situation as-is. Uncertainties and tensions are examined, and challenges and opportunities are identified. Taking into account the perspectives of different roles, insights can be used to align inter-organizational arrangements and, in the end, better steer on the integration of mobility hubs. In a sense, this research builds a bridge from theory to practice.

The questions for the semi-structured interviews are based on insights gained during the review of previous studies. Therefore, the results can be seen as a more in-depth practical elaboration on these topics. Broadly speaking, the identified gap between ambitious visions and implementation stood out. On different themes, challenges are identified which affect the implementation of visions. For instance, the challenges and dynamics related Mobility as a Service (MaaS). While certain visions mention one application to view and book hub-related services, such a system is not to be expected in the near future. Another example are the target groups of shared mobility: while certain visions regard all people as the target group of shared mobility, this objective seems challenging given current the shared mobility market circumstances: from a business perspective it is hard to lower the rates of shared mobility, which some people think are high.

In relation to the studied body of research, the user-perspective turns out to be vitally important for the integration of mobility hubs. It does, however, seem to be quite underexposed many reports.

8.2 Limitations

This study has potential limitations. Below, several of these limitations are identified and elaborated upon. In doing this, the trustworthiness criteria as presented in *Table 16: criteria for ensuring trustworthiness in qualitative research projects (based on Shenton, 2004)* serve as a guideline.

• **Amount and roles of interviewees:** although there is no set rule on the number of participants needed for a strong body of evidence, one of the limitations of this qualitative research could be the amount of interviewees. Due to examining three case studies, the number of interviewed participants with a certain role is limited. For instance, only one housing association could be interviewed and only two participants active in providing shared mobility have been interviewed. It could be possible that shared mobility providers with slightly different roles (e.g. providing shared scooters or bikes) would have generated different results. An increased number of perspectives and interviewees in different roles could have enhanced the *credibility (i.*e. *the congruency of findings with reality* (Shenton, 2004)).

• **Users:** findings showed that the user-perspective of shared mobility is of paramount importance. Due to the management approach, interviewing users fell beyond this research's scope. A more elaborate approach that also includes the user's perspective would enhance the credibility of the research.

• **Dutch context:** the three analyzed developments all take place in the Netherlands. Although their contexts differ between each other, the Dutch context is their common denominator. Findings therefore might not fully apply to other (international) contexts. This could potentially affect the *transferability* of findings (*the extent to which the findings can be applied to other situations (Merriam, as cited by Shenton, 2014))*. Examples of contextual differences affecting the transferability are a country's market dynamics, the division of public and private responsibility, and the design of the built environment and infrastructure. Nonetheless, certain findings are less context-dependent and therefore expected to be more transferable. Examples are the ways of designing and operating hubs, the importance of user-aspects, and the different organizational forms of hubs.

• **Broad and interdisciplinary scope:** findings show that mobility hubs are a multifaceted topic: subjects in a wide variety of realms have passed the revue. As a result, the scope was broad and interdisciplinary. Although some topics were dived deeper into, some other topics were not comprehensively examined or were not the participant's main expertise.

• **Cross-sectionality:** the topic at hand is very actual and continuously developing. Interview were only conducted during within a narrow timeframe. Although this research is not a snapshot – the interviews also had a retrospective and prospective nature – it should be noted that the examined case studies have not yet been completed at this moment in time. Therefore, it is hard to examine in what way certain choices, decisions, and uncertainties have turned out over time.

09
Conclusion

9. Conclusion

9.1 Conclusion

This research examines how developers can steer on the integration of shared mobility hubs within urban developments. Firstly, the review of previous studies has provided theoretical background on the topics at hand. Secondly, three cases studies are examined with the purpose of gaining first-hand insights and experiences from practice. Both the literature and empirical studies are used to answer the main research question:

Main Question	**How can developers steer on the integration of shared mobility hubs within urban developments?**

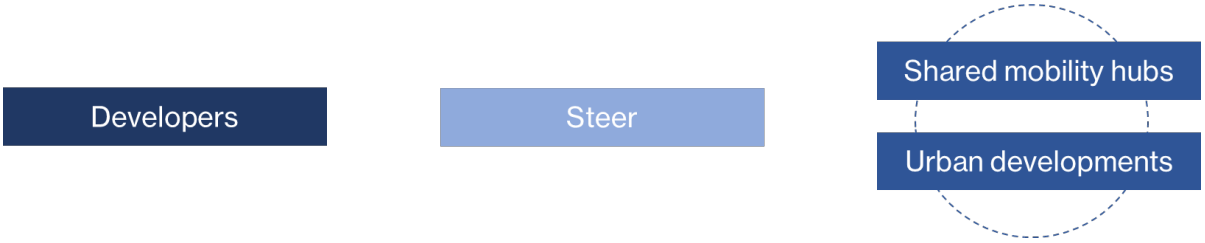
All in all, it can be concluded that the way developers steer on mobility hubs is dependent on the following aspects:

- **The needs of the urban development organization and the needs of users**
- **The purpose that the mobility hub should serve**
- **The eventual type of mobility hub (product)**

Thus, steering on the integration of shared mobility hubs (management approach) is heavily dependent on the context and constraints of the urban development. Therefore, two different hub typologies are discussed in the expert panel so that different contexts are taken into account. In the following section (*recommendations for practice*) detailed conclusions are provided on how developers can steer on mobility hubs.

9.2 Recommendations for Practice

This research examined how developers can steer on the integration of shared mobility hubs within urban development. Thus, recommendations are provided for urban developers in particular. The focus will be on the initiative phase since the end result can mostly be steered upon during this phase. However, the later phases are also taken into account.



The way the recommendations are structured are as follows:

1. **Determining needs and objectives for the urban development**
   Within the urban development, what are the user's needs and what are the needs of the Urban Development Organization?
2. **Determining the Product**
   If a mobility hub seems like a possible solution, what should it do?
3. **Steering on the integration process**
   How can developers (within the urban development organization) steer on integration process of shared mobility hubs within the urban development?

In a certain sense, the above structure can be viewed as sequential. However, it could rather be regarded as building blocks: all urban development projects are subject to change over time. Therefore, previous choices should be monitored throughout the process: if needs and objectives have changed, the purpose and the eventual mobility hub could change as well. For this reason, it should always be checked if new choices are aligned with previous conditions.

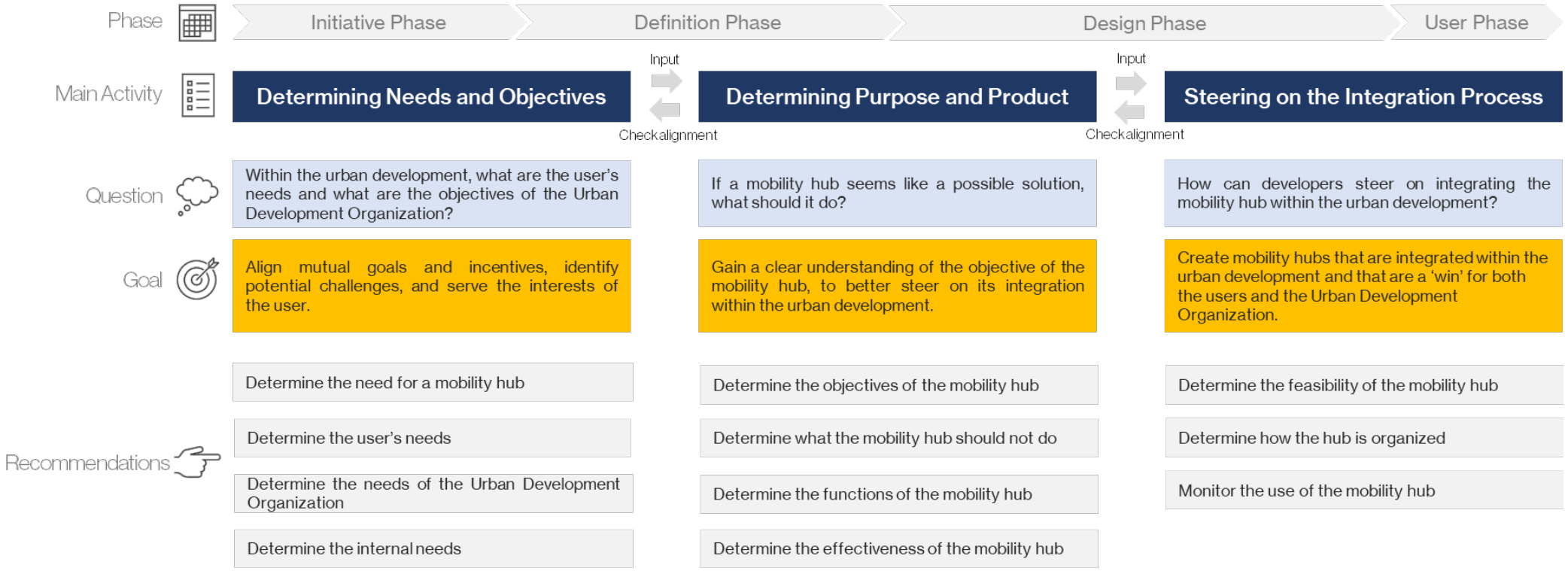


Figure 31: recommendations for practice (own work)

☞ Determining Needs and Objectives

Within the urban development, what are the user's needs and what are the objectives of the Urban Development Organization?

Goal	Align mutual goals and incentives, identify potential challenges, and serve the interests of the user.

☞ *Determine the user's needs*

Determining the user's need for mobility: in the end, urban developments are made for the end-user. Therefore, in the first place, the developer should determine what the need for mobility in an urban development is, and what it will be in a certain area. This involves current and future residents of the area. To gain a better understanding, the needs from outside the development area should also be assessed. The mobility patterns and ought to be assessed from both a quantitative and qualitative perspective in order to get the full picture. Understanding should be gained on the underlying reasons for certain behavior (e.g. financial or cultural). While it is hard to already involve future residents in this stage of the project, (general) characteristics of the target groups can be studied. Taking the user's needs into account in this stage, prevents mobility from being an afterthought.

→ Assess current mobility patterns
→ Assess current mobility needs
→ Assess future mobility needs

} → Determine the user's mobility needs

Determine the user's need for other functions: besides mobility, it should also be assessed if there is a need for other functions in the neighborhood. Having a proper understanding of these needs allows for integrally taking into account mobility and other functions.

☞ *Determine the internal needs*

At the very beginning of the initiative phase, determine what the development company wants to get out of the project. This objective is often interrelated to the overarching (municipal) visions for the area. The following aspects play a big role in this:

- Number of square meters per function
- Housing segments and target groups
- Desired mobility solutions (including the amount of parking)

→ Detect potential opportunities and challenges related to these objectives

☞ *Determine the needs of the Urban Development Organization*

In order to align the developer's needs with the needs of the Urban Development Organization, it needs to become clear what the objectives of other (potential) stakeholders of the urban development organization are with regard to mobility solutions. At this early stage, the developer, municipality, and social housing corporation are important voices to take into account.

→ Identify common ground
→ Identify misaligned objectives

Secure the aligned objectives with the area's mobility vision. Have an open conversation about the reasons that certain objectives are misaligned, determine how it will affect the plans and, if necessary, try to find ways to overcome these barriers.

→ Secure aligned objectives in a mobility vision
→ Assess the impact of misaligned objectives on the development plans

☞ *Determine the need for a mobility hub*

In the end, it should be determined whether a mobility hub fits within the mobility vision and has potential to serve the interests of the users as well as the Urban Development Organization. If this is the case, a deeper understanding ought to be gained on the mobility hub as a product and its purpose.

→ Determine if a mobility hub potentially fits within the development's mobility vision

Typologies

Purpose: it should be determined if parking is to be organized at a distance in a parking garage, or if a buzzing *wijkhub* is to be created to propel the urban development. While both typologies fall under the typology hub, their social effect, value and organizational approach is different.

Size: The typology is also heavily dependent on the size and the area that the hub serves. Naturally, a bigger wijkhub would also include more functions and would have more *equipment*. A bespoke design has to be created based on both its purpose and size.

☞ Determining the Purpose and Product

If a mobility hub seems like a possible solution, what should it do?

Goal	Gain a clear understanding of the objective of the mobility hub, to better steer on its integration within the urban development.

Mobility Hub Concept

☞ *Determine the objectives of the mobility hub*

Determine the objectives of the mobility hub, both for the Urban Development Organization as well as for the users. These objectives usually have to do with mobility, energy, social, or financial aspects. For each of these objectives, determine if it serves (certain stakeholders of) the Urban Development Organization and/or the user. Examples could be:

- Preventing congestion
- Stimulating active mobility
- Lowering the parking standard
- Lowering the number of cars on the street
- Creating more quality in the public space
- Creating and/or storing energy
- Propelling sustainable transport
- Social objectives (e.g. meeting places)
- Mixed-use program
- Day-long liveliness
- Enhancing logistic flows in the area
- Commercial / non-commercial use
- Decreasing transport poverty
- Set a behavioral change in motion
- Being accessible for all or certain target groups

☞ *Determine what the mobility hub should not do*

Also, determine what the hub should definitely not do. Examples could be:

- Forcing users to use shared mobility
- Increasing transport poverty
- Competing with existing services in the (surrounding) area
- Decreasing liveliness

☞ *Determine the functions of the mobility hub*

Having identified the objectives, the functions of the mobility hub should be determined.

Shared mobility related functions

- Offering shared modalities
  - Shared bikes
  - Shared cars
  - Shared e-scooters
  - Shared cargo bikes
  - (Moving) vans
- Station-based / free-floating
  - Geo-fenced areas
- Offering digital solutions
  - Multiple applications
  - 1 MaaS application
- Functioning within a shared mobility network
- Connection to public transport network

Other mobility related functions:

- Parking spots
- (Bi-directional) charging poles
- Bike storage
- Logistical consolidation point

Other functions:

- Parcel collection point
- Office / workplaces
- Cafeteria
- Retail
- Meeting places
- Community space
- Service shop
- Solar panels
- Energy storage (battery)

☞ *Determine the effectiveness of the mobility hub*

• **Determine what other measures are a prerequisite for the hub's success:** once determined what the purpose of a mobility hub should be, developers can look at what other measures can strengthen the desired effect. For example: if it is desirable to stimulate active mobility developers could look at enhanced bike infrastructure, safer public space, safe and accessible bike storage (STOMP-principle). Furthermore, it should be determined if flanking policy is needed from the municipality (such as adjusted parking policies in surrounding areas to prevent a waterbed effect). With regard to flanking policy, it should be determined if there is sufficient political support so that the needed policy is implemented to the needed extent and at the right time.

• **Effects on users:** the implementation of mobility hubs affects the organization of mobility in an area. Therefore, it is important to examine what groups will be affected positively or negatively by a certain mobility concept in an area and in what way the freedom of mobility is affected. Examples of this are if people want or can adjust their behavior in the desired way. Also, shared mobility in combination with lower parking standards could potentially create mobility poverty for people that cannot afford shared mobility if they cannot park an own car which they need. On the other hand, a well-functioning mobility hub could become a flywheel for increased popularity of shared mobility and therefore boost the concept.

• **Steering on behavioral change:** the use of shared mobility requires behavioral change. Therefore, the behavioral aspects of shared mobility should carefully be considered. Ways of facilitating or enhancing this behavioral change can be considered. On the one hand, participation trajectories can gain input about the resident's preferences. On the other hand, residents could be introduced to shared mobility early-on and be coached in order to steer on the functioning of the mobility concept.

• **Effects on area:** while the hub could be an efficient way of organizing a programmatic setup, its effects on the (surrounding) area should be considered. For example, if a hub contains a parcel collection point it might compete with existing shops in the area. To have a positive impact on the area, a possible solution could be to facilitate local initiatives to start/continue businesses in the hub.

• **Mobility Program of Requirements:** a mobility program of requirements can serve to translate visions into concrete implementations in the area. It is therefore advised to have a mobility program of requirements, so that all stakeholders become aware of the direction that the mobility concept is heading. In this way, an overview can be gained on what the mobility concept encompasses and how these requirements can best be realized.

☞ Steering on the Integration Process

How can developers steer on integrating the mobility hub within the urban development?

Goal	Create mobility hubs that are integrated within the urban development and that are a 'win' for both the users and the Urban Development Organization.

☞ *Determine the feasibility of the mobility hub*

• **Incentivize stakeholders to enhance the hub's business model:** when all stakeholders benefit from participating in the hub, its chance of success increases. Therefore, developers should think about which party is best at carrying out which task, and how incentivization can be maximized in both the short and long term. Discuss opportunities and doubts and needed partners, in order to create a hub that is commercially viable. Depending on the municipality's stance, the following topics are to be considered:

- ➔ How long, and at which stakeholder's expense will the mobility guarantee be?
- ➔ What business climate do the mobility providers prefer? (e.g. with regard to competition)

• **Determine the approach to the hub's feasibility** when assessing the hub's business model, its effects could also be considered in a broad sense: the business case might not be viable from a financial perspective, but in a broader sense the social cost benefit analysis, on the area's scale, could be positive. Feasibility is also about what is technically possible: while some mobility concept might be desirable (e.g. only having 1 application) its technical feasibility should be taken into account and a realistic approach ought to be implemented. It should be agreed upon what the role of the municipality is: if the hub has a social function which is not financially feasible, it might be necessary to fund with public money.

• **Identify known-unknowns:** the mobility hub concept is novel and therefore not all ins and outs are crystallized. During the process, it should be determined what aspects are still uncertain. In this way, stakeholders can anticipate on their potential impact.

☞ *Determine how the hub is organized*

• **Determine the organizational form:** the organization form of hub is largely dependent on the stance of various stakeholders and the actual product that is organized. While a homeowner's association might be the right scale to organize a smaller hub inside an apartment building, the organization gets more complex when a hub is a stand-alone unit (i.e. *wijkhub*). Therefore, it is recommended that the hub be steered by a body at area scale. Within the overarching organization, the division of roles and the amount of expense and risk for each stakeholders should be determined. The organization and exploitation of the particular hub depends on the following aspects:

- Landownership
- Investment & construction
- Exploitation

• **Take adaptivity of the concept into account:** A mobility guarantee can serve to provide certainty in the upcoming years. Adaptivity can serve to anticipate change and uncertainties. However, the hub should not only be physically adaptable. In order to adapt to future needs, it is also important to have adaptivity in the organization of the hub's concept. If the area's mobility concept is organized at area scale and after completion the ownership is handed over to HOA, this could potentially hamper adaptivity at the area's scale later on: collaboration between HOAs would then be a prerequisite. To have an adaptable and integral mobility concept for the entire neighborhood, it is therefore advised to keep control at a larger scale. This can be achieved by holding on to land positions and/or having a larger body responsible for the provision of the mobility (hub) concept.

☞ *Monitor the use of the mobility hub*

In order to learn lessons from realized mobility hubs, it is paramount to monitor its use. This would include quantitative data about the way it is used (e.g. occupation rates) and also qualitative data: how do users experience the hub, what aspects are they satisfied with and what other aspect would they preferably have adjusted? Additionally, with regard to scalability, monitoring is of importance as well. Choices about the transformation of the hub are important in this regard (e.g. to scale up or down, or add other functions). Lastly, having data about the hub's use at one's disposal could aide parties in making hubs more successful. For instance, stakeholders could use positive data to publicly promote its success, and hereby create additional support. Also, user data can help to better anticipate the hub's business case and make it more predictable.

9.3 Recommendations for Future Research

There are a number of gaps in the knowledge on mobility hubs that follow from this research's findings. Mobility hubs are a multifaceted topic. Therefore, further research could zero on in several realms of interest:

• **User aspect:** the user aspect of mobility hubs turned out to be understudied. As findings show that is a major topic of interest, more work is needed on how to robustly assess the preferences of different target groups. Additionally, it would be helpful to know how these insights can be connected to the mobility hub.

• **Societal role:** if the mobility hub is viewed as an object with particular (societal) objectives, it is interesting to do research on the role of privates and public parties. Especially the underlying values that affect amount of governmental interference on the mobility hub. Since the hub is a location where supply meets demand, this could include an analysis on the pros and cons of the mobility hub market regulation. Particularly, this is interesting with regard to an affordable shared mobility business proposition for social target groups.

• **Lack of precedents:** currently, there is a lack of realized mobility hubs that are up and running. As this research is cross-sectional, the cases are only analyzed at one moment in time. Later on, it would be helpful to analyze how these three cases have evolved over time and then compare it with the results and findings of the current research. In hindsight, it could additionally include an analysis on the following: what choices were made during the development and for what reasons? How were the mobility solutions implemented and how does it function?

• **International context:** the case studies examined within this thesis are set within the Dutch context. Shared mobility is evolving all over the globe and therefore, an international cross-case analysis would be helpful to gain insights on best-practices.

• **Autonomous mobility:** within this research, autonomous mobility is not taken into account. However, since autonomous driving techniques are developing at a rapid pace, its impact on the mobility hub concept could be interesting to study. Especially with regard to the need for parking and the reshuffling of free-floating modalities. It could be examined whether hubs could have a vehicle distribution or energy function if self-driving cars become a reality.

• **Asset:** results indicate that views differ on what a mobility hub actually entails. Therefore, it is hard to pin down what 'product' is in fact analyzed. With regard to the capital and operational expenditures, it would be beneficial to carry out further research on how to quantitatively assess business models. This would allow to run calculations on the mobility hub as an asset.

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11. Appendices

Appendix I:
Reflection

Appendix II:
Informed Consent Form

Appendix III:
Research Introduction Letter for Interviewees

Appendix IV:
Interview Protocol

Appendix I:
Reflection

In this reflection I look back on the research process. I will reflect on the final product and the process of getting there. It will be structured in a chronological order, reflecting at each phase in hindsight.

I experienced the first phase of the research as a non-linear process. Despite having thought about my research topic for a fair amount of time before starting the semester, it was still challenging to really pin down the topic. The challenging part of this phase was to perform the balancing act to make progress on all aspects of the research. For example: studying the theoretical background while not having decided on the final subject, and processing information and needs from the internship company while also taking into account my mentors' feedback and input.

In my opinion, having two mentors is valuable as two approaches helped in breaking free from fixed thoughts and to realizing that sometimes multiple approaches are possible. This was helpful in the early states of the research, because at that time there is still a lot of room for the topic to adjust. During feedback meetings, my mentors oftentimes asked for the 'why' behind certain choices. This forced me to deeply think about my choices and underpinnings at times when I had not done this.

I found it challenging to plan all interviews within the schedule I had created for my P2 report. While some interviews were planned sooner than expected, others were more challenging to schedule. Despite the large amount of work needed to process the interviews, I am glad that I have finished all interviews in time. The semi-structured interviews were really fitting to the topic, as it was valuable to follow the participant's line of thought and sometimes ask some deeper questions about parts of it. In this way, I gained insights about the 'why' of certain answers.

While implementing the results of the interviews, I was receiving and processing large amounts of detailed information. As a result, I found it challenging to keep the big picture in mind and think out of the box. However, I experienced that building the presentation slides helped me in zooming out: presentations need to be to the point and this forced me to only include the most important aspects of the research. Additionally, having conversations with fellow students reflecting on my work, also helped in gaining new perspectives.

All in all, I have greatly enjoyed working on my master's thesis. I have learned a great deal on this topic and, in my opinion, gained valuable insights into the dynamics that play a role within the field of shared mobility. I am content with the set of evidence, although there is always room for a stronger argumentation including a broader set of perspectives from participants and more theoretical background. The topic is developing rapidly and it was interesting to work on a topic that is so actual and touches upon both the urban densification as well as the mobility challenges that our society is facing. I believe that this research indicate how multifaceted the topic is and I hope it can add to debating the difference values involved.

Although my topic (shared mobility hubs) in this thesis is approached through the lens of *management in the built environment*, I believe that it very much relates to architecture as well. Therefore, it fits within the MSc AUBS. I would be very interesting if the topic can also be approached through a more architectural scope. When it comes to the transferability of this research, I feel that it to a large extent is replicable as the methodology is explained in a comprehensive and clear manner.

• Additional question 1: *If you had to go through the entire process once again, what advise would you give yourself?* → In this case I would advise not to underestimate planning and processing the interviews. This took up more time than I had expected. Since the outcomes of the research depend on the interviews, they are vitally important and therefore I would advise to reach out to the participants sooner.

• Additional question 2: *If you had an extra semester to elaborate on the current research, what would you add?* → If I had one more semester to elaborate on the current research, I would dive deeper into the value discussion that is related to mobility hubs. Since the discussion about mobility hubs is about people's way of life, I feel like it would be really valuable to focus more on the social aspects. This would not only include the user's perspective, but also a more political and socio-economical approach.

Appendix II:
Informed Consent Form

Betreft: geïnformeerde toestemming onderzoek

Datum: …….. - ……. - ……..

Geachte heer/mevrouw,

U wordt uitgenodigd om deel te nemen aan een interview voor een afstudeeronderzoek genaamd:

> *Shared Mobility Hubs in Urban Developments - A qualitative research on how developers can steer on the integration of shared mobility hubs within urban development*.

Dit onderzoek is een afstudeeronderzoek dat wordt uitgevoerd door Rik van den Bogaerdt, student aan de opleiding *MSc Management in the Built Environment* aan de TU Delft. Het bedrijf waar de afstudeerstage plaatsvindt is Heijmans N.V.

Doel onderzoek: Het doel is om te onderzoeken op welke manier ontwikkelaars kunnen sturen op de integratie van deelmobiliteitshubs binnen gebiedsontwikkelingen. Naast het onderzoeken van de theoretische achtergrond, worden interviews gehouden met actoren die betrokken zijn bij dit onderwerp.

Interview: U wordt gevraagd om deel te nemen aan een interview voor dit onderzoek. De data uit het interview zullen gebruikt worden voor wetenschappelijke doeleinden (het afstudeeronderzoek en afstudeerproces). Het interview zal ongeveer 60 minuten in beslag nemen. Graag zou ik de audio van dit interview willen opnemen om achteraf uit te werken en te analyseren. In dit interview zullen de volgende onderwerpen aan bod zullen komen:

- Uw benadering van het begrip mobiliteitshub, in relatie tot gebiedsontwikkeling.
- Uw ervaringen op het gebied van samenwerken aan en sturen op mobiliteitshubs (binnen het project [projectnaam])
- Uw perspectief op kansen en barrières in het organisatieproces van mobiliteitshubs, zowel in de ontwerpfase als de exploitatiefase.

Vertrouwelijkheid en data: Uw data worden vertrouwelijk behandeld. De data worden geanonimiseerd en alleen voor de wetenschappelijke doeleinden van dit onderzoek gebruikt. Het uiteindelijke onderzoek wordt gepubliceerd op de TU Delft Repository en zal publiek toegankelijk zijn. Interview-transcripten zijn alleen inzichtelijk voor de begeleiders van het afstudeeronderzoek en zijn niet inzichtelijk buiten de TU Delft. De naam van de gebiedsontwikkeling wordt genoemd in het onderzoek, evenals uw functie en een korte omschrijving van uw bedrijf (uw naam en de naam van uw bedrijf wordt niet genoemd).

Terugkoppeling: Na het interview wordt ter validatie een samenvatting van de resultaten van het interview aan u teruggekoppeld. De samenvatting van de bevindingen vanuit de interviews wordt verwerkt in het te publiceren onderzoek.

Deelname: Uw deelname aan dit onderzoek is volledig vrijwillig, en u kunt zich elk moment terugtrekken zonder reden op te geven. U bent vrij om vragen niet te beantwoorden.

Bij vragen en/of klachten kunt u met mij contact opnemen.

Met vriendelijke groet,
Rik van den Bogaerdt

In te vullen door de geïnterviewde & onderzoeker

- Ik verklaar op een voor mij duidelijke wijze te zijn ingelicht over de aard, methode, doel en belasting van het onderzoek.

- Mijn vragen zijn naar tevredenheid beantwoord.

- Ik begrijp dat het geluids- en/of beeldmateriaal (of de bewerking daarvan) en de overige verzamelde gegevens uitsluitend voor analyse en wetenschappelijke presentatie en publicaties zal worden gebruikt.

- Ik behoud me daarbij het recht voor om op elk moment zonder opgaaf van redenen mijn deelname aan dit onderzoek te beëindigen.

Ik heb dit formulier gelezen en ik stem in met deelname aan het onderzoek.

□ **Graag ontvang ik aan het eind van het onderzoek de gepubliceerde thesis.**

Plaats: _____

Datum: _____

_____
(volledige naam, in blokletters)

_____

(Handtekening deelnemer)

“Ik heb toelichting gegeven op het onderzoek. Ik verklaar mij bereid nog opkomende vragen over het onderzoek naar vermogen te beantwoorden.”

Rik van den Bogaerdt

_____

Contactgegevens onderzoeker:

Naam: Rik van den Bogaerdt
Telefoon: *[telefoonnummer]*
E-mailadres: r.vandenbogaerdt@student.tudelft.nl

Begeleiders afstudeerscriptie:

Eerste begeleider

Naam: E.W.T.M. (Erwin) Heurkens
E-mailadres: E.W.T.M.Heurkens@tudelft.nl

Tweede begeleider:

Naam: P.W. (Paul) Chan
E-mailadres: P.W.C.Chan@tudelft.nl

Begeleider afstudeerbedrijf

Naam: Marco Bosch
E-mailadres: mbosch1@heijmans.nl

Appendix III:
Research Introduction Letter for Interviewees

Delft, [Datum]

Betreft: **afstudeeronderzoek mobiliteitshubs**

Geachte heer/mevrouw,

Voor mijn afstudeeronderzoek aan de opleiding *MSc Management in the Built Environment* (TU Delft), ben ik geïnteresseerd in de volgende vraag:

> ***Wat zijn de ervaringen van actoren in het samenwerken aan en sturen op de integratie van deelmobiliteitshubs binnen gebiedsontwikkelingen?***

Graag zou ik u willen interviewen om te leren van uw perspectief en ervaringen. In dit interview wil ik de volgende onderwerpen aan bod laten komen:

- Uw benadering van het begrip mobiliteitshub, in relatie tot gebiedsontwikkeling.
- Uw ervaringen op het gebied van samenwerken aan en sturen op mobiliteitshubs binnen het project [projectnaam]
- Uw perspectief op kansen en barrières in het organisatieproces van mobiliteitshubs, zowel in de ontwerpfase als de exploitatiefase.

Dit onderzoek voer ik uit met Heijmans Vastgoed als afstudeerbedrijf. Data uit de interviews wordt vertrouwelijk en anoniem behandeld. Bijgevoegd is het *Formulier geïnformeerde toestemming* waarin de interviewprocedure en de behandeling van data staat toegelicht.

Als u vragen heeft over dit onderzoek, kunt u contact met mij opnemen.

Met vriendelijke groet,

Rik van den Bogaerdt
r.vandenbogaerdt@student.tudelft.nl
[telefoonnummer]

Universiteit: Technische Universiteit Delft
Faculteit Bouwkunde, master track Management in the Built Environment
Julianalaan 134, 2628 BL Delft
Begeleider afstudeeronderzoek: Erwin Heurkens (E.W.T.M.Heurkens@tudelft.nl)

Bedrijf afstudeerstage: Heijmans N.V.
Contactpersoon afstudeerstage: Hans Broekman (hbroekman@heijmans.nl)

Appendix IV:
Interview Protocol

Interviewprotocol

Voor interview

□ Uitnodiging interview verzonden
□ Formulier geïnformeerde toestemming getekend (eventueel achteraf)
□ Uitnodiging verzonden (tijd & locatie; indien digitaal link)

Start interview

□ Dank participatie uiten
□ Controle geïnformeerde toestemming
□ Wijzen op opnemen interview en opnieuw toestemming vragen ter controle
□ Aanzetten opname-apparaat + backup device / opname binnen online videoconferentie starten
□ Korte introductie onderzoeker & onderzoek

Checklist afsluiting

□ Vragen of de geïnterviewde nog iets kwijt wil of vragen heeft
□ Procedure validatie kort toelichten
□ Laten weten dat de scriptie na publicatie met de geïnterviewde kan worden gedeeld

---

Functie en rol

1. **Kunt u allereerst wat vertellen over uw functie en rol binnen uw bedrijf, en de rol die u speelt binnen gebiedsontwikkeling(en)?**

Vragen concept mobiliteitshub

2. **Wat houdt het concept mobiliteitshub (wijkhub) voor u in?**

   Is een mobiliteitshub volgens u meer dan alleen mobiliteit?

   Welke functies heeft een mobiliteitshub?

3. **Hoe ziet u het fysieke ontwerp van een mobiliteitshub voor zich, binnen een gebiedsontwikkeling?**

4. **Wat is de relatie van een mobiliteitshub tot de omgeving eromheen?**

   Is het maken van een mobiliteitshub binnen de gebiedsontwikkeling maatwerk, of kan een blauwdruk op meerdere locaties worden toegepast?

5. **Gebruikersaspect: wat zijn volgens u de doelgroepen van deelmobiliteit?**

6. **Op welke manieren denkt u deelauto's voor meer mensen aantrekkelijker te kunnen maken dan autobezit?**

   Op welke manier denkt u mensen met een kleinere portemonnee en/of mensen die erg van eigen auto afhankelijk zijn, te kunnen overtuigen van deelmobiliteit?

Vragen organisatie & Sturen

7. **Wat zijn uw werkzaamheden binnen uw bedrijf / de projectorganisatie bezig met mobiliteitshubs, en wat zijn uw werkzaamheden m.b.t. deelmobiliteit(hubs)** (*indien nog niet beantwoord bij Functie en Rol)*

8. **Wat zijn uw ervaringen in het samenwerken met partijen aan deelmobiliteit /mobiliteitshubs binnen de gebiedsontwikkeling?**

   Met welke partijen werkt u samen binnen de gebiedsontwikkeling en in welke fases bent u betrokken?

   Waar loopt u tegenaan in het samenwerken met partijen aan mobiliteitshubs?

   Hoe denkt u dat deze knelpunten kunnen worden opgelost?

   Waar zitten de grootste kansen binnen deze samenwerking?

9. **Wordt er volgens u genoeg regie genomen op het vraagstuk mobiliteitshubs?**

   Hoe kan de sturing op mobiliteitshubs binnen gebiedsontwikkeling worden verbeterd?

   Welke partijen kunnen hierin een rol spelen?

10. **Hoe ziet u de organisatie van een mobiliteitshub voor zich (exploitatie, business plan) voor het gebruik van de hub?**

    In impressies vaak scooters en fietsen bij de hub; verwacht u dat free-floating deelmobiliteit ook baat heeft bij mobiliteitshubs?

    Gebruik voor bewoners binnen gebied, of als overstaplocatie van of naar een OV-station? (zakelijk & privé)

    Hoe ziet u de organisatie van datastromen van deelmobiliteit & de mobiliteitshub voor zich?

11. **Denkt u dat het gebruik van de mobiliteitshub gaat veranderen op den duur?**

    Zo ja, hoe kan deze afweging worden meegenomen in het ontwerp van de hub? (adaptiviteit; netwerk)

Vragen Integration (digital/physical) & input

12. **Hoe verwacht u dat het concept MaaS (Mobility as a Service) zich gaat ontwikkelen in de komende jaren?**

    Gaat MaaS de manier van samenwerken binnen gebiedsontwikkeling veranderen?

13. **Energie: Kijkend naar elektrische (deel)auto's; welke rol verwacht u dat bidirectioneel laden gaat spelen binnen de mobiliteitshub en gebiedsontwikkeling?**

    Welke plek binnen energieconcept en hoe wordt dit georganiseerd? (buurtbatterij, PV-panelen; VVE; Energiecoöperatie; netbeheerder?))

14. **Hoe kijkt u aan tegen het concept White Label Hubs? (hubs die door meerdere operators gebruikt kunnen worden om zo een groter dekkend netwerk te creëren)**

    Denkt u dat alle aanbieders van deelmobiliteit positief/negatief aankijken tegen White Label Hubs?

Vragen Case Study's

Ik bestudeer in mijn onderzoek **3 case study's** waarin ik de toepassing van (wijk)mobiliteitshubs onderzoek:

- **Centrumgebied**; nieuwbouw rond het centraal station van een middelgrote stad
- **Grotere gebiedsontwikkeling** met een netwerk van hubs
- Herstructurering van jaren 50-60 wijk; veel **corporatiewoningen**; waarin wordt verdicht, in een middelgrote gemeente.

15. **Beïnvloedt het type en de locatie van de wijk de geschiktheid voor mobiliteitshubs, en waarom wel/niet?**

    Wat ziet u als de meest geschikte locatie voor de mobiliteitshub?