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Executive Summary

This deliverable provides a general overview of research results about hub typologies, the network of hubs and the user profiles that might be distinguished. This is key information to KAVA development in other workpackages of the SmartHubs project, and in particular to the hub model development. We have brought research results together from our scientific partners in this KAVA, and policy documents from our city partners. Together with a brief review of international documentation on mobility hubs, this deliverable provides information that forms a basis for future knowledge development within cities and this KAVA. We find that many cities worldwide are working on a hub strategy and are trying to design an optimal network that meets the needs of the travellers and supports policy objectives. However, more knowledge is needed that supports policy making (where to locate what type of hub) in this relatively new field of mobility. Fundamental questions that should be answered include who exactly uses hubs and what are their needs. This deliverable indicates that there is not much understanding of which type of hub is used by what type of user. This is needed, also to develop efficient networks. Knowledge that is useful to governments when designing networks and strategies. Research on mobility hubs seems yet to be fragmented and not very elaborated, which might be explained by the fact that hub strategy developments are still in an early phase. European and national research projects like SmartHubs have started to answer fundamental questions on the impact and design of mobility hubs and its networks. But more is needed.

1. Introduction

The number of people in cities is growing, vehicles and technologies are rapidly changing, and cities like Amsterdam are implementing progressive policies to create more liveable urban spaces. The mobility system of the future will be different and be most likely more flexible, digitally integrated and differently organised when it comes to public transport systems and shared services. A new anchor point in the future journey will be the mobility hub, a place where these new and different modes of transportation come together. The mobility hub should bring more efficiency, and create more space for citizens in densely populated areas. Many cities embraced hubs as part of the future, but realising them comes with many questions (see also Fronteer, 2021). Which types of hubs are there, and what should they look like? Who will develop and manage them? And what should be the role of the municipality and the market?

This deliverable will not provide answers to all those questions. It intends to bring basic knowledge and information together on the hub concept that is useful and relevant to cities working on a hub strategy. Within the context of the SmartHubs project the information of user profiles and the different types of hubs is useful activities carried out in other workpackages (e.g. the development of a model to support cities in developing their hub network). Moreover, the identification of future (research) needs and identification of knowledge gaps is important for future activities within innovation communities like the EIT Urban Mobility. Since many European cities consider to develop a hub vision, this deliverable aims to bring knowledge together that can feed those visions and be relevant for upscaling and improving hub developments, and drive important urban objectives such as accessibility and quality of public space.

In order to understand the hub concept, the intentions that cities and service providers have with hubs and how this can contribute to both social and private objectives there is a need for knowledge. In this deliverable we bring information together from different sources. Research results from (international) studies were collected, and city strategy documents have been analysed. In addition, the authors interviewed Hely company (mobility service provider in the Netherlands) to understand their business and its operation. They have provided information about the profiles of their customers that was useful for this study.

This deliverable is structured as follows. Section 2 describes the different types of hubs that are usually distinguished with an example of the typology used in Amsterdam. Chapter 3 briefly describes the essence of hubs in a network. Section 4 brings together research results on the user profiles for the different hub categories after a review of literature and policy documents. Section 5 concludes.

2. What is a Hub?

Over the last several years, rapid changes in technology and travel choices raised the profile of mobility hubs, suggesting that they may be an important tool for the future of urban transportation. Cities worldwide (e.g. Portland in the US and Amsterdam in the Netherlands) explore the role that mobility hubs may play as a part of an urban mobility system that is changing. The mobility transition that emerges has been recognised by cities and includes trends that go from owning to sharing, from fixed to flexible and from unimodal to multimodal. Individual shared mobility and public transport will soon be part of a single integrated system under the name of public shared transport.

It is expected that with the advent of new forms of mobility there will be a need for locations where modes meet and interchange takes place. These places are hubs. Mobility hubs are the co-location of multiple travel options (Portland Bureau of Transportation, 2021). And hubs are foreseen to be the nodes in the new multimodal mobility landscape in Amsterdam (Fronteer and Amsterdam, 2021). Due to the flexible nature of the new mobility system, hubs will have different appearances and will continue to change. For travellers, hubs will be the start, transfers and end-points of their journey. Although the largest and most comprehensive hubs tend to occur in large cities, they can be useful and have impact in many situations, including campuses, small neighborhoods and communities where better coordination between modes and alternative mobility services may decrease conventional car use.

Hubs are developed to support city's objectives and enhance sustainable transport goals. A research overview carried out in the US/Canada identifies positive travel impacts of hubs (Victorian Transport Policy Institute, 2021). By improving connections between modes, mobility hubs help people travel with non-automobile modes and reduce congestion and improve air quality. It may also enhance equity (by providing affordable and accessible alternatives) and support efficient land use. In addition to a transport function, mobility hubs may also fulfill essential functions for the development of the surrounding area and neighbourhood (Fronteer and the City of Amsterdam, 2021). They can serve as meeting places, places for social initiatives, or shared facilities. Hubs may also contribute to a mobility system with a reduced role for the private car, thus reducing the pressure on public space. Cities might also define a regulatory framework for hubs and its operation. Amsterdam wants public hubs to be accessible to everyone, inclusive by design, and flexible so they adapt to changing needs of society (see also City of Amsterdam, 2021). It has also defined key requirements for the future hub network: recognizable and uniform, digitally connected and accessible (and within reach)). Portland aims (amongst others) for fair and equitable access (whatever this may be), and universal in design.

2.1.   Hub elements/services and typology

Hubs are different in size depending on the type of elements and services it brings together. The following elements can be distinguished (see e.g. study for Portland (Portland Bureau of Transportation, 2021)):

- Transport and trip making services (public transport stops, microtransit services, passenger pick up and drop off spaces, kiosks for payment and information services, real time transport information, freight (un)loading areas);
- Parking and charging facilities (cars, bikes, scooter, carsharing, etc);
- Amenities (like WiFI, shopping, community space with waiting facilities)

As with existing stations, all should be accessible with possibly prioritised walkways and safely designed infrastructure (pedestrian crossings, elevators, etc.).

Multiple classifications or typologies can be found in policy documents and research literature. Portland identifies Major, Mid size, Minor and Mini hubs, whereas Amsterdam uses location for its classification (see below). The typology is itself may not be that important, but the different types of hubs together define the network in urban areas and may be very relevant for its performance. Too many large hubs in a city network may not be efficient and/or profitable. Governments should be well aware about the different options when designing a network strategy.

In the context of defining a shared network for passenger transport in Amsterdam, 5 types of hubs are identified by the city of Amsterdam (Fronteer and City of Amsterdam, 2021):

- Private hub: shared mobility on private property, operated by users, owners or cooperatives;
- Neigbourhood hub: small scale offer of shared mobility in neigbourhoods, always within 5 minute walking distance;
- District hub: central location in the district where different transport modes and functions come together;
- City hub: convergence of transport modes on (inter)urban nodes, mostly at train stations;
- Regional hub: transition of urban and regional transport network, central role for parking.

Hubs may be owned and managed by private operators (most likely the smaller hubs, with restrictions in access), but can also be developed by governments together with private stakeholders. Public authorities will have different roles depending on the type of hub. Private hubs can be facilitated and supported by cities, whereas other hubs might be operated and/or managed by the government.

Hub types can already exist, but may also be created at new locations or with new spatial developments. Location is key for the quality of a network and serving the needs of mobility users. The location is different per hub type. Amsterdam illustrates the hub types with information about the location (Fronteer and the City of Amsterdam, 2021):

- Private hub: new and existing apartment buildings and company car parks;
- Neigbourhood hub: fixed, flexible or digital points in the public space where shared mobility can be parked;
- District hub: central locations in city districts;
- City hub: built on regional/national public transport hubs
- Regional hub: along city borders and outside the city at P+R locations and plazas where regional traffic is handled.

3. Hub network

Many cities face the challenge to do something with the hub concept and develop a strategy. This strategy starts with a vision and a certain ambition to design a network of hubs in urban areas. This involves in many cases to analyse the existing transportation network (supply) and consider future demand. Matching supply with demand may also lead to a search for new locations or add services/upgrade existing transfer points. This can be done with existing transport planning tools and transport models to assess options and implications. This requires careful planning, since infrastructure decisions are costly and fixed for a long term period.

Amsterdam has ambitious plans when looking at the growth expectations for hubs as outlined in the strategy document. Private hubs and neigbourhood hubs are expected to increase from 14 now, to 800 in 2030. Questions arise whether those numbers are realistic, efficient (impact declines when there are too many hubs with similar services in a certain area), and how to manage and operate (public versus privately). Clearly, an assessment of existing networks with an overview of the potential of (new) locations and urgency is needed.

Many regions and cities nowadays investigate the existing situation of mobility networks and explore the potential for future mobility hubs which is reported in ambitious development plans. A recent example of such a study in the Netherlands is carried out for the West Brabant region (see Goudappel and APPM, 2021). Starting point was the existing situation of the region with a variety of cities, a well developed transport infrastructure network and good public transport. The study defines six different types of hubs and explores locations where hubs could be (furhter) developed. It looks at the potential and urgency of development of hubs (in time) and also assesses the costs of the construtution. The interesting part of the analyses in the context of this deliverable, is the assessment of the potential and urgency to built new or modify existing hubs.

In order to assess the potential of certain locations within the region for hub development, the study looks at the position in the network (spatial proximity) and the level of urgency (support of stakeholders and existing botllenecks related to spatial planning). In particular the network analysis is interesting, also for user profiles. The potential of hubs is scored higher when the proximity to the number of jobs and citizens (catchment area) is higher (5 or 10 minutes walking or cycling to hub, depending on the type of hub) and when more jobs and citizens can be reached within 45 minutes by public transport from the hub. The analysis also looks at the number of people who use the hub (getting on/off buses, trams, trains). The quality of the infrastructural network is determined by the frequency of public transport that serves a hub, the proximity (in minutes) to highway entry and the quality of the cycle network. All assessments of hub locations have been carried out based on quantitative and qualitative (expert judgment) scores.

The study ranks the existing hub locations and recommends to consider those locations with highest potential and urgency as most promising (also taking future developments/scenarios into account). Diversity is important for chcoices by the West Brabant region. The authors recommend to invest in at least one hub per hub category. In this case (with 6 different hub types) that gives 6 locations for investment

(out of 19 that scored high on potential and urgency) where in the short run improvements could be realised that add value. For instance, the Bergen op Zoom Station (City Hub type) has been identified as a hub that could benefit from the provision of more shared mobility services, charging points for e-bikes and e-scooters, more bike-parking and meeting locations. And recent research for Amsterdam has indeed indicated that small investments and offering for instance bike sharing services could lead to substantial gains in terms of accessibility of jobs. Hence, hub network planning can lead to substantial benefits but requires thorough analysis.

4. Hub user profile

An important question when designing a hub network is what type of travellers will make use of a hub. A mobility hub should fulfil the needs of its users to be successful. This makes it important to define the users, to analyse their needs and to adapt the hub and its services to those needs.

There are different types of (potential) hub users which can be analysed by looking at different background factors. The city of Amsterdam defines different target groups in order to develop an efficient hub strategy and change mobility behaviour (City of Amsterdam, 2021): citizens, visitors and commuters. Within those groups Amsterdam also distinguishes between frequency of travelling, type of vehicle used (car or bike) and destination (tourists in city centre, or event visitors). It is also possible to look at the socio-economic profile of travellers. Income, age and education might be factors that are relevant for hub design. Smaller hubs with a few services (bike sharing, car sharing) tend to focus on people living nearby (citizens) eager to make use of shared services (people who do not own a car or are willing to give this up). Hence, hub user profiles will vary with hub type. The table below gives an indication of different possibilities for hub user profiles. We have added the different hub categories for Amsterdam in the first column just to indicate that profiles will be different for different hub types.

Hub type	User profiles	Mobility profiles (access to/from hub)	Socio economic profiles
Private Hub	Citizens	Car owners/users	Income
Neighborhood hub	Companies	Walking	Age
District hub	Tourists	Cyclists	Gender
City hub	Commuters	Users of shared services	Education
Regional hub	Students	Touringcar users	
Logistics hub	Leisure travelers	Taxi users	
		Public transport users	

Table 4.1: Hub user profiles and hub categories (Amsterdam as example)

There is some research carried out towards hub user profiles and mobility behaviour, but very fragmented and in an indirect way. CROW (2021) brings some research results together for the Netherlands. Results indicate that people younger than 45 year with a positive attitude towards shared mobility are willing to use hubs. CROW also reports that shared mobility services are more often used by students, and starting people on the housing market in larger cities (based on data from service providers like Greenwheels and Hely). Car sharing services are more often used by single people who are highly educated and with a higher income. Research in Amsterdam (carried out to get a better understanding of shared mobility services and

the impact this might have on the city) amongst users of car and bike sharing services in the city indicates that they are relatively young, higher educated and in many cases student or people with a job.

Results from a stated preference study in the Hague indicates that (Claasen et al., 2020):

- Hubs might affect car ownership: 11 to 15% of the respondents considers to give up car ownership
- Much depends on the type of hub, the costs of services, proximity and conditions
- Younger people are more eager to use hubs: age is important
- Frequent public transport users are more eager to give up car ownership

Since hubs are most often linked with public transport, users of public transport are important. A study in Amsterdam provides interesting results in the context of hub user profiles. The city of Amsterdam has commissioned a multidisciplinary study towards the impact of the recently built North/South metroline in the city (opened in July 2018). This metroline has 8 different stations which all have a hub function where people transfer between modes and services are offered. Central station is the largest station and can be characterized as a city hub In the Amsterdam network. Research (see Goudappel Coffeng, 2019) indicates that North/Southline travelers tend to be rather young (48% was younger than 27 in 2019) and frequent users (more than 66% travels at least once a week). The hub station is reached in most cases by walking or other public transport.

5. Conclusions

This deliverable brings basic research results together about mobility hubs, the network of hubs and the user profiles that can be distinguished. Many cities are working on a hub strategy and trying to design an optimal network that meets the needs of the travellers. This comes with very relevant challenges about management, design principles and funding. We have focused on the basics of hubs and tried to collect information from city practice and scientific results with the focus on Amsterdam and the Netherlands.

Multiple classifications or typologies of hubs can be found in policy documents and research literature. All refer to size and number of services and sometimes ownership. The typology in itself may not be that important, but the different types of hubs together define the network in urban areas and may be very relevant for its performance. Hubs may be owned and managed by private operators (most likely the smaller hubs, with restrictions in access), but can also be developed by governments together with private stakeholders. All cities have in fact already a network of hubs in place (being public transport stations), the challenge is to develop those with new mobility services and allow smaller to be developed locally. Location is key for the quality of a network and serving the needs of mobility users, but requires careful planning by public and private operators.

Hub network design is not easy and more research is needed to feed hub development strategies of cities and urban regions to create efficient networks. This deliverable has indicated that attempts are being undertaken to identify hub potential and urgency and provide decision makers with information about where to locate what type of hub. It requires careful design and understanding of the existing network and the location of hubs in a cities. It is important to understand the function of (existing) hubs in a network and analyse its (future) potential in serving users and citizens to get efficient and sustainable from A to B. Small hubs might be located in areas with low car ownership to serve a need to get to bigger hubs and use public transport. At the other hand, hubs might also serve commuters by being located near bigger employment locations where shared biking services might be very useful.

Who uses hubs? A very fundamental question to understand the needs of travellers and provide good quality hubs and hub services, and very important input for hub network analyses. This deliverable indicates that there is not much understanding of which type of hub is used by what type of user. We know a lot from public transport travellers in general (relatively young, commuters and students), but we know less about the use of specific stops or stations in certain cities or regions. Small or private hubs tend to be used more by people without a car and relatively young and eager to try new forms of mobility. However, more research is needed to understand who is willing to use hubs and potentially change behaviour in a more sustainable matter. Knowledge that is useful to governments when designing networks and strategies.

Meanwhile the development of a decision-support tool (DST) for locating hubs is on-going, which will combine GIS technology with Multi-Criteria Decision Analysis techniques, as there are several dimensions and criteria to be considered when locating a hub. The DST will look at some aspects of the location problems mentioned above, such as the interaction among the hubs, but its aspiration is not to cover extensively the network effect phenomenon that might occur after the operation of the hubs or the full set of choices of citizens/users of the hubs, because that would require building a complete network demand model which is outside the scope of this project.

Research on mobility hubs seems yet to be fragmented and not very elaborated, which might be explained by the fact that hub strategy developments are still in an early phase. European and national research projects like Smart Hubs have started to answer fundamental questions on the impact and design of mobility hubs and its networks. But more is needed. It is recommend to share data between governments and service providers to develop a better understanding of hub operation and management. Developing a hub strategy requires cooperation.

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7. Acknowledgement

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