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eHUB technical and functional requirements

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Summary sheet

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Organisation	Abbreviation	Country
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Promotion of Operation Links with Integrated Services aisbl (POLIS)	POLIS	Europe
Taxistop asbl	Taxi	Belgium
Autodelen.net	Auton	Belgium
Bayern Innovativ GMbH	BI	Germany
Cargoroo	CA	The Netherlands
URBEE (E-bike network Amsterdam BV)	URBEE	The Netherlands
Gemeente Nijmegen	NIJ	The Netherlands
Transport for the Greater Manchester	TfGM	Great Britain
Stad Leuven	LEU	Belgium
TU Delft	TUD	The Netherlands
University of Newcastle upon Tyne	UN	Great Britain
Ville de Dreux	DR	France
Stadt Kempten (Allgäu)	Kemp	Germany
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1. eHUB definition

An eHUB is a physical cluster of different transport modalities. It is a transport hub based at a local level. Different zero-emission (electric as well as non-electric) and shared transport modes are made available. EHUBs can be linked together in a network, as well as connected to the existing public transport network. This combination creates transport hubs and enhances connectivity.

The hubs need to be tailored to local conditions: to the different neighbourhoods, different centres (commercial, business, educational, cultural, tourist etc) or transfer locations. EHUBs can vary in size, type, quantity of transport modes available and additional service levels. It will depend on the existing transportation context, the user needs and spatial context. It can be as small as only two (e-)bikes at a street corner or it can contain a combination of e-(cargo)bikes, light electric vehicles (such as e-scooters and e-cargo bikes), even electric carsharing and/or public transport possibilities. Additional services such as ticketing facilities, waiting zones, (postal) lockers etcetera, can be considered available when located within a 10-minutes' walk.

Implementation of eHUBs envision an impact on multiple levels:

- It reduces emissions of fine dust, on al large scale.
- Different means of transport contribute to the possibility for multimodal transport in time and space (this includes connections to public transport).
- Shared means of transport contribute to a more efficient use of the vehicles.
- Reduction of the pressure on public space due to reducing parked or riding means of transport.
- The means with the smallest impact on the public domain (and environment) can be stimulated on the appropriate level, creating awareness and engagement among travellers (reverse traffic pyramid (see figure 1)).

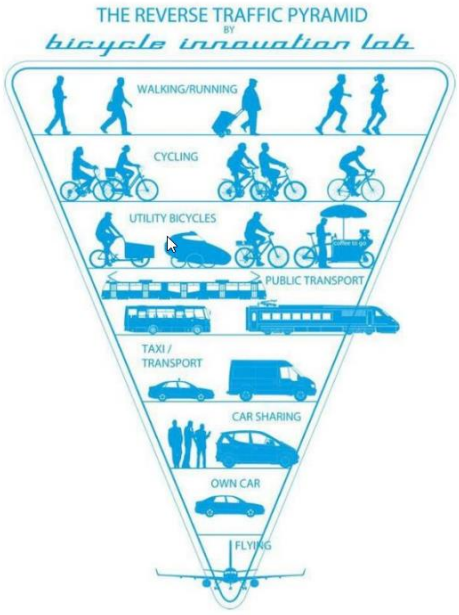

Figure 1: Reverse traffic pyramid (source: bicycle innovation lab)

2. eHUB types

Categorising eHUBs is not an easy task. Local spatial context is a very important factor, creating infinite possibilities for sizes of eHUBs and the variety of shared mobility offered.

Based on the position of a location within the local transportation network, there can be a theoretical classification in three types.

2.1 Type 1: Interregional connections

- From this point there are public transport connections (large range of bus, tram or metro connections, IC and local trains) for traveling between larger regions
- In general there are a large number of possibilities for a shift in mode of transport, for travellers to continue their trip within the city or outside of it.
- There is a large demand for transportation options, many people pass this point during travel.
- Example: From the railway station of Leuven, one can travel to various corners of the country by train. The station is the largest hub for regional transport by bus. There are car and bicycle parking facilities. Shared bicycles are offered. There are extended ticketing opportunities. Lockers are available, a covered waiting space, and opportunities to eat and drink.

2.2 Type 2: Regional connections

- At these locations there usually are public transport connections (local trains and or different busses), to easily travel within the region.
- On the other hand it can be a large parking space promoting opportunities for carpooling or a change of transportation mode towards another (commercial, educational, tourist, cultural, business etc.) centre.
- The preferred behavioural change, with regards to the reverse traffic pyramid, is focused towards a specific centre or other types of hotspots (commercial, business, educational, touristic, cultural…). Outside of it, where traffic pressure is diminished, this necessity is lower.
- Example: From the railway station of Heverlee (a sub-municipality of Leuven), one can travel to smaller local train stations (on the line Leuven-Ottignies)). There is a bus stop with 5 lines passing by. There are car and bicycle parking facilities. Shared cars are offered and shared bicycles will be offered in the near future. There is limited covered waiting space. There are some opportunities to eat and drink.
- Example: The Science park Arenberg parking is located near the driveway of the two highways passing Leuven. It is nearby the science and engineering campus of the University of Leuven. It is close to a bus stop where, users of this parking, can take a bus to the city centre for free.

2.3 Type 3: Local/neighbourhood connections

- Availability of different types of shared mobility very close to specific departure points (such as home locations), often referred to as first or last (mile) kilometre connections. This is generally the starting point of a journey and therefore an opportunity to offer other modalities than cars to make a modal shift.
- Sometimes there is a public transport connection to regional or interregional hubs. In other cases, there is only public transportation on demand or no public transportation available at all.

- Outside of centres or hotspots, shared cars can be a more sustainable offer to try and reduce private car use.
- The offer can be clustered or more dispersed for a specific neighbourhood.
- The preferred behavioural change, with regards to the reversed traffic pyramid, is focused towards a specific centre or other types of hotspots (commercial, business, educational, touristic, cultural…). Outside of it, where traffic pressure is diminished, this necessity is less.

Each type of hub can become as large or as small as required or as local conditions are able to make available (within the existing public infrastructure). The quantity and types of means of transport to be offered, need to start based on an estimated demand and tweaked according to growth when necessary (and possible).

3. Means of transport per type

Every city, every municipality, every neighbourhood has its own spatial context. The public domain has a limited amount of space available. For projects to be developed the requirement can be taken into account beforehand. General requirements cannot be set too strict, because of the large variety of possible eHUBs (there is possible overlap between different types). The goal is to offer and integrate the different means of transport and additional services in the best possible way. Standard means of transport should be provided, adapted vehicles for specific types of users can be provided (usually this is done based on specific demand). Planning large developments can offer opportunities for shared mobility in contrast to the usual focus on individual private parking spots.

3.1 Type 1: Interregional

Shared (electric) low impact mobility (such as (electric) bikes, cargo bikes, steps etc.)

People arrive, possibly covering substantial distances. The distances from this point onwards are more often small distances, often referred to as the last mile. For this reason, the offer can be focussed on soft (shared) mobility options in order to create the lowest possible impact on the public domain. A large number of means and types are justified, due to a large number of travel movements.

Low impact mobility parking

There should be extensive parking spaces for shared low impact mobility options as well as private ones. Easy to use, safe and accessible parking space motivates the usage of the means of transport.

Shared (electric) cars

This type of hub is characterized by extended (interregional) public transport connections. The arrival or departure from this point onwards using a car (even when shared) should generally be discouraged. The majority of movements from this point onwards are short and possible to be covered using soft modes of transport or, when longer, through the interregional public transport-possibilities.

Car Parking

Car parking should be discouraged in the same way the usage of cars is, because where there are parking spaces, there will be cars.

3.2 Type 2: Regional

This type can be categorized in at least two large subtypes:

- Within a city (multifunctional) centre or different type of hotspot (commercial, business, educational, touristic, cultural…)

Shared (electric) low impact mobility (such as (electric) bikes, cargo bikes, steps etc.)

Movements from this point onwards for small distances need be have a focus on soft (shared) mobility options as to create the lowest possible impact on the public domain.

Low impact mobility parking

There should be extensive parking spaces for shared low impact mobility as well as private ones. Easy to use, safe and accessible parking space motivates the usage of the means of transport.

Shared (electric) cars

A lot of city centres (with a lot of transport pressure) aim to be car-free (or at least a car shy) zones. The arrival or departure from this point onwards using a car (even when shared) should generally be discouraged. The movements from this point onwards are more often short and can be done with soft modes of transport or longer through the regional public transport-possibilities or passing by edge parking spots, mentioned in next subtype.

Car Parking

Car parking should be discouraged in the same way the usage of cars is. Where there are parking spaces, there will be cars.

- On the edge of a city centre or different types of more segregated hotspots (commercial, business, educational, touristic, cultural…)

Shared (electric) low impact mobility (such as (electric) bikes, cargobikes, steps etc.)

Movements from this point onwards towards a multifunctional centre need be have a focus on soft (shared) mobility options as to create the lowest possible impact on the public domain, where transport pressure is biggest.

Low impact mobility parking

There should be enough parking spaces for the offer of shared low impact mobility means. Next to this some private parking can be provided. It is important to encourage (shared) soft mobility towards the centre and having an option for shared mobility to more peripheral areas.

Shared (electric) cars

Non-car owners can start their journey, away from the centre, starting from these edge parkings. This keeps centre inhabitants from having to stall their cars in the centre, where they have a lower need for them.

For a more segregated uni-functional centre, shared cars are optional. When traffic pressure is low and certainly if the public transport connection is limited, shared cars can even be preferred.

Car Parking

There should be extensive and safe parking spaces for private cars available. This will encourage leaving cars here when traveling to the city centre and switching to a mode of transport with lower impact on the public domain. When making transversal movements (by-passing the centre) these parking spaces can be used for stimulation of carpooling. The spaces with shared cars should have preferred positioning close to the driveway on and off as a way to promote them.

3.3 Type 3: Local/neighbourhood

This type can be categorized in at least three large subtypes: Peripheral neighbourhoods, neighbourhoods on the edge of a centre or hotspot or neighbourhoods within a centre.

Shared (electric) low impact mobility (such as (electric) bikes, cargobikes, steps etc.)

Modest offer of shared low impact mobility can be offered based on the user numbers. Preferably the offer would be slightly larger than demand. The presence can stimulate awareness and behavioural change. Availability will stimulate testing and maybe eventually becoming a regular user.

Within a centre the offer can be larger due to higher density of inhabitants and more passers-by.

Low impact mobility parking

There should be at least a medium number of safe and easy to use parking spaces for shared low impact mobility as well as private ones. Ample and safe parking promotes the use of these mobility types.

Shared (electric) cars

Modest offer of shared cars can be offered based on the user numbers outside of centres or other hot spots. Maybe even slightly more to stimulate behavioural change from private towards shared car use.

Within a centre, even on neighbourhood level, car use can be discouraged.

Peripheral neighbourhoods are often largely dependant on car use which justifies an offer of shared cars.

Car Parking

Car parking in accordance to the offered shared mobility.

4. Look and feel

What is required, preferred or non-desirable for the physical appearance and functioning of an eHUB? First is the orientation with focus on the point of view of the user. In additional we have its spatial integration, which pays attention to the existing spatial context and how to take this into account. Finally there is the eHUB infrastructure required to provide the means of transport and to nudge users towards specific behaviours (encouraging and discouraging specific modes of transport for specific trips). This preferred behaviour correlated to the previously mentioned reverse traffic pyramid (see figure 1).

4.1 Orientation

The eHUB should be recognizable and visible, so the user can quickly link the eHUB to its possibilities and the mental quality label. It needs to have an intuitive setup for users.

- The **recognizability** will be inspired by the branding of Flemish Mobipoints (see figure 2). The icons for different types of shared mobility will be used by all partners. Shared mobility providers can use the logo when customers are making a reservation (in an app, at the ticket booth, online…). Integrate the logo at the physical eHUB: on the information pole, on the parking spaces…
  The logo of Mobipoints will be used by Leuven and the other pilot cities, if it can be embedded within the larger regional branding strategy of each individual city.

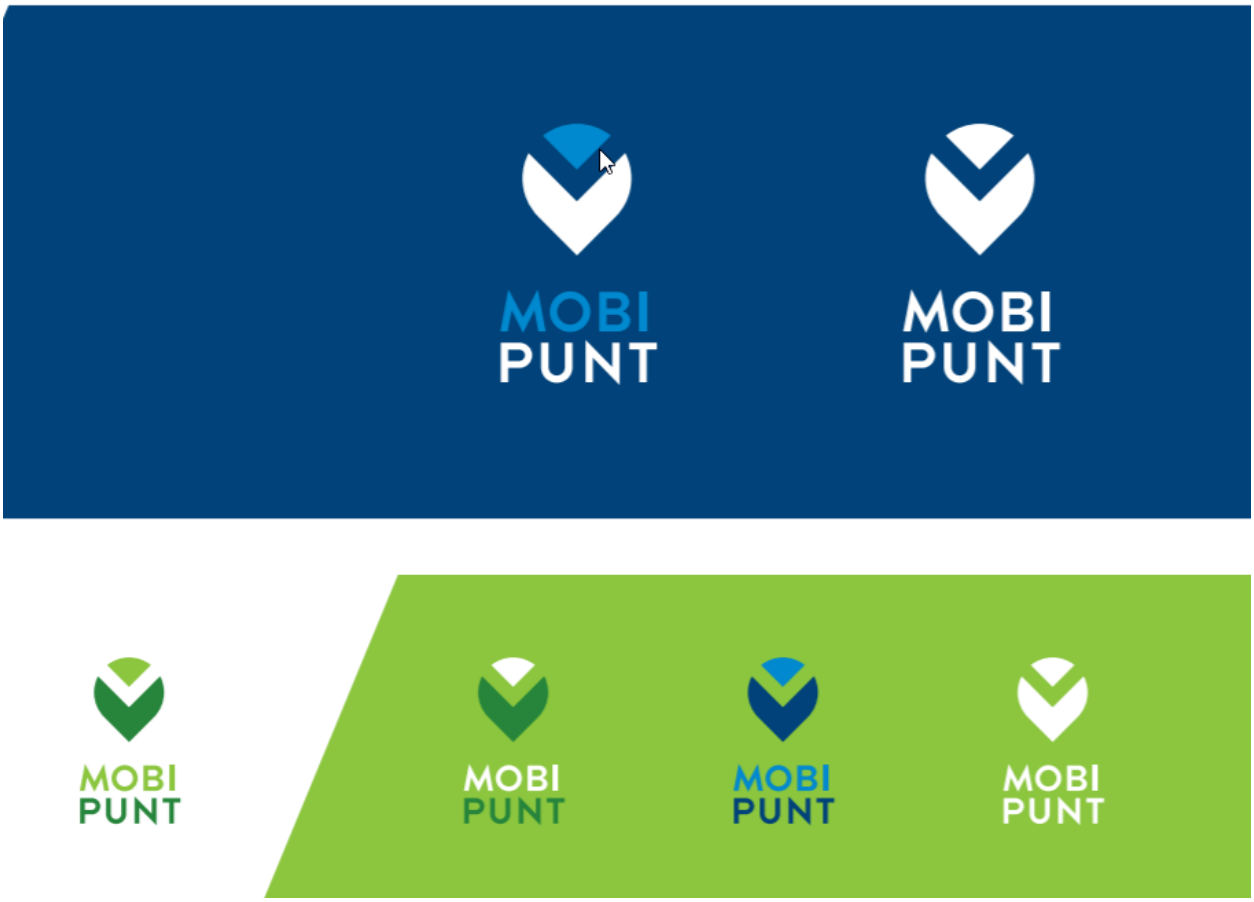

Figure 2: Official Flemish Mobipoint identity

- The aspiration is to be as **visible** as possible at the eHUB as well as outside of it. The pole or traffic sign (digital or analogue), should be visible from as many angles as possible. Clear indications towards the eHUB or to link between parts of an eHUB need to be clear and intuitive. Next to this optional indicators: like different license plates or stickers on the shared mobility modes, can be provided to increase visibility outside of the hub.
- It should be intuitive and readable to identify which means of transport are available and how to utilise them. Using agreed upon logo's on the poles, as well as on its parking spaces, has the goal to transcend **readability** above the local and even regional level to a European level.
- Information should be provided according to the available means of transport. When there is a public transport stop nearby real-time information would be preferable. Information on proximity of other nodes (eHubs within the network) and their offer within the hub-network

can also be useful. This is also the case for the number of parking spots for cars, especially for busy parking spots.

4.2 Spatial Integration

An optimal location for planning an eHUB would be a location where some of the required (and/or optional) infrastructure is already present and there is free space available, so that the local infrastructure can be supplemented as required. This also means that it is already known to local users as a parking space of some sort.

Opportunities arise where a re-structuring of the public domain is planned, this way the eHUB infrastructure can already be taken into account during the design phase.

Spatial integration means taking inventory of the current transportation situation as well as the existing arrangement of the public domain. These situations will provide strengths, weaknesses, opportunities and threats. The goal is to use them well taking into account the:

- Accessibility of the hub from different directions and availability for all types of users
- Accessibility of the offered means of transport with priority for low impact mobility options. Preferred behaviour of the users (reverse traffic pyramid): low impact mobility parking spots as well as shared means of transport, should be easy to access.
- Fit within the existing traffic structure and movement lines of different users of the public space. Provide a safe and easy way to access the appropriate transportation route.
- Safety should be a priority within the current traffic situation, design should prevent conflicts between different means of transport. Priority should be given to the safe connections for soft means of transport.
- Next to this, it should also be safe using and storing the means at the eHUB. It should be well illuminated with preferred presence of social control.
- Comfort and convenience when using the hub refers to a waiting area. Specific for the transition to public transport this aspect has added value. Preferable it provides shelter for wind and rain. It is an opportunity to add to sustainability with green roofs and/or solar panels. Other changes between modes presented should not require waiting time.

4.3 Infrastructure

The public space is generally open and accessible to all people. It is the combination of public roads, public parking spots, bike lanes, pavements, public squares, parks etcetera. Public spaces are designed by the local government in order to serve all user as best as possible. There are some important guidelines to keep in mind when designing it:

- Flexible: it needs to be able to transform over time in order to fit changing needs, it is never finished
- Accessible: it should be designed in order to avoid exclusion
- Logical, intuitive

Low impact mobility use needs to be stimulated. Therefore a lot of attention should be paid when planning its infrastructure. This consists of a cycle network as well as low impact mobility parking spaces. The cycle network is very important, however it is not part of the scope of this project. Parking opportunities should

easily connect to the existing cycle network. It should be easier to use than the car parking facilities provided.

Note: One car parking space can provide parking for 8 to 10 bicycles. Features such as bike lanes, bicycle parking, car-share parking spaces, charging hubs are crucial to make shared low impact mobility visible , easily accessible, safe and convenient.

Low impact mobility infrastructure

The locations of low impact parking opportunities, need to be convenient, near to, or in the direction of the intended destination. Important is that they do not disturb the movement of other users of the public domain. When convenient, it discourages people from leaving their vehicles at inconvenient locations. Plus, when well organised, people are more encouraged to use it. The parking spots should be laid out in an easy and accessible way, to encourage their usage.

The eHUBs should provide space for the shared as well as private bicycles.

Depending on the way electric shared bikes are managed, there might be a need for charging facilities at the eHUB. When they are available, it is interesting to have opportunities for private e-bikes to charge (or other e-transport systems i.e. electric wheelchairs) as well.

Parking needs to be safe and secure, this can be accomplished with a conscious selection of the location (social control), the design and lighting.

Level 1 and 2 hubs will need plenty of bicycle parking. For long term parking covered and possibly secured parking is preferable, this is expected near public transport hubs. Simple outside racks are sufficient for short term parking.

There are different types of bike racks. There are two important factors to be taken into account: it needs to facilitate as many numbers, as well as types of vehicles as possible. In addition it is important that there are plenty of opportunities to secure your bike to a rack. The best way of securing your bike (or other means of low impact mobility transport) is connecting the frame (not only the wheel) to a rack. Based on these factors mobilitylab.org identified more and less convenient types of racks in the figure 3 below.

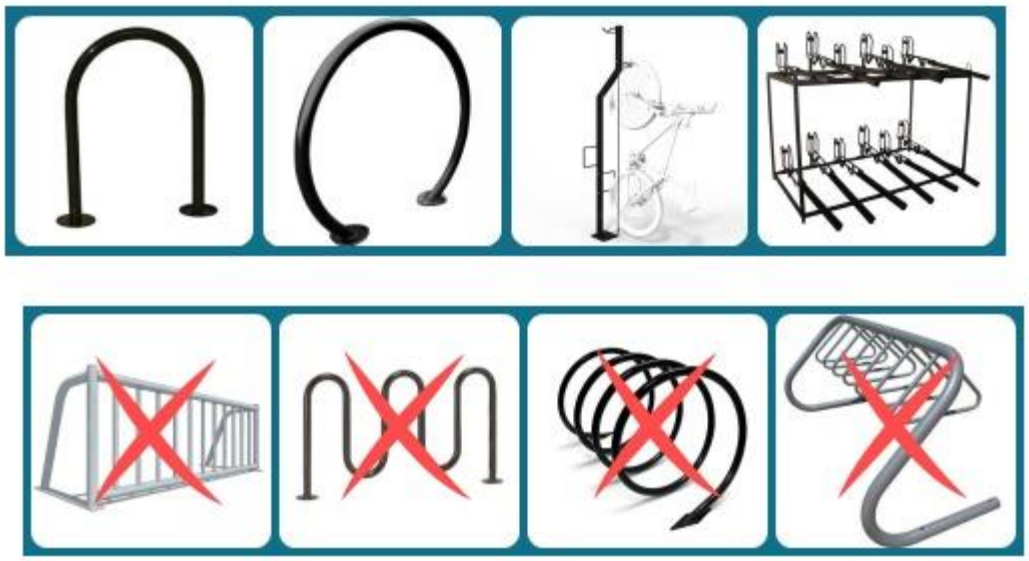

Figure 3: Types of bike racks (source: https://mobilitylab.org)

The Reference in Flanders for functional measurements of bicycle parking spots is determined in a 'parking guide:

- Between the 2 central axles of bike: minimal 0.6m and recommended 0.75m
- Length of 1.9 – 2.0m

Respecting these measurements, all types of low impact e-mobility should be able to be stalled, except for cargo-bikes. These require a spot of minimum 2.6m length and 0.7m width (based on information from Cargoroo).

Car infrastructure

Locations for private and shared car parking can differ and need to be setup based on preferred transport behaviour. Parking should be more difficult (and/or more expensive), where pressure on public domain is high. Parking for shared cars can be less strict as to diminish the necessity of having a private car and stimulate sharing cars.

A lot of commercial or tourist centres are car-free (or car-shy-) zones, in coordination with policy, at these locations the private parking should be minimal or even non-existent. Parking spaces are limited in the centres, but plenty at the edges of these centres, with exception for some parking spaces for shared cars.

Other types of centres (educational, business or others) are usually less strict with regards to their car policy. Nevertheless the goal should be to bundle car parking as much as possible with connection to safe and low impact mobility travel routes to travel to the intended destination.

With focus on low emissions, e-car use should be stimulated. This can only be done with sufficient charging opportunities at parking spots. Shared electric cars should have preferred parking at a charging pole. Providing charging possibilities for private cars is interesting as well, especially when electric infrastructure is already present.

Charging possibilities for e-cars:

- Battery swap: changing the battery for a charged one; this does not require extensive charging facilities at the eHUBs
- Inductive charging: via induction of an electromagnetic field (frequency 10-150 kHz) between the road surface and the car
- Conductive charging: connection of the car with an electric charging station with a cable
- Charging speeds
- Slow charging are most suited to parking where people typically stay for at least 30 minutes to 2 hours or longer. This should be sufficient for private cars when visiting a specific location.
- Shared electric cars would preferably have fast charging to increase the usage per day.

The parking regulation for Leuven determines the following measurements for car parking: length – width – height.

- Covered or inside parking space: 5m – 2.75m – 1.8m
- Parking on the public domain, outside requires: 5m – 2.5m;
- Depending on the angle position of the spaces, the distances between spots on either side can differ (more information in figure 4). Note that parallel parking is not recommended for shared vehicles, due to possible limitation of potential drivers (for example not being able to parallel park).

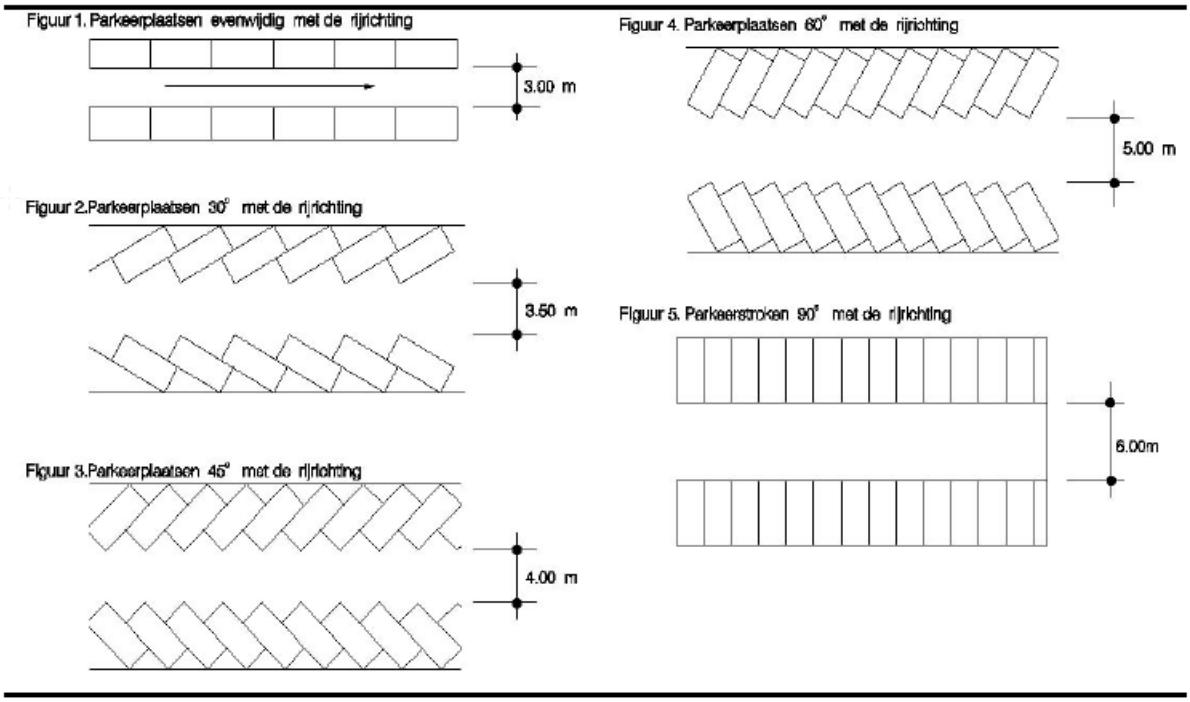

Figure 4: Car parking distances for different angles (www.leuven.be)

5. Preferred and possible additional services offered per type

The additional service levels will also be very dependent on what is already available, what the demand is and what is possible at a specific location.

Services	Preferred	Possible
Type 1	Ticketing Indoor waiting PT information Information on other means of transport on different locations Taxi's Lockers (storage, charging, e-commerce…) Cash machine	Kiss and ride Bike repair staffed service Smartphone charging Water WIFI
Type 2	Ticketing machine Covered waiting area PT information Information other means of transport on different locations	Kiss and ride Taxi Unattended bike repair stand Cash machine Water
Type 3	Bench	Ticketing machine Covered waiting area Unattended bike repair stand Water

Table 1: Additional services per eHUB type

6. Service levels for shared mobility providers

The shared mobility market is peculiar and fragile. It is in the hands of the private sector but very strongly dependant on local authorities. It is important that there is a public private partnership.

This partnership is based on agreed upon service levels to be upheld by all parties within the partnership.

Shared mobility providers will have the permission to use the public space to offer and stall the offer of shared mobility. This can be by utilizing provided public infrastructure, or through placement of and use of specific stalling or parking infrastructure, by the provider itself. Different locations have different service level expectations for the providers.

It varies per country and is up to the local government to set boundaries for shared mobility.

One extreme option is to allow all providers to offer and stall shared mobility vehicles anywhere in the public space. Dependant on each individual situation, regulation is required in varying degrees, in order to prevent chaos.

Minimum service levels can be determined using lessons learned in cities so far:

Important negative aspects from previous experiences are:

- Added pressure on the public domain: allowing every provider to start as they please can create too large of an offer, taking up large surfaces of the public domain.
- Badly parked vehicles can create a nuisance for other users of the public space.
- No clear accountability for the vehicles if a provider should go bankrupt

Lessons learned in cities where shared mobility is present

- Start with limited number; balanced use of the public domain can be done using a licensing system
- Licensing system requires a prohibition for offering shared mobility without a licence
- Clear rules on parking and consequences for non-regulatory parking
- Real time tracking necessary so that vehicles can be located at all times
- Defining parking of prohibited-parking zones

Additional service levels can be setup for a wide range of conditions:

Specification on

- information sharing
- software integration
- efficient and equitable manner – accessibility quality availability
- required coverage of specific geographic areas of the city to ensure greater equity of access
- modes fitted for people with reduced mobility
- regular reporting of data
- differentiating between fuelled and electric cars to operate

7. Sources

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- https://www.leuven.be

The eHUBS Consortium

The consortium of eHUBS consists of 15 partners with multidisciplinary and complementary competencies. This includes European cities, leading universities, networks and electric and shared mobility providers.

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