Optimalisation of hub locations in the Vervoerregio Amsterdam

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Summary

Due to increasing pressure on the mobility system and at the same time a shortage of space within urban areas, there is a need for smart solutions. One of these solutions is to offer shared mobility, where vehicles are shared and thus take up less space than self-owned vehicles on the one hand, and on the other hand increase the accessibility of the city by offering new options of transport mode choice. One way to realize shared mobility is through hubs. The shared vehicles are parked at a hub, after which they can be rented and then returned to another hub. Within the Amsterdam transport region, the effects of such a hub system on the use of shared mobility and the effects of this within the region are currently being examined.

Therefore, this study determines the optimal locations of hubs in the Amsterdam transport region and then calculates how many people will use shared mobility in this placement of hubs. This assumes that shared mobility (shared car, shared bicycle, shared scooter) is used between two hubs: pick up at a hub near the start of the journey, and then return it at the hub near the end point of the journey. In addition to walking to and from the hubs, the option of using shared mobility as part of a public transport journey, where the pre- or post-transport consists of a shared bicycle or shared scooter, has also been included.

To determine the optimal hub locations, the traffic situation in 2030 was considered. For this purpose, the traffic model of the Transport Region, the VENOM, was used. This traffic model predicts how many people make a journey on an average working day, and which mode of transport they use to do so: by car, bicycle or public transport. In this study, a fourth option is added: per shared mobility between two hubs.

Determining optimal hub locations was done by a genetic algorithm, in which a different placement of hubs was investigated in each iteration until no more better solutions were found. The best solution is to install hubs in which the perceived usefulness (travel costs, travel time) of all passengers is as good as possible, looking at both passengers who use shared mobility and passengers who still use a traditional mode of transport (car, bicycle, public transport). A mode choice model has been used to determine who uses shared mobility.

A total of five scenarios were calculated using the optimisation algorithm, in which the number of hubs, the size of the hubs, the subsidy given on tariffs and the switching penalty for using hubs were varied. The baseline scenario looked at the situation in which 150 hubs are realized in the Amsterdam transport region. A maximum of 4 shared cars, 15 shared bicycles and 10 shared scooters will be stationed at each hub. The minimum distance to be covered with a shared bicycle or shared scooter is 1 km and for a shared car 5 km. The maximum travel time in minutes is 45 minutes for a shared bicycle and 36 minutes for a shared scooter.

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In total, the prediction is that with the chosen distribution of hubs throughout the region, 1300 journeys with shared mobility will be realized in the morning rush hour of an average working day. Converted to a total working day, this would amount to about 9500 rides, of which 25% with the shared car, 40% with the shared bicycle and 35% with the shared scooter. In total, 40% of shared mobility journeys are a combination with public transport, where the shared bicycle or shared scooter is used to travel from the public transport station to a hub near the destination.

However, there is also a downside: there is almost half as much demand from passengers than journeys that can be made with the realised supply of shared mobility. Half of the passengers therefore miss out: there is no shared vehicle available for them in the desired place. This misconduct mainly takes place around the major public transport stations, such as Amsterdam Central, Amsterdam Sloterdijk, metro station Noord, Diemen-Zuid, Hoofddorp. There is also more demand for shared scooters in the yet to be realized Strandeiland district than the hub (with 10 shared scooters) can offer. It is therefore advisable to look at a differentiation of the number of shared vehicles per hub. However, it should be realized that the "OV-fiets" is not included in the model. At train stations, it is likely that the OV-fiets will continue to be used more often than any new regional shared bicycles. This makes the amount of misconduct smaller in practice than the model predicts.

In addition to the baseline scenario, several variations were also examined as shown in Table 1. For example, the scenario in which the fares of shared bicycles and shared scooters are subsidized shows a considerable increase in shared bicycles and shared scooter rides, up to a share of 0.63% shared mobility in the total region, or three times as much as in the baseline scenario.

A neighbourhood hub scenario with a larger number of smaller hubs shows that there is sufficient demand for shared cars in the outlying areas, but smaller hubs in the city centres work less well as a result of (even) more demand than supply.

In an extreme scenario in which all hubs are activated, it is possible to gain good insight into the maximum share of shared mobility in the region: 6,350 journeys in the morning rush hour of an average working day. In addition, it can be seen that the total share of public transport journeys (including journeys that use shared mobility as pre- or post-transport) is (marginally) higher in each scenario than the share of public transport in the study area without shared mobility: this is 21.40%.

Table 1: Overview scenario's and most important results

	Base	Subsidy	Neighbourhood hubs	All hubs	Base without transfer penalty
Scenario definition		Subsidy on usage costs shared bike and scooter	More hubs, but less vehicles per hub	All hubs activated	As base, but without considering a transfer penalty on the hub
Number of hubs	150	150	250	466	150
Number of shared mobility trips in morning peak	1.306	4.567	2.013	6.354	1.468
Number of trips where no shared mobility was available	1.146	2.867	1.948	3.412	1.503
Share of shared mobility in modal split	0,18%	0,63%	0,28%	0,87%	0,20%
Total share public transport in modal split *(21,4% in situation without hubs)*	21,45%	21,56%	21,44%	21,51%	21,45%
Estimate of number of shared mobility trips for a whole working day	9.500	33.200	14.600	46.200	10.700

The model results presented are indicative, but can be used to determine the actual locations of future hubs, and also to consider the extent to which it is useful to apply a subsidy to shared mobility. It should be noted, however, that this study looked at a specific shared mobility system in which shared vehicles are in principle always parked at hubs (both on the origin and destination side). A system such as the OV-fiets (renting and returning at the same 'hub') or most shared scooter systems (renting and returning at a random place within a certain area) can function differently and attract other travellers, which was not looked at in this study. It is also important to look closely at the journeys where there is demand for shared mobility, but the supply is not sufficient. After all, a lot of 'misreaching' can ensure that travelers will ultimately use the shared vehicles less.

In any case, it can be concluded that, according to the transport model used, there is sufficient demand for shared mobility in the region, whereby this can also be of added value outside the municipality of Amsterdam for increasing the accessibility of the region. If all hubs are realised, this will lead to a total share of 0.87% in the modal split. In addition, the number of public transport journeys is also increasing, as a result of the combination offered with a shared bicycle and a shared scooter as a pre- or post-transport of public transport.

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