Assessing the impact of large-scale shared mobility systems using MATSim

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ABSTRACT

Shared mobility systems such as car-sharing, bike-sharing or ride-sourcing are expected to disrupt the current urban transportation system. This notion is supported by the incessant growth of shared mobility systems worldwide in the last decade and a growing body of literature indicating substantial impacts on the transportation system. For example, research focusing on car-sharing has revealed several positive impacts like less vehicle travel and lower emissions or reducing the need for parking by reducing private vehicle holdings [1,2]. Bike-sharing was found to be an effective measure to shift suburban residents' mode choice towards public transportation, although in city centres, savings in vehicle kilometres travelled often are more than offset by necessary relocations of bikes [3]. Similarly, ride-sourcing is expected to offer a first-last-mile connection to public transportation, but first studies indicate a negative overall impact on the transport system [4]. Currently, the market share of shared modes is still generally low and so is their impact on the transportation system. However, not only the magnitude, but also the nature of the impact of the different shared modes may change, once the systems grow further. Hence, given the substantial growth rates of the services, it is important to study their impacts in case of a large-scale implementation. To estimate their impact on urban transportation for such a case, it will be crucial to understand if and under which circumstances different shared modes are complements or competitors both with each other and with other modes of transportation.

To account for the interactions of the new modes with each other and with the transport system, the agent-based micro-simulation MATSim [5] is used as the main tool for this research. In MATSim, a synthetic population reflecting census data acts on a virtual world representing the given infrastructure such as road network, land use or availability of transport modes. Each agent has a daily plan, which it strives to realise as efficiently as possible. To do so, they can make decisions on departure times, modes, routes etc. After multiple iterations allowing agents to further optimize their plans, a stochastic user equilibrium is reached, which represents the individual behaviour in the real-world system.

Implementations of car-sharing, bike-sharing and ride-sourcing are already available in MATSim, but so far, the different systems have only been implemented and studied separately. For this research, the different implementations of shared mobility systems were adapted so that for the first time they can be simulated jointly allowing to observe their interplay. For this research, both station-based and free-floating schemes of shared mobility are considered. Each of the schemes is implemented as individual mode, but can be used as a part of a multi-modal trip, e.g. in combination with public transportation.

Using the city of Basel, Switzerland, as a case study, different scenarios are addressed in the simulation by varying for example the number and density of the vehicle fleets of the various systems as well as their price levels. To estimate the impact of policy measures on the success of the different

shared mobility schemes, some of these measures are also included in the scenarios. Among these are service levels of public transportations, car taxation or access regulations for parts of the urban area.

The research presented in this paper will provide a menu of scenarios of different large-scale implementations of shared mobility systems and accompanying policy measures. For each scenario, indicators such as the total travel time in the network, the overall transport-related energy consumption and the profitability of shared mobility providers will be calculated. The results of this research will contribute to a better understanding of how the different forms of shared mobility interact with each other as well as with the transport system. Using the insights provided by the simulations, the market potential and possible composition of a shared mobility system can be determined from an operator's perspective. Moreover, the different scenarios help policy makers to take qualified decisions on shared mobility systems knowing about the costs and benefits as well as the effectiveness of policy measures in channelling their development.

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