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Disaggregated car fleets in microscopic travel demand modelling

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Abstract

Microscopic travel demand models take the characteristics of every individual person of the modeled population into account for computing the travel demand for the modeled region. The real world mobility of individuals strongly depends on the specific available car, if any. However, mode choice models usually take a standard average car as reference. This paper shows an integrated approach to model the travel demand with respect to car specific attributes. The proposed work uses a synthetic population for the German capital of Berlin and simulates the travel demand for different examples that replicate car specific changes in fuel price, fleet distribution and entrance restriction. Some of these car-specific measures influence the travel behavior on a level that cannot be modeled when using an average car at all. Furthermore, the results show significant changes in usage of specific car segments, which would be difficult to model using an averaged car.

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*Keywords:*travel demand; microscopic modeling; car fleet; disaggregated cars; agent based modeling

1. Motivation

Classic 4-step transport models have been dominating the operational use for traffic simulation, measure assessment and decision making for a long time. But flow-orientated modelling has certain limits, such as hardly achievable consistencies of trip chains or of shared resources as cars in the same household. This led to the idea, that transport is the sum of trips of individual persons, finally resulting in microscopic demand models[13]. These microscopic approaches maintain personal attributes as driving licenses and manage shared household resources such as the available cars for computing consistent daily activity patterns. Current microscopic travel demand models generate the travel behavior for every person in a synthetic population with respect to the person's household context to determine the population's reactions of changes in costs, travel time and/or demand. Often, an averaged vehicle is used. But the typical usage of an averaged vehicle does not take the individual costs of the vehicle's usage into account, which largely depend on the car's fuel consumption and type of engine. Therefore, growing interest in disaggregated car fleet appears as logical extension for microscopic travel demand models

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and has been implemented in various models[4,11]. However, car-specific attributes are often limited to load capacity and costs but do not extend to fleet distribution and location choice.

Currently travel demand models are increasingly applied to evaluate emission measures in local areas, such as access zones for different engine types[14]. Exempting electric vehicles from parking fees and taxes are also investigated[8], which has a major impact on mode choice and furthermore on the whole trip chain. Such car specific restrictions that have a significant impact on travel demand cannot be modeled adequately using a standard average car.

In this work, an approach to integrate a disaggregated car fleet in a microscopic travel demand model is presented. The simulated persons adopt their mode and location choice with respect to their personal car-specific costs and restrictions. The proposed approach is evaluated in different scenarios with varying prices, fleet structure and accessibility. The results show that the resulting behavior can be better interpreted if cars are not represented by an average standard instance.

The remainder is structured as follows. At first, the travel demand model used within the research is described in section 2. In section 3, the used simulation scenarios are explained. The results are given in section 4. This document ends with a summary, given in section 5.

2. Proposed model

This work presents the integration of a disaggregated car fleet in a microscopic activity based travel demand model called Travel-Activity PAttern Simulation (TAPAS)[9] and shows an application example for vehicle-specific measurements including access zones and fuel pricing.

Fig. 1 shows the flow chart of the simulation model which consists of four parts: population generation, activity generation, location choice and mode choice. The result of a TAPAS simulation mainly consists of a day plan for each person contained in the simulated population. This day plan consists of activities, locations, used modes, as well as travel-times. The final plan is checked for feasibility with respect to the simulated person's time and budget constraints. If the plan gets rejected, plan generation is repeated until an acceptable plan is found.

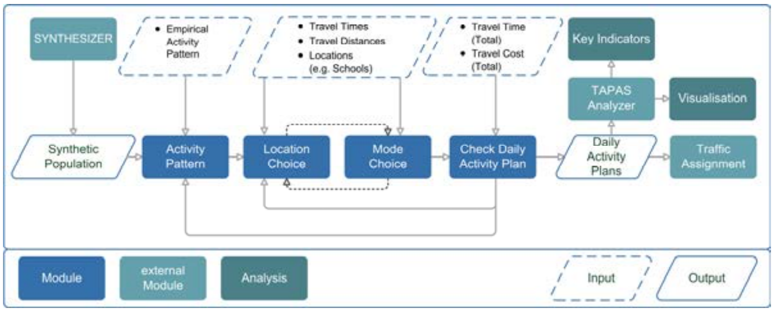

Fig. 1. TAPAS flow chart

The population in TAPAS is generated by combining various statistical data. Therefore the well-known Iterative Proportional Fitting (IPF) approach[3,7] was used to estimate household and person-level joint distributions for 12 different districts of Berlin. Afterwards, these distributions were used within the Iterative Proportional Updating (IPU) algorithm[17] for calculating sample household weights. This weight-based procedure for stochastic drawing of households results in the generation of a synthetic population that closely matches household and person-level distributions[17]. Finally, the households are further spatially distributed over the study area based on population density per block building. Each person of the synthetic population includes socio-demographic characteristics such as age, gender, employment status, mobility budget, public transport ticket, driver license and bike ownership. The associated households' attributes comprise the number of members, a specific total income and an available number of cars. The resulting population is stored in a database and can used for simulating different scenarios.

The car ownership is modelled by assigning an externally specified fleet, which consists of the numbers of vehicles per size, value, and fuel-type. Each household has an affinity to own up to two cars based on household size, income and number of driving licenses. The car affinity is derived from data of the SrV2008[1], one of the large national household time studies (NHTS) in Germany. Shares are expressed by a probability vector for having zero, one or two cars.

TAPAS computes the daily activity plan for each person by finding locations for each activity and determining the mode to get there. The individual persons are processed at household level. All persons from a