DESIGN OF A STATED PREFERENCE SURVEY TO ANALYZE INTERMODAL CHOICE BEHAVIOR OF CARSHARING USERS

Anna Reiffer, Martin Kagerbauer, Tim Hilgert, Michael Heilig, Peter Vortisch*
Institute for Transport Studies, Karlsruhe Institute of Technology (KIT)
Kaiserstrasse 12, 76131 Karlsruhe

**corresponding author*
Tel.: +49 721 602 47735
E-Mail: anna.reiffer@kit.edu

Keywords: carsharing, discrete choice model, demand modeling, stated preference survey

Problem Statement and Research Objectives

Transportation mode choice modeling is a quintessential step in travel demand modeling. The method of choice is to use revealed preference data from household surveys or trip diaries for discrete choice analyses. However, in recent years new modes of transportation have emerged which are often not represented adequately, neither in household travel surveys nor transportation models. Especially intermodal trips are often disregarded. In this paper, we focus on mode choice behavior of carsharing users on access and egress trips to and from carsharing stations.

Carsharing is a mode of transportation that has emerged in the late 1990s and has grown ever since (*1*). In traditional household travel surveys like the German Mobility Panel (MOP) or Mobility in Germany (MiD), the sample of carsharing members is still too small for mode choice models as carsharing is not used as regularly as other modes of transportation (*3; 2*). Thus, the likelihood of carsharing being chosen on a trip during the survey period is very low. Furthermore, survey designs often disregard intermodal behavior of respondents, meaning that there is missing information on modes of transportation when looking at a trip chain. In the case of carsharing, for example, station-based services often do not allow for vehicle availability comparable to owning a vehicle, i.e., the shared cars are often located at such a distance that walking is not always feasible whereas a privately owned vehicle is almost always parked within walking distance. Having to access a shared vehicle from a larger distance inevitably leads to an intermodal trip, where the trip might consist of not only a short walk but also of a public transit or bike ride as well. There are some survey designs, predominantly used in the US (*4; 5*) that are able to represent this trip chain behavior, however, surveys in Germany still often lack this possibility. Therefore, even if they include carsharing as a possible mode of transportation, there is no information on the individual stages, i.e., how the respondent got to the carsharing station.

The presented work includes a summary of the results of a preliminary analysis of data from a German carsharing provider and the design of a stated preference survey constructed to gather information on mode choice behavior for access and egress trips to and from a carsharing station. Furthermore, expected results on access trip behavior are included along with willingness-to-pay measures for access trip time.

Methodological Approach

Preliminary to a stated preference survey, carsharing data were analyzed to understand how carsharing is used. The data included the information on all bookings made in 2017 by subscribers of the services provided by stadtmobil Karlsruhe GmbH. The only other carsharing provider in the area is Flinkster, a service provided by Deutsche Bahn Connect GmbH. However, with ten vehicles stationed within a close radius around Karlsruhe central station, Flinkster cannot compare to stadtmobil. The

latter provides 944 cars at 277 stations in and around Karlsruhe and accounted for 232,675 bookings in 2017. Considering the high market share of stadtmobil Karlsruhe GmbH, the analysis is limited to users of this provider, and the stated preference survey is designed for those users as well.

To gather more insight into the behavior of carsharing users, a cluster analysis based on the aforementioned booking data was conducted. The k-means clustering algorithm was applied using frequency of usage, distance of single trips, variance of trip distances, tariff classes, day of the week the trip started as variables. Subsequently, the gap statistic was used to predetermine a fitting number of clusters statistically and using the heuristical elbow criterion, five was found to be the most suitable. A more detailed description of the work can be found in (*6*). After interpretation of the cluster characteristics, the following profiles were identified:

- Commercial Users
- Regular Weekly Activities
- Irregular Activities
- Second Car Replacement
- Travelers

Subsequently, to identifying different usage profiles, a stated preference survey was designed to gather more in-depth information on the entire trip and the stages of the trip that includes carsharing, i.e., not only characteristics of the trip while using the carsharing vehicle but also insight on how people get to and from the carsharing station. The survey is conducted online using a sample limited to subscribers of carsharing. This ensures that the respondents are not faced with situations which they might consider implausible. The sample is furthermore reduced by local restrictions, as only carsharing users of stadtmobil Karlsruhe GmbH are asked to participate. The supply of shared vehicles in Karlsruhe provided by stadtmobil is comparably high, and so is the rate of participation. Even though carsharing is not widely used in general, respondents in Karlsruhe tend to have more experience using the service, and therefore better results are to be expected compared to conducting the same survey in another region. Respondents are first be asked to provide data on socio-demographics, such as their age, gender, household income (aggregated into groups), household size, number of children, zip code of residence, number of privately owned cars, and so on. After providing data on socio-demographics, respondents are asked to answer hypothetical questions regarding the access to a carsharing station. They are given the distance to the carsharing station at which they will start their carsharing trip and are asked to choose between five different modes of transportation. The alternatives vary in time, cost and number of changes. The alternatives are

- walking (defined by travel time),
- bicycle (defined by travel time),
- shared bicycle (defined by access time, travel time and cost),
- passenger (car; defined by travel time and waiting time), and
- public transport (defined by access time, travel time, waiting time, number of changes and cost).

Alternatives are only included if the respondents first attest that they have access to that mode of transportation. Specifically, if respondents previously answered that they do not own a bicycle, then this alternative will be excluded from the choice set. The questions will differ both in the levels of time, cost and number of changes as well as the distance to the carsharing station. The attribute levels are also adapted based on previous statements on socio-demographics, for example, the cost shown for public transport is lower for respondents who stated that they have a season transit pass.

The hypothetical situations are presented to the respondents in similarly to a multimodal route choice application. The routes as well as the different trip chains are shown for each individual mode of transportation (see **Figure *1***). This schematic presentation helps resondents to better understand the hypothetical situations. In particular, the composition of the total travel time is visualized in a comprehensible manner.

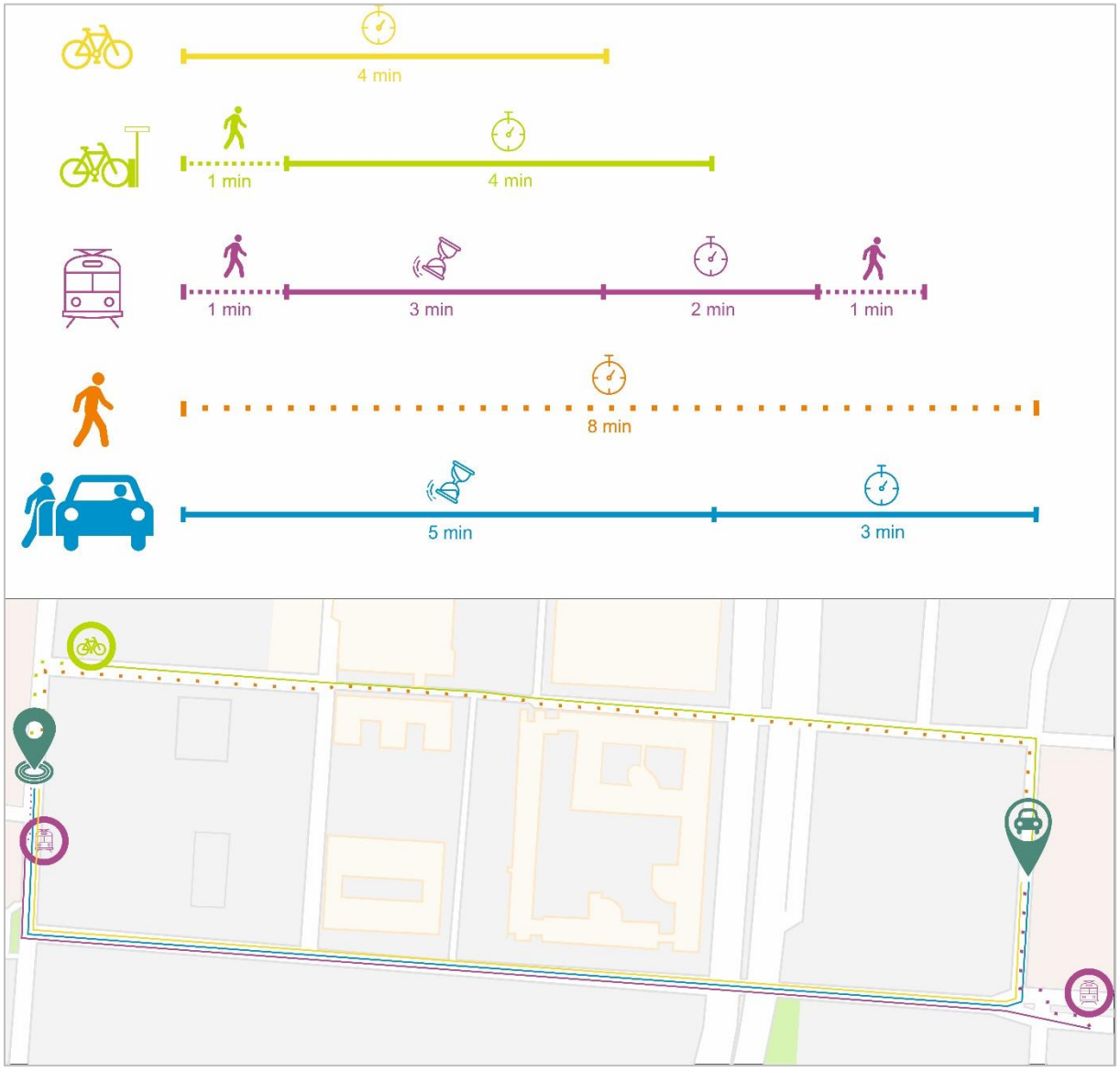

Figure 1 - Exemplary representation of a hypothetical choice situation

The data gathered from the aforementioned survey is used for transportation mode choice models using either multinomial, nested or mixed logit approaches. A multinomial logit model serves as a base model. A nested model is analyzed as correlations between modes might arise. These models are tested against mixed logit models to test if allowing for random taste variation yields better results. On the basis of the model parameters, further analyses are conducted, where willingness-to-pay measures are the main focus.

Expected results

Preliminary analysis reveals there is a possible correlation between the modes bicycle and shared bicycle, as travel times are only marginally different. We, furthermore, hypothesize that willingness-to-pay for access and egress trips is lower than for the carsharing trip itself or other trips, especially unimodal trips. This is justified by the fact, that the sole purpose of access and egress trips is to have a way to another mode of transportation, in this case carsharing and the high cost of these trips would rather lead to the choice of a transportation mode other than carsharing.

References

1. Bundesverband CarSharing e.V. *Anzahl registrierter Carsharing-Nutzer in Deutschland in den Jahren 2008 bis 2018*.
2. Zumkeller, D., B. Chlond, T. Kuhnimhof, M. Kagerbauer, C. Schlosser, M. Wirtz, and P. Ottmann. *Deutsches Mobilitätspanel (MOP) —wissenschaftliche Begleitung und erste Auswertungen Bericht 2008,* Institut für Verkehrswesen (KIT), 2009.
3. infas, DLR, IVT Research, and infas 360. *Mobilität in Deutschland - Ergebnisbericht*, 2017.
4. RSG. *2017 Puget Sound Regional Travel Survey - Final Report*, 2018.
5. U.S. Department of Transportation, and Bureau of Transportation Statistics. *2017 National Household Travel Survey.* https://nhts.ornl.gov/downloads. Accessed January 31, 2019.
6. Reiffer, A., T. Wörle, L. Briem, T. Soylu, M. Kagerbauer, and P. Vortisch. Identifying Usage Profiles of Station-Based Car-Sharing Members Using Cluster Analyses. In *TRB 98th Annual Meeting Compendium of Papers,* Washington, D.C., 2019.