(NON-) TRAFFIC RELATED FACTORS INFLUENCING THE ACCEPTANCE OF SHARED TRANSPORT SERVICES

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hEART 2020
9th Symposium of the European Association for Research in Transportation

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1 Introduction

The current discussion about how to reach climate targets for the transport sector (EEA, 2018) mainly focuses on two areas: improving the efficiency of vehicles and shifting transport toward more sustainable modes (Dalkmann and Brannigan, 2007). As improving efficiency might lead to negative side-effects such as rebound effects (Dimitropoulos et al., 2018), increasing the use of shared transport services might be crucial. These services offer the potential to shift transport demand away from motorized individual transport that is responsible for 32 % of transport related greenhouse gas emissions (EEA, 2018). Moreover, they could enhance multimodal transport behavior leading to a more sustainable transport system (Olafsson et al., 2016). However, how this shift might be realized and which factors are crucial to focus on is still subject to controversial debates. Thus, within this paper, we focus on shifting potentials towards shared transport services aiming for a better understanding of driving factors.

Past research shows that socio-demographic factors as well as personal attitudes affect transport choices (e.g. Burghard and Dütschke, 2019; Habib, 2019; Becker et al., 2017b). Furthermore, according to diffusion of innovation theory (Rogers, 2003), five factors are crucial for potential users to adopt new services or products: The relative advantage over established alternatives, compatibility with values and needs of the adopter, complexity of understanding or using the innovation, trialability in the sense of being able to test the innovation before deciding to adopt it and observability including its consequences. Previous empirical findings underline the importance of these factors for carsharing (Burghard and Dütschke, 2019).

Additionally, further personality-related characteristics drive mode choice: Rieser-Schüssler and Axhausen (2018) showed that routine seeking and environmentalism offer explanations for why people choose certain modes of transport. Hence, this might hold for shared services, too.

One drawback of extant research about shared transport services is their mostly regional or service-speciffic context (e.g. Morton, 2018; Becker et al., 2017a). Therefore, we extended the set of shared transport services surveyed to carsharing, bikesharing, scootersharing and ridesharing (see Figure 1). For this study, we presented the services as follows: Carsharing and bikesharing could be both station-based and free-floating with the extension that bikes could be non-electrified and electrified, i.e. pedelecs. Scootersharing refers to the rather new phenomenon of electrified scooters carrying one person and being operated as free-floating service. Ridesharing was presented as on-demand service transporting one single or several persons with routing optimization.

The aim of this study was to build on the findings above and to explore the effects of selected innovation-related demand-side factors on the usage intention towards these four shared transport services. To do so, we conducted a representative study in German cities. Using this data, we estimated probit regressions in order to analyze the driving or hindering factors of the acceptance of shared transport services.

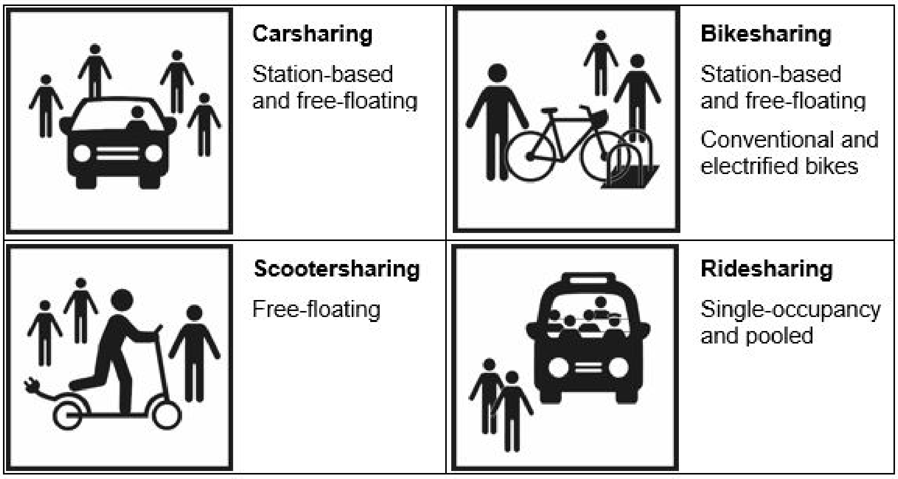

Figure 1: The four transport services studied: car-, bike-, scooter- and ridesharing

2 Method

2.1 Sampling and Participants

The study was conducted as an online survey using quota sampling. Only residents of German cities larger than 100,000 inhabitants were eligible for participation in the study (we applied the RegioStaR categorization (BMVI, 2020)). In total, N = 3,061 participants were recruited through the access panel of a service provider. Quotas for participants with the following characteristics were fixed on the basis of reference values provided by Eurostat for German cities above 100,000 inhabitants: region of residence (North, East, South), education (low, middle, high), and gender x age category (18-29, 30-39, 40-49, 50-59, 60-69, $>$ 70 years). Participants were randomly assigned to one of four sub-samples that differed with respect to the shared mobility service that was described and evaluated by participants (car-, bike-, scooter-, or ridesharing). The quotas applied to each sub-sample. After cleaning the dataset and excluding current users of the services, we analyzed the following sub-samples: carsharing (n = 471), bikesharing (n = 469), scootersharing (n = 446), ridesharing (n = 413). Data collection took place from late September to early October 2019.

2.2 Material

This section describes the assessment of the relevant variables here.

Sociodemographic variables. Participants indicated their age, gender, household income, level of education as well as the ZIP code of their residence.

Urban residence. Based on the reported ZIP code, we categorized participants into residents of urban areas with high-density characteristics (coded 1) and participants not living in these areas (coded 0). We used RegioStaR 7 for categorization (BMVI, 2020). High-density urban areas refer to metropolises (RegioStaR 71), less dense urban areas to regiopolises and cities (RegioStaR 72).

Mobility tools. Participants indicated whether they possessed a driver's license (0 = no, 1 = yes), the car accessibility in their household (1 = always, 2 = frequently, 3 = rarely, 4 = never), and whether they usually possess a subscription to public transport (transit pass; 0 = no, 1 = yes).

Environmentalism. To measure environmental concern, participants indicated their agreement with three statements (e.g. "Protecting the environment is an important concern to me.") on scales ranging from 1 ("I do not agree at all.") to 5 ("I agree completely."). The scale indicated a high level of validity (Cronbach's alpha = .94).

Routine seeking. Routine seeking was measured using a selection of five items (Cronbach's alpha = .72) from the respective subscale of the resistance to change scale (Oreg, 2003). Participants indicated their agreement (e.g. "I'd rather be bored than surprised.") on the same scale as environmentalism. We expect that the more people tend to seek routines, the less probable they are to use something new to them.

As described above, the theory about diffusion of innovations is based on five major factors, determining user acceptance (Rogers, 2003). Due to the scope of this research project, we focused on four factors (excluding relative advantage). Participants evaluated the presented transport service with respect to these four dimensions. We adapted scales from recent literature on the adoption of carsharing (Burghard and Dütschke, 2019). Since the scale measuring observability did not surpass the threshold of validity for all four sub-samples (Cronbach's alpha $< .7$), we excluded it from our analyses here.

Compatibility. To measure compatibility, participants indicated their agreement with four statements. For building the factor, one was dropped due to validity reasons (Cronbach's alphas: .92 to .94). Scales range from 1 ("I do not agree at all.") to 6 ("I agree completely.") with an additional do not know option (e.g. "Using [carsharing] is in line with my habits."). We expect that higher evaluations of compatibility should be related to a higher usage intention probability.

Ease of use. To measure ease of use, participants indicated their agreement with four statements. Again, one was dropped for building the factor due to validity reasons (Cronbach's alphas: .77 to .84) using the same response scale as for compatibility (e.g. "To use [carsharing] is simple."). We expect that higher levels of ease of use to be related to higher probabilities regarding usage intentions.

Triability. To measure triability, participants indicated their agreement with one statement using the same response scale as for compatibility: "I have the opportunity to try [carsharing] to judge it." As with compatibility and ease of use, higher scores on the triability scale are said to be related to a higher usage intention probability.

Usage intention. Participants indicated whether they could in principle imagine to use the mobility service they were presented with on a five-point scale (1 = definitely not, 2 = rather not, do not know, 4 = possibly yes, 5 = definitely yes). In order to better understand the (non-) traffic related factors driving or hindering adoption of the four transport services, we generated a dichotomous variable indicating intention to use the respective service in general. We aimed to analyze clear statements whether people would intend to use the services or not. Hence, we took two categories as usage intention ("possibly yes", "definitely yes") and the remaining three as no usage intention ("definitely not", "rather not", "don't know"). In doing so, we aim to be closer to real decisions transport users face in their daily routines.

3 Results

This section shortly introduces the distribution of the dependent variable usage intention across the five scale-points. Thereafter, the regression results are presented.

Figure 2 shows the reported intentions to use the shared transport services among respondents. It can be seen that ridesharing (35 %) and carsharing (31 %) exhibit the highest shares towards usage intention. 76 % would rather not use scootersharing or do not know whether they would use it. Bikesharing follows closely with 73 %.

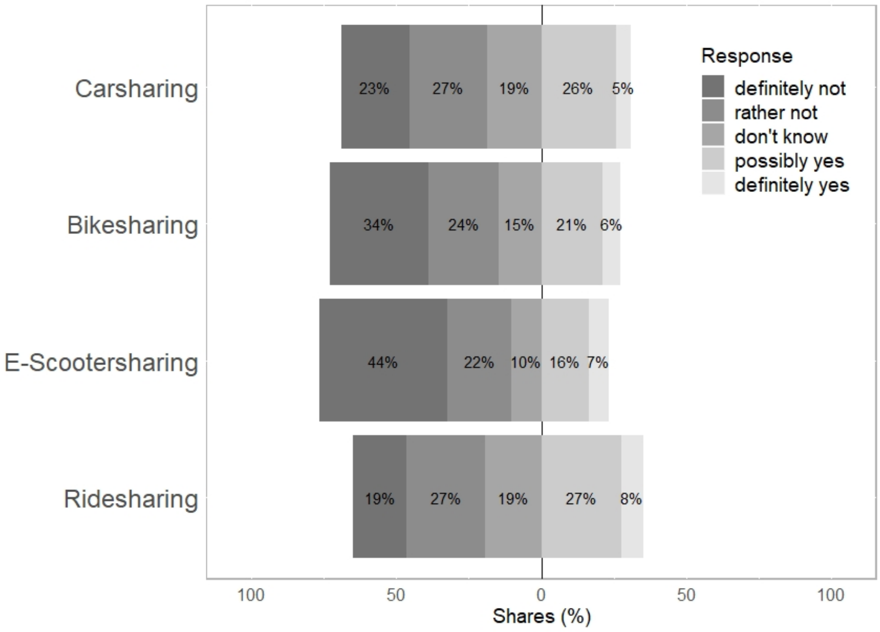

Figure 2: Usage intention for car-, bike-, scooter- and ridesharing

To analyze the influence of the variables in focus on acceptance of the services, we estimated one probit regression per shared transport service and used the binary variable indicating usage intention as dependent variable (Table 1). For comparability, we drew on almost the same set of regressors (see 2.2 Materials), which was also informed by descriptive results beyond the scope of this paper.

	Carsharing	**Bikesharing**	**Scootersharing**	**Ridesharing**
Age	-0.002	-0.002	-0.001	-0.001
Male	0.042	-0.046	0.004	0.016
Middle Income[1]	-0.006	0.043	-0.024	-0.089 *
High Income[1]	-0.111 *	-0.104 *	0.063	-0.054
Middle Education[2]	0.012	-0.017	0.054	0.055
High Education[2]	0.023	0.045	0.043	0.167 **
Urban Residence	-0.037	-0.098 **	0.030	0.040
Driver's License	-/- [3]	-0.042	0.001	-0.065
Car Availability	-0.018	-0.040	-0.081 *	0.016
Transit Pass	-0.038	-0.020	-0.040	0.041
Environmentalism	0.006	-0.014	0.007	0.003
Routine Seeking	-0.052 **	-0.018	-0.029 $^{\tau}$	-0.042 **
Compatibility	0.108 ***	0.072 ***	0.137 ***	0.147 ***
Ease of Use	0.054 **	0.070 ***	0.011	0.044 *
Trialibility	-0.013	0.019	-0.007	-0.004
Observations	471	469	446	413
Pseudo R^2	0.22	0.24	0.46	0.51
Likelihood Ratio Test	3.71e-20	2.90e-20	1.43e-39	6.73e-51
Log Likelihood	-219.05	-210.24	-133.06	-135.54

p-values of probit coeffcients are given as follows:
*** $p < 0.01$; ** $p < 0.1$; * $p < 0.05$; $^{\tau}$ $p < 0.10$ (robust standard errors)

[1] Income is net income of private household (after taxes and social insurance contributions). The reference category is low income (< 2,000 €).
High income is above 4,000 € (see Federal Statistical Office (2018)).
[2] The reference category is low education (up to O-level).
High education is a bachelor's degree and above.
[3] Respondents were filtered so that those of the carsharing sub-sample had to hold a driver's license. Hence, this variable was excluded here.

Table 1: Average marginal effects on usage intention for car-, bike-, scooter and ridesharing from single probit regressions for each service.

Respective Likelihood Ratio Tests show very high significance of the estimated models. The Pseudo R^2 ranges between .22 (carsharing) and .51 (ridesharing).

For the purpose of interpretability, we calculated average marginal effects (AME). Compatibility exhibits a highly significant positive impact in all models. The direction of impact is as expected: A higher compatibility of the service with the person's values and needs is related with a higher usage intention probability. The impact is rather high: 14.7 ppts. for ride-, 13.7 ppts. for scooter-, 10.8 ppts. for car- and 7.2 ppts. for bikesharing. Ease of use is significant for all models but scootersharing. The direction is again as expected: An easier use of the service is related with a higher usage intention. The impact is lower than what can be seen for compatibility: It is 7.0 ppts. for bike-, 5.4 ppts. for car- and 4.4 ppts. for ridesharing. Trialibility does not show significant effects. Routine seeking shows significant effects for carsharing (-4.6 ppts.), ridesharing (-4.2 ppts.) and scootersharing (-2.9 ppts.). The direction is again as expected: Lower levels of seeking for routines are related to higher probabilities of usage intention.

Interestingly, holding mobility tools is of almost no significance for the usage intention. The exception is scootersharing with car accessibility exhibiting a negative effect (-8.1 ppts.). Hence, for scootersharing, having access to a car in the household is related to a lower probability concerning usage intention.

A residence in a highly dense urban area exhibits a significant effect in the bikesharing model only (-9.8 ppts.). This translates into a lower probability of the intention to use bikesharing in highly dense urban areas. It might be related to sometimes bad cycling conditions in dense areas or a better public transport system that is not available in less urbanized areas.

Whilst age and gender do not play significant roles in all four models, higher incomes are related with less usage intention for car-, bike- and ridesharing. As this especially holds for the highest income category, it might indicate that there is an income-bound up to which these services are attractive. On the contrary, high education is related to a higher probability to intend to use ridesharing (16.7 ppts.).

4 Discussion and Conclusion

As the results show, the innovation-specific individual-level variables enhance the understanding of the usage intention towards the shared transport services in question here. The effects of compatibility show that, as with most modes of transport, shared transport service need to be neatly integrable into the values and needs of transport users. Previous findings show that compatibility is related to attitudes towards carsharing (Burghard and Dütschke, 2019). Our analyses show that this finding can be extended to usage intention. Moreover, this effect also holds for bikesharing, scootersharing and ridesharing. The non-significance of environmentalism is in contradiction to previous findings (Rieser-Schüssler and Axhausen, 2018). However, for the study at hand, respondents could only state their usage intention to the shared service without being offered an alternative. This might overlay respective effects. Nevertheless, although respondents indicated rather high environmental concerns, this seems not to affect the choice regarding shared transport services. On the other hand, we could confirm effects of routine seeking (Rieser-Schüssler and Axhausen, 2018). As in previous studies for carsharing (Becker et al., 2017a), we could reinforce the finding of gender effects. Becker et al. (2017a) showed this effect for free-floating but not for station-based carsharing. As we did not follow this differentiation here, we can only conclude a general effect of gender for carsharing in total. Our findings of holding mobility tools not playing a heavily significant role for the intention to use one of the services might be surprising. However, previous studies mostly analyzed reduction of vehicle ownership after having joined a, for instance, carsharing service (Becker et al., 2018; Namazu and Dowlatabadi, 2018). From our data, we can conclude that missing private car accessibility is not a prerequisite for the intention to use shared transport services.

This study explored non-traffic and traffic related factors influencing the usage intention of carsharing, bikesharing, scootersharing and ridesharing. We found innovation-related variables such as compatibility or ease of use to be important and socio-economic characteristics of respondents such as age, income or education to be of lower importance.

Acknowledgement

This publication was written in the framework of the Profilregion Mobilitätssysteme Karlsruhe, which is funded by the Ministry of Economic Affairs, Labour and Housing in Baden-Württemberg and as a national High Performance Center by the Fraunhofer-Gesellschaft.

References

Becker, H., Ciari, F., and Axhausen, K. W. (2017a). Comparing car-sharing schemes in Switzerland: User groups and usage patterns. *Transportation Research Part A: Policy and Practice*, 97:17–29.

Becker, H., Ciari, F., and Axhausen, K. W. (2018). Measuring the car ownership impact of free-floating car-sharing – A case study in Basel, Switzerland. *Transportation Research Part D: Transport and Environment*, 65:51–62.

Becker, H., Loder, A., Schmid, B., and Axhausen, K. W. (2017b). Modeling car-sharing membership as a mobility tool: A multivariate Probit approach with latent variables. *Travel Behaviour and Society*, 8:26–36.

BMVI (2020). *Regionalstatistische Raumtypologie (RegioStaR)*. Retrieved from https://www.bmvi.de/SharedDocs/DE/Artikel/G/regionalstatistische-raumtypologie.html.

Burghard, U. and Dütschke, E. (2019). Who wants shared mobility? Lessons from early adopters and mainstream drivers on electric carsharing in Germany. *Transportation Research Part D: Transport and Environment*, 71:96–109.

Dalkmann, H. and Brannigan, C. (2007). *Transport and Climate Change: Module 5e: Sustainable Transport: A Sourcebook for Policy-makers in Developing Cities*. Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, Eschborn.

Dimitropoulos, A., Oueslati, W., and Sintek, C. (2018). The rebound effect in road transport: A meta-analysis of empirical studies. *Energy Economics*, 75:163–179.

EEA (2018). *Greenhouse gas emissions from transport*. Retrieved from https://www.eea.europa.eu/data-and-maps/indicators/transport-emissions-of-greenhouse-gases/transport-emissions-of-greenhouse-gases-11.

Federal Statistical Office (2018). *Wirtschaftsrechnungen: Laufende Wirtschaftsrechnungen: Einkommen, Einnahmen und Ausgaben privater Haushalte*, volume 6 of *Fachserie 15 - Wirtschaftsrechnungen*. Wiesbaden.

Habib, K. N. (2019). Mode choice modelling for hailable rides: An investigation of the competition of Uber with other modes by using an integrated non-compensatory choice model with probabilistic choice set formation. *Transportation Research Part A: Policy and Practice*, 129:205–216.

Morton, C. (2018). Appraising the market for bicycle sharing schemes: Perceived service quality, satisfaction, and behavioural intention in London. *Case Studies on Transport Policy*, 6(1):102–111.

Namazu, M. and Dowlatabadi, H. (2018). Vehicle ownership reduction: A comparison of one-way and two-way carsharing systems. *Transport Policy*, 64:38–50.

Olafsson, A. S., Nielsen, T. S., and Carstensen, T. A. (2016). Cycling in multimodal transport behaviours: Exploring modality styles in the Danish population. *Journal of Transport Geography*, 52:123–130.

Oreg, S. (2003). Resistance to change: developing an individual differences measure. *The Journal of applied psychology*, 88(4):680–693.

Rieser-Schüssler, N. and Axhausen, K. W. (2018). Investigating the Influence of Environmentalism and Variety Seeking on Mode Choice. *Transportation Research Record: Journal of the Transportation Research Board*, 2322(1):31–41.

Rogers, E. M. (2003). *Diffusion of Innovations*. Free Press, Riverside, 5th edition.