THE IMPORTANCE OF ACCEPTANCE FOR THE USAGE OF MULTIMODAL SHARING SYSTEMS IN CORPORATE TRANSPORTATION

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ABSTRACT

The present study aims to investigate user acceptance and usage behaviour of a multimodal transportation sharing system for business travel. Integration of a multimodal sharing system with battery electric vehicles, electric bicycles and public transport, was established at the Chemnitz University of Technology. The field trial was designed as a longitudinal study with four data collection points: prior to system use, and at two, 16, and 24 weeks post system use. At each data collection point, both users and non-users reported high system acceptance as assessed by both Van Der Laan Acceptance – Scale and the Technology Acceptance Model. Over time, system acceptance varied between and within the two groups, with acceptance remaining same in non-users, while significantly increasing for users. Usage experiences may increase acceptance and support users to adapt to new mobility concepts.

Keywords:

Business travel, electric vehicles, multimodal mobility, user behaviour, user experience

1. INTRODUCTION

Intelligent mobility concepts including sharing systems, and alternative means of transport such as battery electric vehicles (BEVs), electric bicycles (pedelecs), and public transport, are promising solutions for sustainable future mobility, given their reduced emissions. Moreover, in recent years, car-sharing popularity is growing rapidly worldwide. In 2014 nearly 5 million people used such a service compared to 0.67 million in 2008 (ACEA, 2017). Car-sharing leads to a reduction of travelled kilometers (Shaheen et al., 2009) and emissions (Firnkorn & Müller, 2011). Due to the combination with other means of transport an efficient land use and multimodal transportation (i.e. having access to different means of transport in making a trip) is favoured (Schröder & Wolf, 2017). These changes in transport behaviour are thought to be attributable to a positive attitude towards alternative and sustainable means of transport (Genikomsakis, Ioakimidis, Bocquier, Savvidis, & Simic, 2013; Kuhnimhof et al., 2011). Studies show, that alternative mobility systems (i.e.

electric driven) have higher acceptance values compared to conventional combustion systems (Kilian-Yasin, Wöhr, Tangour, & Fournier, 2016).
Positive environmental effects of car-sharing systems may be further increased by the incorporation of BEVs in this context, due to their potential to run without emissions. The integration of bicycles and public transport use into a multimodal mobility behavior provide additional sustainable and pro-environmental benefits (Nikitas, Wallgren, & Rexfelt, 2016). Despite the known positive environmental effect of multimodal sharing systems, such services are relatively novel and often not comparable, due to city-specific solutions, even within a single nation (Willing, Brandt, & Neumann, 2017). Research examining the acceptance of such a multimodal system is lacking. However, user perspective is a key element for market penetration of new mobility systems, with acceptance being an important indicator for the usage of alternative mobility systems and means of transport (Bühler et al., 2014; Kilian-Yasin et al., 2016). Furthermore, acceptance is the pre-condition for making use of an alternative mobility system, and improves the likelihood of a successful adoption process (Kilian-Yasin et al., 2016). Previous research has shown that experience is a relevant moderator for acceptance and evaluating BEVs (Bühler, Cocron, Neumann, Franke, & Krems, 2014; Cocron & Krems, 2013). Several studies focusing on user acceptance of BEV-sharing systems, have shown influencing factors, such as individual (e.g., income and education), and service-related factors (e.g., price and type of car) (Genikomsakis et al., 2013; Kilian-Yasin et al., 2016; Wang et al., 2017). A reported barrier to car-sharing adoption is insurance coverage (Shaheen et al., 2012). These economic barriers pose a confounder in the study of user acceptance. Compared to personal car-sharing users, corporate car-sharing users consider handling-related factors more important for acceptance of a system. Corporate car-sharing refers to a free of charge car pool used by employees for business travel. In a study of Fleury, Tom, Jamet, and Colas-Maheux (2017), ease of use (i.e. effort expectancy) was the primary factor in acceptance of this service. Thus, acceptance in corporate transportation is uninfluenced by economic therefore provides a better model to investigate users' acceptance of multimodal sharing systems.
To better understand the adoption process of a new mobility system, we evaluated changes in user acceptance by employing multi-point data collection on the same participants, over a longitudinal study. This investigation in the context of multimodal sharing systems and corporate usage is still missing in the literature.

1.1 Study objectives

The objectives of the present study were to investigate a change in users' acceptance and usage behavior of a multimodal sharing system (MSS), for business travel, over six months. The following research questions (Q) were addressed:

Q1: How can employee's usage behavior of MSS, in the context of corporate-related mobility at Chemnitz University of Technology, be characterized?

Q2: How does user's MSS acceptance change over time?

Q3: Is there a difference between MSS non-users and users regarding acceptance?

2. METHODOLOGY

The present research was part of a field study, conducted at Chemnitz University of Technology (Born et al., 2016). A corporate MSS, with free access to four BEVs, eight pedelecs (i.e. electric bicycles), and public transport was integrated into a corporate travel offered to employees. The MSS was only available for business travel and for academic staff. Participants were able to reserve and book their favoured means of transport via a web application booking tool (i.e. ICT solution). The booking tool for all means of transport was available at four university charging stations, at different locations, and additionally via the study webpage. For further details, see Born et al. (2016).

3.1 Study design

The longitudinal study design involved four data collection points: prior to participants receiving free access to MSS (T0m1), and two (T0), 16 (T1) and 24 (T2) weeks post MSS usage. MSS launch and data collection commenced on August 1st, 2016. At each data collection point, participants completed an online questionnaire. After T0m1, participants received a comprehensive technical briefing of the MSS, including vehicle and booking tool handling, conditions of use (e.g., restricted to business travel), and required data collection points. To yield a high sample size, new participants were able to continually enrol in the study, resulting in different sample sizes at each data collection point (N_{T0m1} = 184, N_{T0} = 147, N_{T1} = 98, and N_{T2} = 61). Only participants who completed all four data collection points, are analysed herein.

3.2 Participants

Information on the project was distributed via university newsletter, internal press release and the study homepage. Any interested university staff, of approximately 2500 employees were able to access the study via an application questionnaire on the study webpage. Participant inclusion criteria were (1) active employment with Chemnitz University of Technology (due to

aspects pursuant to insurance law; e.g., no parental leave), (2) willingness to take part in the data collection, and (3) acceptance of the legal conditions of use.
Participants were categorised as non-users and users. Non-users did not book any business travel via the MSS. Users completed one or more business trips using one of the offered means of transport. Non-users (N = 15) and users (N = 46) did not differ in demographics (Table 1). Of the MSS non-users, 73% were male, 80% university educated, and with a mean age of 38 years (SD = 11.87). Similarly, MSS users were majority male (80%), with a university education (96%) and a mean age of 37 years (SD = 8.98).

Table 1
Participant demographics.

	User	Non-user	Total	Significance test between the two groups
N	46	15	61	
Gender				
Male	37	11	48	$\chi^2(1) = .340$,
Female	9	4	13	$p = .560$
Age	$M = 36.93$	$M = 37.73$	$M = 37.13$	$t(19.50) = .24$,
	($SD = 8.98$)	($SD = 11.87$)	($SD = 9.67$)	$p = .813$
Education				
University	44	12	56	$\chi^2(3) = 4.761$
Master/Prof. school[1]		1	1	$p = .190$
Vocational education	1	1	2	
Still in education	1	1	2	

Note. Significance tests were two-tailed. [1] Prof. school = professional school.

3.3 Questionnaires

The Van Der Laan Acceptance – Scale (Van Der Laan et al., 1997) and the Technology Acceptance Model (TAM; Davis, Bagozzi, & Warshaw, 1989) were used to assess the MSS acceptance. The instructions were framed: “Please assess the MSS at Chemnitz University of Technology as a whole; including all components and functions necessary for operation. Please assess the integration of BEVs, pedelecs, and public transport, into a comprehensive transport concept. Consider vehicle access, networking, and booking tool.”

3.3.1 Van Der Laan Acceptance – Scale

The Van Der Laan Acceptance – Scale consists of the two sub-facets usefulness (five items) and satisfaction (four items), with items answered on 5-point semantic differential from -2 to +2. Examples are superfluous/effective (usefulness) and unpleasant/pleasant (satisfaction). Satisfaction and usefulness were assessed at all data collection points. Reliabilities

(Cronbach's alpha) for usefulness were from questionable to good ($α_{T0m1}$= .75, $α_{T0}$ = .76, $α_{T1}$ = .60, $α_{T2}$ = .86). Reliabilities for satisfaction were from acceptable to excellent ($α_{T0m1}$= .83, $α_{T0}$ = .72, $α_{T1}$ = .83, $α_{T2}$ = .90).

3.3.2 Technology Acceptance Model

We used the three sub-scales: perceived ease of use (PEU), perceived usefulness (PU), and behavioural intention to use (BIU). All sub scales were answered on a six item 5-point Likert scale from 1 *strongly disagree* to 5 *strongly agree.* Example items for each sub scale are "Using the MSS was easy to learn for me." (PEU); "Overall, I find the MSS useful." (PU); and "I intend to use the MSS in the future." (BIU). The three sub-scales were assessed at T0, T1 and T2. PEU-reliabilities were from good to excellent ($α_{T0}$ = .87, $α_{T1}$ = .86, $α_{T2}$ = .90). PU- reliabilities ($α_{T0}$ = .80, $α_{T1}$ = .78, $α_{T2}$ = .86) and BIU-reliabilities ($α_{T0}$ = .83, $α_{T1}$ = .74, $α_{T2}$ = .79) were from acceptable to good.

3.4 Data Collection of MSS-usage

To examine the MSS usage, we reviewed booking data, logged via the booking system. Each participant's MSS interaction (reserved, revoked, cancelled, or completed trips, with the three means of transport) was recorded in the study database. Only completed trips (independent of travel mode choice) are reported here.

3. RESULTS

Repeated measures analysis of variance (ANOVA) was used to examine the influence of experience on acceptance. The data collection points were considered as within-subjects-variables (Van der Laan: four points of data collection, TAM three points of data collection). Practical experience was used as between-subject-variable to investigate differences in the MSS acceptance between users and non-users.
Univariate outliers were tested according to Grubbs (1969). One outlier (z = 3.769) was identified and removed in the satisfaction$_{T0m1}$-scale. Main effects and interactions were interpreted with a significance level of p > .05, and two-tailed tests were used. Interactions were used to examine if non-user and user groups differ in their MSS acceptance over time. Effect sizes are interpreted according to Cohen's conventions (1992): $η^2_p$ = .01, weak; $η^2_p$ = .06, moderate; and $η^2_p$ = .14, strong effect.

4.1 MSS usage

Characterisation of employee's corporate-related mobility usage behaviour of MSS (Q1) was based on 467 completed trips, recorded by 46 users over 24 weeks. The completed trips equated to approximately 3510 driven kilometres.

The BEVs were used most frequently (267 trips, 2520 km), followed by pedelecs (105 trips, 560 km), and then public transport (95 trips, 430 km). There was high variability in usage frequencies of the MSS and driven kilometres between users and at each data collection point. On average, each user completed 10.2 trips (*SD* = 16.15, *MIN* = 1, *MAX* = 107) with an average distance of 7.56 km (*SD* = 9.24, *MIN* = 1 km, *MAX* = 94 km). Usage frequencies and corresponding driven kilometres are displayed in Figure 1.

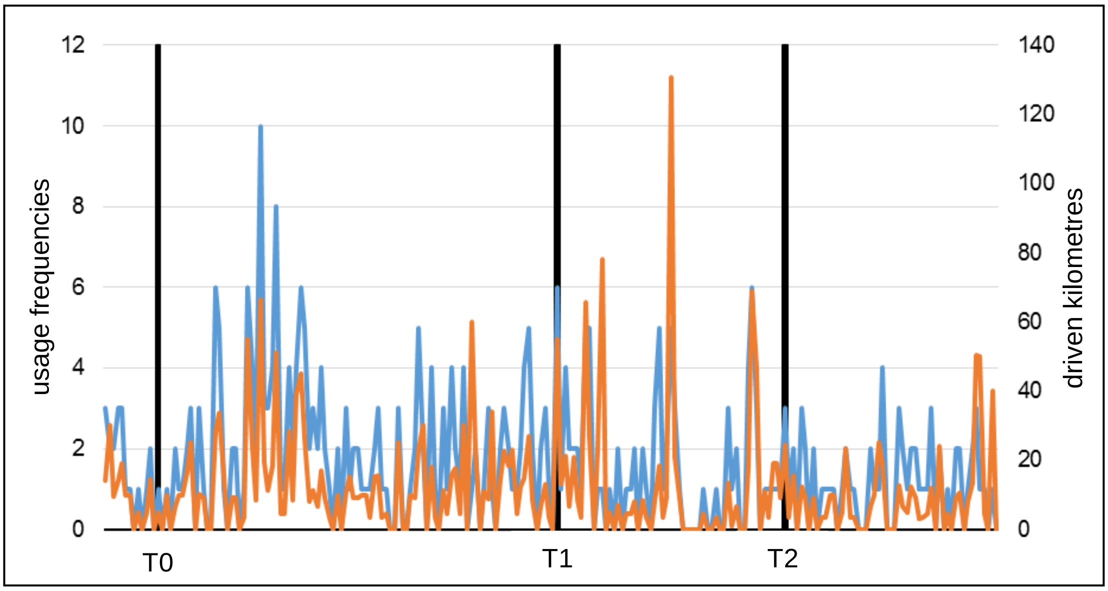

Figure 1. Usage frequencies and driven kilometres of the MSS at three data collection points, over 24 weeks.
Note. The figure refers to the aggregate usage frequencies (blue) and driving distances (orange) across all means of transport per day.

Within the first 14 days (between technical briefing and T0) there were 128 trips (corresponding to 805 driven kilometres). Between T0 to T1 (after 16 weeks) there were 274 trips (1919 driven kilometres) and between T1 and T2 (24 weeks) there were only 65 trips (786 driven kilometres).

4.2 MSS acceptance

At each data collection point, MSS acceptance is high. Descriptive statistics of the Van der Laan and TAM-sub scales between the different data collection points and between users and non-users are shown in Figures 2 and 3 respectively.
Except for usefulness, there are no significant changes in any acceptance-sub-scale over time ($F_{usefulness}(3, 59) = 3.21$, $p = .029$, $\eta^2_p = .05$, $F_{satisfaction}(3, 59) = 1.13$, $p = .335$, $\eta^2_p = .02$; $F_{PEU}(2, 59) = 1.34$, $p = .265$, $\eta^2_p = .02$; $F_{PU}(2, 59) = .11$, $p = .885$, $\eta^2_p = .00$; $F_{BIU}(2, 59) = 1.32$, $p = .271$, $\eta^2_p = .02$). The significant time effect in usefulness results because of the decrease between T0m1 and T1 in the non-user group. Post hoc test

(Bonferroni-corrected for multiple comparisons) revealed a significant (p = .015) decrease.

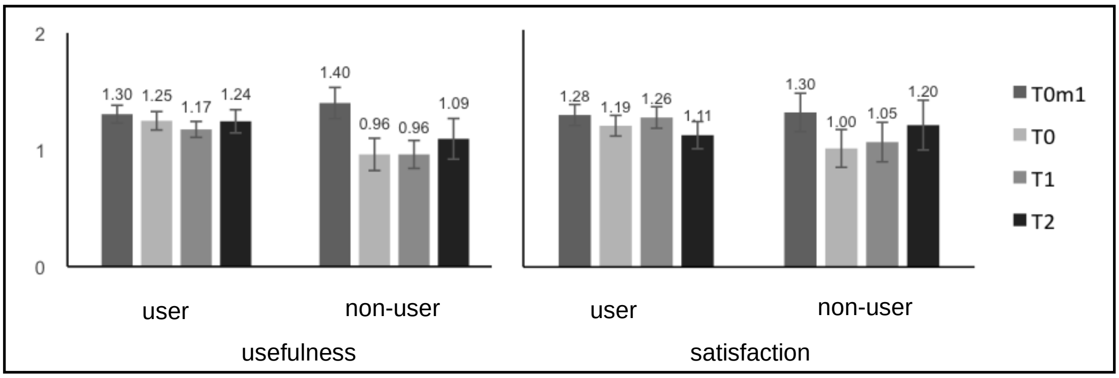

Figure 2. Usefulness and satisfaction of the MSS between users and non-users at four data collection points.

Note. N_{user} = 46, $N_{non\text{-}user}$ = 15. The usefulness and satisfaction scale ranged from -2 to +2. Error bars represent the standard error. Mean values are shown at the respective bars.

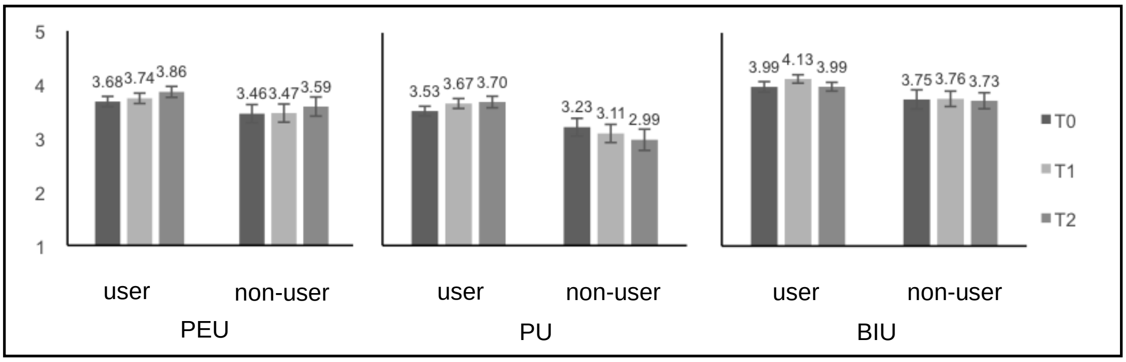

Figure 3. PEU, PU and BIU of the MSS between users and non-users at three data collection points.

Note. N_{user} = 46, $N_{non\text{-}user}$ = 15. The PEU, PU and BIU scale ranged from 1 to 5. Error bars represent the standard error. Mean values are shown at the respective bars.

There were no significant interactions between point of data collection and group ($F_{usefulness}(3, 59) = 1.38$, $p = .252$, $\eta^2_p = .02$; $F_{satisfaction}(3, 59) = .52$, $p = .643$, $\eta^2_p = .01$; $F_{PEU}(2, 59) = .04$, $p = .948$, $\eta^2_p = .00$; $F_{PU}(2, 59) = 2.54$, $p = .087$, $\eta^2_p = .04$; $F_{BIU}(2, 59) = .17$, $p = .808$, $\eta^2_p = .00$). Changes in users' MSS acceptance over time (Q2), was determined through analysis of satisfaction and usefulness at four data collection points. Users and non-users had highest values in satisfaction and usefulness pre acceptance (T0m1; prior to experience). Over usage time, inhomogeneity in MSS acceptance (even for non-users) was observed in both non-user and user groups. In non-users, an increase in usefulness and satisfaction was observed, significant for the former. For users, no significant difference was found in usefulness or satisfaction at time points during experience. Compared to non-users, users

PEU in MSS acceptance is somewhat higher, however not significant (small effect size). Over time, within group variation is minimal. Similarly, compared to non-users, user PU is higher. Within groups, over time, PU increased in users, and decreased in non-users. These changes were non-significant. BIU values were near consistent between and within groups, over usage time.
To determine whether there is a difference between MSS non-users and users regarding MSS acceptance (Q3) group comparisons were made. PU and BIU were significantly different between users and non-users ($F_{usefulness}(1, 59) = 1.61$, $p = .209$, $\eta^2_p = .03$, $F_{satisfaction}(1, 59) = .60$, $p = .443$, $\eta^2_p = .01$, $F_{PEU}(1, 59) = 2.57$, $p = .114$, $\eta^2_p = .04$; $F_{PU}(1, 59) = 10.45$, $p = .002$, $\eta^2_p = .15$; $F_{BIU}(1, 59) = 6.45$, $p = .014$, $\eta^2_p = .10$). Small effect sizes indicated higher MSS acceptance for users compared to non-users. Except for $usefulness_{T0m1}$, $satisfaction_{T0m1}$ and $satisfaction_{T2}$ users reported higher levels of MSS acceptance compared to non-users. Large effect sizes were investigated for PU and BIU.

4. DISCUSSION

This paper presents the results of a longitudinal study conducted at Chemnitz University of Technology, to investigate the acceptance and usage behaviour of a MSS for corporate travel within a 24 week duration. The analysis revealed high usage frequencies of all three means of transport and high values of user acceptance of the MSS and underlie the importance of MSS in the business context. The longitudinal study design and multi point data collection enabled investigation of the adoption process of the MSS. Variation in long-time acceptance, and the influence of usage experience independent of economic-related confounding variables such as sharing costs and insurance coverage, were evaluated. PEU and PU increased over usage time, with both non-user and user groups showing high acceptances values of the MSS. This suggests the positive pro-environmental effect of the MSS is recognised by both groups. The high acceptance values combined with high usage-independent BIU-values suggests that there is potential for increased future use of the MSS.

4.1 Limitations

When interpreting the high acceptance values, the following limitations should be considered. First, user sample is biased to university educated single site population within a university. Thus, the user segment of university employees is not representative for the general population. Previous research has found, that university members have a higher attitude to car-sharing services compared to the general population (Zhou, 2012).
Second, we only could investigate the acceptance and usage behaviour of a single university. A multi-site corporate car-sharing system comparison, with university educated and non-university educated users, may be more

informative of user acceptance of MSS. Due to the four main locations at Chemnitz University of Technology, business trips could be artificially generated and it could be that this context represents not a typically picture of a corporate MSS. Furthermore, given the university context may not be representative of corporate MSS, a mixed sample of industry and university users may be insightful. Further, high variability in the distances travelled (1 km vs. 94 km) and number of trips (1 vs. 107 trips within 24 weeks) taken by each user, also affects user acceptance. Categorising distance and users as low, medium, high users, may reveal differences in acceptance.

Last but not least, due to the fact, that the previous car-sharing system with conventional combustion engineering vehicles was still additionally available, all university completed business trips, and number of car-sharers, were unidentifiable. Availability of owner cars, satisfaction of the car-sharing with conventional combustion engineering vehicles, limited numbers of BEVs and pedelecs, all contribute to user acceptance and satisfaction of MSS. For example, the limited range and space (only a double-seater) of the BEVs could lead to a considerably number of regular business trips, which could not have been completed with the MSS.

5.2 Future research

The presented research provides the framework for further investigations. First, within the paper we used a preliminary sample. We plan to extend this study by increasing and broadening our user sample, and including additional data collection points to determine when specific changes occur. This enables advanced analysis (e.g., regression analysis to predict usage behavior) and will provide a comprehensive outline of the MSS.

Second, the effect of all components of the MSS (i.e. booking tool, vehicle access and means of transport) requires investigation. Other usage influencing factors such as personality traits and environmental attitudes could be examined under controlled conditions where vehicle type, as well as distance travelled, are comparable. Our findings showing less frequent use of pedelecs and public transport compared to BEVs, provides opportunity for future investigations on differentiating acceptance factors. Such factors may include means of transport, time efficiency, trip distance, weather conditions, luggage, comfort, convenience, and reliability.

Finally, our pilot study provides a framework for further studies examining user experience and interaction with other MSS because sustainable mobility systems are topical.

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