Evaluation of an Integrated Intermodal Travel Service

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Abstract: Combining heterogeneous mobility services during one single trip, intermodal traveling is hindered by barriers on different levels. Especially, by incorporating (electric) sharing services, e.g., car- or bikesharing, complex travel chains might occur. To provide flexible intermodal mobility to users, integration has to be realized in various areas: Beyond the provision of comprehensive travel information, it is possible to integrate even further on the business model level. Within a large field test of a comprehensive travel information system, called Mobility Broker, perceptions towards an integrated offering of heterogeneous mobility services are examined. Hereby, different services are not only integrated concerning travel information, but also in the area of distribution. Results indicate that the solution has the potential to deliver extensive flexibility for mobility users and to lower barriers towards alternative mobility modes. Nevertheless, transparent implementation is required and capacity issues could form an obstructive bottleneck. Furthermore, data security and privacy issues could be barriers for widespread acceptance of bundled tariffs.

1 INTRODUCTION

Contemporary mobility and transport modalities have to meet a variety of criteria, which are difficult to realize: They must meet community needs, such as broad accessibility, comfort, safety, sustainability and affordability. In the past, mobility options were not interlinked, but today, they must be intermodal, flexible and designed as "door-to-door" mobility chains. Also, it is becoming increasingly important to integrate users into the design process for new products to achieve widespread diffusion and market acceptance (Göransson et al., 2004). This is also applicable to infrastructure planning, in which citizens demand to participate in decision processes. Thus, the predominantly technology-centered planning of infrastructural mobility concepts, without integrating citizens into the decision making processes, is no longer viable.

Beside single transitionsBeside single transitions, e.g., from conventional to electric cars, from cars to (e-)bikes, from personal to public transfer, a special focus lies on the improvement of combined solutions: Intermodal traveling (Spickermann et al., 2014). Intermodal traveling, which describes the switching of various heterogeneous modes of transportation during one single trip (Nobis, 2013), is becoming increasingly popular. Hence, city planners have to consider comprehensive solutions for urban planning (Ziefle et al., 2014). (Huwer, 2004) investigated beneficial synergies of combined mobility services. (Digmayer et al., 2015) especially underline ecological benefits by incorporating environment-friendly modes, e.g., car- or bikesharing. But the utilization of intermodal traveling is actually affected by barriers on different levels.

Optimal integration of different mobility services on comprehensive travel information systems is investigated in several research projects around the globe (Beutel et al., 2015; Wells et al., 2013; Rehrl et al., 2004). On this technical basis, business models have to be adapted and aligned to new conditions.

Due to the heterogeneity of mobility services, the integration in the area of distribution is challenging: sharing services differ substantially in utilization, payment and tariff assessment base, compared to traditional public transport services. Moreover, different and complex tariff systems have to be combined effectively.

Herewith, we primarily investigate the perceptions of test persons towards an integrated offer consisting of heterogeneous mobility services.

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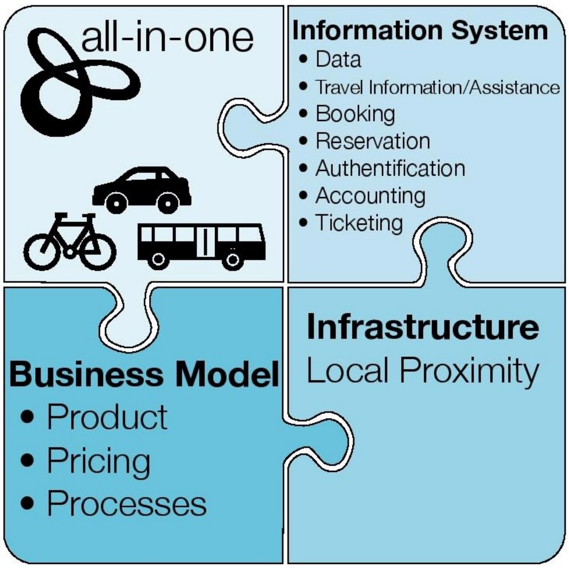

Figure 1: Areas of integration.

The remainder of this work is structured as follows. Section 2 describes the relevant theoretical basis. Afterwards, Section 3 studies describes related work and identifies the research gap. Section 4 describes the conditions of the conducted field test in detail and presents the results. Finally, Section 5 concludes the work.

2 THEORETICAL BACKGROUND

Intermodal traveling is hindered by various barriers at different levels. On a technological basis, travel information has to be provided via a comprehensive travel information system. Thereby, travel information systems vary in extent and functionalities. In addition, various heterogeneous tariff systems can be combined on a business model level. Moreover, the mobility service infrastructure can be provided in local proximity.

This section presents the relevant theories, concerning the described integration layers (Figure 1).

2.1 (Advanced) Travel Information Systems

Navigation systems for motorized individual transport and timetable information systems for public transportation services were initially developed separately in form of stand-alone solutions (Rehrl et al., 2004). Further developed travel information systems combined these approaches and provided routing even for buses and trains.

The steadily growing range of emerging transportation modes, their heterogeneity as well as intermodal travel behavior demanded more complex and comprehensive travel information systems. Advanced travel information systems use information and communication technology to provide travel information to a wide range of users, who use different modes of transportation with a diversity of characteristics (McQueen et al., 2002). The assistance through advanced travel information systems goes beyond the provision of information and enables to manage the complexity of planning, booking and utilization of intermodal travel chains (Beul-Leusmann et al., 2013). Hence, the routing becomes increasingly multi- and intermodal (Hrncir, 2013). Accordingly, user requirements increase and become more divers (Vogelsang et al., 2015), (Stopka and Fischer, 2015).

These travel information systems have the potential to optimize the execution in complex transport networks (McQueen et al., 2002). By fostering the combination of ecologically friendly modes with public transportation services, a reduction of CO_2 emissions can be achieved (Digmayer et al., 2015).

In principal, there is a large variety of travel information systems, which differ in range of covered modes and functionalities. In Germany, famous system examples are Qixxit[1] by Deutsche Bahn and moovel[2].

Moreover, SUPERHUB combines heterogeneous mobility services with the help of intermodal routing (Hrncir, 2013). The offers are additionally provided via a mobile application. The system uses a flexible best price solution. Moreover, sustainable mobility behavior is encouraged by a behavior management component (Wells et al., 2013).

OLYMPUS[3] is a B2B-system, that provides flexible multimodal transport solutions with focus on electric vehicle sharing (Buchinger et al., 2013). Main emphasis is the efficient interconnection of sharing infrastructures of independent providers to realize synergy effects and to provide an uniform service to the users.

2.2 Price Bundling

In principle, the subject *bundling* is located in the theoretical field of pricing and has been investigated for decades (Bouwman et al., 2007). With reference to information systems and web technologies, the area is called e-Pricing (Brunken, 2010). *Price-bundling* is described as the combination of multiple

[1] /https://www.qixxit.de/en/
[2] https://www.moovel.com/en/
[3] http://www.proeftuin-olympus.be/en

identifiable products, services or rights of one or multiple providers, sold via one package-offering with an aggregated price (Diller, 2008). *Price-bundling* is closely interwoven with *product-bundling*, (Wiedmann et al., 2001) and describes the combination of multiple products. As a consequence, *bundling* incorporates both: a product or service assortment-aspect as well as a price-aspect (Diller, 2008). Hence, the term *service-bundling* refers especially to a combination of services instead of products or goods.

(Kotler, 1999) distinguishes different product levels, e.g., the core product or augmented products, depending on their function for the bundle. Bundling can be designed and implemented in several forms: *Pure-bundling* refers to selling a bundle exclusively. This means that it is not possible to purchase product parts of the bundle separately. In the opposite scenario, called *mixed-bundling*, both the bundle and the individual products are offered. Another form of bundling are *tie-in sales*, where the buyer of one main product agrees to buy one or several complementary goods, which are necessary to use the main product (Simon and Wuebker, 1999). There are some additional forms of bundling, eġ. add-on bundling or cross couponing, which will not be discussed further, because of their limited applicability in the area of heterogeneous mobility services.

Bundling products or services is a widespread practice (Bouwman et al., 2007; Simon and Wuebker, 1999): Microsoft Office combines several office applications, e.g., Word or Excel. Another example are menus sold by McDonald's, usually consisting of a burger, french-fries and a soft drink. These menus are often sold with a certain discount, compared to the aggregation of separate prices. Within the areas of service bundles, (Krämer, 2009) investigated the bundling of telecommunication services.

(Wiedmann et al., 2001) define a process of an integrated pricing- and product-strategy, which consists of the following steps: Determining frame conditions, identification of customer preferences / willingness to pay, price & product optimization, development of an integrated price- and product strategy and implementation.

3 RELATED WORK

(Huwer, 2004) investigated the combination of carsharing and public transportation services in two German regions, Aachen and Mannheim. In this scenario, carsharing services were offered as an add-on to public transportation. The studies showed, that combined offers can be beneficial from providers as well as from customers' perspective. In particular, new customer segments could be won.

(Hoffmann et al., 2012) examined some effects of a combination for public transportation, electronic car- and bikesharing. They provided a smart card solution, serving as an integrated authorization method. The tariff consisted of a time based subscription to public transportation modes, supplemented by a specified contingent for sharing services. They concluded that a tariff combination holds big potential to increase user flexibility. Moreover, they underlined positive user behavioral changes in form of substituting people's own cars.

Collectively, (Huwer, 2004) and (Hoffmann et al., 2012), investigated combined offerings of heterogeneous mobility services. Their holistic studies also incorporated the pricing area, but without addressing any price biases. (Wirtz, 2014) especially focused on the effects of flexible tariffs of public transportation modes, provided by electronic fare management systems. The author examined significant psychological effects of flat-rate-offerings, influencing the mobility behavior.

This work distinguishes itself from the described contributions primarily concerning the travel information system, Mobility Broker, which constitutes the central part of the following studies. The main emphasis is on system features considering the distribution of heterogeneous mobility services, incorporating an integrated booking, accounting and pricing.

4 FIELD TEST

To examine user's perceptions from manifold perspectives, we conducted a field test, consisting of two phases. Within these phases, qualitative as well as quantitative data on user's perceptions were collected. The test was conducted by using the comprehensive travel information system "Mobility Broker", whose architecture and functionalities are described in (Beutel et al., 2015) using the IXSI interface (Kluth et al., 2015). The system allows to query, book and utilize heterogeneous modes of transportation of independent mobility providers. Moreover, integrated accounting functionalities for intermodal travel chains are provided. Specific test conditions and results are presented in the following chapters.

4.1 Prerequisites and Conditions

In August 2015, the mobility station at RWTH University Campus successfully opened for an initial test phase. The station locally combines electronic car-

Figure 2: Impressions of a test user, interacting with the system at the campus' mobility station.

and bikesharing as well as public transportation services. Within this phase, services were provided by ASEAG (local public transportation services company) as well as VeloCity Aachen (local e-bikesharing services). Participants had the possibility to use two e-cars and up to four e-bikes, connected to respective charging stations. In addition, the participants' access card enabled them to use public transport services (bus).

In a second, constitutive test phase, we observed 14 test users in more detail. We selected participants under the premise of possession of, or access to an android smart-phone device and regular presence (occupationally or study related) in the area of the provided mobility services. Figure 2 depicts some impressions of test users, interacting with the mobility services at the mobility station. This test setting enabled the users to become familiar with the system on the one hand and on the other hand, allowed to gain valuable qualitative insights.

After registration, a key card and an authorization PIN were provided to each participant. In addition, the obligatory front-end mobile application, developed by RegioIT GmbH and RWTH Aachen University for android smartphones, was provided as well. Beyond the querying, intermodal trip planning, booking and reservation of services, the application allowed to check actual mobility quotas.

During two introductory test days, users had to complete the following use cases, accompanied by the researchers: Small groups, consisting of two persons each, initially had to query for available services around them. After checking the bikesharing capacities, they had to unlock, use and return an e-bike by smart card and mobile application. Thereupon, probands had to use the e-smarts with the mobile application and the smart card as well. In the process users especially learned to (dis-)connect the vehicle as well as the authorization at the respective charging station. Following the introductory days, participants had the possibility to use the system for the duration of 4 weeks. In principal, this usage was free of charge, but it was recommended to consider a provided mobility test quota.

4.2 Field Test Results

In the following, first the qualitative results from comments of the test users are presented, followed by the quantitative data gathered from a survey among test users.

Table 1: Qualitative evaluation results.

System Functionalities

- “The system informs me. Hence, I include more possibilities into my decision process (...).”
- “I could use routes I had not known before.”
- “You don’t have to go to a station to check for capacities.”
- “Need to implement the functionality to display vehicle battery status.”
- “As a result of misinformation (caused by wrong predictions / false capacity notifications), the trust into the system disappears and the usage decreases.”
- “(...) i wished for an centralized feedback portal to avoid contacting employees every time.”
- “More information concerning actual travels with notifications etc..”
- “Problem: user data is handed to other providers.”

Services

- “I use different services than before, e.g., bikesharing.”
- “I am more inclined to switch from my own car to car- and bikesharing.”
- “More frequent switches of used modes.”
- “(...) The right mode of transportation every time, depending on the current requirements.”
- “Larger reach for electronic cars needed, to reach destinations that are far away.”
- “Bikes need porter and bicycle lock.”
- “Integration of parking services/space into the system!”
- “Easier/ faster unlocking of e-cars needed.”

Pricing

- “With an integrated tariff, I personally would use more modes that before and maybe use car- and bikesharing more consciously.”
- “Tariffs for bikesharing are more attractive in warmer seasons.”,
- “Better overview of available quotas.”
- “More different tariffs to choose between would be desirable.”

Infrastructure

- “More stations for car- and bikesharing needed.”
- “Carsharing stations need more lighting.”
- “(...) relatively flexible and spontaneous decision making, under the circumstances that the infrastructure is suitably developed.”

Qualitative Results

First, the qualitative results from the test group are presented. For evaluation purposes we categorized the participants’ responses and summarized them in Table 1. Test-persons had the possibility to respond to open survey questions if the information systems influences their mobility behavior, if their had positive or negative experiences and if their had critics and remarks.

Concerning the system integration, users especially stated the centralized travel information as a main advantage: Various responses, e.g, “The system informs me. Hence, I include more possibilities into my decision process (...).” indicate that comprehensive travel information results in a more varied mobility behaviour. One person remarked especially “(...) relatively flexible and spontaneous decision making, under the circumstances, that the infrastructure is suitably developed.” However, possible drawbacks were identified, too: “As a result of misinformation (caused by wrong predictions / false capacity notifications), the trust into the system disappears and the usage decreases.”

Concerning the transportation services, more specifically concerning the e-cars, faster and easier unlocking was required. In addition, test persons required a larger range for the electric vehicles. With reference to the e-bikes a test person commended that a “porter and a bicycle lock” would be useful. Even the integration of available parking space was stated as a desirable additional service.

With a tariff bundle, one person “(...) would use more modes than before and maybe use car- and bike-sharing more conscious". Test persons stated, that personalized (and seasonal) price bundles would be beneficial.

Quantitative Results

In addition to the qualitative research, we conducted a survey to quantify perceptions and opinions of participants. The survey aimed exclusively at participants of the test phases. 37 persons responded in total. Because of partially incomplete surveys, up to 29 datasets were usable for quantitative evaluations. 7 of the test persons were female, 22 were male. The majority of participants (55.2%) were students. Concerning the usual mobility behavior, 41.4% stated not to use carsharing. Even more (55.2%) do not already use bikesharing yet.

In a five point Likert scale, (1= very negative, 5= very positive), we asked test- persons how they evaluate the integration of heterogeneous transportation services on the basis of information systems. In general, 24 of 27 persons evaluate the integration positively or very positively. Especially the system Mobility Broker is evaluated positively or very positively by 19 of 26 test persons. This could possibly be a result of the prototypical status of the system and the limited infrastructure so far. Moreover, 62.5% of the participants evaluate service bundles positively or very positively.

In addition, we asked, if test-persons agree on being more open towards specific modes of transportation after using the system (five point Likert scale, 1=totally disagree, 5= completely agree). 22 of 28 persons state to be more open (rather agree or completely agree) towards carsharing services after using the system. Similar results were evaluated for bikesharing services (21 of 28 test-persons). Asked if test-persons agree on preferring to pay mobility services separately, the majority (60.0%) does not tend to do so (rather agree or completely agree). Answering a Yes or No- decision, 62.0% think that the quotas should not be bound monthly. Moreover, test-persons had to state their preferred quota for sharing services in one month. The required average budget for bikesharing is 18.9 hours per month, for carsharing 20.2 hours and 154.4 kilometers per month.

Central part of the survey is the evaluation of selected aspects of integration, depicted in figure Figure 3. The Figure shows the importance of test-persons towards specific aspects, which was asked via a fife step Likert scale from very important to completely unimportant. It is remarkable, that the basic degree of importance of all investigated aspects is high. This indicates that the general topic of integration in the intermodal context is highly relevant for test-persons. However, "integrated user data" presents an exception to this general trend, which could be due to increased sensitivity of users towards issues of privacy and security.

In general, services can be priced depending on the actual use or alternatively via an fixed price. Tendencies towards a fixed price / flat rate solution can be observed. This phenomenon is called flat rate bias. This tendency can not be explained exclusively depending on the characteristics of usage, but rather on beneficial effects, that go beyond the simple monetary value of the services (Wirtz, 2014). Various scientific studies investigated price biases in manifold service sectors before (Stingel, 2008), (Wirtz, 2014), (Tobies, 2009).

Because of the prototypical system status, investigation of changes in use as an result of a specific pricing measure seem not reliable for this particular case. Therefore, the focus in this work has so far been on motivational aspects. However, to get an idea of the possible effects of a flat-rate offer in the context of integrated mobility solutions, the price bias was investigated preliminarily. Our studies rely on the bias declaration construct by (Wirtz, 2014), who investigated the following effects: An insurance effect represents the fact, that a customer appreciates, a fixed price which is not as volatile as prices depending on the actual usage. The items used in the questionnaire are formulated accordingly to (Wirtz, 2014), with little adjustments due to the new context. For the insurance effect, we used the formulation "I prefer to be safe and pay the fixed price. For this, it is never going to be more expensive.". Moreover, a fixed price allows to spontaneously increase the usage of mobility services without a significant increase of the costs. According to specific theories, costs weight differently, depending on the point of time, at which they occur. In case of flexible tariffs, costs occur promptly and are perceived more grave, whereas the paying of fixed tariffs is more pleasant, which is described as the taximeter effect. With the item "Would the price not be fixed, I constantly would try to save a trip. This would be stressfull and take too much time." the taxameter effect had been evaluated. A reasonable choice among prices can only occur even if all relevant information is present. The convenience effects represents the value of fixed prices for the customer, who do not have to collect and compare various prices of heterogeneous mobility services. Therefore, we used the formulation "The effort to determine the cheapest price, normally is not worth it.". Finally, the self-discipline-effect describes the desire

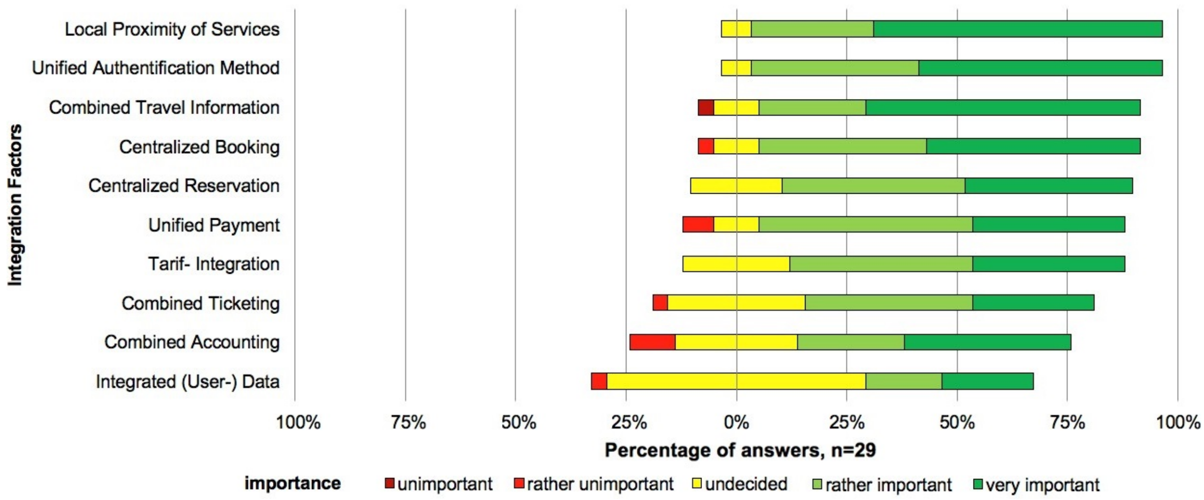

Figure 3: Importance of selected integration factors.

to change the actual consuming behavior, which was evaluated with the item "In case of paying a fixed price, I potentially would chose other destinations as usual and travel to them via different modes of transportation.". All items were evaluated in a fife step likert scale, starting from totally disagreement to complete agreement as well as providing two gradations and a undecided-option.

Concerning the investigated service bundles, survey results show that there is some agreement concerning insurance (48.1% agreement, n=27), taxameter (48.1% agreement, n=27) and self-discipline effects (59.3% agreement, n=27) in the multimodal context. Only the convenience effect is estimated significantly weaker (22.2% agreement, n=27). These results incorporate rather agreement and complete agreement of test-persons. This indicates that test-persons tend to be price conscious concerning the incorporated modes of transportation. A possible explanation could be that a majority of test-persons were students, who already possess a student-ticket for public transportation services.

5 DISCUSSION

This study examined perceptions of test persons qualitatively as well as quantitatively, in a usage-context concerning an integration of heterogeneous mobility services, based on the travel information system Mobility Broker.

In general, results underline that all investigated aspects of integration are important to the test persons. This indicates that mobility providers should pay attention to this topic and cooperate to satisfy the need of an heterogeneous mobility behavior free from barriers on different levels.

Various sources have underlined the beneficial potential of combined mobility services (Huwer, 2004; Hoffmann et al., 2012). The field test and the survey underline these results by showing that participants were more aware of options such as car- and bike-sharing and also more motivated to use them. This was shown in the comments as well as the quantitative survey. In this respect, it could be shown that the bundled tariffs can play an important role for the promotion of new mobility concepts and modes of transport (sharing models and electromotive). However, the field test also exposed disadvantages and challenges of price bundling for mobility tariffs that could possibly hinder the widespread acceptance of such tariffs. It has become clear that the participants need to make a trade-off between the convenience of getting information, booking and billing via one platform and privacy, by giving away their personal data to several providers of mobility services at once. Furthermore, their mobility usage needs to be monitored in a scenario where they buy particular "mobility budgets" (range or time), which could raise data security and privacy issues. The participants also requested more transparent information on various levels, e.g. a battery display for e-bikes and a notification when they reached the limit of their prepaid mobility budget. For the use of social networks, it has been shown that misuse of personal data is something that concerns users, and that this was independent of perceived control over one's data (Kowalewski et al., 2015). Although mobility services are not connected to personal data like personal preferences for products, photos and videos (as it is the case in social networks), the fear of data misuse might also affect mobility platforms with bundled services. Future studies will therefore need to evaluate how providing of information and control of data to the users affects acceptance of mobility tariffs. Concerning the bundled travel information, usability will become an important issue, as complexity increases with the amount of information displayed, especially on mobile devices (Habermann et al., 2015). When looking at the effects of flatrate tickets, participants overall did not agree that it was too tiresome to look for a cheap tariff and choosing the flatrate instead. This could be an effect of the relatively young sample, who were mostly students and therefore typically do not have an income of their own yet. They might therefore be more cost-conscious. This shows that special pricing models for different target groups might be needed, according to different user requirements. A further issue examined referred to the validity of the mobility budget: When tariffs are created in the way that the mobility budget, e.g. kilometers bought for car-sharing usage, is cut at the end of the month, this might lead to several problems: All users who have not used up their budget until the end of the month might want to use car-sharing in the last days of the month to make the most of their tariff. This might cause capacity problems when no more cars are available, which in turn could cause frustration among users. This tariff-design was unattractive for almost two thirds of our test-users. Alternatively, packages of kilometers and time could be offered which do not expire after one month, but can be used over a longer period of time. This result further illustrates that care has to be taken with regard to the details of the tariff design, considering possible limits of the infrastructure as well as user preferences.

5.1 Limitations and Future Work

Concerning the field test, the mobility services sometimes were not available for limited times because of the prototypical status of the system. Many responses of participants referred to the limited test area. Future research promises valuable findings with an extended infrastructure, covering more of the surrounding area. This would indeed increase the usefulness of the specific services for the users. As another consequence of the prototypical status of the system, we created the described field test free of any charges. Specific payment of the services could possibly influence some of the results. Interesting future studies could investigate the exact changes of the mobility behavior, depending on selected service bundles.

As other studies show, people's preferences may vary among different user groups (Ziefle and Wilkowska, 2015). Hence, investigating other specific groups of users is necessary as well.

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