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The Acceptance and Use Behavior of Shared Mobility Services in a Rural Municipality

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Abstract: In rural regions, needs-based mobility services play an important role in the provision of public services. Shared Mobility Services can optimally complement local public transportation such as buses and trains, even in rural regions, and support the transformation of transportation. There is already research on Shared Mobility Services in the literature, but there is no comparison between all of Germany-wide and a specific municipality. We were interested in learning to what extent there is acceptance among citizens and what their usage behavior is towards such new alternatives. We also aimed to find out whether there are differences between large cities and rural regions and to what extent they differ from each other. In this case study, interplay was demonstrated using the example of a funded Smart City mobility project in a German rural municipality. The objective was to show whether the potential exists to initiate traffic turnaround with the help of Shared Mobility Services. In a quantitative survey of 418 German citizens, 114 of them from the rural municipality, the acceptance and usage behavior of Shared Mobility Services (in the form of car, bike and e-scooter sharing) was investigated. The results show that participants are very interested in Shared Mobility Services and have already gained initial experience with such services. However, there is still a lack of comprehensive services; for instance, the demand for car sharing is still too low, as many citizens still own a private vehicle. Our results show that citizens are too little informed about Shared Mobility Services and that these services need to be advertised much more strongly and clearly, both in analog and digitally. Our study shows that traffic turnaround can be achieved and that many citizens can imagine greater use of Shared Mobility Services in their everyday lives in the future. However, for this to happen, the necessary infrastructure must be in place in rural regions, and local authorities must motivate citizens with sufficient educational work about what is on offer and how to use it.

Keywords: acceptance; UTAUT; shared mobility; travel behavior; rural; municipality

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1. Introduction

Sustainability is important and necessary for climate change. Digitization and networking play important roles and can support and specifically achieve mobility transformation. Especially in rural regions, optimal mobility transformation can be achieved by supplementing local public transport. But how can this be implemented in a sustainable way and how can the existing services be redesigned in a more sustainable way? This question has long been occupying researchers, but an answer is gradually approaching [1–5].

In the municipal context, however, several challenges arise, e.g., the increased water and energy consumption, lack of space, poor air quality. Even in the rural context, the challenges do not stop: poor network coverage, low attractiveness, or poor connectivity [4,6,7]. Various researchers have already shown that challenges (especially in the area of mobility) are acute in densely populated areas (e.g., commuters or supply logistics) [7,8] and that smart mobility solutions should be pursued that take the first and last mile into account [9]. On the market, there are already first approaches to solving challenges like traffic flow

optimization, improved public transport network, on-demand services, and the sharing economy [4,6,7].

In the municipal context, there are lighthouse cities that present quarters or approaches to solve these challenges, such as Vienna or Songdu [10,11], but there are also rural cities that are trying to address these challenges early on.

There are already studies on Shared Mobility Services in the literature, but there is no comparison between all of Germany and a specific municipality. Our objective was to find out to what extent there is acceptance among citizens and what their usage behavior towards such new alternatives looks like. Furthermore, we wanted to find out whether there are differences between large cities and rural regions and to what extent they differ from each other. In this case study, the interaction was demonstrated using the example of a funded Smart City mobility project in a German rural municipality. The objective was to show whether there is the potential to initiate traffic turnaround with the help of Shared Mobility Services.

This case study, therefore, presents the results of a Smart City mobility project of a rural municipality in Germany, which looked at the acceptance and usage behavior of Shared Mobility Services (using the example of car, bike, and e-scooter sharing) with the help of an advanced UTAUT2 model [12]. In a quantitative case study with 418 citizens from Germany and 114 from the city of Lohmar, we investigated the acceptance and usage behavior of Shared Mobility Services (car, bike, and e-scooter sharing).

2. Related Work

2.1. Mobility (as a Service)

Mobility and activity are the cornerstones of our society. Citizens have always had and still have the need to constantly move and explore the globe. So did Columbus, leading to the opening up of international relations, and so do citizens still today. It has become irrelevant whether citizens move within a city, a country, or a continent or in between. It also does not matter whether it is for business or private. The world is so interconnected that citizens can move and develop freely. In recent years, however, this activity has become a downfall because the environment suffers extremely. The greenhouse emission of a flight, for example, is on average 284 g per person-kilometer [13]. In contrast, trams emit only 75 g per person-kilometer [13]. For these reasons, among others, the United Nations (UN) adopted 17 Sustainable Development Goals (SDGs) in 2016 to stop climate change [5]. The COVID-19 pandemic significantly changed the mobility of citizens since 2020 because overnight travel was prohibited and public transport posed a potential risk of infection [14].

In parallel, new types of mobility have also developed in recent years, and mobility has been seen not only as a means of transport but also as a service that meets the new and increased needs. The concept of Mobility as a Service (MaaS) was established. MaaS describes "multimodal and sustainable mobility services addressing customers' transport needs by integrating planning and payment on a one-stop-shop principle." [15]. In the scientific context, various forms of MaaS have already been studied. For example, Aapaoja et al. (2017) investigated how MaaS differs in urban, suburban, and rural regions [16]. In rural regions (the case of this study), MaaS is mainly used for the first and last mile, since many citizens have their own vehicles, as the regions are poorly connected to public transport [16]. Further, Hult et al. (2021) studied shared mobility approaches in Sweden and were able to show that in rural areas, citizens need to participate more for MaaS to be successful [17].

2.2. Smart Mobility

As mentioned above, life is becoming increasingly interconnected and characterized by interdependencies. However, according to the UNs 17 SDG this must happen in a sustainable way [5]. Cities and municipalities have a lot of catching up to do, but at the same time, the situation offers enormous opportunities. A city is considered "[. . .] smart when investments in human and social capital and traditional (transport) and modern

(ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance" [2]. In order for a city or municipality to achieve this smartness, the transformation must be initiated. There are several approaches to this [1,3,4,18], but in this paper, we focus on Giffinger's approach [4]. In 2007, he defined six performance areas of a Smart City: Smart Environment, Smart Governance, Smart Mobility, Smart Economy, Smart People, and Smart Living [4]. In the context of this case study, we focus on Smart Mobility since the Smart City project in Lohmar has a focus on mobility. The first overarching studies have already been carried out in this regard, such as the smart mobility approach in various cities [19,20] and using new approaches to design the mobility in Smart Cities [21].

2.3. Shared Mobility

One way to implement MaaS is through shared transportation such as cars or bicycles or even via walking or ride pooling. The present study focuses on Shared Mobility Services (short SMS) since in the Smart City, cars are mainly chosen as the transportation option rather than public transit. Therefore, for Lohmar, the three most common Shared Mobility Services were studied: car sharing, bike sharing, and e-scooter sharing. It should be noted here that in Lohmar, only e-scooter and bike sharing were options during the period of this case study. All Shared Mobility Services are offered in two variants, first station-based and second station-independent (also known as free-floating). In station-based systems, the devices are parked at specific locations, and in free-floating systems, the location can be freely chosen. In the case of car and bike sharing, there are also options between classic and electrically powered engines. E-scooters are always electrically powered [22]. However, all systems are interconnected with ICT and reservations, booking, use, and billing are based on this.

In the scientific context, shared mobility has also already been analyzed from various contexts. Mobility apps have also been studied. For instance, the design of shared mobility systems was investigated by Willnat et al. (2021) [23] and Schulz et al. (2021) investigated the needs satisfaction of users of bike sharing apps [24]. In addition, initial acceptance research has been conducted on shared mobility in general, for instance in Australia [25] and in five European cities [26], but also in the specific examples of young riders [27], ride pooling [28], car sharing [29,30], and e-scooters [31–33]. Last, there are already preliminary studies looking at the impact of the COVID-19 pandemic on shared mobility [34]. However, to the best of our knowledge, no research group has studied Shared Mobility Services acceptance and usage behavior using a rural municipality as an use case example.

3. Method

3.1. Use Case: Rural Municipality Lohmar

The municipality Lohmar is located between Bonn and Cologne in the Rhineland in Germany and is bordered by the hills of the Rhineland and the river Agger. Covering an area of over 60 square kilometers, approximately 31,000 citizens live surrounded by nature in 30 small to medium-sized villages. The citizens are integrated into the municipal life in many ways, be it through associations, working groups, or participation processes (as in the example of this survey). The municipality wants to actively involve the citizens because this is the only way to move the municipality forward. A milestone in recent years was the approval of funding for the Smart City project in 2020, which focuses on the topic of smart mobility. Hereby the municipality wants to tackle the mobility problems and make the mobility offers more sustainable. Furthermore, the attractive location will now be used to further strengthen the public transport, so that this benefits all citizens, the economy, industry, and the municipality itself.

3.2. Methodocial Approach

To understand the Shared Mobility Services acceptance and usage behavior in the city of Lohmar, a shared mobility case study was designed as part of the city's funded Smart

City project. With the case study, the municipality wanted to understand how citizens use Shared Mobility Services, what they think about it, and what their mobility behavior is in general. For this purpose, an online survey with scientific question constructs in the form of an extended UTAUT2 model was set up and conducted by the university's scientific employees (partner in the Smart City project) with the help of the city of Lohmar in the period from December 2021 to March 2022. The online survey was distributed in the city of Lohmar as well as around Germany in order to be able to contextualize the results into a wider context. In Lohmar, the online survey was distributed through channels such as mail, social media, local newspaper, local advertising in the form of leaflets or posters, and events. Nationwide, the online survey was mainly disseminated via online forums, networks, and social media. The aim of these efforts was to achieve the highest possible response rate. Before the survey was posted online, it was tested by three people of different ages to check comprehensibility, and their feedback was integrated. In retrospect, it can be said that the mix of different media in Lohmar made it possible to achieve a very wide range in terms of age, profession, and wealth of experience. In terms of Germany, however, the 18-to-29 age group is somewhat overrepresented, see Figure 1.

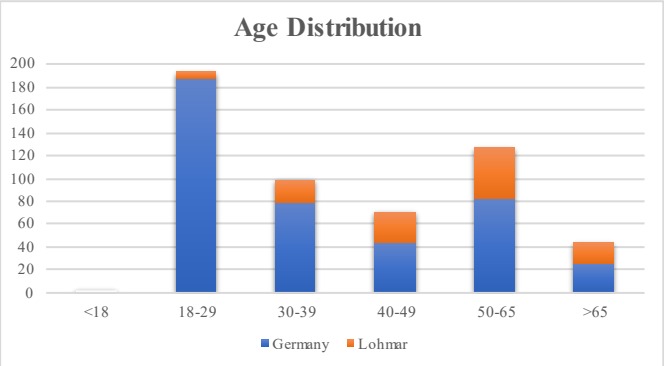


Figure 1. Age distribution for Germany and for Lohmar only.

The online survey begins and ends with a query for demographic data. At the beginning, the postal code is queried in order to adapt the survey. In addition to the standard online survey, the citizens of Lohmar were asked additional questions at the end. The content section of the online survey begins with previous experience with Shared Mobility Services and their use for example "Have you already had experience with the Shared Mobility Services described?" After that, the constructs from the UTAUT2 model were asked, as well as their extensions (see Section 3.3 Survey Design), for example, PE, "Using Shared Mobility Services increases my chances of reaching places that are important to me"; HM, "Using the shared mobility service is fun"; or PIIT, "Among my colleagues and friends, I am usually the first to try out new Shared Mobility Services.". Finally, Lohmar-specific questions were asked, e.g., about the living situation, the size of the household, the number of persons in the household who are able to drive (i.e., persons over 18 years of age), the ownership of vehicles, and connections to public transport. Further, the survey asked which type of mobility is used for which reasons and what the greatest mobility challenges are in Lohmar. Finally, the citizens were asked about their knowledge of the funded Smart City project. The questions were mostly asked with a 7-point Likert scale, although other questions with free text fields, such as the greatest mobility challenges. On average, the participants needed 17 min to complete the online survey.

After cleaning the data, 418 citizens took part in the nationwide online survey of whom 114 (27.3%) came from Lohmar. In the nationwide survey, 49.5% were female, 49.8% were male, and 0.7% were diverse. In the city of Lohmar, the proportions were 41.2% female, 57.0% male, and 1.8% diverse. The other demographic details can be seen in Table 1, and the age distribution can be seen in Figure 1.

Table 1. Demographics of the use case online survey respondents.

Demographics	Germany	City of Lohmar
Age Range [in years]	18–79	20–79
Age Mean [in years]	39	51
Availabily of Car Sharing [in %]	56.7	0.07
Availabily of Bike Sharing [in %]	52.6	35.08
Availabily of E-Scooter Sharing [in %]	56.9	57.0
Cars in Household [in %]	80.1	99.1
Households Mean [total]	-	3
Household with citizens over 18 [in %]	-	83
Citizens [total]	418	114

3.3. Survey Design

The success of a product or service is closely linked to its acceptance. The more people accept a product or service, the more it will be used. This type of research has long existed, and various models and theories have been developed. The best-known and most meaningful models in the field of information systems are Technology Acceptance Model (TAM) [35], Theory of Reasoned Action (TRA) [36], theory of planned behavior (TPB) [37], and Unified Theory of Acceptance and Use of Technology (UTAUT) versions I and II [12].

For this case study, the UTAUT2 model was used as a basis because it is an extension of the previously mentioned models. The UTAUT2 consists of seven constructs. The first construct describes the attitude toward using the Shared Mobility Services (Performance Expectancy (PE)), exactly to what extent citizens can gain an advantage when using Shared Mobility Services [35]. The second construct describes the expectancy of Shared Mobility Services usability (Effort Expectancy (EE)). This relates to citizens' perceptions of the ease of using Shared Mobility Services [38]. The third construct describes the social influence from friends and acquaintances to use Shared Mobility Services (Social Influence (SI)). To what extent do a citizen's friends influence him or her in the use of Shared Mobility Services [12,39]. The fourth construct describes the prerequisite for using the Shared Mobility Services (Facilitating Conditions (FC)), i.e., does the citizen have the necessary resources to have access to Shared Mobility Services at all [12,37,40]. The fifth construct describes the motivation to use the Shared Mobility Services (Hedonic Motivation (HM)), in other words, the fun factor [39,40]. The sixth construct describes the value for money of the Shared Mobility Services (Price Value (PV)). The more balanced citizens perceive the PV of Shared Mobility Services, the higher the usage [38,41,42]. The seventh construct describes habits of using Shared Mobility Services (Habit (HT)). The more the services become part of everyday life, the greater their use, which leads to their habituation [38]. These constructs all affect the intention to use the Shared Mobility Services (Behavioral Intention (BI)), which in turn the active use of Shared Mobility Services (User Behavior (UB)) in combination with FC and HT [34,38,43]. The UTAUT2 model was extended for this case study by the following four constructs. This construct was added to the case study because the city considers the influences from the media domain to be very high and would like to investigate it more closely [44–47]. The construct PSU describes the perceived benefit of Shared Mobility Services for one's own social environment (Perceived Social Usefulness) [48]. The construct PEU describes the fun factor of new digital applications (Perceived Entertaining Usefulness) [49,50]. The constructs PSU and PEU act together on the construct ATI, which describes the technological interaction with new digital applications (Affinity for Technology Interaction). The higher the affinity, the greater the use of Shared Mobility Services [51–54]. The construct PIIT lastly describes the curiosity about a new digital technology (Personal Innovativeness In IT). The more curious citizens are about Shared Mobility Services, the more they are tested and used [55,56]. The entire model is shown in Figure 2.

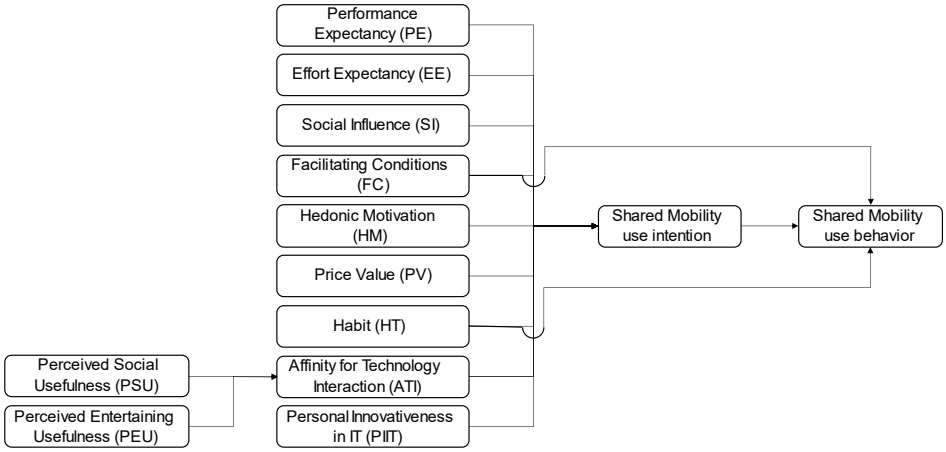
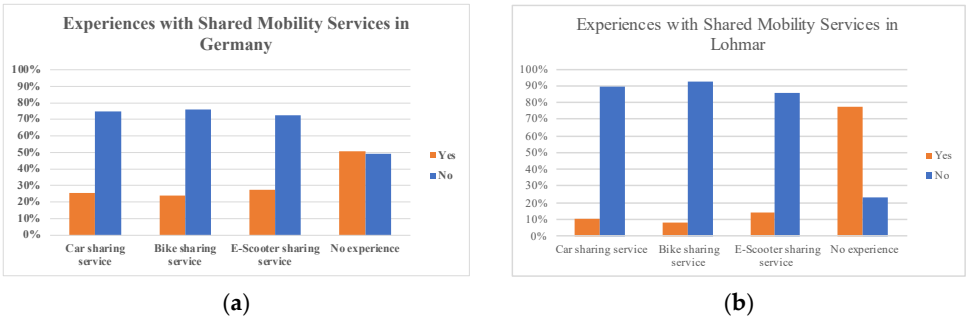


Figure 2. Survey Model.

4. Results

The results of this case study are compared between citizens from all over Germany and citizens specifically from Lohmar. The results of this case study relate to the following factors for overview: experience with Shared Mobility Services, Imagination to use Shared Mobility Services, Performance Expectancy (PE), Effort Expectancy (EE), behavioral intentions (BI), habit (HT), and personal innovativeness in IT (PIIT). Specific Shared Mobility Services were listed, and citizens were asked about their experiences with each: carsharing, bike sharing, and scooter sharing.

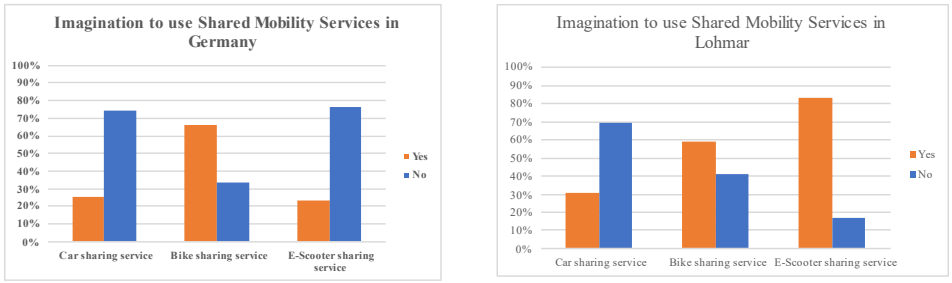
Regarding car sharing services, 25% of all citizens from all over Germany already had initial experience with car sharing compared with the city of Lohmar, where only 11% have experience with car sharing services. Across the country, 24% of all citizens had already experienced bike sharing compared with 8% in Lohmar. E-scooter sharing was used by 28% of all citizens and only 14% of citizens in Lohmar. Overall, 51% of all citizens from Germany indicated that they had not yet had any experience with Shared Mobility Services, and in the city of Lohmar, the figure was 77%. See Figure 3.



(**a**) (**b**)

Figure 3. Experience with SMS: (**a**) Germany vs. (**b**) Lohmar.

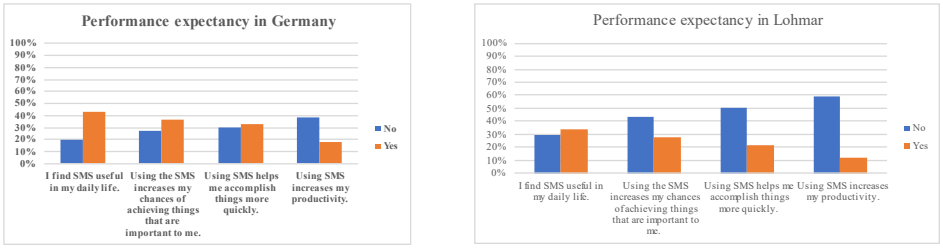
In terms of usage, we asked citizens whether they could imagine using Shared Mobility Services. Around three quarters, 74%, of all citizens in Germany could imagine using car sharing services compared with 31% from Lohmar. Regarding bike sharing services, 34% of all citizens could imagine using such services, and 59% in Lohmar could imagine it. Finally, 77% of all citizens and even 83% of citizens in Lohmar could imagine using e-scooter sharing services. See Figure 4.



(**a**) (**b**)

Figure 4. Imagination to use SMS: (**a**) Germany vs. (**b**) Lohmar.

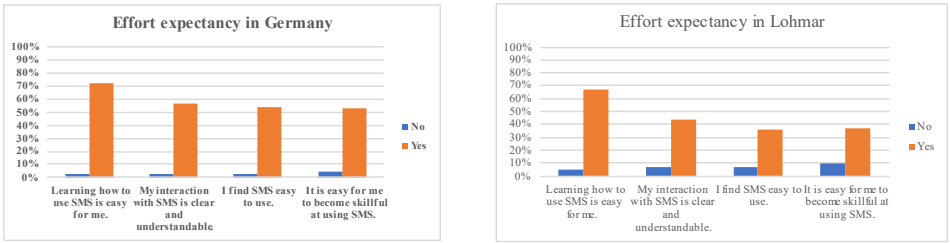
In terms of Performance Expectancy (PE), 43% of all citizens across Germany indicated that they find Shared Mobility Services useful. In the city of Lohmar, 34% of citizens find Shared Mobility Services useful in their daily lives, and 37% of all citizens said that Shared Mobility Services increased their chances of reaching places that are important to them; in Lohmar, 27% agreed with this statement. Of all citizens, 33% said that using Shared Mobility Services helped them get things done faster, and in Lohmar, 21% agreed with this statement. That the use of Shared Mobility Services increases productivity was stated by 18% of all citizens, and in Lohmar, 12% agreed with this statement. See Figure 5.



(**a**) (**b**)

Figure 5. Performance Expectancy (PE): (**a**) Germany vs. (**b**) Lohmar.

In terms of Effort Expectancy (EE), 72% of all citizens find Shared Mobility Services easy to learn and use, and 63% of citizens from Lohmar agreed with this statement. For 57% of all citizens, the use of Shared Mobility Services is clear and understandable, and in Lohmar, 44% also stated that handling of Shared Mobility Services is easy for them. Shared Mobility Services were reported to be easy to use by 54% of all Germans and 36% of Lohmar residents. In addition, 53% of all citizens stated that Shared Mobility Services are easy to handle and 40% in Lohmar agreed with this statement. See Figure 6.

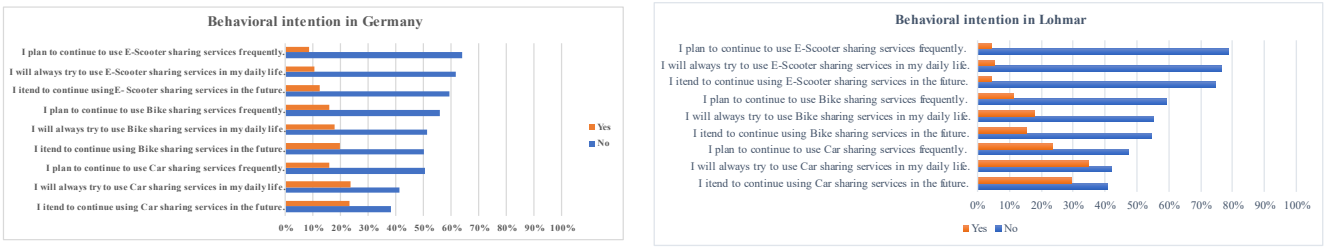


(**a**) (**b**)

Figure 6. Effort Expectancy (EE): (**a**) Germany vs. (**b**) Lohmar.

In terms of Behavioral Intentions (BI), survey respondents were asked about their intentions to use the various Shared Mobility Services: car sharing, bike sharing, and e-scooter sharing. Across Germany, 23% of all citizens indicated that they would use car sharing services at their place of residence in the future, and in Lohmar, 29% of the citizens

intended to do so around town. Bike sharing services will be used in the future by 20% of all citizens in Germany at their place of residence, while in Lohmar, it is just 15%. Regarding e-scooter sharing services, 12% of all citizens stated that they will use such services at their place of residence in the future, and in Lohmar, 4% agreed with this statement. See Figure 7.



(**a**) (**b**)

Figure 7. Behavioral Intention (BI): (**a**) Germany vs. (**b**) Lohmar.

In terms of Habit (HT), among all citizens in Germany, a total of 35% said they were enthusiastic about using Shared Mobility Services, and in Lohmar, 38% of citizens were enthusiastic about the services offered. See Figure 8.

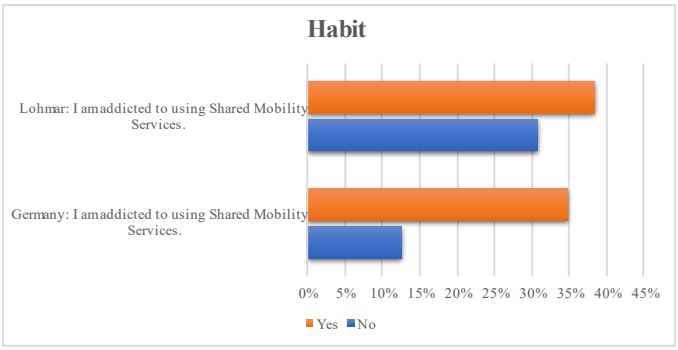


Figure 8. Habit (HT): Germany vs. Lohmar.

In terms of Personal Innovativeness In IT, 30% of all citizens nationwide indicated that they did not hesitate to try new Shared Mobility Services. In Lohmar, 29% of citizens indicated that they would not hesitate to try new Shared Mobility Services. See Figure 9.

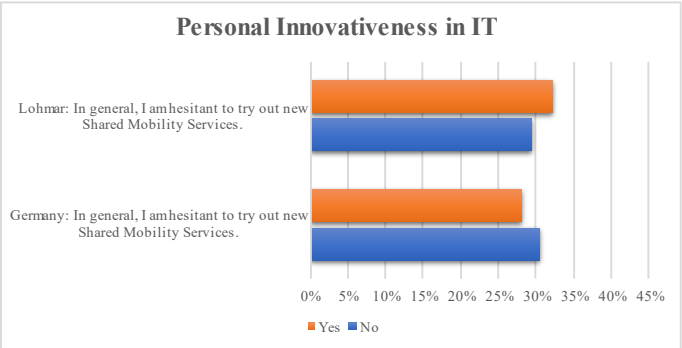


Figure 9. Personal Innovativeness in IT (PIIT): Germany vs. Lohmar.

5. Discussion

This case study shows that Shared Mobility Services are already known and are already used by some of the citizens or that they have already heard about them. However, Shared Mobility Services are more widespread in large cities than in rural regions, and this

case study shows that citizens living in cities have more experience with Shared Mobility Services, where these services are more available. Similar results have been reached by other researchers in the context of electromobility car sharing [30] or during city trips as opposed to rural travel [57]. Shared Mobility Services are a good alternative and a great addition in cities where one is dependent on a vehicle or transportation of any kind [19,21]. The comparison between Germany as a whole and the city of Lohmar help to understand which Shared Mobility Services are particularly well received and helpful as well as where there are still weaknesses. In general, in a direct comparison, all citizens are interested in Shared Mobility Services and would at least like to try them out, be it car, bike, or e-scooter sharing. Especially in Lohmar, 83% of citizens could imagine using e-scooter sharing, although only 31% could imagine using car sharing. This reflects that in Lohmar, citizens own their own cars and that the distances they need to travel are probably far; the need is not yet so high that they need to switch to car sharing. In contrast, 59% could easily see themselves using a bike sharing service. Given the more than 170 km of hiking and biking trails, it can be assumed that citizens will have more use for bicycles to get around, especially electric bike sharing.

In light of the fact that German citizens as a whole believe that Shared Mobility Services are generally easy to use, it is evident that the limited use of Shared Mobility Services is not because of technical incomprehensibility but rather the fact that existing available services are still limited. Additionally, there is still low demand in the city of Lohmar due to privately owned vehicles. This is supported by figures from the Federal Association for Car Sharing in Germany [58]. Over time, however, the need may change and lead to higher demand as parking becomes more scarce, especially in city centers, and the cost of resident parking is expected to increase (in Germany, an increase by a factor of 10 is currently being discussed [59]). Additionally, the price of gasoline has increased enormously due to the Ukraine war [60], and citizens are more likely to switch to Shared Mobility Services in the future due to higher personal vehicle operating costs.

Of course, this case study also has its limitations. For example, only a fraction of Germans were surveyed and only 0.36% of the citizens from Lohmar. In Lohmar, a very evenly distributed age structure was achieved, while in Germany as a whole, the age group 18 to 29 years is overrepresented. This naturally leads to a slight imbalance.

Therefore, we recommend repeating the case study after the introduction of the measures of the Smart City mobility project in the city of Lohmar, which we will do. In doing so, we will specifically improve the inconsistencies of this study. We also hope that this will improve comparability with other cities of Lohmar's size, but the case study could also be conducted in other countries to compare the results. In addition, we will develop and present all results of the structural equation model, including hypothesis generation, calculation of the structural equation model, and evaluation and discussion of it.

6. Conclusions

The results of this case study show that Shared Mobility Services are viewed and perceived positively and with overall interest. In order to increase the use of Shared Mobility Services, it is particularly important that the services can be used area-wide and easily as well as. The services also need to be promoted much more strongly so that awareness increases and citizens learn about what is available. Many citizens lack experience with Shared Mobility Services because they receive no or insufficient information about it. This is where municipalities could do educational work. Disseminating information via some analog but especially digital channels such as social media, can be helpful for increasing curiosity and demand and attracting more users.

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