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Shared Mobility Service Usage Patterns – Results of a Representative Survey in Budapest

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ABSTRACT: To increase the share of shared mobility, understanding the general characteristics of active users and, moreover, the characteristics of non-users is essential. In this paper, we aimed to reveal the correlation between travel habits, general personal characteristics, and the use of shared mobility services, such as scooter-sharing, bike-sharing, and car-sharing. The data from a representative online survey were used; the respondents are citizens of Budapest, Hungary, and have a driver's license. We found that the active users are mainly from the younger generation with higher educational levels and higher incomes. Most users have subscriptions for more than one shared mobility service type. Furthermore, the service availability in the neighborhood and the car ownership influence car-sharing use. These findings contribute to the limited knowledge of the choice between different shared mobility types. The results can be used by operators to improve shared mobility services; the target groups of a campaign can be identified by the results.

KEYWORDS: shared mobility; bike-sharing; scooter-sharing; car-sharing; usage habits; questionnaire survey

1. INTRODUCTION

Shared mobility in urban environments is a growing sector worldwide, offering individual travel without the disadvantages of owning a vehicle and improving vehicle utilization. In Europe, there are approx. 900 cities where bike-sharing (BS) (Meddin, 2022), at least 91 cities where scooter-sharing (SS), and at least 72 cities where car-sharing (CS) (Fluctuo, 2024) are operating.

Though the shared services usage is increasing (Fluctuo, 2024), these services still have a minor share in the transportation sector. Understanding the motivation for usage is essential to increase the share, introduce motivation measures, and improve the service quality. Accordingly, we aimed to reveal the correlation between travel habits, personal characteristics, and shared mobility service usage. An online questionnaire survey was conducted, and responses from people with a driver's license were collected in Budapest, Hungary. The novelty of the research is that the sample is externally valid as the sample size is large and representative of the gender, age group, and educational level of Budapest inhabitants over 18 years old. Moreover, according to our knowledge, such a representative survey focusing on shared mobility usage, investigation BS, SS, and CS together has not been executed in Budapest recently.

The structure of the paper is as follows. The literature is reviewed in Section 2. The case study and data collection are described in Section 3. The results are discussed in Section 4. Finally, Section 5. contains concluding remarks.

2. LITERATURE REVIEW

We have reviewed scientific papers on BS, SS, and CS usage, focusing on factors affecting their usage.

A study based on BS membership and trip data was conducted in Minnesota, where car trips are dominant (Wang & Lindsey, 2019). It was found that BS users are disproportionately male, and their age is inversely proportional to their willingness to use BS services. Furthermore, people in lower socio-economic status are more likely to use BS services. The findings on gender and age are in line with other studies, e.g., in London (Ogilvie & Goodman, 2012), Lyon (Raux et al., 2017), Vancouver (Winters et al., 2010), Melbourne, and Brisbane (Lee et al., 2021a). There are mixed findings on the socio-economic status. It was found that high income among members is more typical than among the population (Raux et al., 2017; Winters et al., 2010). Ogilvie & Goodman (2012) suggest that this contradiction may be because BS stations are more common in wealthy neighborhoods. Ricci (2015) also found that BS stations are often established in wealthy neighborhoods, and the positive effect of BS station proximity on the probability of becoming a member has also been verified by Raux et al. (2017). Once the inequality in station deployment is considered, people with lower income use the BS service more (Ogilvie & Goodman, 2012). The gender gap in BS can be observed in cycling in general, which may reflect the safety conditions of the infrastructure (Kronsell et al., 2020). In line with that, Garrard (Garrard, 2021) found that the proportion of male and female cyclists is equal in cycling-friendly cities, while cyclists are disproportionally male in car-dominated cities. A study found that car owners use BS services more than non-car users in Hangzhou, China (Shaheen & Guzman, 2011). However, most of the studies found that BS services have the potential to reduce car ownership and vehicle miles traveled. An analysis conducted found that car ownership was reduced in every city where BS service was present (Fishman et al., 2014). Similar findings were made by (Hyland et al., 2018) and Lu et al. (2018).

Factors influencing SS are similar. A study in Seoul found that the younger generation has a greater willingness to use SS, and the gender ratio is slightly higher for males than females (Lee et al., 2021b). It was also found that higher-income people are more likely to use SS. The finding on age also aligns with other results from the US ((Mobility Lab, 2019), (PBOT, 2018)) and Europe ((Laa & Leth, 2020), (Mouratidis, 2022), (Chrétien & Louvet, 2019)); however, the gender

gap was more considerable. People without tertiary education are more likely to use SS (Mouratidis, 2022), which is contrary to other findings in this field (Chrétien & Louvet, 2019), (Jiao & Bai, 2020). SS can replace various transportation modes; it may be more effective in substituting private cars than BS services, and SS can replace taxi trips because it is more cost-efficient and a fun way to travel (Guo & Zhang, 2021). Most studies found that SS can replace various trips (e.g., walking for recreational purposes (McKenzie, 2019) or public transportation (PT) (Moran et al., 2020)). Moreover, it can be combined with PT, replacing walking on the last mile (Chrétien & Louvet, 2019).

CS service is a well-researched area, and many papers deal with the socio-demographics of users. Based on previous studies (Amirnazmiafshar & Diana, 2022), CS is generally accepted; however, male users travel more frequently. Users are typically in their mid-20s to mid-30s. High education and higher income positively correlate with the demand for CS. Finally, the number of cars per household is significantly lower for CS users than for others. However, some differences between cities may arise. For example, it was found that in Munich, most users are aged between 35 and 49, which may be because CS services were implemented earlier in Germany than in other countries (Aguilera-García et al., 2022). Analyzing the differences between CS and BS users, it was found that CS users are slightly older, earn less, belong to households with more children, and have fewer cars (Wielinski et al., 2017).

Close to our aims, Mouratidis (2022) investigated BS, SS, and CS services together, but the literature review suggests that there are significant differences among cities in the socio-demographics of shared mobility service users. Moreover, cultural differences are visible in regions, such as the thinking about private vehicles and public service use. Effective measures must be based on the location-specific situation. Therefore, our study is niche in that no previous analysis has considered BS, SS, and CS at once in Budapest.

3. METHODOLOGY

3.1 Study site: Budapest, Hungary

Budapest is the capital of Hungary, with 1.7 million inhabitants living in 525.2 km2. Besides the dens and frequent PT, as of November 2024, one municipality-operated station-based BS (Bubi), two international free-floating SS (Dott, Lime), and three Hungarian free-floating CS (Greengo, MOL Limo, wigo) service providers are operating. The BS was launched in 2014, CS in 2016, and SS in 2018.

The service area of BS covers the city center, currently 37.8 km2; the area development is oil-stain-like. 211 stations are in the system, resulting in 5.6 stations per km2, which is lower in Paris (33) but quite the same as in Soul (6.5). 2460 of the same type of regular bikes are available. The monthly pass costs 2.5 EUR, including free first 30 minutes for each ride. The SS and CS operators have a similar downtown-based service area. However, there are differences in its extension and the number of external areas. The service area of the operators is around 110 km2, but Dott has over 200 km2 areas covering the eastern outskirt. The fleet of the SS operators is homogenous, and they apply a minutes-based tariff (from 0.15 EUR/min in both cases). The fleet of Wigo and MOL Limo is diverse. Thus, Greengo uses only electric and smaller cars. All operators have around 500-500 cars. Greengo (from 0.25 EUR/min) and Wigo (from 0.25-0.35 EUR/min) have a minutes-based tariff; thus MOL-Limo applies a distance-based (from 0.6-1 EUR/km) tariff. For comparison purposes, a single ticket for PT costs 1 EUR, and one liter of petrol costs 1.5 EUR.

Though the coverage of shared mobility services is between 20 and 40 percent, the most densely populated areas are covered, reaching most inhabitants. Files must be in MS Word only and should be formatted for direct printing, using the MS Word provided. Figures and tables should be embedded and not supplied separately.

3.2 Data collection and analysis

The data collection was carried out by TÁRKI (Social Research Institute), and it took place between 20 October and 10 November 2024. The questionnaire included major blocks: the respondents' general transportation modes, shared mobility usage habits in general, and focusing on CS, and socio-demographic characteristics. This paper focuses on shared mobility usage habits in general; thus, the third block was excluded. The questionnaire included questions with multiple-choice and Likert scales (agreeing or disagreeing on a scale of 1 to 7). One of the main aims of shared services, especially CS, is to reduce private vehicle ownership to create the opportunity to use a vehicle privately without owning it. Accordingly, only Budapest residents with a driver's license could participate in the survey. This part of society is the main target group of shared mobility; these respondents may explain the intention to use CS services.

Altogether, there are 836 valid answers, which are representative of the population of Budapest with age, gender, and education level. To eliminate sampling error and to increase external validity, we used weighted data (the weights were calculated based on the statistics of the Hungarian Central Statistical Office). However, the sample includes only respondents with a driver's license, therefore, the results have to be looked at with caution, especially regarding BS and SS, which do not require a driver's license.

We have formed several hypotheses based on previous results (a hypothesis was accepted if the correlation between the variables was significant): (H1) Men are more likely to use shared services than women. (H2) A higher proportion of younger people use shared services than older people. (H3) The higher the level of education, the higher the use of shared mobility services. (H4) The higher the monthly income, the higher the use of shared mobility services. (H5) The availability of shared services in the neighborhood influences its usage with a positive correlation: with availability, the probability increases. (H6) CS users are more confident drivers, and SS users are more reckless drivers. (H7) Private vehicle availability is a disincentive to the use of shared mobility services. (H8) The more committed someone is to owning a private car, the less likely they are to use CS.

4. RESULTS AND DISCUSSION

The target group of the survey was those who have driver's license, which may explain the fact that 83 percent of the respondents often have access to private or company cars; an additional 10 percent occasionally. Most of the respondents (91%) do not have access to private electric scooters. And only more than half of the respondents have access to private bikes (29 percent often, 27 percent occasionally; Fig. 1).

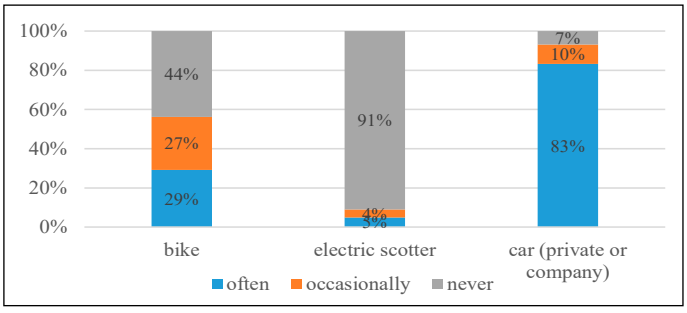

Fig. 1. Access to vehicles. N=836

14 percent of the respondents do not have access to any vehicle. 76 percent of those who have access to an electric scooter (N=73) have access to a bike and a car as well. Furthermore, 92 percent of those who have access to a bike (N=464) have access to a car as well. 40 percent of those who have access to a car (N=754) do not have access to any other private transportation mode. These respondents can be the hidden target group of shared services. However, convincing this group to use shared mobility services is challenging as high-quality and customized shared mobility services should be provided to cancel long-term ownership.

4.1 Shared mobility service usage

Service use categories were determined as follows: never used it, former users, and active users. 29 percent of the respondents use at least one type of shared mobility service (N=241). 25 percent of the respondents are active CS, 13 percent are active BS, and 11 percent are active SS users (Fig. 2). The higher share of CS users may be explained that the target group of this survey was those who have driver's licenses. The churn rate, namely the share of former users, is the highest in SS (18%).

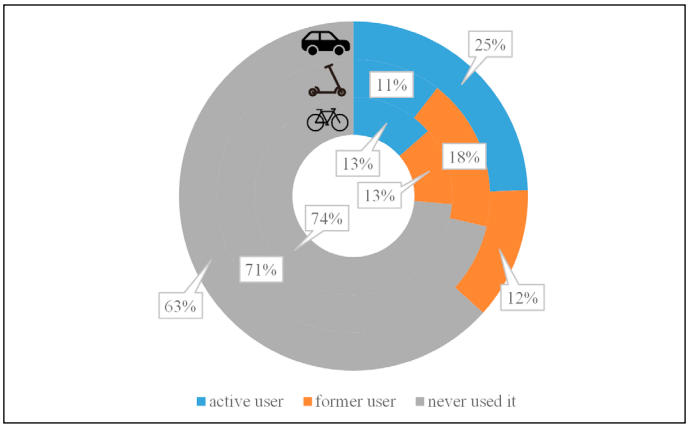

Fig. 2. Shared mobility service type use; CS N=836, BS N=822, SS N=836.

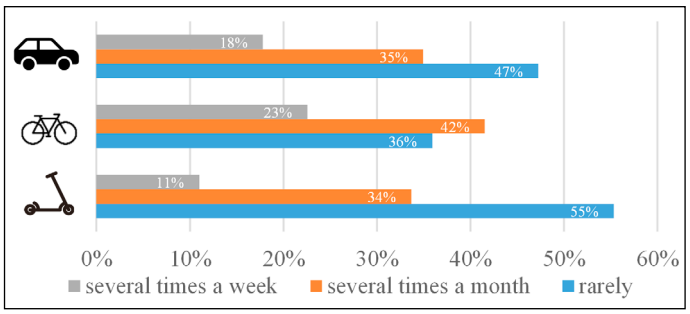

Fig. 3. Usage frequency of shared mobility service types among active users; CS N=202, BS N=107, SS N=86.

Accordingly, 202 CS, 107 BS, and 86 SS active users are in the sample. The minority of the active users use the services frequently (several times a week). The most active users are BS users; 23 percent use it several times a week; the least active are the SS users (Fig. 3). Note that only respondents living in Budapest and having driver's licenses were achieved; inland or international tourists and youngsters were not included in our survey. The majority of active CS (53%) and BS (64%) users use the services at least several times a month, though the majority of active SS users use the service less often than monthly (55%).

Only 17 percent of active users (N=241) have access to all three shared mobility service types, which represents just 5 percent of all respondents (N=836). However, there were no respondents who used all three types frequently. Almost half of the CS users (47%) have only access to CS, but only 20-20 percent of BS and SS users do not have access to another service type. Active CS users have access to BS (21%), SS (12%), or both micromobility forms (21%). However, only 5 percent of the frequent CS users have access to both types of shared micromobility.

Trips made by shared mobility services are likely to replace trips made by traditional transportation modes. Respondents were asked to select traditional transportation modes they would have used instead of shared mobility services in their last five trips.[1] Among all users, shared mobility use mainly substitutes PT trips (Fig. 4). 80-86 percent of active users indicated that they would have made at least one of their last five trips by PT. A similar was found in (Moran et al., 2020) regarding the SS users. The correlation is strong and statistically significant in CS usage frequency. Frequent CS users would have chosen PT instead of CS more than rare CS users. This tendency is less favorable in a city-level picture, as using CS instead of PT results in higher road traffic. Moreover, substituting private car use is also high. 72-78 percent of the active users would have chosen a car if shared services had not been available. This substitution is the most favorable in city-level traffic, especially if BS or SS is used instead of private cars. Frequent CS users would select private cars instead of CS less than those who use CS rarely. Accordingly, the less committed users insist on their private car more. Based on the frequent CS users' substitution, CS can reduce car ownership long-term, as stated in Fishman et al. (2014) and Hyland et al. (2018). Though it is usually stated that scooters are used instead of walking (Kopplin et al., 2021), all active users selected walking and private bikes or scooters the least; around 50 percent of the active users would have used these modes. Only 38 percent of active CS users indicate bike or scooter as a possible substitution mode.

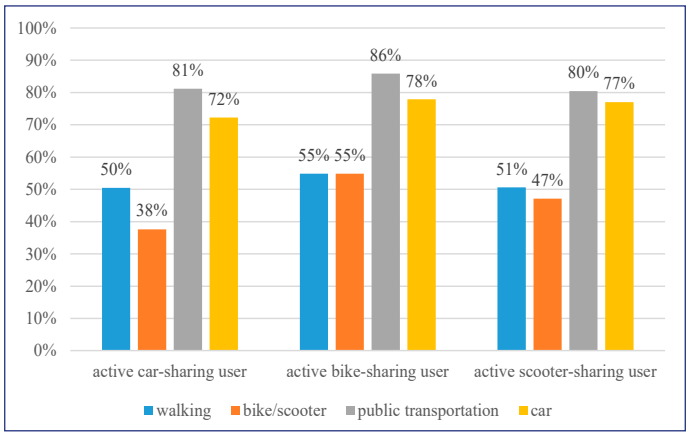

Fig. 4. Alternative traditional transportation mode instead of shared mobility service usage by active users; active CS users N=202, active BS users N=113, active SS users N=87; for each Khi² test p=0.000

Usually, shared vehicles are used during the whole trip; multimodal use is rare, especially in the case of CS. 70 percent of the active CS users (N=197) rarely or never use another transportation mode besides CS, though this share is 56 percent for shared-scooter (N=85) and 60 percent for BS (N=105) users.

4.2 Shared mobility service usage and socio-demographic

29 percent of the respondents (N=836) use at least one service actively. Though there is no significant correlation between

1 Question: Think of your last five trips where you used a shared vehicle of some kind. If it were not for these services, what mode(s) would you use for your different trips? More options could be selected.

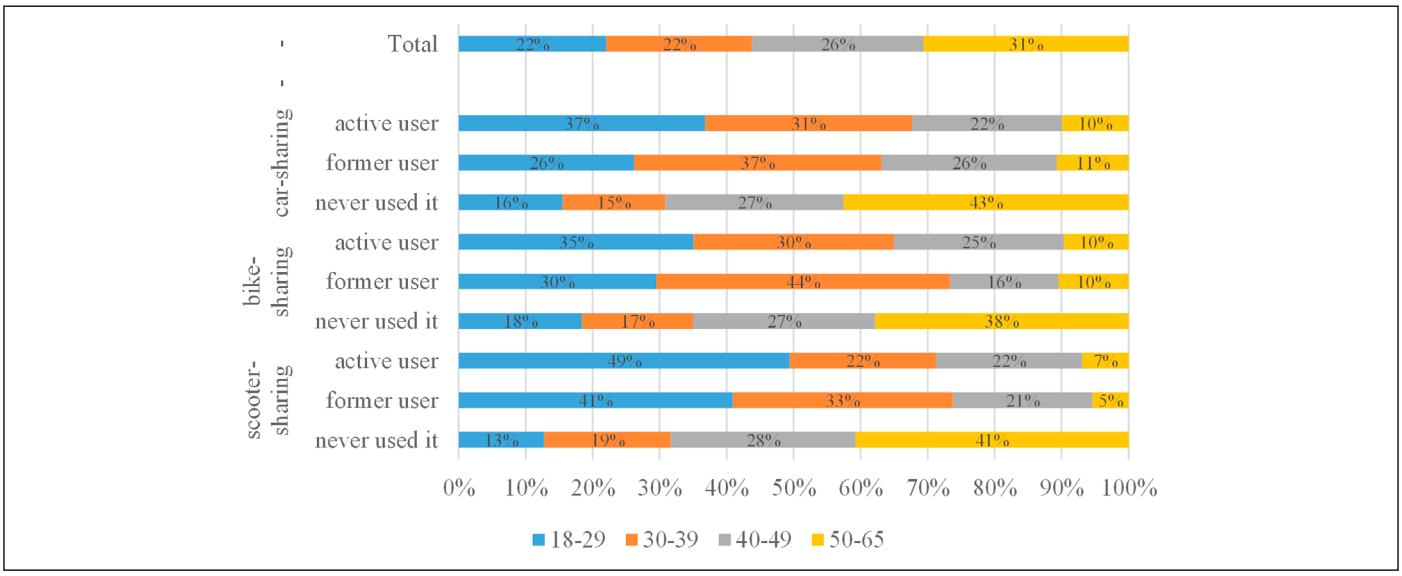

Fig. 5. Shared mobility service users by age. CS N=827, BS N=823, SS N=826; Khi² test p=0.000

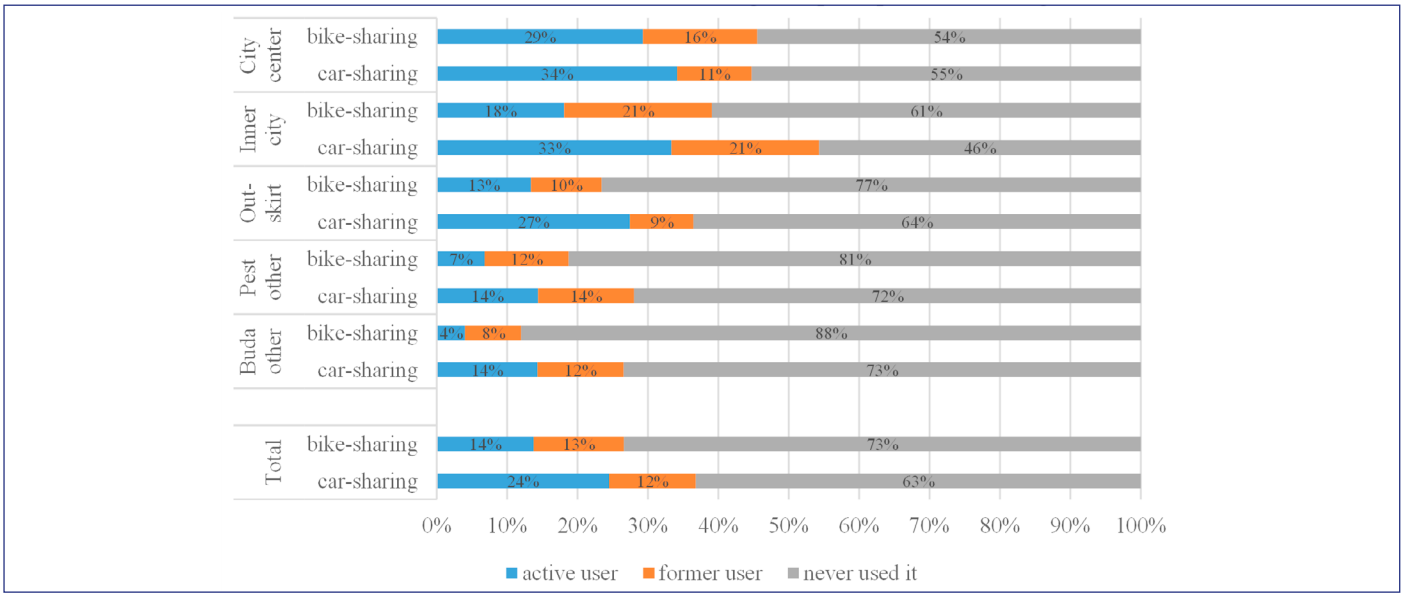

Fig. 6. BS (N=828) and CS (N=825) use affected by areas where the service is available. BS and CS are available in city-center and inner city. In outskirt only CS is available. Khi² test p=0.000

service use and gender, men use shared services slightly more, 33% against 26%. Accordingly, *hypothesis H1 was supported, but not statistically*. Our finding is in parallel with the findings of previous research (e.g., (Amirnazmiafshar & Diana, 2022; Laa & Leth, 2020; Lee et al., 2021b))

Among all shared mobility users, the younger generation (18-29 age group) is overrepresented, which means that while in the whole sample, this age group is represented by 22 percent, among the active BS users, this ratio is 35 percent, among the active SS users it is 49 percent, and among the active CS users it is 37 percent (Fig. 5.). Within those who never used the services, the older generation (50-65 age group) is overrepresented; in the whole sample, this age group is represented by 31 percent; in the case of shared mobility modes, the share of them is around 40 percent. *These results supported hypothesis H2 and in parallel with the findings of the literature* (e.g., (Amirnazmiafshar & Diana, 2022; Lee et al., 2021b; Wang & Lindsey, 2019)

The education level and income are correlated with shared mobility service usage. The more educated someone is, the more likely they are to use shared mobility, which was also found by (Chrétien & Louvet, 2019) for SS and by (Amirnazmiafshar & Diana, 2022) for CS. Only 19% of the respondents who had 8 grades or apprenticeship qualifications used at least one of the services; this share is 27% among graduates and 35% among higher educated respondents (in the whole sample, the share is 30%). The more monthly income the respondents have, the more likely they are to use at least one service (N=699). Under 485 EUR, only 10 percent, between 485 and 725 EUR, 19 percent, between 725 and 1215 EUR, 37 percent, and above 1215 EUR, 38 percent of the respondents use shared mobility services. Similar findings were revealed by (Raux et al., 2017) and (Winters et al., 2010) for BS. Accordingly, *hypotheses H3 and H4 were supported.*

The respondents, according to their residence, were categorized. Based on the functional territory, proximity to the city center, and population density, areas were defined: city center (functional center), inner city (high population, close to the city center), outskirt (high population density, distant to the city center), Pest other (low population density), and Buda other (mostly hilly and low population). The location of the residence in relation to the service area influences the use of shared mobility services (Fig 6.). Those who live in areas where BS (city center and inner city) and CS (even in the outskirts) are available have significantly higher proportions of active users than in the whole sample. Among the inhabitants who live in Pest other, Buda other areas, these ratios

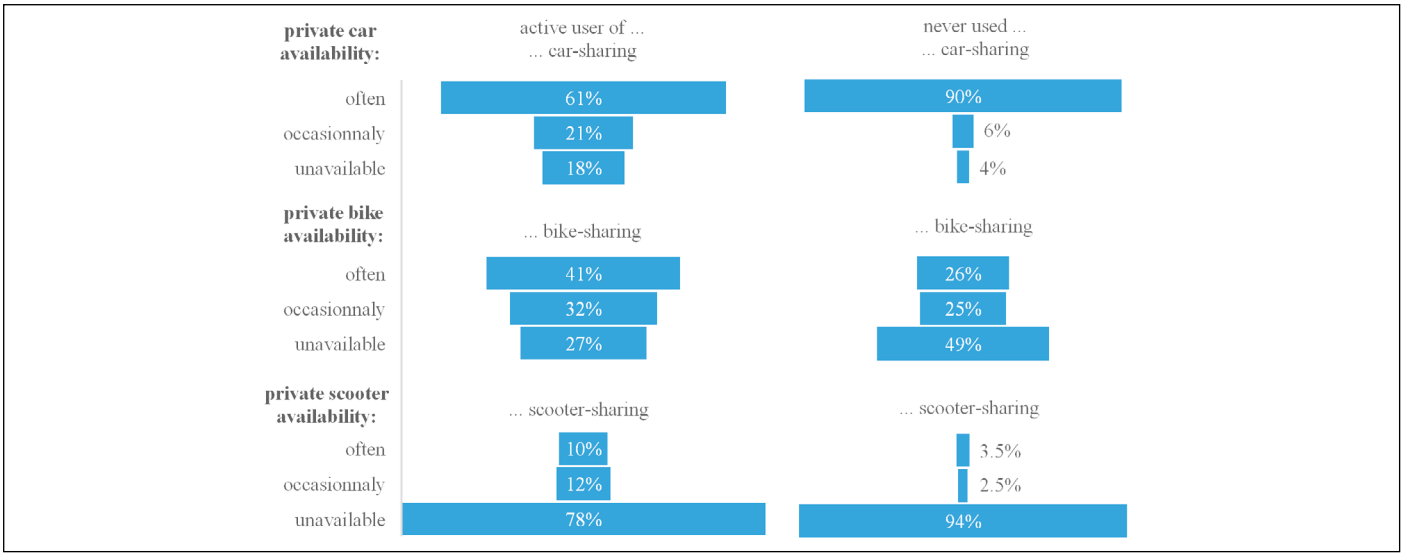

Fig. 7. Relationship between private vehicle availability and shared mobility service use; active user of CS N=199, BS N=111, SS N=86; never used CS N=520, BS N=599, SS N=578. Khi² test p=0.000

are smaller, and the non-users are higher. The correlation between SS and residence was not significant. *Accordingly, hypothesis H5 was supported for BS and CS*.

The respondents evaluated their driving skills, such as rule-following, confidence, and other skills, on a 1-5 scale. A significant correlation exists between rule-following self-perception of driving skills and SS usage. The active SS users evaluated themselves as reckless drivers more (20%) than those who never used SS (11%). This result underpins the common assumption among non-users that scooter users are reckless drivers (Wallgren et al., 2023). Furthermore, though reckless drivers represent 15 percent of the whole sample, their share among active CS users is 18 percent, but statistically, it is not significant. However, the majority (75%) of active users consider themselves a rule-follower driver. Accordingly, *hypothesis H6 was partially supported: SS users are more reckless drivers, but there is no statistically significant correlation between CS users and self-confidence.*

4.3 Shared mobility service usage and current mobility habits

Most active CS users often have (61%) or occasionally have (21%) access to a private car. The tendency is similar with active BS users; 41 percent often have access to a private bike, and 32 percent occasionally (Fig. 7). This would mean that CS and BS are used as a substitute transportation mode besides private car and bike use as the private option is widely available. Contrarily, the majority of active SS users do not have access (78%) to a private scooter. Accordingly, SS may be used as a complementary transportation mode. Of those who have never used CS, almost everyone has access to a private car at least occasionally (96%). Accordingly, it can be stated that private car availability rather deters the use of CS; as also found in (Olde Kalter et al., 2020) that travelers' attitudes towards car use and ownership are very stable over time. Consequently, hypothesis H7 was supported. Half of those who have never used BS services do not have access to private bikes. It can be concluded that there is significant potential for BS to grow; those who do not have private bikes at home can be future BS users. However, as found in (Kronsell et al., 2020), infrastructure development may be necessary. Only a small minority of those who have never used SS have access to private scooters. Based on the sample, it can be concluded that the use of electric scooters is generally low.

Considering the access to a vehicle type and the use of another shared mobility service type, it was found that those who have no access to a private car (7 percent in the whole sample) are present in higher ratios among the active SS users (12 percent). Moreover, those who have access to a private car use BS in smaller proportions (66 percent of active BS users have access to a car; contrarily, 88 percent of respondents who never used BS have access to a car). Accordingly, car ownership negatively influences shared micromobility use. This is against the finding in (Shaheen & Guzman, 2011), which states that car owners use BS more actively.

Analyzing the availability of a vehicle type and the frequency of shared mobility usage, the correlation is strong between car accessibility and CS usage. Those who do not have access to private cars (17 percent in the whole sample) use CS with higher frequency: 29 percent among those who use it several times a week and 26 percent among those who use it several times a month. On the contrary, if one or two private cars are available, the ratio of those who use CS is smaller. 55 percent of those who have access to one car and 28 percent of those who have access to two cars use CS services only rarely, even though the proportion of those with access to one car and two cars in the total sample is 45 percent and 21 percent, respectively. This result also supports the H7 hypothesis.

Attitudes towards car ownership were investigated by statements[2] assessed on a 7-element Likert scale. 87 percent of the respondents agreed that owning a car is useful for carrying big packages or traveling longer distances. However, among active CS users, those who indicated this statement as less important use CS services more frequently. Only 17 percent of active CS users indicate this statement as less important, but among the frequent CS users, their share is 39 percent. Considering car as a status symbol is higher among the age group 18-30 (43%) and lower among all the other age groups than in the whole sample (27%). However, the share of the opinion that a car is not a status symbol at all is only 31 percent in the total sample. Accordingly, the status

2 Statements in the questionnaire: It is essential for me to have my own car because... (1) ...it is essential for me to have my own car because it is a work tool. (2) ...it is important for me to have my own car because it is always available when I need to deliver luggage or when I have to go on a long trip. (3) ...it is important for me to have my own car because it is part of my private sphere (I can store personal belongings in it, it provides a comfortable environment). (4) ...it is important for me to own a car because it is a status symbol. (5) ...it is important for me to own a car because I do not want to travel with strangers. (6) ...only a car can give me freedom and independence in transportation.

symbol cannot explain the higher usage share of CS among the younger generation and the lower usage share among the elderly generation. 58 percent of the respondents agreed that car ownership improves personal independence. There is a negative, but statistically not significant correlation, between this attitude and the car sharing usage frequency. Those who agree with this statement use CS less frequently and vice versa. Furthermore, 72 percent of the respondents agree with the importance of having private space provided by a private car. The correlation is significant with CS use; among the active users, the disagreement with this statement is significantly higher (34%) than in the whole sample (21%), and among the non-users, the agreement is slightly higher (75%) than the ratio of those who agree in the whole sample (72%). Accordingly, hypothesis H8 was only partially supported because considering the car as a status symbol was higher among the younger generation who use CS more frequently.

5. CONCLUSION AND POLICY IMPLICATIONS

As a main contribution, this study presents the results of a representative survey from Budapest, Hungary, which aimed to reveal the correlation between travel habits, general personal characteristics, and the use of shared mobility services (scooter-sharing, bike-sharing, and car-sharing).

The main findings are as follows: The active CS users are inclusive; half of them do not use another type of shared mobility. However, almost half of the shared mobility users have subscriptions, at least for two different types of service, but no respondents used all three service types frequently. Among all shared mobility users, the younger generation is overrepresented. The education level and income are positively correlated with shared mobility service usage. The more income the respondents have, or the higher their educational level is, the more likely they use at least one service

Shared mobility usage substitutes mostly previous PT use. Frequent CS users would have chosen PT instead of CS more than rare CS users. This switch is not favorable as it increases road traffic. However, the switch from private car use was also significant, possibly supporting the ease of traffic issues. Frequent CS users would select private cars instead of CS less than those who use CS rarely. Accordingly, the less committed users insist on their private car more. We found that private car availability is rather a deterrent to the use of CS; for those who have never used CS, almost everyone has access to a private car at least occasionally. Furthermore, if one or two private cars are available, the use of CS is less frequent among active users. In addition, we found that the availability of shared services in the neighborhood influences its usage; in areas where BS and CS are available, there are significantly higher proportions of active users than in the whole sample.

As a limitation, only respondents with driver's licenses were included; thus, in some cases, the CS users are overrepresented, and SS or BS users are underrepresented. However, the results may contribute to service operation planning and support in defining the target group of a campaign. First, the increase of the service area coverage for all types may result in increased use. Second, since the majority of the users are of higher social status, it would be beneficial to make the pricing more flexible for CS and SS; furthermore, to advertise the affordable BS use more efficiently, this way these services could serve people with lower status. And lastly, on a more general level, there is a need to change the mindset of society. This would require awareness-raising campaigns as well as changes in the regulations, such as reducing the costs for those who use shared mobility services on the way to work (as opposed to using company cars), making parking cheaper for CS, introducing integrated tariff system for different shared mobility services and conventional public transportation etc. The potential in this topic is wide. In our further studies, we plan to analyze the sample, revealing typologies and elaborating a technology acceptance model for CS.

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