Identifying Vehicle Preferences and System Requirements of Potential Users of Shared Mobility Systems (SMS)

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Abstract: Shared mobility systems (SMS) enable short-term on-demand access to mobility without the costs and responsibilities that come with vehicle ownership. A careful investigation of the motivation, values, and barriers that different socio-demographic groups have towards SMS may shed light on the gaps that mobility providers may still need to fill in order to attract broader population groups. The objective of this paper is an investigation of the conditions under which potential users would adopt sharing services and which vehicles they would prefer in the context of SMS. We explore (i) the willingness of individuals to use SMS, (ii) the preferences of potential users regarding types of vehicles in SMS, and (iii) requirements towards the features and design of SMS. We study the characteristics of potential users and non-users of SMS. Furthermore, we associate socio-demographic and travel behavior attributes of potential users to their SMS preferences and requirements. These effects might be a valuable source of knowledge for tailored system designs and setups for SMS providers. By working with audience segmentation, SMS communicators may develop persuasive messages customized for each group.

1 INTRODUCTION

Shared mobility systems (SMS) enable users to have short-term access to transportation modes on an as-needed basis (Karbaumer & Metz, 2021; Shaheen et al., 2017; Tangerine, 2021). In recent years, free-floating services, where a vehicle can be parked after usage within a given service area, have spread internationally and are steadily gaining momentum (Abouelela et al., 2021; Ramos et al., 2020). Several environmental, social, and transportation-related impacts have been attributed to SMS (Shaheen & Cohen, 2018). Commonly reported benefits are the reduction of private vehicle ownership and the extension of public transport catchment areas (Jochem et al., 2020; Shaheen & Cohen, 2018; Tangerine, 2021). In addition, cost savings, increased economic activities near multi-modal hubs, opportunities for trips not previously possible via public transportation, and an increase of active travel such as walking and cycling are also among the expected effects (Ma et al., 2020; Shaheen & Cohen, 2018).

The existing literature covers the characteristics of users and non-users of SMS. Investigations of users reported that SMS customers are generally well-educated, younger adults between 21 – 45 years old, with middle and upper income, no children, living in urban built environments with limited access to private cars (Bieliński & Ważna, 2020; Hinkeldein et al., 2015; Khamissi & Pfleging, 2019; Nobis & Kuhnimhof, 2019). Younger adults may be attracted by SMS as they tend to be less car-oriented than previous generations, keen on new technology, and open towards alternative transportation means (Winter et al., 2020). Considering that the current users of SMS show specific socio-demographic characteristics, such as young age and life in an urban environment, it is evident that a large group of the population has not been attracted to SMS yet. Other populations, such as families, people taking care of minor-aged children, those living in rural areas, or the older population show according to research a different mobility pattern and may thus have different mobility requirements (Ramos et al., 2020;

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Romanowska et al., 2019). Therefore, a careful investigation of motives and values that different socio-demographic groups have towards SMS may shed light on the gaps that mobility providers may still need to fill to attract a wider population range.

Various motives and barriers underly the choice of transport modes (Pripfl et al., 2009; Romanowska et al., 2019). Pripfl and colleagues (2009) categorized these factors into the two main groups: "purpose-rational" and "social-emotional". The purpose-rational motives included user-friendliness, time, cost, comfort (convenience, possibilities, and weather resistance while traveling), availability, accessibility, and reliability. The social-emotional factors were independence, status, pleasure, privacy, absence of stress, security, and environmental awareness. Ramos and colleagues (2020) determined the motives to use SMS. The researchers distinguished the accessibility of pick-up locations of sharing vehicles near the workplace or home, expenses reduction, sustainable traveling, comfort when traveling, the convenience of having access to the sharing vehicle in case of need, and avoiding responsibilities with maintenance and repair for the own vehicle. They identified several *mobility styles* of users and non-users based on environmental concerns, personal norms, and transport behavior. The convenience of having a car only when needed and avoiding private vehicle maintenance were among the most selected motives among all mobility styles.

It is important to bear in mind the motives and barriers of travel choice while designing SMS features. The system should offer an easy, quick, and user-friendly experience. In the past, billing, retrieving access to the vehicle, and recording the trip information were paperwork time-consuming processes (Pawłowska, 2021). The recent shift towards digital technologies enabled the widespread adoption of SMS offers (Phillips, 2017). To utilize the service, a person needs to hold a smartphone, a digital payment account, a credit or debit card. These prerequisites guarantee seamless reservations and cashless payments (Mireia & Ribas, 2019). Damage, cleanliness issues reporting, and driving license validations also shifted to a smartphone app. This functionality allows the user and provider to avoid paperwork and offers spontaneous digital access to sharing vehicles around the clock (Phillips, 2017). Therefore, management of the online platform, its optimization, and promotion are among the key activities of SMS operators (Mireia & Ribas, 2019).

It is essential that the SMS platform is clear, stable, and reliable (Stopka, 2014). Phillips (2017) noted that if it takes more than 30 seconds to book a vehicle, there is an increased possibility that the user will terminate the booking process and abandon the service. Thus, ease of use, personalization, user effort, and performance can be identified as important criteria to provide a good user experience (Wannow et al., 2021). Though, the users of car-, bike-, or scooter-sharing often need to become customers of more than one service to cover all their transport needs, as few providers offer multiple SMS from a single platform (Mireia & Ribas, 2019). A user has to be familiar with the multitude of applications which could be time-consuming and incomprehensible. Integrating a range of various vehicle types into one platform could make the users aware of the available alternatives and save time for the registration in several applications (Mireia & Ribas, 2019).

The availability and reliability of sharing are important to overcome the barriers to service acceptance. Sanders and colleagues (2020) showed that some people worry that the sharing equipment will break or malfunction, the battery of the electric vehicles will not be charged, or the vehicle will not be available when needed. Barriers such as a vehicle being hard to find when needed or sometimes broken were more likely to be addressed by those who have frequently used SMS (Sanders et al., 2020). To provide a positive customer experience, the service provider should maintain the fleet clean, charged, and functioning. Customer support is essential to resolve emerging questions and issues (Pawłowska, 2021). When necessary, the transportation means should be relocated to maintain adequate availability (Sanders et al., 2020).

Perceived high fees are among the main barriers for people that never used SMS (Bieliński & Ważna, 2020; Wannow et al., 2021). A further psychological barrier is a lack of trust. For example, the COVID-19 pandemic significantly affected the safety perception of the most (Nikiforiadis et al., 2020). More people avoid using items that have been previously used by others and do not believe, that SMS operators take the necessary precaution measures (e.g. vehicle disinfection) (Nikiforiadis et al., 2020). To improve the image of SMS in the post-pandemic world, the operators need to convince people that their vehicles are safe to use. The use of self-cleaning materials to cover the vehicles' contact points, installing hand sanitizer or disposable glove dispensers, optimizing the frequency of equipment cleaning, or developing innovative marketing campaigns to improve hygiene practices could be among the strategies towards the acceptance of SMS after COVID-19 (Awad-Núñez et al., 2021; Gauquelin, 2020).

Motivation, values, and barriers towards SMS were found in the literature. However, few studies have investigated how users' attributes are associated

with requirements towards SMS. We believe that fulfilling the key requirements towards sharing is a crucial factor to motivate individuals to use SMS. Therefore, the objective of this paper is an investigation of the conditions under which potential users would adopt sharing services and which vehicles they would prefer in the context of SMS. In the following sections, we explore the preferences and requirements towards vehicle types and features of SMS, as well as their relationship with socio-demographic and travel behavior. In this way, we aim to contribute to research by characterizing potential users and non-users of SMS, describe the preferences for certain sharing vehicles, and explain requirements towards SMS. With these insights, mobility providers could improve their service and marketing strategies to customize the business to various groups.

2 METHODOLOGY

2.1 Survey and Variables

To better understand the potential user preferences and requirements for SMS, the data retrieved from a broader online survey in Munich was used. The questionnaire was distributed to respondents online for one month starting February 2021 using SoSci Survey (*SoSci Survey*, 2021). The participants had access to the questionnaire in German through a web link. The target population was the students and personnel of Munich University of the Federal Armed Forces (UniBw, 2021) between 18 and 68 years.

The broader survey was designed to understand the daily transport choices, willingness to reduce car use and choose alternative transport modes. The questionnaire consisted of eight parts. On average, it took 10 to 15 minutes to complete the questionnaire which included questions on the (1) criteria for the vehicle purchase, (2) frequencies, (3) reasons, and (4) purposes of vehicle use, (5) attitudes towards accessibility and connectivity via public and private transport, (6) attitudes towards sharing and (7) autonomous vehicles. (8) Socio-demographic included data on age, gender, income, household size, availability of children of minor age in a household, higher level of education achieved, and occupation. In the present study, the data on travel behavior and socio-demographic were utilized (Table 1). Travel behavior was described by the access to a car, access to a bike, ownership of a seasonal public transport ticket, and frequency of heavy items transportation. Gender, age, minor-aged children in a household, and income were selected as socio-demographic descriptors. For each variable, the categories “I prefer not to answer”, “No answer”, or “Not applicable” were treated as missing values which affected the number of valid cases for a particular indicator.

2.2 SMS Attitudes

Information about the general willingness to use SMS, the preferences towards specific sharing vehicles, and requirements towards SMS was collected. Respondents were asked if they could imagine using SMS in the future. They could select between the options “I want to use sharing services in the future” and “I don’t want to use sharing services in the future”. Yet the question on the willingness to use SMS did not specify the mode of service, as the goal was to find out if the respondents are generally open to using SMS. Subsequently, to find out which particular vehicles people would use in the context of the SMS platform (e.g. a smartphone app), the participants were asked to select among several options: cars, bikes, cargo bikes, and scooters. Multiple choices were possible. Finally, the respondents were invited to state their comments, preferences, and recommendations regarding the design, features, and functions of SMS in free text fields. The data was further processed to form meaningful categories (Table 2). Depending on the free text context, the expressions were assigned to the categories of motives and barriers underlying mode choices (Pripfl et al., 2009; Ramos et al., 2020). These categories were user-friendliness, availability, price, reliability and security, comfort and quality, and environmental friendliness. Further categories were formed based on the explicitly mentioned requirements such as flexible pick-up and drop-off for sharing vehicles, a wide operation radius of SMS, and a wide range of vehicles in the sharing platform. The category needed to be mentioned in at least 1 % of comments, in order to be further investigated. Some respondents mentioned multiple requirements, which were further reflected in the dataset. If the expression indicated one of the categories, the category was marked with “1”, otherwise “0”. Some inputs, such as “Practical” or “Functional”, were considered too vague to assign to any category, therefore excluded from the further analysis.

2.3 Statistical Analysis

2.3.1 Sample

To investigate the sample’s representativeness, the characteristics were benchmarked against the latest Munich Census for gender, age, and household size

(Statistische Ämter des Bundes und der Länder, 2020), and income in Munich according to Kistler and colleagues (2017) (Table 3).

2.3.2 Relationships

To explore the relationship between personal characteristics, the willingness to use, and requirements towards a sharing system, we computed

Table 1: Travel behavior and socio-demographic variables.

Type	Variable	Level	Measure
Travel behavior	Public Transport Season Ticket	1 – Don't own; 2 – Own	Ordinal
	Access to Car	1 – Never; 2 – Seldom; 3 – Often; 4 – Always	Ordinal
	Access to Bike	1 – Never; 2 – Seldom; 3 – Often; 4 – Always	Ordinal
	Transport of Heavy Items	1 – Never; 2 – Seldom; 3 – Often; 4 – Always	Ordinal
Socio-demographic	Gender	1 – Female 2 – Male	Nominal
	Age	1 – Younger than 20; 2 – 20 – 34; 3 – 35 – 49; 4 – 50 – 64; 5 – older than 65	Ordinal
	Children of Minor Age in Household	1 – No; 2 – Yes	Ordinal
	Income	1 – less than 1000 €; 2 – 1000 € – 2000 €; 3 – 2000 € – 3000 €; 4 – 3000 € – 4000 €; 5 – 4000 € – 5000 €; 6 – more than 5000 €	Ordinal

Table 2: Requirement categories and typical expressions of potential users of SMS.

Category	Typical expressions
User-Friendliness	"Uncomplicated", "Flexible", "Easy to use", "Uncomplicated to use", "Easy to book", "Easy to operate", "Easy to lend and return", "Simple billing", "Simple registration", "Non-bureaucratic", "User-friendly mobile app", "Online reservation", etc.
Availability	"Availability", "Sufficiently available", "Quickly available", "Easily accessible", "Available around the clock", "Always available", "Sufficiently number of available vehicles", etc.
Price	"Cost-efficient", "Inexpensive", "Low cost", "Reasonable price", "Fair price", "Good price", "Good price-quality value", "Not too expensive", "Affordable", etc.
Flexible Pick-up and Drop-off	"Drop-off at destination possible", "Drop-off and pick-up locations should be flexible", "A sufficient number of pick-up and drop-off locations", "Flexible parking facilities", "Free-floating use", "Decentralized pick-up and drop-off", etc.
Wide Operation Radius	"Important connections should be accessible", "Connection to public transit stops", "Parking in rural areas", "Reasonable operation range", "Possible to use for recreation (e.g. trip outside the city)", "Sufficiently large operation radius", etc.
Reliability & Security	"Reliable vehicles", "Possible to reserve a vehicle in advance", "Secure", "Insured vehicles", "Resistant", etc.
Comfort & Quality	"Comfortable vehicle", "Comfort", "Possible to adjust the seat", "Cleanliness", "Clean", “Disinfected”, “COVID-19 disinfection”, "Well-maintained vehicles", "Appropriate quality of vehicles", "Good condition of vehicles", "Regular vehicle maintenance", "Weatherproof, etc.
Range of Vehicles	"Large and varied offer of vehicles", "Vehicles for different use-cases (e.g. cargo bike, bike, scooter)", "Vehicles, which I don't have myself, should be offered", "Diverse choice", "Wide choice of vehicles", etc.
Environment-Friendliness	"Electric environmentally-friendly vehicles", "Environmentally friendly", "Sustainable", etc.

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the strength and direction of the association using bivariate correlations. Depending on the measurement of the variables (nominal or ordinal), we used Spearman's rank-order correlation (r_S) for pairs of ordinal variables and the point-biserial correlation (r_{pb}) for pairs of nominal and ordinal variables. The software used was IBM SPSS Statistic (IBM, 2021). For data exploration, we chose a significance level of alpha less or equal to 5 %.

3 RESULTS

3.1 Sample

The collected data led to 877 responses. The respondents were military (44.6 %) and civil (4 %) students, military personnel (5.9 %), academic (22.8 %) and non-academic (14.8 %) employees, and professors (7.9 %) of Munich University of the Federal Armed Forces. A percentage of 45.2 % of survey participants lived in accommodations on the campus territory, of which 91.2 % were students. All military students in our sample were paid for military service. The sample demographics are presented in Table 3. The median age group was between 20 and 34; the median income was 2000 € – 3000 €. On average, the sample household consisted of 2 people. The majority (62.1 %) of respondents were men. Entries that fell into the categories "I prefer not to answer" or "No answer" were marked as missing and excluded from the valid percentage. The dataset reflects some limitations in representativeness compared to Munich inhabitants. More than half of the respondents were active military members. Females, individuals under 20 and over 65 were underrepresented. The respondents reflected a much higher percentage of individuals between 20 and 34 years with net income 2000 € – 3000 €. These socio-demographic characteristics, however, correspond to the attributes of typical SMS users (Liao & Correia, 2020).

3.2 Willingness to Use SMS

A total of 805 respondents gave a valid response about their future intent to use sharing. A percentage of 78 % was rather open towards SMS in the future. A percentage of 22 % did not plan to try it. Correlations were run to determine the relationship between the willingness to use SMS, travel behaviour (ownership of a season ticket for public transport, having access to a car, having access to a bike, need to transport heavy items), and socio-demographic (gender, age, minor-aged children in household, income) (Figure 2). There was a statistically significant positive correlation between willingness to use SMS in the future and ownership of a season ticket for public transport (r_S = 0.105, n = 771, p = 0.004). Furthermore, having access to a car (r_S = -0.166, n = 770, p < 0.001), the need to transport heavy items (r_S = -0.101, n = 769, p = 0.005), and age (r_S = -0.091, n = 770, p = 0.012) negatively correlated with the willingness to use SMS, which was statistically significant. In contrast, there was no significant relationship between the willingness to use SMS in the future, bike access (r_S = 0.033, n = 764, p = 0.361), gender (r_{pb} = -0.007, n = 765, p = 0.909), children of minor age in a household (r_S = -0.084, n = 429, p = 0.081), and income (r_S = -0.019, n = 717, p = 0.616).

3.3 Vehicles for SMS

To investigate preferences towards SMS vehicles and requirements towards SMS as described in the following two sections, the dataset was narrowed to those respondents who reported willingness to use SMS. This led to 630 valid responses. The respondents were asked which types of vehicles they would use in the context of the SMS platform (e.g. comprehensive smartphone app). The participants could select multiple options among cars, bikes, cargo bikes, and scooters. The majority selected cars (62 %) and bikes (54 %), followed by scooters (46 %). Cargo bikes were selected by 24 percent (Figure 1). A correlation was applied to assess relationships between vehicle preferences and characteristics of individuals willing to use SMS (Figure 2). There was a statistically significant positive correlation between gender (r_{pb} = 0.118, n = 603, p = 0.004) and car as a preferred SMS option, meaning that men were more likely to choose car-sharing compared to women. The lower the income, the more people tended to opt for cars in SMS (r_S = -0.113, n = 571, p = 0.007). People having access to a bike (r_S = -0.082, n = 604, p = 0.045) did not tend to choose bikes as SMS option. However, sharing cargo bikes were preferred by those having access to a bike (r_S = 0.116, n = 604, p = 0.004) and households' members with minor-aged children (r_S = 0.178, n = 338, p = 0.001). Statistically significant negative correlations were found between the choice of scooter-sharing, ownership of public transport seasonal ticket (r_S = -0.156, n = 607, p < 0.001), and age (r_S = -0.102, n = 607, p = 0.012).

Table 3: Sample demographic compared to Munich Census and Kistler et al. (2017).

N = 877		Participants	Valid percent	Benchmark	Valid percent vs. Benchmark
Gender	Female	221 (25.2 %)	28.7 %	48.3 %	- 20 %
	Male	545 (62.1 %)	70.9 %	51.7 %	+ 19 %
	Other	3 (0.3 %)	0.4 %	-	+ 0.4 %
	Invalid answer	108 (12.3 %)	-	-	-
Age	Younger than 20	17 (1.9 %)	2.2 %	18 %	- 16 %
	20 – 34	516 (58.8 %)	66.9 %	25 %	+ 42 %
	35 – 49	126 (14.4 %)	16.3 %	22 %	- 6 %
	50 – 64	102 (11.6 %)	13.2 %	18 %	- 5 %
	65 or Older	10 (1.1 %)	1.3 %	17 %	- 16 %
	Invalid answer	106 (12.1 %)	-	-	-
Household size	1	90 (10.3 %)	20.9 %	50 %	- 29 %
	2	173 (19.7 %)	40.1 %	29 %	+ 11 %
	3	68 (7.8 %)	15.8 %	11 %	+ 5 %
	4	79 (9.0 %)	18.3 %	7 %	+ 11 %
	5+	21 (2.4 %)	4.9 %	3 %	+ 2 %
	Invalid answer	446 (50.9 %)	-	-	-
Monthly net income	Up to 1000 €	11 (1.3 %)	2 %	7.9 %	- 6 %
	1000 € – 2000 €	104 (11.9 %)	14 %	30.8 %	- 17 %
	2000 € – 3000 €	443 (50.5 %)	62 %	26.8 %	+ 35 %
	More than 3000 €	160 (18.2 %)	22 %	34.6 %	- 13 %
	Invalid answer	159 (18.1 %)	-	-	-

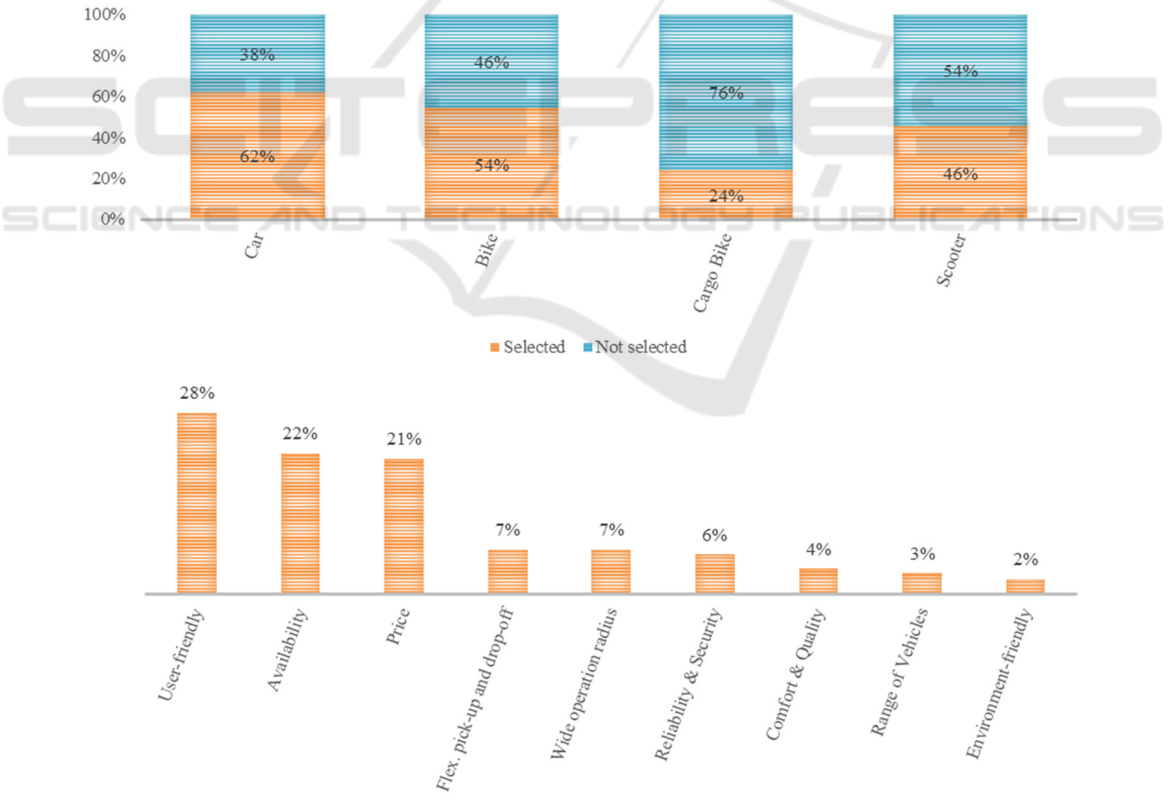

Figure 1: Preferred vehicles and requirements towards SMS.

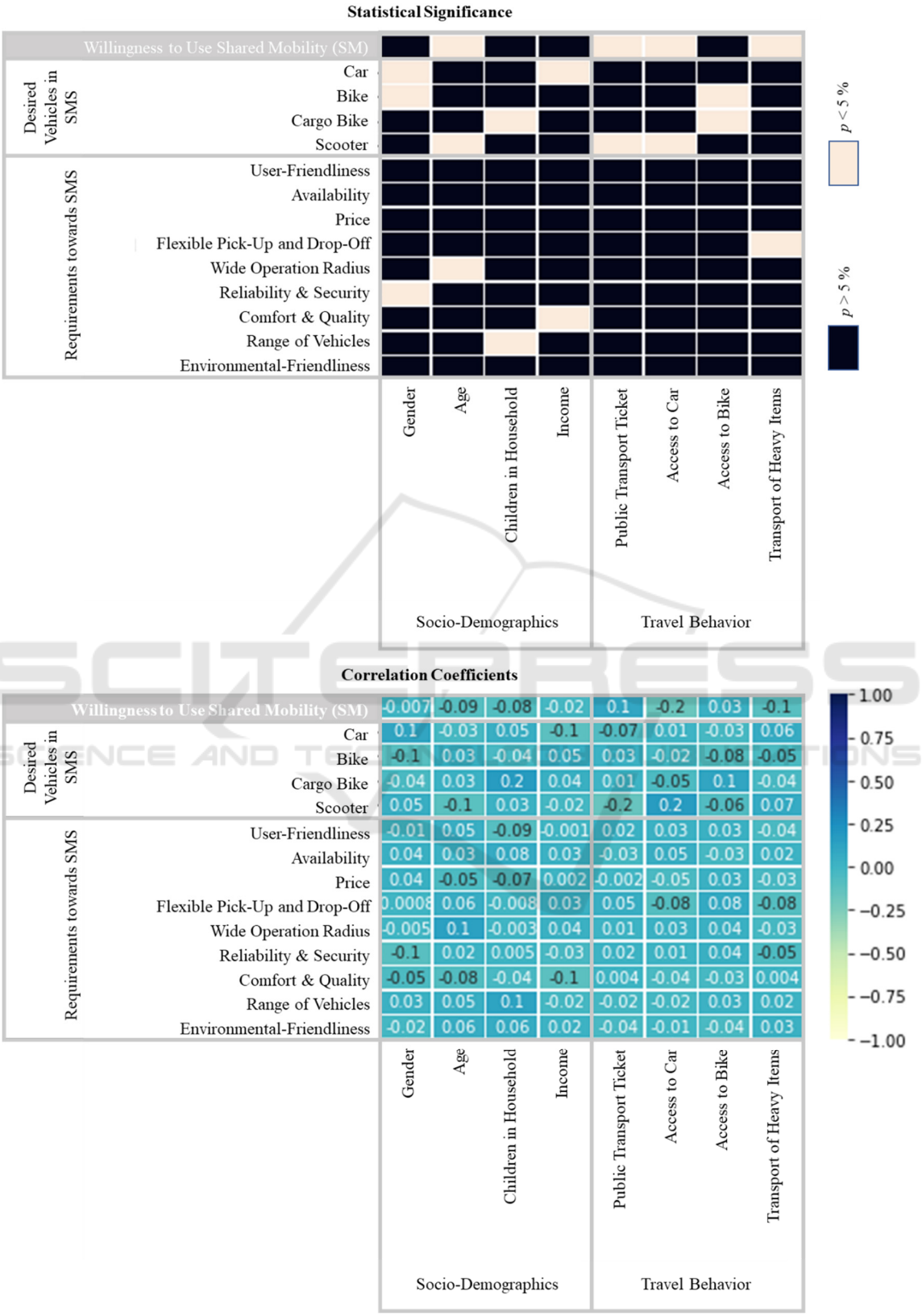

Figure 2: Statistical significance and correlation coefficients.

Significant positive correlation was between those who have an access to a car and scooter-sharing choice (r_S = 0.176, n = 607, p < 0.001). This could be interpreted that public transport users and older people were unlikely, and private car users were likely to choose scooters in the context of SMS. In addition, there was a significant negative correlation between gender (r_{pb} = -0.098, n = 603, p = 0.016) and the choice of bike-sharing, implicating that women were more likely to choose sharing bikes than men.

3.4 Expectations and Requirements towards SMS

The free-text requirements towards SMS were interpreted and decomposed into several categories (Table 2). The most frequently mentioned requirements towards SMS were user-friendliness, availability, and reasonable price (Figure 1). Requirements such as wide operation radius of the mobility system, flexible pick-up and drop-off locations for the sharing vehicles, reliability, and security of the system and vehicles were mentioned by roughly 7 %. The respondents stated that sharing vehicles should be well-maintained, clean, and comfortable. For further analysis, these expressions were coded as “Comfort & Quality”. 3 % of potential users mentioned that they would benefit from a combination of various vehicles in the sharing system. Environmental friendliness was also among the factors which motivate some people (2 %) to use SMS.

Travel behavior and socio-demographic were correlated with the categories of requirements towards SMS (Figure 2). The correlation revealed that those who did not need to transport heavy items were likely to state that SMS should feature flexible vehicle pick-up and drop-off areas (r_S = -0.082, n = 606, p = 0.044). The significant negative correlation depicted that women were more concerned about the reliability and security of the system than men (r_{pb} = -0.100, n = 603, p = 0.014). The statement that sharing systems should have a wide operation radius positively correlated with the age of respondents (r_S = 0.142, n = 607, p < 0.001). Respondents who live in households with minor-aged children pointed out that SMS should include various types of sharing vehicles (r_S = 0.130, n = 338, p = 0.017). The lower-income population seemed to be more concerned about the comfort and good quality of the vehicles in the sharing system (r_S = -0.110, n = 571, p = 0.008) than higher-income individuals. No significant relationships with travel behavior and socio-demographic were found for requirements such as user-friendliness, availability, price, and environment-friendliness.

4 DISCUSSION

This study explored the willingness to use SMS, the preferences of potential users regarding types of vehicles in SMS, and requirements towards SMS. The data was collected via a stated preference survey in Munich where SMS is widely available and various sharing vehicles are already present on the streetscape. The survey respondents formed a sample drawn from the Munich University of the Federal Armed Forces, namely military and civil students, military personnel, academic and non-academic employees, and professors. Regarding the willingness to use SMS, about two out of three respondents were eager to use these mobility options. This relatively high percentage corresponds to a German-wide affinity for sharing in the mobility sector (Fischlein, 2019). Furthermore, we analyzed how travel behavior and socio-demographic correlated with the eagerness to use SMS. The results show that the possession of a season ticket for public transport, car accessibility, the need to transport heavy items, and age had significant effects on the intention to use SMS. In our study, younger people were more eager towards SMS than older ones. This complies with the findings that SMS users are young individuals of 21 – 45 years (Bieliński & Ważna, 2020; Ramos et al., 2020). As we found a positive correlation between the ownership of season tickets for public transport and willingness to use SMS, we assume that people who regularly use public transport are potential SMS users. Previous studies also stated that compared to the general population, users of SMS are relatively heavy users of public transport (Franckx & Mayeres, 2016; Torrisi et al., 2021). These findings depict the association of public transport and SMS user groups.

People having access to a car and the need to transport heavy items tended to be less willing to use SMS. This corresponds to previous findings that a great part of SMS users live in carless households (Bieliński & Ważna, 2020; Zolfaghari et al., 2014). Previous research has shown that those who own or regularly have access to a car may also have strong emotional bonds with their cars and that the associated self-identity may prevent people from using SMS (Coleman, 2015; Sheller, 2004). The survey by Khamissi & Pfleging (2019) indicated that the concept of SMS lacks the perception of individual freedom. Possible waiting times and restricted vehicle availability affect the feeling of one’s flexibility (Khamissi & Pfleging, 2019). We assume that these factors could play a role in the decision-making of those who need to transport heavy items. These people may rely on private or company vehicles for

transport. These findings imply that it might be challenging for a sharing provider to convince those who depend on private cars to use SMS.

To study which vehicle types are preferred in the context of SMS, we analyzed the responses of people willing to use SMS in the future. Men and lower-income individuals tended to choose cars as a part of a sharing system. Previous studies also revealed that car-sharing services are mostly used by men (Kawgan-Kagan & Popp, 2018). The tendency that people with lower income opted for cars to be a part of SMS could be associated with lower car access and ownership rates among this group (Karen et al., 2019). We assume that these individuals might have unfulfilled mobility needs which are associate with car use. In this case, car-sharing could be a suitable mobility solution offering access to a car without the costs for vehicle purchase, insurance, and maintenance.

Bikes for SMS were likely to be chosen by women rather than by men. Previous studies, however, identified the gender gap in bike usage (Gorrini et al., 2021; Hosford & Winters, 2019; Prang, 2017). Gorrini and colleagues (2021) showed that women use bike-sharing services less than men. We assume, biking and bike-sharing services already gained an essential positive image and acceptance among women in Munich. In similar environments, women are potential bike-sharing users. Consistent with previous studies (Winters et al., 2019), people having access to a bike did not associate with the potential bike-sharing users.

Cargo bikes as a part of SMS were selected in 24 % of the cases, which is way less comparing to the choices of cars, bikes, and scooters. Cargo bike-sharing is not yet widely established in Munich and a few people have experience using cargo bikes. In our study, the potential users of cargo bikes were people who have access to a bike and households with minor-aged children. Becker and Rudolf (2018) reported a high percentage of experienced cyclists and households having children under 18 years among the power users of cargo bike-sharing. In Europe, cargo bikes are gaining popularity and becoming an attractive alternative for families with children (Behrensen & Sumer, 2020). SMS providers may consider including cargo bikes in their fleets to make their services more attractive to households with children.

Older adults were unlikely to choose scooters in the context of SMS. Consistent with the previous findings (Abouelela et al., 2021; Bieliński & Ważna, 2020; Sanders et al., 2020), potential scooter-sharing users are rather young. The scooter-sharing operators have attracted the car-less population who either walk or take public transport to go to their destination (SFMTA, 2019). However, in our study, public transport users were unlikely and those who had access to a car were likely to choose scooters to be included in SMS. This might be due to the contradictory image of scooters and recent debates about their usefulness and environment-friendliness (Carter, 2021).

We also identified the user requirements towards sharing and associated attributes of potential SMS users. This kind of segmentation is a valuable source of knowledge for marketing strategies for SMS providers tailored to attract more users. By working with audience segmentation, SMS providers may develop framings that increase the salience of the message for each group and, therefore, be more persuasive. The SMS requirements that were prominent in the present study were user-friendliness, availability, reasonable price, flexible pick-up and drop-off for vehicles, wide operation radius, reliability, security, comfort, good quality, a wide range of vehicles in SMS, and environment-friendliness. In this study, no significant relationships were found between requirements such as user-friendliness, availability, price, and environment-friendliness, and potential SMS user attributes. Concerning significant correlations, women emphasized the importance of the reliability and security of SMS more often than men. Gorrini and colleagues (2021) studied women's needs and expectations as users of bike-sharing services. Results showed that women were more concerned about safety, security, and factors influencing the perception of danger while cycling and using the current bicycle infrastructures. In our case, the factor of reliability and security were extracted from the free-text comments including aspects such as the possibility to reserve the vehicles in advance and trouble-free functioning of the system. The complexity of the terms complicates the comparison with the previous studies. Respondents who live in households with minor-aged children pointed out that SMS should include various types of sharing vehicles. We associated this with the increased diversity of mobility needs related to parenting (McFarland, 2017). Therefore, people who manage complex family transportation may benefit from the consolidated overview of diverse vehicle types under one clear SMS platform.

In the present study, we found a significant correlation between age and a requirement of a wide operation radius. The younger the age, the more likely people were to indicate this requirement towards a

sharing system. It should be noted, that age correlated with the place of living and, therefore, the distance between home and work or study location. In our sample, young respondents were students of which the majority lived on campus (91.20 %). We believe that the distance between the place of living, work, and education is more likely to explain the tendency to indicate a wide operation radius as a requirement rather than age. In previous studies, people tended to use SMS if there were vehicles available in immediate proximity to their homes or workplaces (Macioszek et al., 2020). In our sample, the people who did not live on campus explicitly stated the requirement of a wide operation radius. Furthermore, there was a significant relationship between income and the reported requirement of quality and comfort. This also should be interpreted with caution. In our sample, lower-income individuals were associated with the group of students. However, 78 % of students in our sample own a car which exceeds the percentage of student car owners in the Munich sample. Having constant access to a car has usually been motivated by comfort (Belgiawan et al., 2011). The relationship between income and comfort may thus be a consequence of this sample.

The methodological design of this study has several limitations. First, the data was collected in the context of a university environment with a high percentage of active military members. This might imply deferring behavior patterns and habits comparing to other populations. Another limitation concerning the sample was the underrepresentation of several population groups, namely people with lower income, women, and the elderly. Without a diverse group of individuals participating in the research, we could not claim that the results may be applied to all people equally. Furthermore, the data was extracted from a broader survey, which did not explicitly target shared mobility, and, therefore, included the questions from other domains. This might affect the response rates and engagement levels. Lastly, the generalization of the present results may be limited by the influence of the current local sharing offer. Regarding the choice of vehicles for SMS and requirements towards SMS, the respondents might have been biased by previous SMS experience and may have tended to choose vehicles that were already well-established in Munich (car-, bike, and scooter-sharing). In future studies, the preferences towards a broader palette of vehicles could be explored (e.g. motor rollers, electric and non-electric vehicles).

In this study, the preferences of people who stated being willing to use SMS were analyzed. It might be of interest to explore the demands and suggestions of SMS non-users to study which barriers and impediments they might have towards using SMS. The comparison with the potential users might give insights about SMS strategies towards inclusivity of broader populations. In our analysis, we focused on stated preferences rather than observed SMS use. In the future, empirical data might be used to compare the stated preference and revealed SMS use as individuals' stated choices may not correspond closely to their actual preferences.

5 CONCLUSIONS

In the last decade, the functions and features of shared mobility systems (SMS) have evolved from complicated paperwork to easy and user-friendly digital applications. Various SMS around the world offer short-term on-demand access to mobility without the costs and responsibilities of vehicle ownership. The potential users of these services have various motivations and values. They associate with socio-demographic backgrounds, previous experiences, and habits. The investigation of conditions under which people would adopt sharing services and which vehicles they prefer in the context of SMS might be useful to mobility providers. With this information, they could expand their services and establish a business customized to various groups.

In this study, we explored several SMS aspects: the willingness to use SMS, the preferences of potential users regarding types of vehicles in SMS, and requirements towards the design of SMS. We used the data collected in Munich in the context of a university environment with a high percentage of active military members. The analysis of socio-demographic and travel behavior showed that the possession of season tickets for public transport, car accessibility, need to transport heavy items, and age had significant effects on the intention to use SMS. Younger people and public transport users were keen on SMS. People having access to a car and the need to transport heavy items tended to be less willing to use SMS.

We associated the people stating the willingness to use sharing with the potential users of SMS and targeted their responses for preferences and requirements towards SMS. Cars, bikes, cargo bikes, and scooters could be selected for the SMS platform. Men and lower-income individuals tended to choose cars as a part of a sharing system. Bikes for SMS were likely to be chosen rather by women than men. We assume that in environments where the positive image of cycling and appropriate infrastructure is well-

established, bike-sharing gains broader acceptance and popularity among women. The potential users of cargo bikes were people who have access to a bike and households with minor-aged children. SMS providers may consider cargo bikes in their fleets to make the service more inclusive and attractive to households with children. Scooters were likely to be chosen by younger adults and those who have access to a car and avoided by public transport users.

We segmented free-text inputs into the requirements towards SMS. The most mentioned entries were user-friendliness, availability, and reasonable price. Requirements such as wide operation radius of SMS, flexible pick-up and drop-off locations for the vehicles, reliability, security, comfort, and quality of the vehicles, and the whole system, combination of various vehicles in SMS, and environmental friendliness were among the motives to use SMS. Women emphasized the importance of the reliability and security of SMS. This included aspects such as the possibility to reserve the vehicles in advance and trouble-free functioning of the system. Households with minor-aged children may benefit from the consolidated SMS platform while managing transportation tailored to the multitude of locations and needs. We also found a significant correlation between age and the requirement of a wide operation radius; income and the value of comfort and quality. These findings, though, should be interpreted with caution due to sample characteristics.

We believe that fulfilling the key requirements towards sharing is a crucial factor to motivate individuals to use SMS. Therefore, we investigated the conditions under which potential users would adopt sharing services and which vehicles they would prefer in the context of SMS. Associating potential user attributes to SMS preferences and requirements might be a valuable source of knowledge for tailored system designs and setups for SMS providers. By working with audience segmentation, SMS communicators may develop persuasive marketing messages customized for each group. In future studies, the demands of SMS non-users and the preferences towards a broader vehicle palette might be studied, and the stated preferences could be compared with the actual use of SMS.

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