The impact of residence location and the accessibility of alternative electric micro-mobility vehicles on electric scooter usage patterns in Hungary

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The congestion, air pollution, noise and injuries caused by excessive traffic are just some of the transport-related issues that cities throughout the world are working to address. Urban transport planners consider electric scooters (e-scooters) to be a viable alternative to other forms of motorised individual transportation, most notably automobiles. While e-mobility alternatives can reduce negative environmental impact, some studies have shown that this depends on the new mode of transport that users adopt. Although sustainable transport options clearly have advantages, most European countries still struggle to integrate e-scooters into the transport ecosystem. Our exploratory research, based on the scientific literature, examines whether a significant correlation exists between place of residence and the use of e-scooters, and if so, how significant it is. For this purpose, we conducted a survey that was completed by 292 people living in Hungary. The data are analysed using cross-tabulation analysis, Kruskal–Wallis rank sum test and K-means cluster analysis to determine whether a correlation is evident between e-scooter usage and respondents' place of residence. We also examined whether the availability of alternative micro-mobility facilities in a neighbourhood influences the use of e-scooters. Based on previous studies and our novel research, the results reveal that neither the place of residence nor the availability of other means of micro-mobility significantly influences users' decision to use e-scooters.

Keywords:
electric scooter,
urban transportation,
Kruskal–Wallis rank sum test (ANOVA)

Introduction

As part of the broader global transformation of urban environments and mobility systems (Behrendt et al. 2022, Cook et al. 2022), rechargeable lithium-ion battery-powered electric scooters (e-scooters) and other micro-mobility devices for rent or private ownership have appeared in Hungary, particularly in Budapest and the Balaton area. Several types of electric transport devices are suitable to the urban mobility context that are primarily used for short journeys of less than 10 km (Behrendt et al. 2022). Although the number of providers and users of rentable electric micro-mobility devices in cities around the world is steadily increasing, practicing e-scooterists are sceptical about the uptake and integration of these vehicles into urban transportation, highlighting the importance of investigating the challenges associated with this new mobility device (Gössling 2020).

As the e-scooter is the newest addition to the electric micro-mobility market, extensive literature has not yet been produced on its social and environmental impacts (Bai–Jiao 2020, Eccarius–Lu 2020). Most studies on the topic have not specifically concerned e-scooters, but electric micro-mobility in general (Lazarus et al. 2020, McKenzie 2019, Younes et al. 2020) and to the best of the authors' knowledge, only a few scientific articles have specifically examined the circumstances of e-scooters' integration as a form of transport in Hungary (Ambrus–Orosz 2020, Szemere–Iványi 2023, Szemere et al. 2024). Considering the above, our exploratory research examines whether the place of residence and the available other mobility devices affect the use of e-scooters.

Our study is structured as follows. The literature review briefly describes the external and internal factors influencing the usage of electric scooters. The third chapter describes the data collection method and outlines our research questions. In chapter four we describe our primary data collection and data analysis methods, while in chapter five we present our results. In the final chapter, we highlight the limitations of our research and identify future research directions.

Literature review

The popularity and adoption of different types of electric micro-mobility devices have grown rapidly in recent years, with an increasing number of vehicles that can be classified in this category. Research on shared micro-mobility focuses on how and why target groups use these forms of transport. These studies can be grouped into the following categories:

- internal factors (i.e. socio-demographic characteristics of users and their motivations),
- external factors (e.g. built environment, topography, weather and accessibility of other vehicles),
- travel-related factors (destination, distance and time of day).

This study investigates how residence location and the availability of alternative electric micro-mobility vehicles influence individuals' willingness to use e-scooters. As these factors can shape demand independently of users, in this section, we review the literature on external factors affecting the demand side.

Work analysing the external factors that influence the demand for electric micro-mobility devices began with the study of non-electric bicycles with docking (Shaheen–Cohen 2019). Since then, increased use revealed several factors that can influence the demand for shared bicycles such as population density, coverage by the service provider, distance between home and work, access to public transport, topography/terrain conditions and weather (Campbell–Brakewood 2017, Fishman et al. 2013, Ricci 2015).

E-scooters are relatively new to the e-mobility market and, as noted in the Introduction, minimal scientific work has investigated the relationship between these devices and the external factors that affect users' adoption. The findings of these academic papers show that in the study areas e-scooters are used for shorter trips (particularly near universities) in inner city districts and in neighbourhoods with cycle paths, which has been attributed to higher fleet density in such urban neighbourhoods (Bai–Jiao 2020, Caspi et al. 2020).

External factors that influence use include access to other vehicles. In most cases, researchers have investigated the impact of car accessibility on scooter use; however, based on the literature reviewed, the relationship does not appear to be significant. For example, in Toronto, previous research has determined that willingness to use a car was not associated with intention to use a rental e-scooter (Mitra–Hess 2021). In Zurich, shared e-scooters are more commonly used by households that do not own a car (Reck–Axhausen 2021), while research from Austin, Texas in the US revealed opposite findings, revealing that car owners are more likely to use shared e-scooters (Blazanin et al. 2022).

Among the external factors, adverse weather conditions such as precipitation, low temperatures and wind clearly have a negative impact on use (Noland 2019); however, no consensus has been reached regarding the purposes for which users use e-scooters or the types of taken. While studies on (docked and electric) bicycle usage clearly have revealed a morning and evening peak period, no such conclusions have been clearly drawn for e-scooters. A 2020 study based on data collected from service providers in Singapore (Zhu et al. 2020) determined that e-scooter use is spatially concentrated in cities near attractions or public transport hubs. In contrast, some authors have shown that e-scooters are more commonly used for commuting between home and work (Caspi et al. 2020, McKenzie 2019), while others have used data extracted from mobile app location tracking, concluding that e-scooters are more likely to be used for leisure activities (Bai–Jiao 2020, Esztergár-Kiss et al. 2022), although relatively little evidence has been produced to support this. The lack of consensus from the various research studies indicates the need for further targeted research to investigate the external factors affecting e-scooters that is not only based on data downloaded from websites, but also on the perceptions and opinions of transport stakeholders.

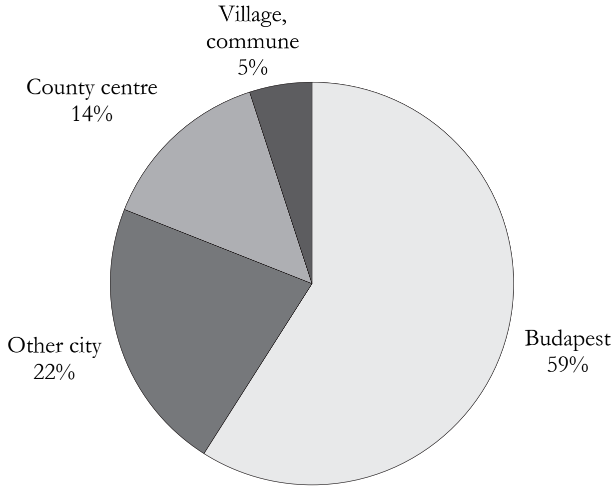
Research questions and data collection

Our secondary research explored the literature on the external factors influencing the use of e-scooters, highlighting the need for further research on this topic. We collected the survey data in Hungary between March 2023 and April 2023, with respondents participating in the survey voluntarily and anonymously. Our target group was the Hungarian population aged between 18 and 65 who had tried an e-scooter at least once previously; therefore, the population was not randomly selected, and 292 individuals responded. The questionnaire was posted to four Facebook groups for e-scooters users and two additional groups where e-scooter users were most likely to occur, and was split into three larger, overarching sections. Respondents included 217 men and 75 women. The highest number of respondents was in the 18–30 age group, with 112 respondents, followed by the 31–40 age group, with 90 respondents, and more than half of the respondents resided in Budapest (59.2%). Notably, these rates do not reflect the gender balance of the Hungarian population, as the 2022 census data estimated 1078 women for every 1000 men. However, the data are roughly similar in terms of the age spread, as the proportion of 18–30 years old is higher than that of 31–40 years old. Regarding residence location, the respondents reflected the national picture, as more than 50% of the population live in Budapest. However, it should be noted that these are only general population figures, and we do not have comparable data on transport participation and vehicle use patterns of these groups. The survey was divided into three main areas, which included e-scooter habits, attitudes towards traffic and mandatory regulations and rating present or missing regulations in order of priority. The importance of regulations was measured using a 5-point scale, with 1 being the least essential and 5 being the most significant. The final part of the questionnaire included demographic questions. Based on previous research, we assume that place of residence is the most important demographic factor that influences the external factors affecting e-scooter usage. Therefore, as illustrated in Figure 1, we divided the sample into four groups-based residence location, each of which yielded a significant number of respondents:

- Budapest,
- county centre,
- other cities (including all cities that are not county capitals and have a population of over 10,000),
- village, commune (including settlements with less than 10,000 inhabitants).

Figure 1

Distribution of study respondents by place of residence



Our research examines how e-scooters can be integrated into urban transportation structures by analysing the opinions, attitudes and habits of different stakeholders involved in using them. The primary research findings presented complement previous complex exploratory research began in 2022. The first stage of our study involved focus group discussions to understand the attitudes of non-users towards e-scooters and regulatory issues, and the current stage specifically examines the perspectives of e-scooter users and the external factors influencing use based on the following research questions:

[Q1]: Does a correlation exist between the use of electric micro-mobility devices and place of residence (cross-tabulation analysis)?

[Q2]: Is the use of electric scooters influenced by where individuals live (cross-tabulation analysis)?

[Q3]: How much does place of residence affect individuals' e-scooter usage habits (Kruskal–Wallis rank sum test [ANOVA])?

[Q4]: Are user groups categorised by residence location similar in terms of electric scooter usage patterns (K-means cluster analysis)?

Next, we present the elements of our analyses that are relevant to these research questions. Individual analyses of the survey outcome variables are significant for establishing the necessary conditions for multi-variate analyses, in addition to the frequency of individual responses (Sajtos et al. 2007).

Primary research methodology

To investigate our research questions, we analyse our data using the SPSS programme. In the first step, we developed a database and defined our variables, using variables with only two possible answers for several questions referencing the literature (Cubells et al. 2023, Bretones–Marquet 2023, Nikiforiadis et al. 2021). Such 'yes–no' (coded 0,1) variables are also referred to as binary variables (Agresti 2007).

Our study examines the relationship between place of residence and e-scooter usage, among other questions. We analysed the responses using cross-tabulation analysis (Ma et al. 2021, Kim et al. 2018), measuring the closeness of the correlation using Pearson's chi-square test and Cramer's V coefficient (from 0 to 1).

We then used a non-parametric test, the Kruskal–Wallis rank sum test to explore differences in the use of micro-mobility tools between groups (Orozco-Fontalvo et al. 2023, Sanders et al. 2020). The survey question, *'Please indicate which of the micro-mobility tools listed below have you used?'* requiring respondents to answer with a score between 1 and 8 (Tóthné 2011).

We also endeavour to determine whether groups categorised by place of residence engaged in similar e-scooter usage, employing K-means clustering analysis for according to several classifying variables. We classified the respondents into three groups based on the average value of the eight micro-mobility devices (e-scooter, scooter, electric bike, electric car, hoverboard, segway, car-sharing service and bike-sharing service) (Ma et al. 2021, Shah et al. 2023). Based on our initial assumptions, we expected to find homogeneity among the residential groups with much higher values of device use, clearly identifying a user stratum that considered the use of e-scooters to be superior to other devices. The results are presented in detail below.

Results

Relationship between electric micro-mobility devices and place of residence

This study initially assumed that vehicle use and residence location are correlated. To investigate this, we performed a cross-tabulation analysis in SPSS, the results of which are illustrated in Table 1. Pearson's chi-square and Cramer's V coefficient values show agreement because respondents only gave binary, yes–no responses. We used Pearson's chi-square (χ^2) to examine the relationship between place of residence and transport use. According to the null hypothesis (H_0), the variables are independent (i.e. no correlation is evident). This can be said for the data set regarding the use of electric cars, bike-sharing service and car-sharing service, where a significant relationship between residence location and usage is evident.

Table 1

Analysing the relationship between electric micro-mobility devices and respondents' residence location using the Pearson's chi-square and Cramer's V coefficient

Type of device	Pearson's chi-square	Cramer's V
Electric bicycle	0.115	0.115
Electric car	0.046	0.046
Hoverboard	0.081	0.081
Segway	0.540	0.540
Bike-sharing service	0.032	0.032
Car-sharing service	0.004	0.004

Our cross-tabulated frequencies reveal that the relationship between electric car use and residence location is significant. Although the popularity of e-cars has increased significantly among the Hungarian population in recent years, most privately owned cars are still petrol or diesel cars (Németh–Kovács 2022). Contemporary research has demonstrated that the primary reason that individuals choose an electric car is environmentally friendly transport, while the main reasons for choosing an electric car for the population are predictability, comfort, low maintenance costs and environmental protection (Vereczkei-Poór–Törőcsik 2023). Predictability is not yet a feature of electric car transport, which lacks the necessary infrastructure (fast charging network) and has a mileage of less than 500 km per charge that favours short urban journeys (Gerse 2020, Kiss–Szalkai 2018).

Use of bicycle and car-sharing services is also influenced respondents' residence location as the calculated value is less than 0.05 in the second column of Table 1. The rationale for this relationship is primarily that such sharing services are not available in all municipalities in the country. The only cities in Hungary where bike-sharing services are available include Budapest, Esztergom, Hévíz, Szeged, Győr, Kaposvár, Nagykanizsa and Debrecen. Three car-sharing providers are accessible only in Budapest. In the other cases, the calculated significance value of the Pearson's chi-square is greater than 0.05, indicating that the null hypothesis of independence of the variables must be accepted. Therefore, the use of e-scooters, electric bicycles, hoverboards and segways do not appear to be influenced by residence location.

We also examined the relationship between hoverboard use and residence location using a cross-tabulation analysis. According to the null hypothesis (H_0), no relationship exists between the two variables. The calculated significance value of the Pearson's chi-square statistic is 0.081, which is minimal but above the specified level of 0.05; therefore, we cannot reject the null hypothesis. Therefore, we can conclude that hoverboard use is not dependent on place of residence. This finding is attributed to the fact that at least four different types of hoverboards are available, with different models designed for different purposes and loads that can be charged in roughly 2–24 hours, and can cover 10–20 km.

We also found segway use and residence location to be independent based on the cross-tabulation analysis performed because the calculated value of the Pearson's chi-square is greater than 0.05, indicating that the null hypothesis of independence should be accepted. The segway is a self-balancing, two-wheeled, electrically powered vehicle that has not really caught on as a means of personal transport in Europe; however, companies that offer segway sightseeing tours to tourists have emerged in a growing number of countries (including Budapest). Subsequently, since this mode of transport is generally not used by residents, the independence between the two variables is a logical outcome.

In all cases, we measured the closeness of relationships using Cramer's coefficient V, where a closer value to one indicates a closer relationship between the variables. The resulting data are presented in the third column of Table 1, and although three of the micro-mobility tools showed a significant association between residence location and tool use, the SPSS analysis indicates that all relationships are weaker than medium strength.

Relationship between electric scooter usage and residence location

After investigating the relationship between the different electric micro-mobility devices available in Hungary and respondents' place of residence, we narrowed down the variables to specifically investigate whether e-scooter usage and residence location are correlated, using a dummy (yes–no) categorical variable and cross-tabulation analysis. Based on Pearson's chi-square, we must accept the null hypothesis because the calculated value is 0.516, indicating no relationship between the two variables. The variables' independence can be explained by the growing popularity of e-scooters across Europe. Currently, there are around 20 million e-scooter users in Europe alone, and rental e-scooters are already four times more popular than car or bike-sharing services, which has been explained in previous literature by the fact that in addition to practicality in avoiding traffic jams, e-scooters include an element of recreation that distinguishes them from other means of micro-mobility (Latinopoulos et al. 2021). Hungary has 80,000 to 100,000 e-scooters on the roads, of which about 25,000 are available for rent or community use, and the remainder are privately owned, according to the Future Mobility Association (JMSZ). Another reason for the disconnect between residence location and e-scooter use is that the population increasingly seems to have 'outgrown big cities' that cannot accommodate more cars. To enable people to get around efficiently, an increasing number of people are switching from cars to micro-mobility devices; however, we are unable to draw a general conclusion for the whole population from our results as our sample was not representative. In the current phase of our research, we considered a group of users who had already tried e-scooters at least once from 2022 onwards; therefore, they are clearly over-represented among the respondents.

How much does the place of residence influence customers' use of electric micro-mobility devices?

Having used a cross-tabulation analysis to examine the potential relationship between residence location and the use of electric micro-mobility devices and the chi-squared test to determine differences in device use based on place of residence, we next used the Kruskal–Wallis rank sum test to explore differences for comparison, presenting the results in Table 2.

Table 2

Analysing the relationship between electric micro-mobility devices and respondents' place of residence using Kruskal–Wallis rank sum test (ANOVA)

Type of device	Pearson's chi-square	Cramer's V
Electric scooter	0.518	adoption
Electric bicycle	0.116	adoption
Electric car	**0.046**	rejection
Hoverboard	0.082	adoption
Segway	0.541	adoption
Bike-sharing service	**0.032**	rejection
Car-sharing service	**0.004**	rejection

Table 2 reveals that the null hypothesis was rejected in four cases. As the Kruskal–Wallis rank sum test does not indicate the exact type of residence is attributable to the differences in asset use, we conducted post-hoc tests for this investigation.

Table 3 presents the results of our pairwise comparison tests for different residential locations and electric car use.

Table 3

Pairwise comparative analysis of the relationship between electric car use and place of residence

Type of residence	Calculated significance value
Budapest–county centre	**0.300**
Budapest–other city	**0.232**
Budapest–village, commune	**0.049**
County seat–other city	0.830
County seat–village, commune	0.589
Other city–village, commune	0.874

The results suggest that the differences in geographic groups' medians revealed by the Kruskal–Wallis ANOVA test are attributable to the different practices in

Budapest compared with other residential locations. The significance level is below 0.50 in pairwise comparisons of the capital with county capitals, other cities and villages and municipalities, revealing a notable difference between the capital and other location types in terms of electric car use.

The Kruskal–Wallis rank sum test indicated that the groups' medians for bike- and car-sharing services do not match; therefore, we performed the necessary post-hoc tests to determine the reason for the difference. As shown in Table 4, the results for the bike-sharing service are not as clear-cut as those for electric car use in Table 2. The pairwise comparative analysis reveals that the null hypothesis, i.e. the concordance of the medians in two cases (county seat–Budapest, village, municipality–Budapest) must be rejected. This is because while Budapest has a total of 130 docking stations and more than 1500 rental bicycles (primarily in inner districts and around the universities), only 55 stations are established in county seats and none are available in smaller villages and hamlets. This does not mean that people living in these areas do not use bicycles, but rather that they use privately owned bikes for leisure activities as well as daily transport for trips of less than 10–15 km, commuting and for longer distances.

Table 4

Pairwise comparative analysis of the relationship between bike-sharing and residence location

Type of residence	Calculated significance value
County seat–village, commune	0.718
County seat–other city	0.276
County seat–Budapest	**0.020**
Village, commune–other city	0.370
Village, commune–Budapest	**0.022**
Other city–Budapest	0.769

As clearly shown in Table 5, in the case of car-sharing services, Budapest behaves differently from other municipalities. In Table 1 we have already highlighted, using the SPSS cross-tabulation analysis function, that a significant, albeit weaker than medium, relationship between car-sharing services and place of residence location is represented. We also asserted that one possible explanation is the existence of three car-sharing apps in Budapest. Therefore, the difference between the medians can be explained by the coverage of car-sharing providers in each municipality and the availability of the service.

Table 5

Pairwise comparative analysis of the relationship between car-sharing service and place of residence

Type of dwelling	Calculated significance value
County seat–village, commune	0.208
County seat–other city	0.237
County seat–Budapest	**<0.001**
Village, commune–other city	0.716
Village, commune–Budapest	**0.024**
Other city–Budapest	0.401

Table 6 presents the exact geographical distribution of respondents in relation to the use of car-sharing services.

Table 6

Popularity of the car-sharing service by respondents' location

Type of dwelling	Budapest	County seat	Other city	Village, commune
Yes	122	38	12	54
No	51	2	3	10

Are user groups similar in terms of electric scooter usage habits?

The Kruskal–Wallis ANOVA test showed that the use of car- and bike-sharing services and electric cars is significantly influenced by respondents' residence location. Since neither cross-tabulation analysis nor the rank sum test identified a relationship between e-scooter use and place of residence, we next employed a K-means clustering procedure to segment Hungarian consumers based on use of electric micro-mobility devices. The clustering procedure distinguished three device use groups and eight factors. The first cluster represented 35% of the respondents, including respondents who used e-scooters, electric cars and bike- and car-sharing services. The second cluster represented 52% of respondents who used only e-scooters among the listed devices, while the third cluster (13%) used all electric-powered devices, except for car/bike-sharing services and hoverboards. These data are summarised in Table 7.

Table 7

Final cluster means in the K-means cluster analysis run in SPSS

Type of device	Final cluster centres		
	cluster 1	cluster 2	cluster 3
E-scooter	1	1	1
E-bike	0	0	1
E-car	1	0	1
Hoverboard	0	0	0
Segway	0	0	1
Bike-sharing	1	0	0
Car sharing	1	0	0

Before describing each cluster in more detail, it is useful to note the F-values in Table 8, which indicates that each cluster is primarily distinguished along the lines of electric car and car-sharing service use. Significant differences between these variables were already shown with respect to the other values for the cross-tabulation analysis and the Kruskal–Wallis rank sum test.

Table 8

ANOVA table from the K-means cluster analysis

Type of device	Sample average	F-value	Level of significance
E-scooter	0.030	2.222	0.110
E-bike	6.329	62.143	<0.001
E-car	13.509	**117.464**	<0.001
H-board	1.457	32.163	<0.001
Segway	6.788	100.724	<0.001
Bike-sharing	9.401	77.770	<0.001
Car sharing	11.110	111.250	<0.001

Cluster characterisation: sustainable youth

This group represents 35% (102) of our respondents. This segment was over-represented by men (76%) and dominated by younger age groups (18–30 years old, 32%; 31–40 years old, 23%). Those aged 51–60 years old were strongly under-represented (3%). This group was dominated by university or college graduates (43%), however, very few had vocational qualifications (6%) compared with the size of the cluster, and they typically lived in Budapest (81%).

Cluster characterisation: metropolis on wheels

This cluster represents 52% of the total sample population (152), making it the largest cluster. Women (5%) and young people (18–30 years old, 9%; 31–40 years old, 6%) were under-represented, and the proportion of people aged 50 and over was very low (1%). The segment was strongly under-represented by people with a tertiary education (9%) and those with up to 8 years of general education (1%). The cluster included urban residents, with the largest proportion residing in the capital (71%).

Cluster characterisation: favouring two-wheeled electric micro-mobility

This cluster represented 13% of the respondents (38). Men dominated the cluster, with the younger age group once again predominating (61%) and those over 50 years old accounting for just 11% of the respondents. The cluster included people with vocational qualifications (31%) and university or college graduates (43%), with strong under-representation of those with eight general secondary school qualifications (2%). Most of the cluster lived in the capital (52%) or in a county town (35%).

Summarising and identifying further research directions

The first step of our exploratory research sought to uncover the attitudes of non-users towards e-scooters in March 2022 using a focus group method (seven mini focus groups that reached the level of theoretical saturation). In the current phase of our research we investigated the e-scooter usage habits among a group of users based on residence locations in Hungary. Our research method employed a quantitative online questionnaire, which was shared via Facebook and completed by 292 respondents.

We investigated the relationship between place of residence and electric micro-mobility devices using a cross-tabulation analysis. Our results revealed that the use of electric cars, bike-sharing services and car-sharing services is significantly associated with the respondents' place of residence, although the Cramer's V coefficient indicated that these associations were only of weak to medium strength. Using cross-tabulation analysis, we also concluded that e-scooter use is not dependent on the respondents' place of residence. We then applied the Kruskal–Wallis rank sum test, finding that geographic groups' medians for three devices (electric car, bike-sharing service and car-sharing service) did not match, running post-hoc tests to determine what could be causing the differences between the groups. In almost all cases, we found that respondents from Budapest behaved differently from those in other types of housing. To answer the final research question, we segmented the sample according to place of residence and use of electric micro-mobility devices. The findings revealed that electric car use had the greatest influence on group formation, followed by car-sharing service, with e-scooter use having the least influence on group formation. Notably, a group that differed from the other two clusters in terms of device use clearly emerged among the clusters, with 52% of the respondents belonging to this group. Although this is the first study to comprehensively analyse the relationship between electric micro-mobility devices and place of residence in Hungary, the research certainly had several limitations. The questionnaire is currently only available in Hungarian, which distorts the results, as for example, students and tourists who were not native Hungarian speakers but lived in Hungary could not complete the questionnaire due to language barriers. Furthermore, although we sought a representative sample and included an adequate number of respondents in each group based on place of residence, Budapest was over-represented. Our exploratory research investigated the relationship between place of residence and e-scooter usage among Hungarian e-scooter users, examining the characteristics of this specific stakeholder group, and our results are therefore useful for the following stakeholder groups:

- Electric scooter rental operators: the data (mainly clustering results) can be referenced to plan marketing campaigns for specific user groups and which locations are suitable for offering e-scooters.

- Scientific research communities: the relationship between residence location and e-scooter usage has not been explicitly investigated before, and the characteristics and attitudes of the clustered groups can be further analysed in future research.
- Other Central and Eastern European countries: neighbouring countries are confronting similar challenges with integrating e-scooters into urban transport systems; thus, the results of our research may also be a valid reference for advancing similar e-scooter communities.

As at this stage of our research we have only focused on the impact of external characteristics on the choice of micro-mobility devices, and we plan to conduct more detailed analyses in the future, including user-specific characteristics (e.g. socio-demographic factors), additional transport modes (public transport and walking) and destination-specific characteristics (accessibility of public transport and destination type). Continued research efforts will support our long-term research objective examining the attitudes of stakeholders representing different interests related to e-scooters to advance the integration of this new type of sustainable alternative vehicle into urban transport.

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