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Barriers to bike and e-scooter sharing usage: An analysis of non-users from five European capital cities

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ABSTRACT

In recent years, shared micro-mobility, particularly bike sharing systems (BSS) and e-scooter sharing systems (ESS), has emerged in many countries with the premise of fostering a more sustainable and healthier urban living. However, available research predominantly focuses on the users of these systems, while non-users and their opinions are often neglected although they may be also perceived as potential users.

This study focuses on a less researched aspect of bike and e-scooter sharing systems: what are the reasons for not using these systems. Through the use of a comparative and survey-based research carried out in 2021 in five European capital cities (Budapest, Lisbon, Rome, Vilnius, and Warsaw), this research discloses the main drivers and behavioral attitudes towards the non-use of BSS and ESS during the coronavirus pandemic, when these means increased in importance as an alternative to public transport due to health and safety concerns.

The analysis revealed that the main barriers to non-users are mainly external and infrastructural, such as other modes of transport being more convenient; safety concerns about riding in traffic; poor road conditions; lack of dedicated cycle networks, and destinations being too distant to be reachable by bike or e-scooter. These findings indicate that the further development and deployment of BSS and ESS in European cities primarily depends on local administrations, and urban transportation policies, and not so much on the users' attitudes and adaptability.

1. Introduction

Shared bike and electric scooter systems (hereafter BSS and ESS, respectively) are becoming an increasingly attractive transport option in several countries around the world (NABSA, 2020; Chai et al., 2021; Meddin Bike-sharing World Map Report, 2022). The introduction of such solutions in urban areas is driven by the need to mitigate the negative effects and overall environmental impacts of traditional modes of transportation, particularly private car usage (Douglas et al., 2011), as well as by economic interests associated with the sharing economy (Spinney and Lin, 2018). Shared micro-mobility can also complement public transport (PT) by providing alternative modes of transport for the first and last mile and reaching areas that are not well served by PT. Shared bicycles and e-scooters can, thus, potentially be an attractive alternative to car travel, reducing CO_2 emissions and, in the case of bicycles, also bring additional health benefits (Crozet, Santos and Coldefy, 2019; Teixeira et al., 2021a).

At the same time, the COVID-19 pandemic caused a shift in travel behaviour and in the use of shared mobility, with travellers opting for private transport to social distancing and limit the risk of infection (Shamshiripour et al., 2020). Likewise, it has also highlighted the importance of resilient transport systems capable of ensuring the mobility needs of citizens during disruptive events by providing mobility options that are compatible with the principles of social

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distancing and at the same time sustainable mobility. Indeed, PT has been particularly affected by the coronavirus due to infection fears, suffering breaking ridership drops (Gkiotsalitis and Cats, 2020; Teixeira and Lopes, 2020; Teixeira et al., 2023) and jeopardizing its ability of safely transport people, potentially further exacerbating our dependence on car use. In response, many cities have begun to encourage cycling and walking by introducing and/or extending cycling lanes, car-free sections and wider sidewalks (ECF, 2020; Buehler and Pucher, 2021). In Europe 32 cities built additional cycling infrastructure, with for example London and Paris announcing 100 km and 80 km of new cycling lanes, while in North America more than 100 cities followed similar initiatives, with the most prominent examples being New York City and Toronto with, respectively 102 and 88 extra km of cycling lanes built (Buehler and Pucher, 2021). These new investments in cycling seem to have been successful in increasing cycling levels, with Kraus and Koch (2020) reporting that European cities which implemented temporary bike lanes as a response to the COVID-19 pandemic registered an average cycling increase between 11% and 48%.

Consequently, the motivations and preferences for shared bike and e-scooter use are an area of research interest for policy makers and operators (Fishman et al., 2014), especially as such systems could be particularly useful during disruptive events like COVID-19 due to their characteristics allowing for maintaining a social distance (Teixeira et al., 2021b, 2022a).

In this sense, the opinion of non-users is of much significance as it can give an answer to the question of why some people do not use bike and e-scooter sharing (when available) and further, in which circumstances they might change their decision. Likewise, during the COVID-19 pandemic, the fact of being a shared vehicle could have also led some users to avoid these systems due to the fear of infection. Therefore, non-users can be an important source of information for making decisions about improving these systems as they provide useful insights into identifying barriers to bike and e-scooter sharing. As Fishman (2016) highlights in his literature review, one of the "current limitations in bikeshare knowledge" is the "sampling of non-bikeshare users" (Fishman 2016, p. 2).

Furthermore, there is a scarcity of studies that focus on more than a single case study, with research comparing BSS and ESS being particularly rare (Bieliński and Ważna, 2020). For this reason, a survey was conducted in five European capitals (Budapest, Lisbon, Rome, Vilnius and Warsaw) with the aim of responding to the following research question:

- *What are the main factors preventing larger swaths of the population from adopting bike and e-scooter sharing systems?*

By identifying the main barriers to the use of bike and e-scooter sharing in five major European capitals during COVID-19, this study provides valuable insights for operators and policymakers on how to improve the promotion of these shared micro-mobility systems, increasing their adoption, and ultimately providing a new sustainable and affordable transport option for their citizens.

The rest of the manuscript is structured as follows. An overview of the literature on the main motivations and barriers to the use of bike and e-scooter sharing is presented next (section 2). This is followed by the presentation of the research methodology (section 3), including a brief description of the case studies and the main research methods. Next, the quantitative and qualitative analysis of the barriers to the use of bike and e-scooter sharing are presented in section 4 and section 5, respectively. We then discuss the results (section 6), concluding with the main research findings and implications, including a list of recommendations to improve the promotion of shared micro-mobility (section 7).

2. Motivations and barriers for joining bike and e-scooter sharing

As e-scooter sharing has emerged more recently than bike sharing,[2] most of the existing literature investigating motivations and barriers still focuses on BSS, with only a few peer-reviewed studies exploring the motivations and barriers for using ESS.

The main motivation for joining either BSS or ESS seems to be the convenience that these systems provide (Ricci, 2015; Fishman, 2016; Hardt and Bogenberger, 2019; Gössling, 2020; Sanders, Branion-Calles and Nelson, 2020). For example, a travel behaviour survey conducted among users of Australia's largest BSS (Brisbane and Melbourne), found that convenience and the existence of BSS stations within 250 m of the workplace were the main predictors of the decision to join BSS (Fishman et al., 2015). Sanders, Branion-Calles and Nelson (2020) conducted a similar survey in the community of Arizona State University (USA) exploring the perceived benefits and barriers to ESS, finding that respondents considered e-scooters "a convenient way to travel, particularly in the heat and compared to walking". Ease of use of the systems can also be associated with convenience. Indeed, among the main identified barriers to the use of bike sharing in Brisbane in the study of Fishman, Washington and Haworth (2012), focus groups participants highlighted the amount of time and effort required to use the system as well as the fact that the BSS was not available at night.

Travel time reduction is also often cited as one of the main perceived benefits of joining bike and e-scooter sharing (Ricci, 2015; Sanders, Branion-Calles and Nelson, 2020). For example, surveys of London BSS users revealed that the main motivation among members to join BSS was that the system is faster than their previous mode of transport (TfL, 2011). In addition, the UK's cross-country surveys of BSS users systematically revealed that convenience and travel time savings are the main reasons for joining bike sharing, particularly among commuters (bikeplus, 2017; comouk, 2018).

Interestingly, users often cite among the main reasons for using ESS or BSS the fact that it is a fun and enjoyable activity (TfL, 2011; Fishman, 2014; Chen, 2016; Buehler et al., 2021; Christoforou et al., 2021). For instance, a survey assessing the profile of e-scooter users in Paris found that the major reasons for using e-scooter were travel time savings followed by playfulness (Christoforou et al., 2021).

The environment and health are also important reasons stated by users, particularly regarding BSS (Fishman, 2014). For instance, UK's cross-country surveys of BSS show that health and environmental concerns are systematically at the top of users' reasons for switching to bike sharing, with environmental reasons becoming more important over the years (bikeplus, 2017; comouk, 2018). In the case of ESS, the environment and health benefits are not so well perceived due to the fact that, on the one hand, e-scooters are associated with a short lifespan (hindering environmental gains) and, on the other hand, the potential health benefits provided by physical activity are residual (as opposed to cycling) (Gössling, 2020; Christoforou et al., 2021).

The affordability of BSS is also often cited as a reason for use (TfL, 2011; Ricci, 2015; Fishman, 2016; bikeplus, 2017; comouk, 2018), as it can offer affordable monthly or annual subscriptions to their users, leading to substantial cost savings (Shaheen, Guzman and Zhang, 2010). ESS are generally more expensive to use than BSS, with high usage costs being perceived as a barrier (Bieliński and Ważna, 2020).

Safety is the main barrier affecting both BSS and ESS due to concerns about riding alongside motorized traffic and fears of falling (Fishman, Washington and Haworth, 2012; Hardt and Bogenberger, 2019; Sanders, Branion-Calles and Nelson, 2020; Teixeira et al., 2022b). For instance, university staff in Tempe (USA) identified that the main barriers

[2] The first e-scooter sharing systems began operating in 2017 in the US (Christoforou et al., 2021), while BSS started to increase in popularity with its 3rd generation that emerged in 2005 in France (Demaio, 2009).

affecting their usage of ESS were related to safety, particularly felt by women with "worries about hitting or being hit by others, falling, and losing control" (Sanders, Branion-Calles and Nelson, 2020). One of the few studies comparing barriers to ESS and BSS use is provided by Bieliński and Ważna (2020) through a survey of Tricity (Poland) residents. In addition to safety concerns, respondents did not see the usefulness of ESS as a mode of transport and considered the system too expensive (especially when compared to BSS), while the main barrier of BSS was more connected to a lack of sufficient numbers of shared bikes (Bieliński and Ważna, 2020).

Finally, the coronavirus pandemic has introduced additional motivations and barriers that can potentially influence the use of bike and e-scooter sharing systems related to fears and risks of infection. Preliminary research indicates that bike and e-scooter sharing systems are perceived to be at lower risk of infection than other shared modes such as PT, but riskier than personal modes such as the private car (Shamshiripour et al., 2020; Teixeira and Cunha, 2022; Teixeira et al., 2022a). At the same time, the fact that these systems are considered at lower risk with respect to infection than PT may also be a new potential motivation for joining BSS and ESS. For example, recent studies from Lisbon on the reasons for BSS use during COVID-19 found that users greatly valued using BSS to avoid PT and to maintain a physical and social distance during their trips (Teixeira et al., 2021b, 2022b).

In summary, the current literature has identified several reasons for using and not using bike and e-scooter sharing. However, most of the existing research focuses on a single case study (either a specific system or a specific city), with only one study identified (Bieliński and Ważna, 2020) directly comparing barriers to BSS and ESS usage. Moreover, most of the research was conducted prior to COVID-19, so the potential impacts of the pandemic on motivations and barriers to BSS and ESS use are still largely unexplored. Therefore, to the best of our knowledge, we present the first study[3] comparing the barriers to the use of bike and e-scooter sharing systems in several European capitals during the COVID-19 pandemic.

3. Data and methods

3.1. Case studies

We used five European capital cities as case studies: Budapest (Hungary), Lisbon (Portugal), Rome (Italy), Vilnius (Lithuania) and Warsaw (Poland), whose main characteristics are shown in Table 1. Although different in size, geographical location and context, infrastructure, population densities, etc., the examined cities exhibit a monocentric urban form, with a rather concentrated and compact metropolitan area in which the studied mobility services are offered. These cities are all showing increasing interest on sustainable mobility and are testbeds for experimenting with bike and e-scooter sharing systems (Diogo et al., 2021). Nevertheless, these cities are all examples of "starter cycling cities", i.e., cities in which the use of bicycles as a mode of transportation is uncommon (BYPAD, 2008; Silva et al., 2019), still struggling to find the best approach to increase their cycling levels and to integrate sharing tools into their urban mobility policies (Diogo et al., 2021). As a result, these cities have a residual share of bicycle use (1–3%), while they are heavily dependent on the use of the private car, which is the main mode of transportation, except in Warsaw, where this mode is supplanted by public transport (Table 1).

Table 2 presents an approximate number of available shared bikes and e-scooters in 2021 in each case study.[4] In general, BSS have existed for longer than ESS, with the first BSS introduced in 2008 in Rome, while the first ESS was introduced 10 years later in Lisbon (in 2018). However, although more recently introduced, shared e-scooters are already more commonly available than shared bikes (~34 000 shared e-scooters versus 10 600 shared bikes), with the exception of Budapest where shared bikes are more common than e-scooters (1 500 shared bikes comparatively to 330 shared e-scooters). Rome has the largest number of available shared e-scooters, while Warsaw presents the largest number of shared bicycles. Because populations sizes differ considerably between cities, we normalized the values by presenting the number of available shared vehicles per thousand inhabitants. With this normalization, we can see that Lisbon, with 19.8, provides the highest rate of shared e-scooters per thousand inhabitants, while Warsaw, with 2.51, presents the highest ratio of shared bikes per thousand inhabitants. In contrast, Budapest and Vilnius have the lowest rates of ESS and BSS with 0.19 shared e-scooters and 0.5 shared bikes per thousand inhabitants, respectively. However, the supply of BSS and ESS in either city pales in comparison to car ownership rates in their respective countries, with the total number of shared micro-mobility vehicles available being one or even two orders of magnitude lower than the number of cars.

Table 1
Case-studies main characteristics (population size, area, density and modal share).

		Budapest	Lisbon	Rome	Vilnius	Warsaw
City population[a]		1 723 836	504 964	2 783 809	597 610	1 794 166
City area (km^2)		525	100	1 285	401	517
Pop. density (inhab./ km^2)		3 283	5 050	2 166	1 490	3 470
Modal Share[b]	*Private Car*	43%	45%	60%	49%	32%
	PT	43%	21%	20%	25%	47%
	Walking	12%	30%	18%	25%	18%
	Cycling	2%	1%	2%	2%	3%

[a] Population data from 2021 in Budapest (KSH, 2021), Rome (I.Stat, 2021) and Warsaw (GUS, 2021), 2020 in Vilnius (Vilnius Municipality, 2020) and 2017 in Lisbon (INE, 2018).

[b] Modal share data from 2020 in Rome (Deloitte, 2020b) and Warsaw (Deloitte, 2020a), from 2019 in Vilnius (Cities.multimodal, 2019), from 2018 in Budapest (Bucsky, 2020) and from 2017 in Lisbon (INE, 2018).

Additionally, Table 2 also provides the length of the current cycling network and planned expansions in each city. Overall, the cities show underdeveloped cycling networks, especially when compared to their population size. Nevertheless, most cities (except for Vilnius) have plans for expanding their cycling networks, the implementation of which was accelerated during the coronavirus pandemic. For instance, Rome has converted 12 km of roads into bike lanes, and the pandemic has spurred the approval of a master plan to build a total of 150 km of cycle paths (Roma Servizi per la Mobilità, 2022), while Lisbon has implemented 26 km of pop-up bike lanes and plans to expand the network to 200 km in the next few years (Câmara Municipal de Lisboa, 2020).

3.2. Data collection instrument

The online survey aimed to explore with a comparative approach the habits, motivations, and attitudes of (1) users and non-users (2) of bike and e-scooter sharing systems (3) in five European capital cities (i.e., Budapest, Lisbon, Rome, Vilnius and Warsaw), (4) before and during/after the pandemic. Aware of addressing urban settings with different socio-political and cultural contexts, as well as different urban transportation systems, infrastructure, policies (etc.), the online survey was designed and distributed in local languages having as target-population citizens living, working or frequently visiting (at least once a week) any of the five cities.

We followed an opportunistic sample approach employing a

[3] Some preliminary results have been published as proceedings in Sanna et al. (2022).

[4] For a more detailed analysis of the different BSS and ESS in operation in each city the reader is invited to consult Diogo et al. (2021).

Table 2
Opening year and approximate number of shared bikes (BSS) and e-scooters (ESS) in operation as well as the length of the current and future cycling network for each city.

	Budapest	Lisbon	Rome	Vilnius	Warsaw
BSS opening year [a]	2014	2017	2008	2013	2012
BSS (n) [a]	1 500	1 000	3 300	300	4 500
ESS opening year [b]	2019	2018	2020	2019	2021
ESS (n) [b]	330	10 000	14 500	1 100	8 300
BSS (n) per 1000 inhab.	0.87	1.98	1.19	0.50	2.51
ESS (n) per 1000 inhab.	0.19	19.80	5.21	1.84	4.63
Cars per 1000 inhab. (country average)[c]	354.4	490.8	635.5	476.5	592.6
Cycling network (km)[d]	256	105	125	93	723.5
Planned expansion (km)[d]	276 (+20)	200 (+95)	225 (+150)	93 (+0)	753.5 (+30)
Km cycle lanes (current) per 1000 inhab.	0.15	0.21	0.04	0.16	0.40
Km cycle lanes (planned) per 1000 inhab.	0.16	0.40	0.08	0.16	0.42

[a] Data for BSS retrieved from "The Meddin Bike-sharing World Map" (online: https://www.bikesharingworldmap.com) in 2021.
[b] Data for ESS retrieved from the operators' websites (i.e., Lime, Bolt, Bird, Dott, etc.) and news sources after mapping the service providers in each city in 2021.
[c] Car ownership data for the country of each city in 2017 (EEA, 2019).
[d] Data sources: Budapest - Bucsky (2020); Lisbon - Câmara Municipal de Lisboa (2020); Rome - Roma Servizi per la Mobilità (2022); Vilnius - Diogo et al. (2021); Warsaw -Warsaw City Council (2022).

standardized guidance for all cities. The questionnaire was distributed exclusively online on social media (specifically, Facebook and LinkedIn) and e-mail databases that targeted both the general population of the five selected cities and those who follow any bike or e-scooter sharing platforms such as social media pages. In particular, dissemination and outreach focused on publicizing the questionnaire on university mailing lists, official pages of parish councils, as well as Facebook neighbourhood groups and pages of residents living or working in areas with BSS or ESS available. Moreover, the questionnaire was widely disseminated to cycling, e-scooter and bike sharing associations in each city. The online survey was conducted between March and May 2021 and was available in each of the languages of the five countries plus English, being administered through a dedicated, multilingual online platform (*Survey Monkey*).

In this paper, we report only the results of the respondents who stated that they were "non-users" of BSS or ESS. Respondents were first asked whether they lived/worked/studied or frequently visited (at least once a week) any of the five cities (if not, the survey would end). Then, they were inquired about the availability of either BSS or ESS near their home, work/study or other frequent destinations (leisure, shopping, etc.). Respondents who stated to be non-users were asked to indicate the level of influence of 15 factors (Fig. 2) on their decision not to use either BSS or ESS through a 5-point Likert measurement scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Additionally, respondents were given the opportunity to indicate further reasons for their decision not to enroll in BSS or ESS.

3.3. Data analysis methods

To achieve the objective of this research, a mixed methods approach was chosen. First, descriptive statistics and non-parametric Mann-Whitney U and Friedman test with pairwise Wilcoxon Signed Ranks post-hoc tests were applied to the survey results to determine the most important barriers to BSS and ESS use. The Mann-Whitney U and Friedman test with pairwise Wilcoxon Signed Ranks post-hoc tests are the non-parametric equivalents of the independent *t*-test and one-way repeated measures ANOVA, respectively, and are used when we have ordinal data such as Likert items (Field, 2013). In this study, we used the Mann-Whitney U tests to identify possible significant differences in the barriers to the use of BSS versus ESS, while using Friedman test with pairwise Wilcoxon Signed Ranks post-hoc tests to rank the most important barriers to the use of BSS and BSS.

Additionally, to complement our quantitative analyses, we employed a content categorical analysis to the opened questions regarding other reasons for not using bike-sharing and e-scooter sharing. This analysis involves the clusterization of text samples (e.g., an answer or part of it) into main categories, in this case main reasons for not using these shared systems, examining the inner diversity within these general themes and highlighting subcategories. A next logical step was to identify associations and dissociations between the different themes. These procedures allowed us to develop consistent interpretations of respondents' shared meanings, taking into account current and previous research.

3.4. Sample description

657 respondents completed the survey, of whom 487 had never used BSS and 579 had never used ESS. Table 3 presents the main socioeconomic and demographic characteristics of the sample: most respondents are between 25 and 54 years old (75%), female (51.9%), with an high school degree (79%), and are employed (75%).

4. Quantitative approach

4.1. Availability of bike and e-scooter sharing

We begin by analysing the share of respondents who stated having BSS or ESS available near their home, work/study or other frequent destinations (leisure, shopping, etc.); the results are presented in Fig. 1.

Shared e-scooters seem to be somewhat more available than shared bikes in the pooled sample of the five cities surveyed, and this trend is also visible in every sub-sample nationwide (except for Warsaw). On average, bike sharing for either work/study or other destinations (such as leisure or shopping) is available to two-thirds (66%) of the pooled sample and just over half of them (54%) near their home. These rates are systematically somewhat higher in the case of e-scooter sharing, as it is available for 70% of the respondents where they work or study or around their other usual destinations and for 60% around their home. Another typical pattern across the five cities is that both bike and e-scooter sharing are more available near the workplace, study or other destinations (leisure, shopping etc.) than around the respondents' homes.

In some cases, however, differences at the country level are clear: bike sharing around respondents' home is less available for Vilnius (36%) and Lisbon (43%), while nearly two-thirds of respondents living in Warsaw (64%) and Rome (60%) and more than half in Budapest (55%) can find shared bikes where they live. Minor but similar discrepancies are also observed in the same cities and destinations in the case of shared e-scooters. The level of those who have access to shared bikes or e-scooters in places other than their residency (e.g., where they work, study or spend leisure time) is more balanced across cities, with

Table 3
Socioeconomic and demographic characteristics of the respondents (N = 657).

		n	%
City	Budapest	117	17.8%
	Warsaw	109	16.6%
	Rome	249	37.9%
	Vilnius	85	12.9%
	Lisbon	97	14.8%
Gender	Male	311	47.3%
	Female	341	51.9%
	Other	5	0.8%
Age	< 18	3	0.5%
	18–24	55	8.4%
	25–34	140	21.3%
	35–44	198	30.1%
	45–54	153	23.3%
	55–64	80	12.2%
	> 64	28	4.3%
Level of education	Basic education	28	4.3%
	Secondary education	100	15.2%
	Bachelor's degree	151	23.0%
	Master's degree	280	42.6%
	PhD or Postdoctoral	88	13.4%
	Non-response	10	1.5%
Employment status	Full time worker	490	74.6%
	Part time worker	38	5.8%
	Student	58	8.8%
	Retired	32	4.9%
	Unemployed or economically inactive	21	3.2%
	Non-response	18	2.7%
Household size	1	108	16.4%
	2	216	32.9%
	3 or more	329	50.1%
	Non-response	4	0.6%
Number of children	0	404	61.5%
	1	114	17.4%
	2 or more	135	20.5%
	Non-response	4	0.6%
Income[a]	Finding it very difficult on present income	19	2.9%
	Finding it difficult on present income	59	9.0%
	Coping on present income	265	40.3%
	Living comfortably on present income	260	39.6%
	Non-response	54	8.2%

[a] Based on the standardized self-assessed household income from the European Social Survey of 2018.

the difference between the availability of these services around respondents' homes and other major destinations largest in Vilnius and Lisbon. In general, most respondents have access to these services in Warsaw, Rome and Budapest, where 70% of the respondents are able to use e-scooters.

4.2. Barriers to the use of bike and e-scooter sharing

We now turn our attention to the barriers to the use of BSS and ESS, focusing on respondents who have BSS or ESS available near their home, work/study or other frequent destinations (leisure, shopping, etc.).[5]

4.2.1. Overall barriers to the use of BSS and ESS

Fig. 2 shows the reasons for not using BSS (in blue) and ESS (in orange), ranked according to the respondents' highest scores. The main reasons for not using BSS or ESS mentioned by respondents (who have BSS or ESS available near their main trip origins and/or destinations) are the opinion that other modes of transport are more convenient (63.9% for BSS and 73.9% for ESS); traffic-related safety concerns (44.1% for BSS and 58.1% for ESS); poor road conditions (49.4% for BSS and 52.1% for ESS); lack of a bike network (50.4% for BSS and 48.7% for ESS) and the destinations (relevant to respondents) being too far by bike or e-scooter (41.7% for BSS and 42.1% for ESS). Other less relevant barriers include the lack of helmets available for use (33.3% for BSS and 39.3%) as well as the cost of using the systems (27.2% for BSS and 36.1% for ESS). Interestingly, the COVID-19 pandemic does not seem be a barrier to BSS or ESS use, being amongst the least important barriers reported by respondents (12.5% for BSS and 10.6% for ESS).

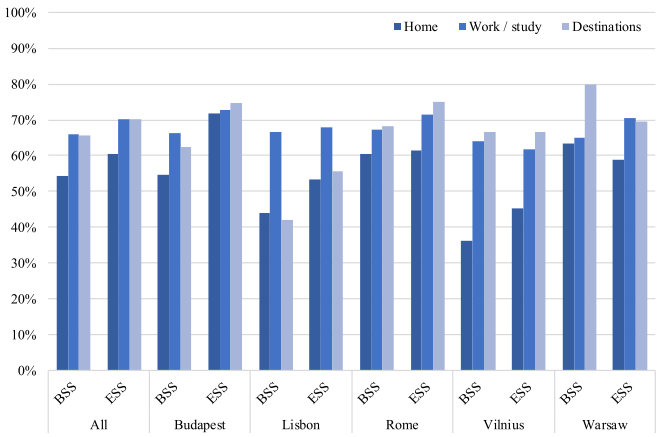

Fig. 1. Percentage of respondents with BSS or ESS available near their home, work/study or other frequent destinations (leisure, shopping, etc.) (N for BSS: All = 487, Budapest = 77, Lisbon = 57, Rome = 207, Vilnius = 72, Warsaw = 74; N for ESS: All = 579, Budapest = 110, Lisbon = 90, Rome = 235, Vilnius = 42, Warsaw = 102).

To assess if the findings from the previous graph were statistically significant, we conducted Friedman tests with pairwise Wilcoxon Signed Ranks post-hoc tests to determine the most important barriers to the use of BSS and ESS (Table 4, Table 5 and Table 6).

Statistical tests reveal that both BSS and ESS have the same top 5 reasons for not using the systems (Table 7). Other modes of transportation being considered more convenient is the main barrier for both BSS and ESS. The lack of a bike network was found to be more important for BSS non-users, while traffic safety concerns were perceived as a more important barrier for ESS non-users. Of the top five barriers, the destinations being too far was found to be the least important to BSS and ESS non-users.

4.2.2. BSS vs ESS

We further explored possible significant differences between barriers to ESS and BSS use by applying the Mann-Whitney U tests (Table 8). Six barriers were found to be statistically different between non-users of ESS and BSS. Respondents have greater concerns about safety while riding in traffic and consider the availability of helmets more important with e-scooters than with shared bikes (14% and 10% difference between respondents who agree or strongly agree, respectively). Moreover, respondents believe that sharing e-scooters are less convenient than other modes, more expensive and do not have enough cargo space comparatively to shared bikes (10.1%, 8.8% and 10.4% difference among respondents who agree or strongly agree, respectively). Conversely, respondents are more likely to find shared bikes in worse condition than e-scooters (12.4% difference).

4.2.3. City by city analysis

We also analysed the possible differences between the barriers to BSS and ESS use in each of the five cities (Fig. 3, Fig. 4, Fig. 5, Fig. 6 and Fig. 7). The overall ranking of barriers to BSS or ESS use is very similar in the five cities, but with a few noteworthy outliers that reflect some city-specific particularities:

[5] In the remainder of our analyses, we consider only those respondents who reported having BSS or ESS available near their home, work/study or other frequent destinations (leisure, shopping, etc.) since the suitable location of the systems close to the users' main origin and destinations is the main prerequisite for using either system.

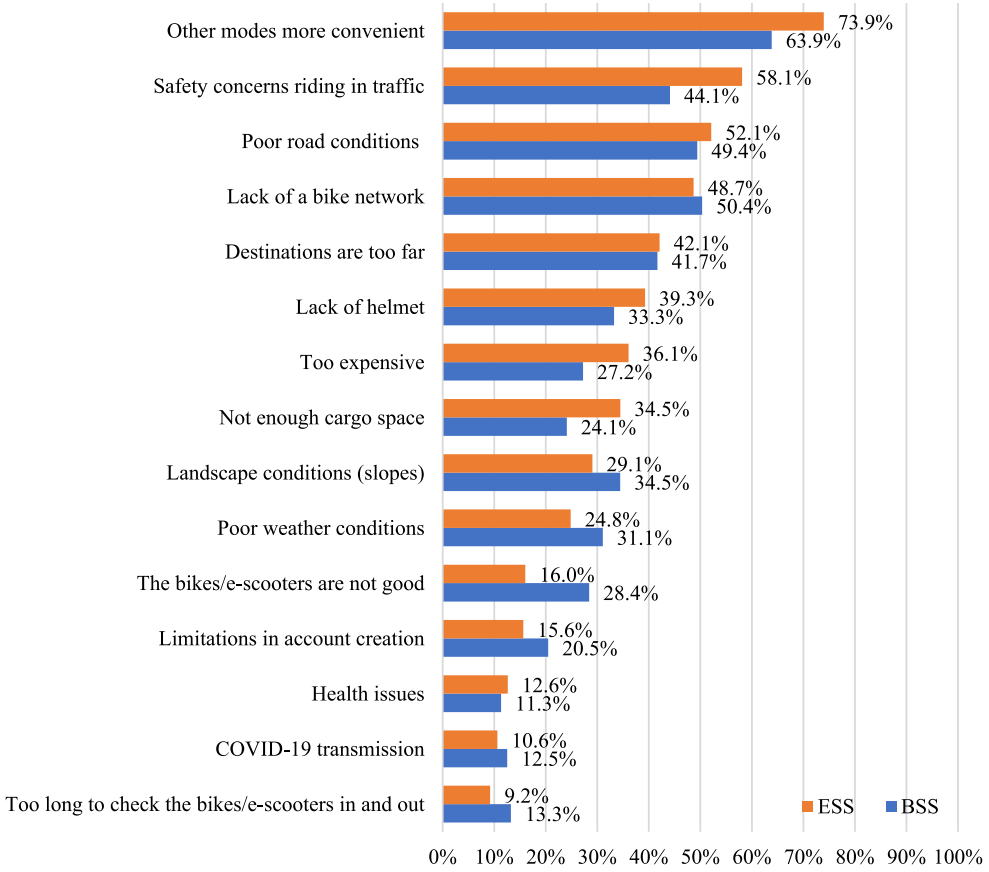

Fig. 2. Reasons for not using BSS (N = 415) or ESS (N = 499) ranked by respondents' agreement rating (only the combined percentage of the two highest ratings - agree and strongly agree - is shown for easier reading).

Table 4
Friedman test results for BSS and ESS.

	BSS	ESS
N	415	499
Chi-Square	78.530	143.365
df	4	4
Sig.	<0.001	<0.001

- In Budapest, the insufficient quality of bicycles was reported as the third most important barrier, with twice the share of the five-city average (55% in Budapest). However, the survey was carried out just before the change of the shared bikes of the main Budapest BSS, *MOL-Bubi*, which has been developed exactly due to quality concerns
- In Lisbon, landscape conditions (slopes) were mentioned more (50%) than the average of the five-city (35%) as well as the limitations in account creation (30% *vs* an average of 20%)
- In Rome, infrastructural issues, such as poor road conditions and lack of bike network, were mentioned more than average (66% *vs* 50% average and 64% *vs* 50% average), as well as landscape conditions (48% *vs* 35% average)
- In Vilnius, bad weather conditions were more a major obstacle (mentioned by 43% *vs* 31% of the five-city average), as well as the quality of shared bikes (mentioned by 33% *vs* 28%) and the time (too long) to check bikes in and out (18% *vs* 13%). However, Vilnius respondents are much less frustrated with traffic safety problems (mentioned by 18% *vs* 44% on average)
- In Warsaw, the price of BSS is certainly not a barrier: only 4% of respondents mentioned it (against 27% of the five-city average). On the contrary, the lengthy procedure to check the bikes in and out is a much more important source of frustration (32% *vs* 13% of the average)

4.2.4. *Barriers to BSS and ESS according to the main mode of transportation*

We also asked respondents what their main modes of transportation were (Fig. 8 and Fig. 9). The majority of respondents chose walking as their main mode of mobility (at least four times a week for 57% of BSS and ESS non-users, based on the five-city average), followed by private car (at least four times a week for 28% of BSS and 27% of ESS non-users) and public transport (at least four times a week for 14% of BSS and ESS non-users).

Finally, we investigated whether the barriers to BSS or ESS use differed according to the mode of transportation used by our respondents (i.e., *do car drivers have the same barriers as PT users or pedestrians?*). In order to do so, if our respondents used a mode more than once a week, we classified them as "frequent users" of that respective mode. The barriers to BSS and ESS use according to the respondents' main transportation modes are depicted in Fig. 10 and Fig. 11, respectively.

The figures reveal that, overall, the barriers to the use of either BSS or ESS are the same regardless the transportation mode used by the respondent. The only exception is related to the non-ESS users that use personal bike as their main mode of transportation: these respondents give less importance to several barriers to the use of ESS (namely, safety concerns riding in traffic, poor road conditions, lack of a bike network, destinations that ae too far away, lack of helmet, slopes, and poor weather conditions), which can be attributed to the fact that these barriers are also common to cycling.

Table 5
Post-hoc pairwise comparisons of the barriers to the use of BSS and associated Wilcoxon Signed Rank tests (N = 415).

Pairwise comparisons	Number of Ranks		Z
Safety concerns riding in traffic vs Other modes more convenient	Negative Ranks	195	−7.751*[b]
	Positive Ranks	83	
	Ties	137	
Lack of a bike network vs Other modes more convenient	Negative Ranks	177	−4.617*[b]
	Positive Ranks	113	
	Ties	125	
Poor road conditions vs Other modes more convenient	Negative Ranks	177	−5.048*[b]
	Positive Ranks	103	
	Ties	135	
Destinations are too far vs Other modes more convenient	Negative Ranks	193	−7.841*[b]
	Positive Ranks	76	
	Ties	146	
Lack of a bike network vs Safety concerns riding in traffic	Negative Ranks	100	−4.226*[c]
	Positive Ranks	142	
	Ties	173	
Poor road conditions vs Safety concerns riding in traffic	Negative Ranks	93	−4.069*[c]
	Positive Ranks	142	
	Ties	180	
Destinations are too far vs Safety concerns riding in traffic	Negative Ranks	129	−1.008[c]
	Positive Ranks	135	
	Ties	151	
Poor road conditions vs Lack of a bike network	Negative Ranks	95	−0.343[b]
	Positive Ranks	93	
	Ties	227	
Destinations are too far vs Lack of a bike network	Negative Ranks	143	−3.070*[b]
	Positive Ranks	92	
	Ties	180	
Destinations are too far vs Poor road conditions	Negative Ranks	139	−2.995*[b]
	Positive Ranks	85	
	Ties	191	

*Significant at the 0.05 level (Bonferroni correction for multiple comparisons).
[b] Based on positive ranks.
[c] Based on negative ranks.

5. Qualitative approach

In this section, we explore the open question on other reasons for not using bike or e-scooter sharing systems through a content analysis. Before proceeding to further analysis, it can be noted that of the 415 and 499 non-users with BSS or ESS available, 136 and 106 respectively, considered it valuable to answer this open question. Fig. 12 presents the distribution of answers per city.

In these answers, the respondents gave details about other reasons not to using BSS or ESS, which they felt added information to the pre-categorized options in the previous questions of the survey, or which they considered important to emphasise and express in their own words. Table 9 presents a categorization of the different reasons given by the respondents for not using BSS and ESS.

We can observe that of the 12 categories identified through the content analysis, 9 are barriers common to both BSS and ESS, with 2 barriers specific to either ESS or BSS. However, although most of the barriers are similar between BSS and ESS responses, the variations in topics, associations with other themes, and the representativeness of each order of motivation within each sample are different, as we will see in detail bellow.

Table 6
Post-hoc pairwise comparisons of the barriers the use of ESS and associated Wilcoxon Signed Rank tests (N = 499).

Pairwise comparisons	Number of Ranks		Z
Safety concerns riding in traffic vs Other modes more convenient	Negative Ranks	184	−7.082*[b]
	Positive Ranks	94	
	Ties	221	
Lack of a bike network vs Other modes more convenient	Negative Ranks	225	−8.671*[b]
	Positive Ranks	85	
	Ties	189	
Poor road conditions vs Other modes more convenient	Negative Ranks	207	−7.755*[b]
	Positive Ranks	91	
	Ties	201	
Destinations are too far vs Other modes more convenient	Negative Ranks	249	−10.658*[b]
	Positive Ranks	65	
	Ties	185	
Lack of a bike network vs Safety concerns riding in traffic	Negative Ranks	162	−2.485[b]
	Positive Ranks	117	
	Ties	220	
Poor road conditions vs Safety concerns riding in traffic	Negative Ranks	127	−0.942[b]
	Positive Ranks	112	
	Ties	260	
Destinations are too far vs Safety concerns riding in traffic	Negative Ranks	191	−4.236*[b]
	Positive Ranks	107	
	Ties	201	
Poor road conditions vs Lack of a bike network	Negative Ranks	78	−2.077[c]
	Positive Ranks	109	
	Ties	312	
Destinations are too far vs Lack of a bike network	Negative Ranks	141	−2.283[b]
	Positive Ranks	106	
	Ties	252	
Destinations are too far vs Poor road conditions	Negative Ranks	157	−3.977*[b]
	Positive Ranks	91	
	Ties	251	

* Significant at the 0.05 level (Bonferroni correction for multiple comparisons).
[b] Based on positive ranks.
[c] Based on negative ranks.

Table 7
Ranking of the top 5 barriers to BSS and ESS usage.

Barriers	BSS	ESS
Other modes more convenient	1st	1st
Lack of a bike network	2nd	3rd
Poor road conditions	2nd	2nd
Safety concerns riding in traffic	4th	2nd
Destinations are too far	4th	4th

5.1. Content analysis of other reasons for not using BSS

The preference for using one's own bicycle is by far the main obstacle to the respondents' motivation to use BSS (Table 9). With far fewer preferences, *personal obstacles* and the *preference for other means of*

Table 8
Percentual differences on the barriers to the use of ESS (N = 499) and BSS (N = 415), results of the Mann-Whitney *U* test and associated significance.

Barriers	Percentual difference (ESS *vs* BSS)					Mann-Whitney *U* test		Differences significant at p <.05 (test)
	Strongly Agree	*Agree*	*Neither agree nor disagree*	*Disagree*	*Strongly disagree*	*U*	*Z*	
Health issues	0.3%	1.0%	−1.0%	4.7%	−5.0%	99455.5	−1.152	No
COVID-19 transmission	−1.7%	−0.2%	0.9%	1.8%	−0.8%	103158.5	−0.107	No
Safety concerns riding in traffic	**9.3%**	**4.8%**	1.5%	−5.1%	−10.4%	85144.5	−4.762	**Yes**
Lack of helmet	**5.5%**	0.6%	2.2%	0.0%	−8.3%	92470.5	−2.870	**Yes**
Other modes more convenient	**7.3%**	2.8%	−3.8%	−4.1%	−2.3%	90732.5	−3.383	**Yes**
Limitations in account creation	−1.8%	−3.0%	11.2%	−1.9%	−4.4%	100,460	−0.806	No
Too expensive	**7.3%**	1.5%	3.2%	−9.0%	−3.0%	87513.5	−4.244	**Yes**
Too long to check the bikes/e-scooters in and out	−0.1%	−3.9%	6.7%	−3.2%	0.6%	102,676	−0.238	No
The bikes/e-scooters are not good	−2.3%	**−10.1%**	8.7%	0.7%	2.9%	91,265	−3.329	**Yes**
Not enough cargo space	**5.2%**	**5.2%**	−3.2%	−2.7%	−4.5%	89,770	−3.631	**Yes**
Poor weather conditions	−0.9%	−5.4%	3.2%	4.1%	−1.1%	99,185	−1.127	No
Landscape conditions (slopes)	−1.1%	−4.3%	5.9%	3.7%	−4.2%	102865.5	−0.175	No
Poor road conditions	4.4%	−1.7%	1.6%	−1.0%	−3.2%	97457.5	−1.571	No
Lack of a bike network	1.2%	−2.8%	2.8%	0.4%	−1.6%	102939.5	−0.156	No
Destinations are too far	2.9%	−2.5%	3.6%	0.1%	−4.2%	98970.5	−1.177	No

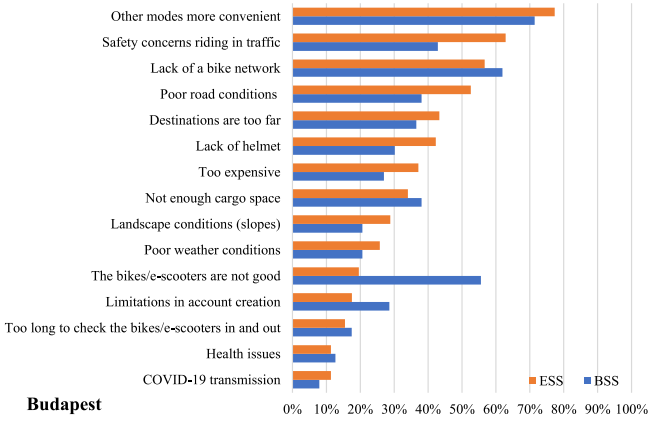

Fig. 3. Reasons for not using BSS (N = 63) or ESS (N = 97) in Budapest ranked according to the respondents' agreement assessment.

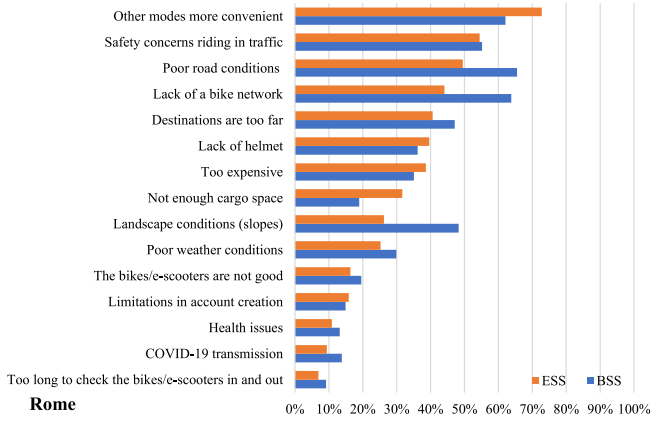

Fig. 5. Reasons for not using BSS (N = 174) or ESS (N = 202) in Rome ranked according to the respondents' agreement assessment.

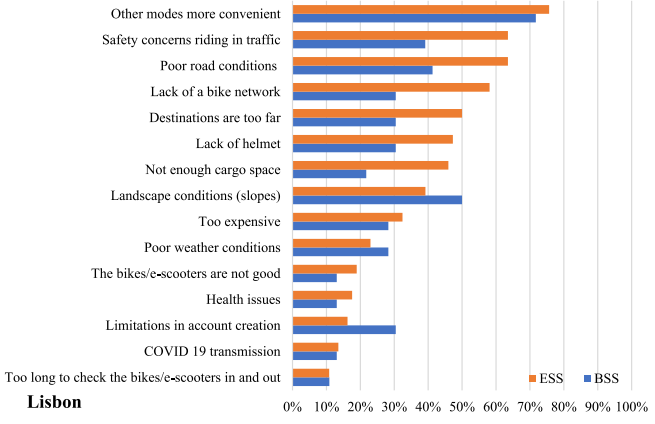

Fig. 4. Reasons for not using BSS (N = 46) or ESS (N = 74) in Lisbon ranked according to the respondents' agreement assessment.

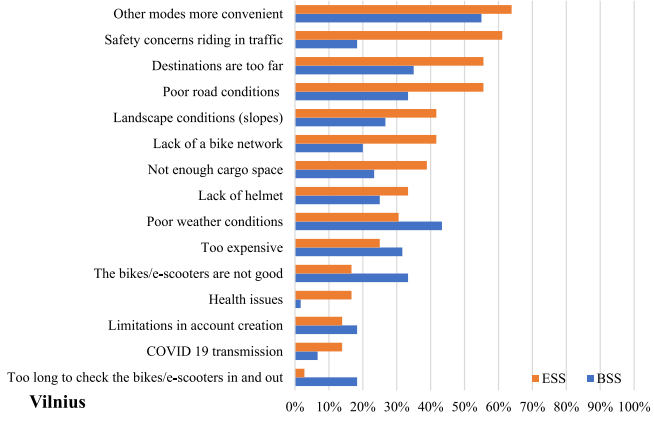

Fig. 6. Reasons for not using BSS (N = 60) or ESS (N = 36) in Vilnius ranked according to the respondents' agreement assessment.

transportation are the next categories with the highest number of entries. The fact that 8 respondents declared that they do not use BSS due to the unavailability of the service near home or workplace reveals the importance of geographical spread of the systems in the periphery/suburbs and outskirts of these cities, a factor which could significantly improve the inclusiveness of these systems. It is also relevant that seven individuals complained about the transport systems, particularly about the BSS but also about the lack of intermodality in their cities.

By delving into the dispositions and representations spontaneously shared by the respondents - highlighting the sets of barriers that are expressed by a greater number of individuals and that show a greater internal diversity and present associations with other categories – some interesting evidence emerges.

Of the answers expressing a *preference for using one's own bicycle*, the

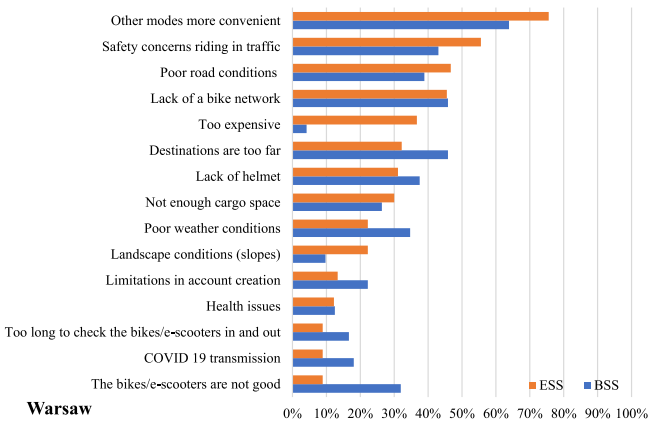

Fig. 7. Reasons for not using BSS (N = 72) or ESS (N = 90) in Warsaw ranked according to the respondents' agreement assessment.

majority is unidimensional, with the simple statement "*I use my own bicycle*" which indicates a preference for owning rather than using a shared bike. The *preference for other means of transportation* includes walking, using private bicycle or car or motorbike and PT. It is relevant to note that all items related to the use of a private bicycle (5 entries) included in this category stated two alternative transports (i.e., "*I use my bicycle/I use my car*").

Personal obstacles include the lack of design for people with disabilities and other physical issues (5 entries), old age (4), being a caregiver of children (5); not being able to ride a bicycle (1), aesthetic reasons with main reference to sweating (4), lack of practice with the mode of transport or confidence in one's personal ability to use BSS.

Among the *technological obstacles*, the most common is the incompatibility of the application with the mobile phone. Additionally, a Roman respondent also mentioned about a substantial "*laziness in filling the registration form by phone using the mobile-app*", which might imply that this registration process is not fast or not fluid enough.

The cluster of *financial obstacles* includes a reference to financial difficulties due to the periods of pandemic lockdowns by a respondent from Lisbon, two direct statements considering BSS to be expensive, and the following justification "*I have two jobs and no time for such leisure activities*", which expresses the daily struggle of this person from Lisbon as well as the representation of bicycles as instruments for leisure and not for transportation.

Among the *complaints about the transportation systems*, one finds mainly criticisms of BSS, such as the poor quality of the bicycles, the long distance between drop off points, the carrier being too high, or simply dislike for BSS. However, there were also complaints about the lack of intermodally with PT, as exemplified by the following quote: "*Rome is a "third world city" without a functioning public transport these services cannot be integrated*". One of the respondents, from Budapest, also criticises the uncivil attitudes in the traffic, which falls in the *perception of unsafety* cluster, in which there are references to the danger caused by cars (with the respondent mentioning a previous bicycle accident as a reason for discomfort in the traffic). Bad infrastructure is also mentioned as evidenced by the criticism of a respondent from Lisbon: "*The automobile circulation should be very limited due to its effects on people's health, pollution, risk and because the city should not be a transit area but an area to be lived in safety*".

Finally, there was a single answer that can be labelled as aversion to the mode of transportation, which was the expression "Bicycle dictatorship" by a respondent from Lisbon, with no further explanation or consideration.

5.2. Content analysis of other reasons not to use ESS

As in the case of BSS, the preference for private bicycle use is by far the main obstacle to respondents' motivation to use the ESS (Table 9). However, the disparity between the number of entries in this category and the next ones in terms of expressiveness is smaller. Again, *personal obstacles* are the second category with the most entries. *Preference for using other transportation modes*, the *perception of unsafety* and *criticism to the lack of regulation* are shown as reasons for not using the ESS by eleven respondents. Notably nine respondents stated *aversion for the e-scooters* as a mode of transportation. On the other hand, five respondents justified not using the ESS by the fact that they *have their own e-scooter*. *Technological obstacles* are more expressive in this sample than in the BSS respondents, while the unavailability of the service in the area of residence/workplace is more declared with regard to BSS.

After this overview, it is relevant to elaborate on the perceptions and representations implicit in each category of answers, as well as to highlight the connections between different sets of reasons within the respondents' testimonies.

Among those who declared a *preference for using bicycle*, most (24 entries) specify "*I use my bicycle*" without further explanation, which indicates a preference for this transport. In addition, one of the respondents declared using private bicycle and private e-scooter. Other reasons for preferring the bicycle are related to the fact that it is perceived as a more stable and controllable means of transport, as well as "*more environmentally friendly*" as stated by a non-user from Rome and "*sporty*" in the words of a non-user from Budapest, compared to the e-scooter with which "*you don't even have to struggle*" despite the high speed it reaches, as commented by a person from Rome. It is relevant to note that two respondents prefer to use the BSS as a reason for not using ESS. The *preference for using other means of transportation* includes references to PT, walking, car and two criticisms to the lack of active movement implied by the use of e-scooters. Furthermore, for five other respondents, the reason for not using ESS is the *preference for using their own e-scooter*, with one of them also declaring to prefer the private bicycle.

The *personal obstacles* shared by the respondents are aesthetics (sweating) (1), old age (4), health problems including disabilities (4), and childcare duties (4).

Most of the respondents that mentioned *technological obstacles* as a reason for not using ESS, explain that the *app* is not compatible with their phone, with one of them considering the system too complex. This set of reasons is reflected in the existing concern about the socio-economic inclusiveness of the technology designed for the ESS (also applicable to BSS).

Two respondents mention *financial obstacles* as a reason for not using ESS, with one of them comparing it to the BSS which is considered more affordable, and the other, a non-user from Rome, mentioning financial difficulties due to the lockdown periods during the pandemic.

In the category *perception of unsafety*, individuals declare that the e-scooter is unstable and difficult to balance. In addition, they mention a lack of confidence and pleasure riding it, criticising ESS for not being an active means of transport and for its excessive speed, with one respondent from Rome mentioning the possibility of being run over by people who are "*not familiar with it*" and/or that are under the effect of alcohol.

The typical response included in *aversion to the mode of transportation* is "*I hate e-scooters*" without further explanation. The perception of being seen as "a nuisance" is also stated by two respondents. The first, a person from Lisbon, uses the strong expression "*annoying to death to everyone except the users*" in addition to the following intense criticism "*The e-roller is a perfect example of humanity's self-deception. Wrapped in a green mask, it is unsustainable, prone to accidents*". This respondent also shares relatively offensive opinions about the ESS users, suggesting that this means of transport should be banned. The second respondent, from Rome, declares to be "*annoyed by the e-scooter culture*" which led us to consider that the spread of ESS and e-scooter use in general, as a novelty, has caused enough noticeable changes in mobility trends to be considered a "*culture*".

The reasons for *criticism to its lack of regulation* are mainly the

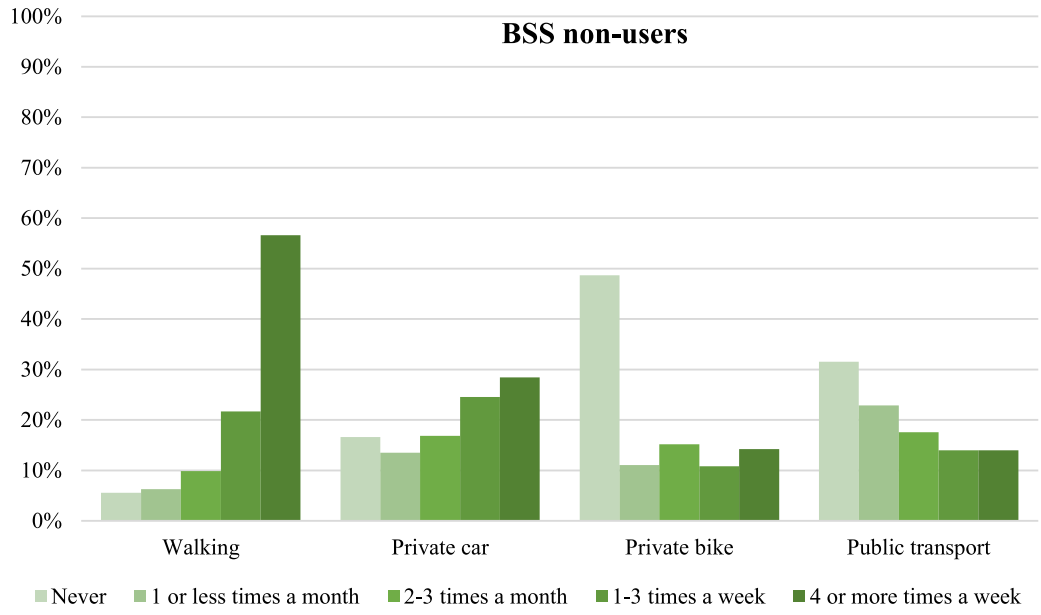

Fig. 8. Frequency of use of main modes of transportation of BSS non-users (N = 415).

mismanagement of its parking and the places where it should be allowed to circulate, with strong criticisms for its use on the sidewalk. One respondent, from Rome, complains about having been "*almost run over several times*" and believes that e-scooters should be banned. Another non-user from Rome shares the following reasoning for opposition: "*in theory it could only go in traffic, while in practice it goes on roads, bicycle-lanes, sidewalks. I wouldn't let it to ride on a bike lane. It is an accident hazard due to its speed. (Well, actually, it is also dangerous between cars and on sidewalks. I'd rather ban it.)*" It seems that according to this individual's view there is no room for ESS in the city. Another respondent shares a similar perspective about the conflictual relationship between e-scooter users and others: "*Obviously the lack of space is a clear problem in Budapest, both for cyclists and scooter riders. In addition, e-scooters are more exposed to this problem, they are not welcomed by pedestrians on the street and by cyclists in the cycle lane.*" As the latest transport trend, e-scooter users are the easiest target to blame for the lack of safety and space, which is a pre-existing condition and mainly a result of the car-centered urban planning that characterize the analyzed cities.

6. Discussion of the results

The results reveal that BSS and ESS share the same barriers affecting their usage in all five cities. These are barriers that are mainly beyond the control of the respondents, i.e., external factors, mostly stemming from the competition from other transportation modes and infrastructural settings (such as the lack of dedicated lanes). Other modes of transportation being considered as more convenient than either BSS or ESS was found to be the main barrier, similar to the findings from other studies, with, for instance, car convenience being also the main reason of non-users of BSS in Australia (Fishman et al., 2014). Likewise, safety concerns of riding a shared bike or e-scooter with traffic and the lack of dedicated bike lanes (which would ameliorate this feeling of unsafety by

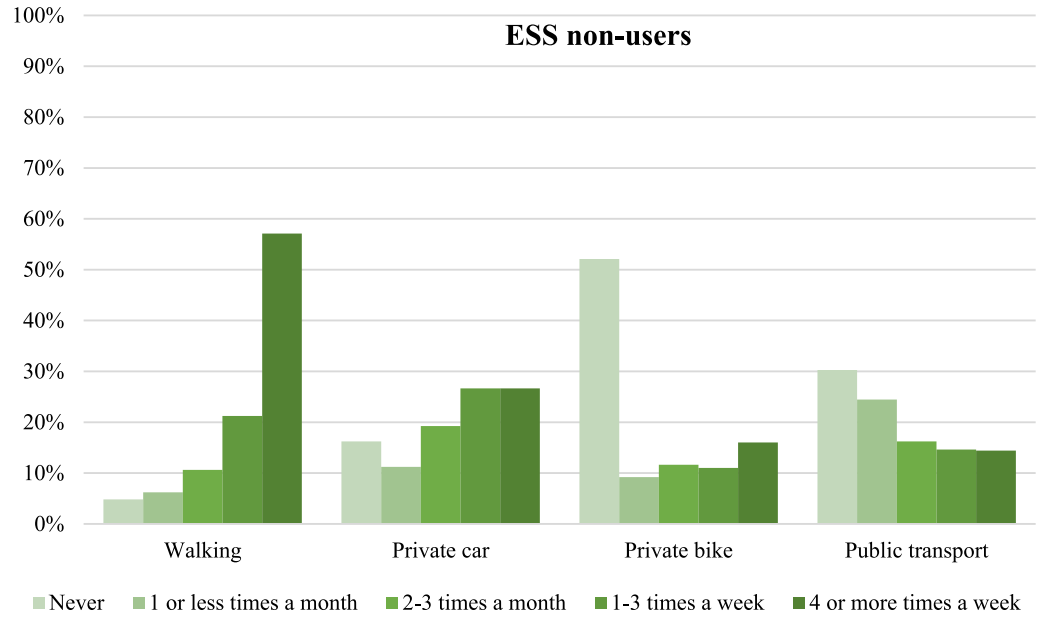

Fig. 9. Frequency of use of the main modes of transportation of ESS non-users (N = 499).

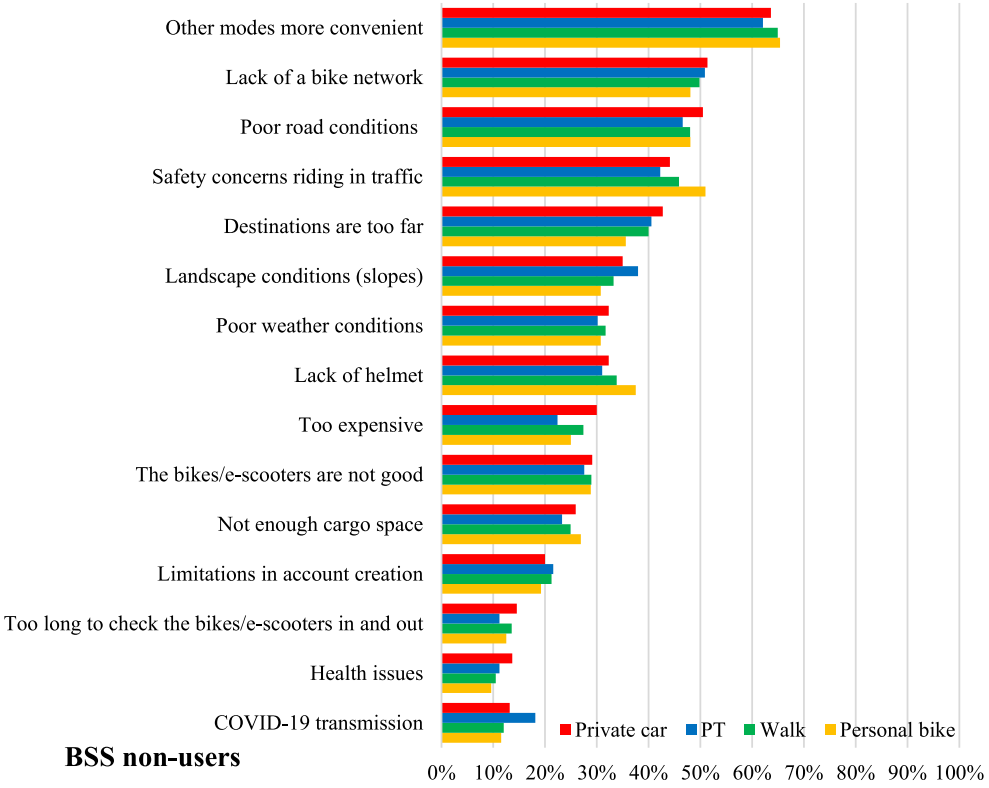

Fig. 10. Barriers to BSS use segmented according to the respondent being a frequent user of a private car (N = 220), PT (N = 116), walk (N = 325) or personal bike (N = 104).

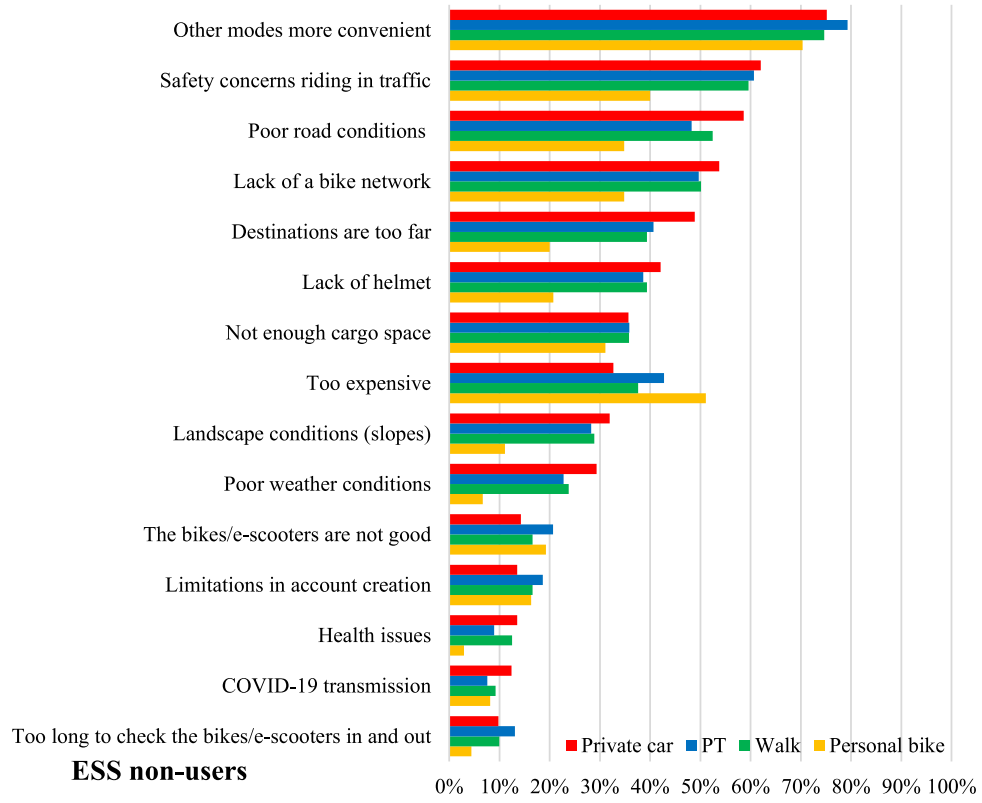

Fig. 11. Barriers to ESS use segmented according to the respondent being a frequent user of a private car (N = 266), PT (N = 145), walk (N = 391) or personal bike (N = 135).

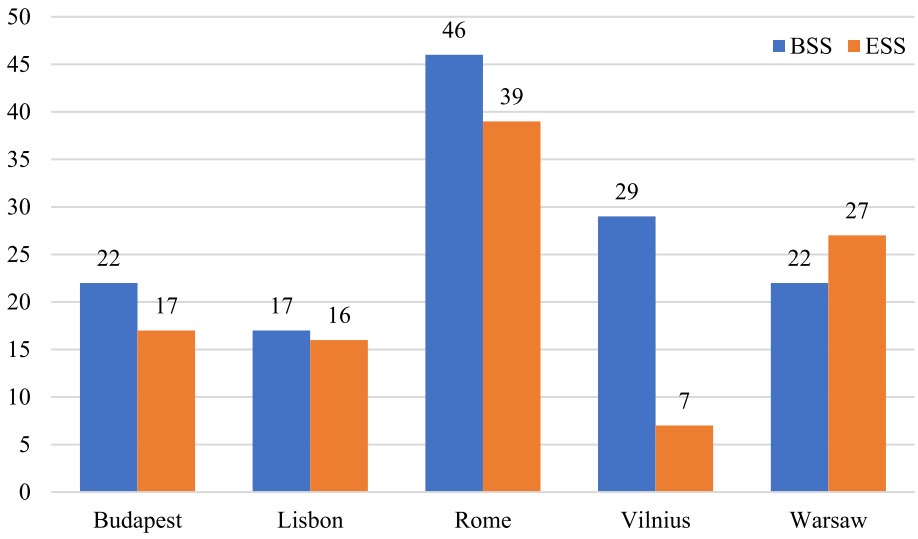

Fig. 12. Distribution of answers to the open question on other reasons for not using BSS or ESS.

separating the users from the motorized traffic) have been identified as a major deterrence for using either system. This is also in line with previous research identifying safety concerns of riding alongside motorized traffic as a major barrier affecting the usage of those modes, particularly in car-dominated cities (Fishman, Washington and Haworth, 2012; Teixeira et al., 2022b), which is also the case of our case-studies.

There are other, less relevant, external factors that prevent possible users from using BSS or ESS such as landscape or poor weather conditions, which are also difficult to adapt to. In the case of BSS, the introduction of e-bikes may help to mitigate some of these negative effects such as hilly terrains or hot weather. There are also some other less frequently mentioned barriers that could as well be eliminated by some adaptation implemented by the BSS/ESS users or providers, such as lack of available helmets, and the price or quality of the shared bikes or e-scooters.

Regarding the differences on barriers to the use of BSS or ESS, most non-users stated similar reasons for both types of micro-mobility systems, although e-scooters were generally considered to be more expensive and a poorer transport option for carrying goods. Most shared bikes provide a basket for transporting small loads, whereas the capacity of e-scooters to carry loads is much smaller. Likewise, BSS overall offer more affordable usage prices, as they often have monthly or annual subscriptions, typically subsidized by public authorities, whereas ESS tend to be more profited-oriented, with most systems using pay-by-the-minute services and not providing monthly/annual passes. Furthermore, the content analysis revealed that e-scooter sharing is viewed much more negatively, with several respondents considering ESS dangerous and even advocating their total ban. Such criticisms can be explained by the novelty of ESS which are a very recent addition and, therefore, not yet well accepted or well-integrated into the broad transport system.

This research also revealed that the coronavirus pandemic was not a major barrier to the use of BSS and ESS. In this sense, our study seems to point to an emerging trend observed in previous research, in which bike and e-scooter sharing systems have increased their relevance during the pandemic, being perceived as alternatives to PT in which a social distance can be maintained (Shamshiripour et al., 2020; Teixeira et al., 2021b, 2022a, 2022b).

Regarding the limitations of our study, we have employed a convenience sampling method, which may lead to self-selection bias. We addressed this limitation by conducting a standardized dissemination strategy for all cities as well as a broad and diverse targeting through the use of several online channels, with the representativeness of our sample being supported by the fact that the main barriers to BSS and ESS were similar across the five cities. Nevertheless, our study cannot be considered as representative of the general population as the distribution method (exclusively online) implies that a potential respondent had to have internet access and computer/smartphone skills. In that sense, the employed recruitment method may also explain why access to a computer/smartphone was not identified as a major barrier for using these systems (most modern BSS and ESS require a smartphone for real-time booking and electronic payment). Nevertheless, this limitation does not invalidate the insights obtained on the other types of barriers.

Table 9
Categorization of barriers to BSS and ESS use resulting from the content analysis.

Barriers	Text sample counts	
	BSS	*ESS*
Preference for using own bicycle	72	38
Preference for using other transportation modes	15	11
Preference for using own e-scooter	–	5
Personal obstacles	20	13
Technological obstacles	3	6
Financial obstacles	4	6
Perception of unsafety	7	11
Unavailability of service near home or workplace	8	3
Complaints about the transportation systems	7	–
Aversion to the mode of transportation	1	9
Criticism to the lack of regulation	–	11
Long distance travels	4	–

7. Conclusions and policy implications

Bike and e-scooter sharing services are on the rise in European cities and represent an increasingly popular topic for academic and applied policy research. However, most existing research focuses on the drivers and motivations of actual users of these systems, while those of non-users (who may still represent an important share of potential users) are often overlooked and their motivations are not studied. This paper examines this neglected aspect in order to support academic and policy research on urban mobility and transportation planning with inputs on what are the barriers to further development of BSS and ESS. The paper analyses the unique data from an online survey carried out in five EU capitals (Budapest, Lisbon, Rome, Vilnius and Warsaw) in the spring 2021, i.e., during the pandemic experience that heavily impacted urban mobility policy and brought BSS and ESS into the spotlight.

The analysis reveals that the main reasons for non-users of BSS and ESS are, overall, common to all five cities. These are typically external, mainly infrastructural, such as the greater convenience of other modes

of transport; safety issues related to riding in traffic; poor road conditions; lack of a bicycle network and destinations too far away by bike or e-scooter. As such, individual users are hardly in a position to significantly influence or overcome these barriers, with only minor adaptations giving them some leeway (such as finding alternative routes to avoid congested areas, unsafe traffic situations or potholed roads), but in general ordinary users have no control over these factors. According to our results, other barriers that have a more individual influence on BSS and ESS use are less relevant. This finding shows that the further development and spread deployment of BSS and ESS in European cities depends mainly on local governance and urban transport policies, and less on the users' attitudes and adaptability.

Accordingly, our study has several recommendations for policymakers for the promotion of bike and e-scooter sharing:

1. Our research provides further support for the implementation of dedicated infrastructure for bicycle and e-scooter usage (e.g., segregated cycling lanes), as it would largely solve most of the main barriers identified in our research (i.e., safety issues related to riding in traffic; poor road conditions; lack of a bicycle network). This dedicated network could also ameliorate the current conflicts and negative opinions especially towards ESS as it would provide users with an alternative to riding alongside motorized traffic or on the sidewalks.
2. The expansion on the dedicated infrastructure to cycling and e-scooter should be built mainly by repurposing car space (e.g., converting car lanes and parking spaces into, respectively, cycling lanes and BSS/ESS stations) as it would decrease the convenience of car use, which is by far the main reason for not using BSS and ESS.
3. The construction of a segregated network for micro-mobility should also aim at connecting the main trip generators as directly as possible to decrease the perception that distances are too long for BSS or ESS use.
4. In the specific case of BSS, the deployment of e-bikes could also increase its coverage area and minimise the barrier of destinations being too far away (while also helping to overcome hilly terrains).
5. Although most of our respondents have BSS or ESS available, the coverage areas of the systems are still limited, being particularly concentrated in the city centres, with an overall insufficient coverage near residential areas. A possible solution could be the provision of funding by public authorities for the expansion of systems in less profitable areas, i.e., on the outskirts of cities.
6. Public authorities should better integrate both BSS and ESS with the broad transport system, especially PT, as they have the potential to solve the first/last mile problem. In that sense, PT and micromobility operators could foster partnerships, in particular by integrating BSS and ESS with the PT ticketing system, which could increase ridership levels for both modes of transport.
7. Lastly, policymakers should consider the potential of shared micromobility to act as alternative transportation modes during public health crisis and similar disruptive events, using these schemes to reinforce transport systems in areas with increased travel demand (e.g., healthcare facilities during COVID-19).

Further research could extend the findings of this study by conducting similar evaluations outside of Europe, particularly in North America where several major cities also have both ESS and BSS in operation. Likewise, further studies (especially with larger samples) could explore possible group differences on the barriers of non-users according with their socioeconomic and demographic characteristics (gender, age, income). Above all, future research should continue to investigate the potential of shared micro-mobility in increasing the sustainability as well as the resilience of transport systems.

CRediT authorship contribution statement

João Filipe Teixeira: Conceptualization, Methodology, Formal analysis, Investigation, Writing – original draft, Writing – review & editing. **Vera Diogo:** Conceptualization, Methodology, Formal analysis, Investigation, Writing – original draft. **Anikó Bernát:** Conceptualization, Methodology, Investigation, Writing – original draft. **Agnieszka Lukasiewicz:** Conceptualization, Methodology, Writing – original draft. **Egle Vaiciukynaite:** Conceptualization, Methodology. **Venere Stefania Sanna:** Conceptualization, Methodology, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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