



Gender perceptions of active mobility: Insights from three European cities

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Abstract

European cities have seen an increase in the use of personal means as an effect of the COVID-19 pandemic: they are asked to accelerate the shift towards more sustainable modes, as the active ones. The current paper tries to shed light on how the perception towards these latter modes changes according to gender. In the framework of H2020 TInnGO project, data collected through a survey in three European cities (Turin, Valencia, Paris) are investigated. Results show that women are more worried about safety, both while walking or riding a bike, as female cyclists do not appreciate sharing space with motor vehicles. Moreover, the absence of a dedicated space for children prevents women from starting to use bike-sharing. Comparing the results in the three cities provides interesting indications and suggestions for including the need of all active modes users in transport planning.

Keywords: Active mobility; gender mobility; safety and security; European cities; mobility survey.

1. Introduction

The impact of the COVID-19 pandemic on people's main routines and habits dumped its considerable effects on the world of transport and mobility. In 2020, local authorities imposed restriction measures to moderate the risk of contagion, primarily through shared means. This health emergency has considerably affected public transport (PT), considering the reduced level of security perceived as a commonly crowded and risky environment. This originated in a relevant shift towards individual travel modes, as they could better support physical distancing. These changes in travel habits are also reflected in the current year and have involved an increase in active means use (Carboni, Costa, *et al.*, 2021). However, apart from cities known to be cyclists' homeland, for instance Denmark or Holland, worldwide municipalities had to face limited spaces for pedestrians and cyclists in their urban planning.

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Some innovative changes have been proposed, such as creating pop-up bike lanes, with the potential to become permanent cycling infrastructure (Transformative Urban Mobility Initiative (TUMI), 2020). In this regard, the European Commission provided explicit guidelines to support cities in implementing short-term transport planning interventions to face the critical situation in 2020 (European Platform on Sustainable Urban Mobility Plans, 2020). This document contains a section devoted to ‘Active Mobility’ pushing cities to make it “a safe and more attractive mobility option during the COVID-19 outbreak”. Practical examples of changes in the infrastructure included “temporary enlargements of pavements and increased space on the road for active mobility options”. Besides, EC suggested reducing “speed limits of vehicles in increased active mobility areas”.

This expected shift towards the active means, namely “all modes of transport relying on human power for propulsion”, due to this emergency, can surely create more sustainable and livable cities. Before COVID-19, walking and cycling accounted for 20-40% of all journeys made in the EU (Hunkin and Krell, 2019). These percentages could be increased by focusing, for example, on those travelers who commonly use PT to prevent them from choosing their private car for their daily routine. Thus, it is relevant to recognize the importance of addressing the half of the world that is commonly not considered while dealing with mobility, namely women. Indeed, they are known to travel by PT more than their counterpart: men in a traditional society get the first right to car usage in a household, primarily for reaching their workplace (Lodovici *et al.*, 2012; Pirra *et al.*, 2021).

The current work is part of the H2020 European project TInnGO - Transport Innovation Gender Observatory (www.tinn.go.eu), aiming to create a framework and mechanism for a sustainable game change in European transport concerning gender and diversity (Pirra *et al.*, 2021). The research focuses on various aspects, including the collection of usable, gender and diversity sensitive mobility datasets whose analysis could support policymakers and innovators in designing and implementing gender and diversity sensitive mobility measures. The project's work is supported by 10 hubs created in 10 different EU countries, namely Sweden/Denmark, the UK, Spain, Portugal, Italy, Greece, France, Germany, Romania, Lithuania, and the Baltic states. Each Hub is expected to cover topics of local importance in gender and diversity-sensitive smart mobility to ensure a link between the developed research to real issues tackled in mobility experiences of different groups (Pirra *et al.*, 2021).

In the TInnGO project framework, the current paper will start from the work presented in (Carboni, Pirra, *et al.*, 2021). It will investigate more in detail the data collected in three European cities, location of TInnGO Hubs. Section 2 will introduce a literature review on the topic, namely women and active mobility, and then we will explain the data collection procedure and the methodology applied (Section 3). The case study section will look at responses collected from Turin, Valencia, and Paris to depict how gender could influence the choice of active modes. Finally, some indications and suggestions for city planning based on this analysis are reported in Section 4.

2. Women and active means

Focusing on particular users requires to “walk a mile in another man (or better, woman)'s shoes”. Luckily, recent research and EU-funded projects, such as TInnGO (www.tinn.go.eu) and DIAMOND (<https://diamond-project.eu/>), have started raising attention to the evident influence that gender has on mobility needs. For example, men

usually travel linearly to their job place, while women have a more complex home-work path, involving other stops as schools or supermarkets (Jain, Line and Lyons, 2011). This burden does not facilitate travelling by bike, preventing women from being recognized as frequent cyclists ((Kawgan-Kagan and Popp, 2018), (Benedini, Lavieri and Strambi, 2020), (Sottile *et al.*, 2019)). A possible solution would require the development and the improvement of cycling networks to increase the connection among schools, shops and services within local neighborhoods (Bourke, Craike and Hilland, 2019).

Women are commonly (expected to be) more attentive to their appearance, including clothes and hairstyle, mainly at their workplace. Thus, they could perceive cycling as not very useful due to the risk of arriving sweaty at their destination or wet after a ride in a rain shower (Kawgan-Kagan and Popp, 2018). As highlighted so far, gendered sustainable transport planning would require seeing the female cyclists as potential users, not as a minority group (Prati, 2018).

Transport safety is a critical factor in females' mobility choices. This could lead women to seek a less efficient or more costly alternative when there is a perceived threat or change their behavior, dress, or speech to avoid sexual harassment or violence (Pirra *et al.*, 2021). While dealing with cycling, they are usually afraid of sharing public space with cars and other cyclists. A possible valuable solution to help women travelling by bike would require a clear separation between bicycles and motorized traffic (Chataway *et al.*, 2014). Thus, the changes observed in the city affected by restrictions and having the potential to become permanent cycling infrastructure, as the creation of pop-up bike lanes, infrastructure (Transformative Urban Mobility Initiative (TUMI), 2020), could draw more women to choose the bike as means of transport. Moreover, the environments around a bike lane can also affect gendered mobility choices, as they prove strikingly more discouraging to females than male cyclists (Grudgings *et al.*, 2018).

Walking increases due to COVID-19, mainly due to the decrease in PT use (Carboni, Costa, *et al.*, 2021), so it is important to investigate the female perception for this sustainable mode. Souza *et al.* (2018) examined women's perspectives for pedestrian mobility planning, recognizing the increasing relevance of addressing gender studies in cities' urban dynamics. Safety is also relevant in the female perception towards this active mode, as fear for personal security can have substantial consequences on women's travel patterns (Stark and Meschik, 2018). Moreover, they could change their habits to feel secure, for example, avoiding walking at night if they are alone or talking on the phone while walking to feel safer (ITF, 2018). According to Hidayati *et al.* (2020), the gender differences in walking's perceived safety are correlated with spatial configuration and socio-cultural constructs. The comparison between walking and cycling shows that the former presents the highest percentages of frightening incidents, while the latter has minor incidents of all travel modes (Stark and Meschik, 2018).

Bike-sharing is a worldwide successful means of transport useful in cities to cover the multimodal gap between other modes. Despite the global increase of users, the gender gap is still essential, with most male users (Wang and Akar, 2019). Men choose this mode mainly for their daily travel, while women consider it for their recreation journeys over the weekend (García-Jiménez *et al.*, 2020). An interesting study conducted by DIAMOND project in Paris, showed that only about 30% of city bike-sharing system users are women (Gorrini *et al.*, 2021). The analysis results demonstrate the factors influencing their choice: accessibility, safety and security, social constraints, weather and topography. Women also seem to be more influenced by the environment and the infrastructure of this recent transport mode (as the spatial characteristics of bike-share

stations or the length of off-street bike routes). At the same time, the bicycle proposed by the provider can lead women to refuse to join this service because, for example, of its weight (Ma *et al.*, 2020) or the absence of baby saddles (Zhang *et al.*, 2015). Besides all these factors, other barriers to use bike-sharing are those already reported for cycling, as the “unsafe driving conditions and need of more traffic rules and speed limits on public roads” (García-Jiménez *et al.*, 2020).

In 2020, the COVID-19 pandemic strongly impacted people’s main routine and mobility habits. To reduce the risk of contagion, governments and local authorities implemented restriction measures to moderate the transfer in general and the use of public transport in particular. This has led, instead, to increased walking activities followed by biking also for women users (Carboni, Costa, *et al.*, 2021), although not in shared mode (Padmanabhan *et al.*, 2021), probably due to the fear of contamination caused by the uncertainty of sanitizing the vehicles (Nikiforiadis, Ayfantopoulou and Stamelou, 2020).

3. Methodology

A survey has been designed to investigate the differences between different users’ mobility patterns, to measure perceptions of the mobility and transport system and their satisfaction in European cities. The survey was based on focus group analyses and a detailed literature review conducted to collect information on female mobility needs, to gain new knowledge of possible barriers and potential improvements that would help transport operators improve the services offered to various users, mainly women (Pirra *et al.*, 2021).

The questionnaire includes four main parts. In the first one information is collected to depict the user’s profile: e.g., gender, age, social level, education, ethnic origin, family composition, accessibility to the car. The second section focuses on investigating mobility habits, with questions about the most used travel mode (e.g., motorized and non-motorized, owned and shared) for different activities (e. g. job, commuting, shopping) and analysis on the mobility offer. The features of the most frequently made trip in a typical week (stages, modes, reason, payment method) are asked too, to better characterize the transport chain (activity patterns) to assess possible differences between women and men.

The subsequent section of the questionnaire aims at investigating the perception of passengers during their journey, with a focus on safety and security perception and the quality of service/infrastructure provision. Indeed, these elements are known to be at the basis of the gendered mobility choices (Pirra *et al.*, 2021). The structure of this section is based on the proposal of a certain number of statements to evaluate the satisfaction levels with the transport infrastructure and the mobility offer related to the most used transport means, asking the level of agreement on a 5-point Likert scale. The last part of the questionnaire investigates the intention to use new mobility services, as a way to enhance accessibility to transport to various kind of users. This information would support transport operators and local authorities to improve their mobility offer fulfilling properly the needs of their citizens.

In this study, we focus on a detailed analysis conducted on the data collected in the section of the survey devoted to investigate the perception of users about the mobility offer and infrastructure. A deeper analysis of the issues related to active modes, also in its shared offer, is proposed by focusing on the questions investigating their use and the

perception of safety, which is a critical factor in women's mobility choices (Pirra *et al.*, 2021).

According to the project-planned activities, the data collection campaign was expected to be run in the TInnGO Hubs cities in spring 2020. However, the COVID emergency forced a delay in the data collection and pushed us to reconsider the original plans (Pirra *et al.*, 2021). Therefore, a pilot activity was run in September 2020, intending to collect the first wave of a limited number of results in the 10 TInnGO Hubs' working-age population. Here, the focus went on the typical journey characteristics in a pre- and post-COVID scenario: results are presented in (Carboni, Costa, *et al.*, 2021). Data analysed in the current paper are part of the second and more extensive wave of results, accounting for a 'new normal' condition all through Europe. Indeed, the questionnaire was spread in November 2020 - February 2021 to a stratified sample of people above 18 in the TInnGO cities. To reach this goal, we relied on the support of agencies having contacts with appropriate panels of respondents.

Statistical tests were applied to data to evaluate differences in the satisfaction levels related to different aspects of mobility using soft modes according to gender. The tests used assumed a null hypothesis of no difference between groups. A parametric test, T-Test, was used to analyse gender in two categories (men and women), and non-parametric tests (Mann-Whitney and Kruskal-Wallis) investigated the differences of perception and satisfaction between respondents grouped in 14 different groups by age and gender.

4. Insights from three European cities

The current analysis focuses on two cities similar in size and number of inhabitants, namely Valencia and Turin. The former is among the most bike-friendly cities in Europe, while the latter is currently adopting solutions to encourage non-motorised vehicles. The results are compared with those of a third European city with more than twice as many inhabitants: Paris. The data collection process was conducted to represent each group of society living in the metropolitan areas of the three cities.

- Valencia is the third biggest city in Spain and is characterized by a population of around 800,000 inhabitants (around 1,5 million in metropolitan area). Concerning modal share, active transport modes account for 45% of trips: most of these are made by walking (40.9%). Bike sharing is present and widely spread, with 3.43 bikes/1000 inhabitants supported by over 156 kilometers of cycle paths and a historical center where vehicles are not allowed to exceed 30 km/h (Kalakou *et al.*, 2018).
- Turin has a population of around 870,000 inhabitants. The metropolitan area includes more than 1,5 million of residents. The modal transport split shows that the majority of trips are made by private vehicles (43%), with similar values for public transport and walking (23% and 25% respectively) and low numbers for bicycling (only 4%). Various bike-sharing systems are present, both free-floating and station-based, with a respective offer of 1.9 and 1.5 bikes/1000 inhabitants (Ciuffini *et al.*, 2020). An operator is also sharing bikes with pedal assistance. An increase in the cycling infrastructure has been observed since the beginning of the pandemic, reaching an offer of 207 km of cycle and pedestrian-cycle paths.
- Paris, with more than 2 million of inhabitants, aggregates in the Metropolitan Area approximately 12,1 million inhabitants. Ile-de-France, the region where the City of Paris is located, is the most populated conurbation in Europe,

accounting for 18% of the total country's population. The population density in Paris municipality has reached record levels recently for European standards, exceeding 20.000 inhabits. /km². Nevertheless, it decreases as we move further away from the centre due to smaller cities separated by rural areas. In recent years, the city has made investments in cycling, and between 2015 and 2020, the length of cycle paths has increased fivefold to around 1000 km¹. There are 4 bike sharing services in the city, including one with e-bikes, 40% used by women (Malandrino and Berman, 2020) .

4.1 Sample description

Table 1 focuses on extraction from the data collected initially (422 respondents in Turin, 443 in Valencia and 400 in Paris, representative samples of cities' population) based on people declaring the use of active modes and having completed the survey's satisfaction sections of at least one transport means among bike, owned or shared, and walking. The individual's gender considers the options of men, women, non-binary and transexual. However, due to the lack of sufficient replies from non-binary and transexual respondents, only men and women are analysed.

Table 1: Sample characterization of active modes users (age and gender).

City	Mode	Gender	18-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65-74 years	>75 years	Total
Turin	OB	M	2	8	9	4	10	7	3	43
		W	7	9	7	6	4	2	1	36
	SB	M	1	5	5	3	1	0	1	16
		W	4	7	7	1	1	1	1	22
	W	M	11	25	29	32	25	18	14	154
		W	12	23	31	37	27	13	7	150
Paris	OB	M	0	4	2	3	1	0	0	10
		W	1	9	5	1	1	1	0	18
	SB	M	1	1	2	1	1	1	0	7
		W	0	5	2	0	0	0	0	7
	W	M	9	15	17	23	25	18	3	110
		W	11	25	24	13	14	17	2	106
Valencia	OB	M	4	2	5	2	2	2	0	17
		W	6	6	6	2	1	1	0	22
	SB	M	1	1	2	2	1	2	0	9
		W	7	5	1	0	0	1	0	14
	W	M	13	14	33	43	29	42	13	187
		W	38	34	44	36	21	20	3	196

Owned bike (OB), Shared Bike (SB), Walking (W)
Men (M), Women (W)

¹ <https://www.francetoday.com/travel/paris/the-paris-bicycle-boom/>

The observation of the age and gender characteristics of this restricted group of people shows different trends in the totals. Paris seems to be the city with the fewest users of active modes, especially for cycling. Turin, on the other hand, is the city with the most responses from owned bicycle users, while Valencia collected responses from the most walkers. A common trend in the three cities concerns the sharing mode: few answers with a prevalence of women, fairly distributed in the age groups but with a prevalence under 55.

5. Results and discussion

Selecting, for example, the sample that uses the walking mode for at least one of its trips, it is interesting to observe the purpose of the trip. The results are shown in Figure 1 considering that the option "walking" was possible for more than one type of trip. It is interesting to note that, for all cities, users choose to walk mainly for pleasure, in particular for shopping. In fact, only for the French city is this mode also used to go to work or university. Moreover, Figure 2 reports the gender distribution of walking mode users for the different trip options in the three cities. Generally, the percentages are equally distributed among genders. Exceptions to this are travelling for work on foot, which in Valencia and Turin is mainly done by women, or visiting friends in the neighbourhood, which in Paris is mainly done by women as opposed to Turin.

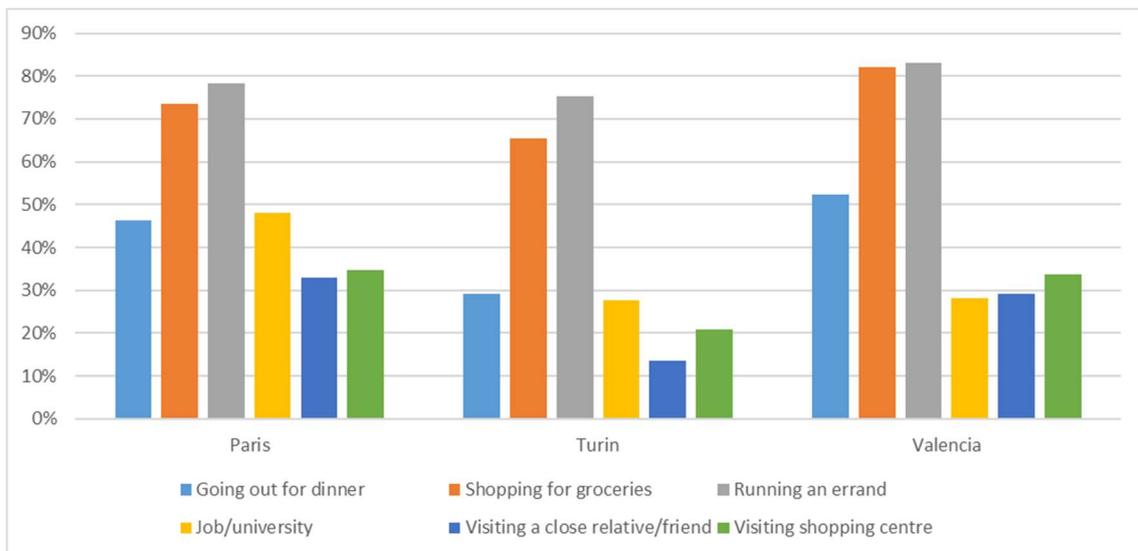


Figure 1: Walking by trip purposes (more than one purpose is possible)

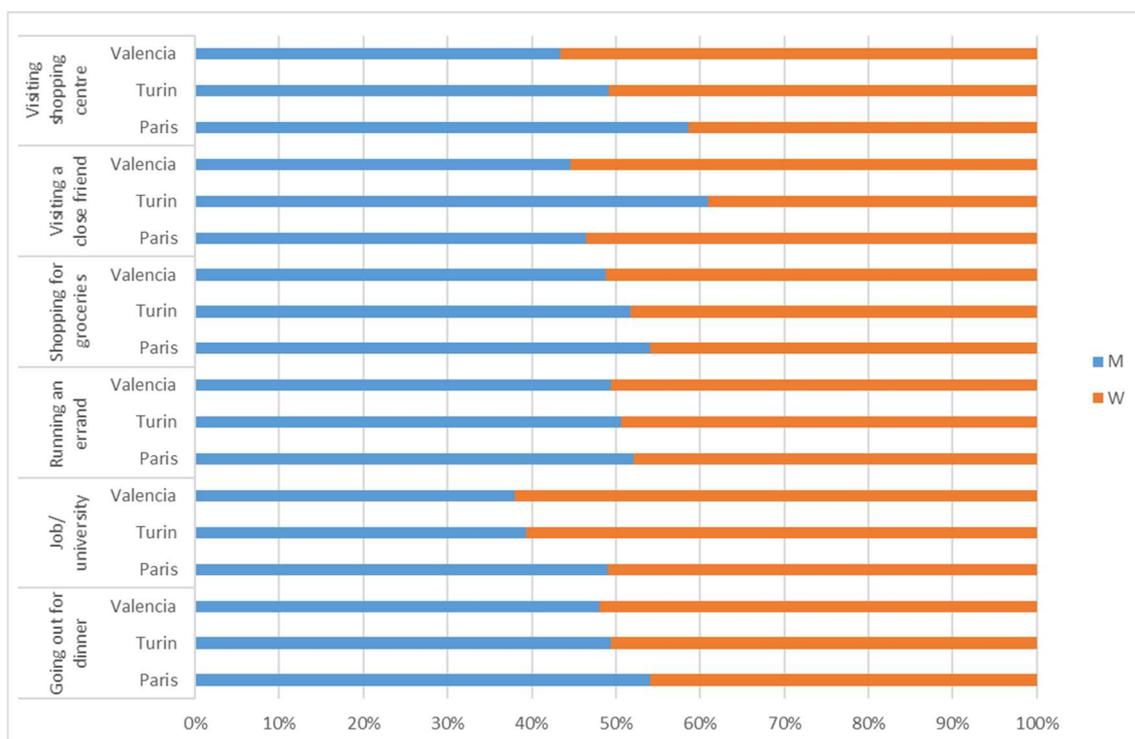


Figure 2: Gender distribution of walking trips

Figure 3, Figure 4 and Figure 5 focus on the questions proposed to assess the satisfaction related to safety, security, and the urban environment's shape for the three active modes. The average rating values are shown (Likert scale 1-5, totally unsatisfied – totally satisfied), revealing differences between cities and gender, providing valuable insights for the policymakers for instance.

In general, the level of satisfaction of Turin's respondents is the lowest, while that of French users seems to be the highest. The average satisfaction value in all analysed cities is 2.7 for the experience with owned bike, 3.0 for sharing bikes and 3.1 for walkers. It is interesting to notice that the city of Turin is the only one where women provided overall higher ratings to the issues investigated compared to men.

More in detail, as regarding the travel experience with owned bike (Figure 3), in Paris and Valencia the men are more satisfied especially about cycle lanes, safety issues and information availability. There is a different trend in Turin, where women seem to have a better experience, although the average score is still lower than in the other two cases. In this city, it is relevant to observe that women appreciate the condition of cycle lanes. The cycling infrastructure is gaining the highest scores by both genders in Valencia, meaning that users enjoy the over 156 kilometers of cycle paths and the historical center where vehicles are not allowed to exceed 30 km/h.

Owned Bike experience	Paris	M	W	Turin	M	W	Valencia	M	W	Total
I am satisfied with the ability to carry bicycles in public transport vehicles	3,6	3,8	3,4	2,0	2,0	2,0	2,2	2,2	2,3	2,4
I am satisfied with the sharing space with cars, motorcycles and other vehicles of this type	3,4	3,4	3,3	2,4	2,1	2,7	2,4	2,4	2,5	2,6
I am satisfied with the sharing space with pedestrians	3,6	3,9	3,4	2,6	2,4	2,8	2,7	2,8	2,7	2,8
I am satisfied with the speed of motorised vehicles in mixed traffic	3,3	3,8	3,1	2,3	2,0	2,6	2,4	2,4	2,4	2,5
I am satisfied with the easiness of connections with other modes of transport	3,2	3,7	2,9	2,3	2,0	2,6	2,8	3,2	2,5	2,6
I am satisfied with the level of information available before my bike journey	3,3	3,7	3,1	2,6	2,4	2,7	2,6	3,2	2,1	2,7
I am satisfied with the level of information provided for cyclists during the journey	3,5	4,0	3,2	2,3	2,2	2,5	2,7	3,2	2,4	2,7
I am satisfied with the cycle parking availability and conditions (security, availability, etc.)	3,2	3,7	2,9	2,3	2,0	2,5	2,6	2,9	2,4	2,5
I am satisfied with the cycle safety during the trip (at junctions, at crossings)	3,4	3,8	3,2	2,4	2,2	2,6	2,8	3,1	2,6	2,7
I am satisfied with the ability to park bikes at stations	3,5	3,7	3,3	2,6	2,6	2,6	3,0	3,1	2,9	2,8
I am satisfied with the coverage of cycle lanes across the city	3,4	3,7	3,2	2,6	2,5	2,7	3,5	3,8	3,2	3,0
I am satisfied with the behaviour of motorists towards cyclists	2,9	3,7	2,5	2,1	1,9	2,4	2,4	2,6	2,3	2,3
I am satisfied with the conditions of cycle lanes (cleanliness, quality of pavements, the width of cycle lanes)	3,3	3,7	3,1	2,6	2,4	2,9	2,9	3,1	2,9	2,8

Figure 3: Level of satisfaction for biking mode (owned) in the three cities (Likert scale 1-5, totally unsatisfied – totally satisfied).

The use of the bike for travelling daily in cities is commonly affected by the need for a proper connection with other modes, mainly for long distances journeys. So, the items “I am satisfied with the easiness of connections with other modes of transport”, “I am satisfied with the ability to carry bicycles in public transport vehicles” and “I am satisfied with the ability to park bikes at stations” can provide feedback about cities. Again, gender seems to influence this, as women commonly provide lower ratings in Paris and in Valencia. The most significant issues remain those related to safety and the behaviour of other motorised users in all cities, perceived more strongly by women.

However, safety issues are also critical for cyclists who choose the sharing mode, as shown in Figure 4. The overall low satisfaction values in this regard are confirmed for Italian users, but in this case they do not differ too much from the Spanish ones. The overall high satisfaction of items strictly connected with the bike sharing offer is worth noticing, namely the location of docks, the number of vehicles, and the information provided for cyclists. However, in the latter case, the perception changes according to gender in Paris, where women see it more critical. There is no clear trend between the two genders for these answers, maybe only for Turin, where women are always a little more satisfied than men.

The cost of the bike-sharing service is perceived differently by the two genders in Paris: indeed, it is the item reaching the highest value of satisfaction among men and one of the lowest among women. However, the opposite situation happens in Valencia, while Italian bike-sharing users provide similar ratings. The need for a good connection with other modes is fundamental for this shared mobility offer and respondents feel satisfied with it irrespective of gender.

Figure 5 shows that the travel experience for walkers is more than sufficient for the three European cities. It is worth observing that, as opposed to the other two soft modes considered, the items considered for walking are rated in a similar way irrespective of

gender. The quality and maintenance of pavement is a critical issue in all cities, and very low values are found in Turin. However, users in all cities seem satisfied with the coverage of pedestrian routes. As could be depicted when looking at the difference among genders in the average values of the item “I am satisfied with the level of safety walking on the streets”, safety is perceived differently also while walking.

Shared bike experience	Paris	M	W	Turin	M	W	Valencia	M	W	Total
I am satisfied with the location of bike stations (location of docks fit my needs)	3,6	3,9	3,3	2,9	2,9	3,0	3,4	3,3	3,5	3,2
I am satisfied with the level of information available before your bike journey	3,2	3,6	2,8	3,1	3,1	3,0	3,2	3,2	3,1	3,1
I am satisfied with the speed of motorised vehicles in mixed traffic	3,5	3,4	3,6	2,6	2,3	2,8	2,3	2,3	2,3	2,7
I am satisfied with the sharing space with pedestrians	3,4	3,3	3,6	2,7	2,3	3,0	2,7	2,6	2,8	2,8
I am satisfied with the information provided in the app I use	3,6	3,7	3,4	3,1	2,9	3,2	3,3	3,4	3,3	3,3
I am satisfied with the sharing space with motorised vehicles	3,2	3,0	3,4	2,6	2,5	2,7	2,7	2,6	2,7	2,7
I am satisfied with the level of information provided for cyclists during the journey	3,7	4,0	3,4	2,8	2,8	2,9	2,8	2,7	2,9	3,0
I am satisfied with the number of vehicles available	3,4	3,4	3,3	2,9	2,8	3,0	3,2	3,4	3,1	3,1
I am satisfied with the easiness of connections with other modes of transport	3,1	3,1	3,1	2,9	2,8	3,1	3,1	3,3	3,0	3,0
I am satisfied with the behaviour of motorists towards cyclists	3,3	3,0	3,6	2,5	2,3	2,6	2,5	2,6	2,5	2,6
I am satisfied with the conditions of cycle lanes (cleanliness, quality of pavements, the width of cycle lanes)	3,5	3,4	3,6	2,9	2,7	3,0	3,2	3,3	3,1	3,1
I am satisfied with the cycle safety during the trip (at junctions, at crossings)	2,9	2,9	2,9	2,7	2,5	2,8	3,0	3,3	2,7	2,8
I am satisfied with the cost of use of shared bicycles	3,4	4,0	2,9	2,8	2,9	2,8	3,1	2,4	3,5	3,0
I am satisfied with the coverage of cycle lanes across the city	3,4	3,0	3,7	2,9	2,6	3,1	3,2	3,2	3,2	3,1

Figure 4: Level of satisfaction for biking mode (shared) in the three cities (Likert scale 1-5, totally unsatisfied – totally satisfied).

Walking experience	Paris	M	W	Turin	M	W	Valencia	M	W	Total
I am satisfied with the access to public transport stops (stations, bus stops, ...)	3,8	3,8	3,8	3,2	3,1	3,3	3,5	3,5	3,5	3,4
I am satisfied with the coverage of pedestrian routes	3,6	3,7	3,6	3,1	3,1	3,1	3,4	3,4	3,4	3,3
I am satisfied with the maintenance and quality of pavement	3,1	3,3	3,0	2,4	2,4	2,5	3,0	3,0	2,9	2,8
I am satisfied with the location of subways and overhead walkways	3,5	3,6	3,5	2,6	2,6	2,6	2,8	2,8	2,8	2,9
I am satisfied with the security offered by pedestrian walkways (for example: offer a clear passage)	3,5	3,7	3,4	3,0	2,9	3,0	3,2	3,4	3,1	3,2
I am satisfied with the easiness and security of connections between different modes of transport	3,6	3,6	3,5	2,9	2,9	2,9	3,2	3,2	3,2	3,2
I am satisfied with the level of safety walking on the streets	3,5	3,7	3,3	2,9	3,0	2,8	3,3	3,4	3,2	3,2
I am satisfied with the information for pedestrians on signposts and maps (for example: remaining waiting time on crosswalks)	3,4	3,4	3,5	2,6	2,5	2,8	3,1	3,2	3,0	3,0

Figure 5: Level of satisfaction for walking in the three cities (Likert scale 1-5, totally unsatisfied – totally satisfied).

Afterward, the parametric T-test is applied with the scope of verifying if the mean value of the two datasets (namely women and men samples) are significantly different from each other and the results are shown in Table 2. The analysis did not show significant

differences between the two genders in the analysed cities regarding bike-sharing statements. Male walkers in Paris were more satisfied with the safety of the routes, as in Valencia, and the infrastructure in general. On the other hand, in Turin it does not seem that women walkers have similar perceptions compared to men, but they are more satisfied with biking conditions. As expected, the safety issue is a relevant aspect that is perceived differently by the two genders.

Table 2: Significant differences between gender in the level of satisfaction.

City	Mode		Higher average
Turin	Owned Bike	I am satisfied with the conditions of cycle lanes (cleanliness, quality of pavements, the width of cycle lanes)	W
		I am satisfied with the sharing space with cars, motorcycles and other vehicles of this type	W
		I am satisfied with the speed of motorised vehicles in mixed traffic	W
	Walking	I am satisfied with the information for pedestrians on signposts and maps (for example: remaining waiting time on crosswalks)	W
Paris	Walking	I am satisfied with the security offered by pedestrian walkways (for example: offer a clear passage)	M
		I am satisfied with the level of safety walking on the streets	M
		I am satisfied with the maintenance and quality of pavement	M
Valencia	Walking	I am satisfied with the level of safety walking on the streets	M

The last part of the survey investigated future trends on different topics. According to the focus of this paper, there are 6 sentences of interest, specifically 3 related to bike-sharing and another 3 related to the concept of environmental sustainability in general.

The statistical tests show that the future trends that received the most discordant responses according to gender are few but significant. In fact, women in Valencia think it is important the availability of shared bicycles with space dedicated to children while women in Turin are more sensitive to environmental sustainability issues.

6. Conclusions

The current paper investigates the influence of gender on the choice of active mobility in three European cities in the framework of the H2020 TInnGO project. Data collected through a survey are analysed to investigate how men and women perceive various items characterizing this mobility offer (infrastructure, safety, service...). The goal is to provide indications and suggestions to propose a more gender-inclusive transport planning.

Safety is confirmed as the primary point to be tackled to increase the number of women interested in using active modes. This happens mainly for the bike, used both as owned or shared. The items investigating this aspect commonly earn the lowest ratings, irrespective of the city. Female cyclists are mainly concerned about sharing space with other vehicles, especially motorized vehicles and are afraid of the driver behavior, confirming the literature on the topic (Chataway *et al.*, 2014). Therefore, a clear separation between bicycles and different kinds of traffic, as suggested by EU as a temporary measure in (European Platform on Sustainable Urban Mobility Plans, 2020), may be switched to a permanent element in order to increase the female cycling rate.

The need for a good connection among various modes of transport is fundamental for women known to do more fragmented daily travels (Jain, Line and Lyons, 2011). Our results demonstrate that female cyclists are less satisfied with this issue in the cities investigated. This aspect should be taken into account, for example, when designing cycle paths or allowing people to carry their bikes on PT. Instead, people using bike-sharing seem less concerned about it, meaning that a good connection with other modes has already been offered.

Another relevant point raised by users of this shared mode is the cost of the service. Men and women in our cities perceive this differently. Thus, the proposal of special discounts could be an option to approach more users. However, as found in Valencia, other ameliorations are needed to increase the number of women interested in this service. Indeed, our results revealed that they seem more sensitive to adding a space dedicated to children to start using this mode, confirming what was found in the literature (Zhang *et al.*, 2015).

Policy-makers can exploit the results of the current work to address better the needs of all their citizen to guarantee a more inclusive sustainable mobility. As seen, women and men have different perceptions while considering active modes. The analysis of data collected from users, and their disaggregated analysis, can help to address the problems they commonly face while travelling. This can support the proposal of proper measures in transport planning going beyond the standard “white male, middle-class, middle-aged, employed, and with full physical and mental capacities”.

References

- Benedini, D. J., Lavieri, P. S. and Strambi, O. (2020) “Understanding the use of private and shared bicycles in large emerging cities: The case of Sao Paulo, Brazil”, *Case Studies on Transport Policy*. Elsevier Ltd, 8(2), pp. 564–575. doi: 10.1016/j.cstp.2019.11.009.
- Bourke, M., Craike, M. and Hilland, T. A. (2019) “Moderating effect of gender on the associations of perceived attributes of the neighbourhood environment and social norms on transport cycling behaviours”, *Journal of Transport and Health*. Elsevier Ltd, 13, pp. 63–71. doi: 10.1016/j.jth.2019.03.010.
- Carboni, A., Costa, M., Kalakou, S. and Pirra, M. (2021) “Gender , Smart Mobility and COVID-19”, in *Mobitas: 3rd International Conference On HCI In Mobility, Transport And Automotive Systems*, pp. 1–19.
- Carboni, A., Pirra, M., Costa, M. and Kalakou, S. (2021) “Active mobility perception from an intersectional perspective: insights from two European cities”, in *Proceedings of XXV International Conference Living and Walking in Cities - New scenarios for safe mobility in urban areas (LWC 2021)*, 9-10 September 2021, Brescia, Italy.
- Chataway, E. S., Kaplan, S., Nielsen, T. A. S. and Prato, C. G. (2014) “Safety perceptions and reported behavior related to cycling in mixed traffic: A comparison between Brisbane and Copenhagen”, *Transportation Research Part F: Traffic Psychology and Behaviour*. Elsevier Ltd, 23, pp. 32–43. doi: 10.1016/j.trf.2013.12.021.
- Ciuffini, M., Asperti, S., Gentili, V., Orsini, R. and Refrigeri, L. (2020) 4 ° Rapporto Nazionale sulla Sharing Mobility 2019. Available at: <http://osservatoriosharingmobility.it/wp-content/uploads/2020/12/IV-RAPPORTO-SHARING-MOBILITY.pdf>.
- European Platform on Sustainable Urban Mobility Plans (2020) COVID-19 SUMP Practitioner Briefing. London.

- García-Jiménez, E., Poveda-Reyes, S., Molero, G. D., Santarremigia, F. E., Gorrini, A., Hail, Y., Ababio-Donkor, A., Leva, M. C. and Mauriello, F. (2020) “Methodology for Gender Analysis in Transport: Factors with Influence in Women’s Inclusion as Professionals and Users of Transport Infrastructures”, *Sustainability. Multidisciplinary Digital Publishing Institute*, 12(9), p. 3656. doi: 10.3390/su12093656.
- Gorrini, A., Choubassi, R., Messa, F., Saleh, W., Ababio-Donkor, A., Leva, M. C., D’Arcy, L., Fabbri, F., Laniado, D. and Aragón, P. (2021) “Unveiling Women’s Needs and Expectations as Users of Bike Sharing Services: The H2020 DIAMOND Project”, *Sustainability. Multidisciplinary Digital Publishing Institute*, 13(9), p. 5241. doi: 10.3390/su13095241.
- Grudgings, N., Hagen-Zanker, A., Hughes, S., Gatersleben, B., Woodall, M. and Bryans, W. (2018) “Why don’t more women cycle? An analysis of female and male commuter cycling mode-share in England and Wales”, *Journal of Transport and Health. Elsevier Ltd*, 10(July), pp. 272–283. doi: 10.1016/j.jth.2018.07.004.
- Hidayati, I., Tan, W. and Yamu, C. (2020) “How gender differences and perceptions of safety shape urban mobility in Southeast Asia”, *Transportation Research Part F: Traffic Psychology and Behaviour. Elsevier Ltd*, 73, pp. 155–173. doi: 10.1016/j.trf.2020.06.014.
- Hunkin, S. and Krell, K. (2019) *Promoting Active Modes of Transport*.
- ITF (2018) *Women’s Safety and Security: A Public Transport Priority*. Paris. Available at: www.itf-oecd.org.
- Jain, J., Line, T. and Lyons, G. (2011) “A troublesome transport challenge? Working round the school run”, *Journal of Transport Geography. Pergamon*, 19(6), pp. 1608–1615. doi: 10.1016/j.jtrangeo.2011.04.007.
- Kalakou, S., Spundflasch, S., Díaz, A. and Pirra, M. (2018) *WP2 Contextualisation of Project cities*. Available at: <http://www.suits-project.eu/wp-content/uploads/2018/12/Contextualisation-of-project-cities.pdf>.
- Kawgan-Kagan, I. and Popp, M. (2018) “Sustainability and Gender: A mixed-method analysis of urban women’s mode choice with particular consideration of e-carsharing”, *Transportation Research Procedia. Elsevier B.V.*, 31, pp. 146–159. doi: 10.1016/j.trpro.2018.09.052.
- Lodovici, M. S., Pesce, F., Malgieri, P., Maffi, S. and Rosa, C. (2012) *The role of women in the green economy: the issue of mobility*, European Parliament. Available at: <http://www.europarl.europa.eu/studies>.
- Ma, X., Yuan, Y., Van Oort, N. and Hoogendoorn, S. (2020) “Bike-sharing systems” impact on modal shift: A case study in Delft, the Netherlands”, *Journal of Cleaner Production*, 259. doi: 10.1016/j.jclepro.2020.120846.
- Malandrino, C. and Berman, L. (2020) *Towards inclusive mobility: Women’s needs and behaviours in the Paris Region*. Available at: <https://transportgenderobservatory.eu/2020/11/06/new-publication-towards-inclusive-mobility-womens-needs-and-behaviours-in-the-paris-region/>.
- Nikiforiadis, A., Ayfantopoulou, G. and Stamelou, A. (2020) “Assessing the impact of COVID-19 on bike-sharing usage: The case of thessaloniki, Greece”, *Sustainability (Switzerland)*, 12(19). doi: 10.3390/su12198215.
- Padmanabhan, V., Penmetza, P., Li, X., Dhondia, F., Dhondia, S. and Parrish, A. (2021) “COVID-19 effects on shared-biking in New York, Boston, and Chicago”, *Transportation Research Interdisciplinary Perspectives. The Author(s)*, 9(September 2020), p. 100282. doi: 10.1016/j.trip.2020.100282.

- Pirra, M., Kalakou, S., Carboni, A., Costa, M., Diana, M. and Lynce, A. R. (2021) “A preliminary analysis on gender aspects in transport systems and mobility services: Presentation of a survey design”, *Sustainability (Switzerland)*, 13(5). doi: 10.3390/su13052676.
- Prati, G. (2018) “Gender equality and women’s participation in transport cycling”, *Journal of Transport Geography*. Elsevier Ltd, 66, pp. 369–375. doi: 10.1016/j.jtrangeo.2017.11.003.
- Sottile, E., Diana, M., Piras, F., Meloni, I. and Pirra, M. (2019) “To play but not for travel”, in *Mapping the Travel Behavior Genome*. Elsevier, pp. 209–228. doi: 10.1016/B978-0-12-817340-4.00012-7.
- Souza, A. C. S., Bittencourt, L. and Taco, P. W. G. (2018) “Women’s perspective in pedestrian mobility planning: The case of Brasília”, *Transportation Research Procedia*. Elsevier B.V., 33, pp. 131–138. doi: 10.1016/j.trpro.2018.10.085.
- Stark, J. and Meschik, M. (2018) “Women’s everyday mobility: Frightening situations and their impacts on travel behaviour”, *Transportation Research Part F: Traffic Psychology and Behaviour*. Elsevier Ltd, 54, pp. 311–323. doi: 10.1016/j.trf.2018.02.017.
- Transformative Urban Mobility Initiative (TUMI) (2020) COVID-19 and Sustainable mobility.
- Wang, K. and Akar, G. (2019) “Gender gap generators for bike share ridership: Evidence from Citi Bike system in New York City”, *Journal of Transport Geography*. Elsevier Ltd, 76, pp. 1–9. doi: 10.1016/j.jtrangeo.2019.02.003.
- Zhang, L., Zhang, J., Duan, Z. Y. and Bryde, D. (2015) “Sustainable bike-sharing systems: Characteristics and commonalities across cases in urban China”, *Journal of Cleaner Production*. Elsevier Ltd, 97, pp. 124–133. doi: 10.1016/j.jclepro.2014.04.006.

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