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Research Article

The Impact of Innovative Transportation Services on Travel Behaviors: A Case Study of Istanbul

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Abstract: There has been a paradigm shift in urban mobility by the developments in information and communication technologies, zero-emission targets in transport. Hence, traditional transportation services are replaced by sustainable, shared, smart, innovative mobility services. In our country's cities, the increasing use of these services, rather than merely serving as an alternative mode of transportation, holds the potential to become an integral part of the city's main transportation system. Understanding the extent to which these services impact individuals' travel behaviors and daily activity choices is crucial for being aware of trends in urban mobility, as well as passenger and freight mobility. This study investigates the impact of innovative mobility services, including micromobility services and vehicle and ride-sharing services in Istanbul, on individuals' travel behaviors, the relationship between individuals' demographic and socioeconomic statuses and their preference for innovative transportation services, and the conditions under which the adoption of these services is higher. Within the scope of this research, a survey was conducted with a sample of 404 individuals in Istanbul, and the survey results were interpreted using descriptive analysis methods and the chi-square independence test as a statistical method. The study provides insights into how individuals' demographic characteristics and travel behaviors relate to the use of innovative transportation services, the effect of these services on the number of trips made by individuals, which types of transportation are replaced by these services, under what circumstances they are preferred or not preferred, and under which conditions those who do not use these services might consider using them.

Keywords: Travel behavior, urban mobility, new mobility services, mobility

Yenilikçi Ulaşım Hizmetlerinin Seyahat Davranışlarına Etkisi: İstanbul Örneği

Özet: Bilgi ve iletişim teknolojilerindeki gelişmeler, ulaşım odaklı emisyonların azaltılmasına yönelik sıfır emisyon hedefleri etrafında kent içi ulaşımda bir paradigma değişikliği gözlenmekte olup; geleneksel ulaşım hizmetlerinin yerini sürdürülebilir, paylaşımlı, akıllı, yenilikçi hareketlilik hizmetleri almaktadır. Ülkemiz kentlerinde kullanımı git gide artan ve kişilere alternatif bir ulaşım türü olarak hizmet vermekten ziyade kentin ana ulaşım sisteminin bir parçası haline gelme potansiyeline sahip bu hizmetlerin kişilerin seyahat davranışlarına, günlük aktivite tercihlerine ne ölçüde etki ettiğini anlamak kent içi ulaşımdaki eğilimlerin, yolcu ve yük hareketliliğin farkında olmak açısından oldukça önemlidir. Bu çalışma ile yenilikçi hareketlilik hizmetleri kapsamında İstanbul'da kullanılan mikromobilite hizmetleri, araç ve sürüş paylaşım hizmetlerinin (1) kişilerin seyahat davranışlarına etkisi (2) kişilerin demografik, sosyoekonomik durumları ile tercih ettikleri yenilikçi ulaşım hizmetleri arasındaki ilişki (3) bu hizmetlerin benimsenmesinin daha yüksek olduğu koşullar çerçevesinde incelenmiştir. Çalışma kapsamında İstanbul'da 404 kişilik bir örneklemle anket yapılmış ve anket sonuçları açıklayıcı analiz yöntemleri ve istatistiksel yöntem olarak ki-kare bağımsızlık testi kullanılarak yorumlanmıştır. Çalışma sonucunda kişilerin demografik özellikleri, seyahat davranışları ile yenilikçi ulaşım hizmetlerinin kullanımı, bu hizmetlerin kişilerin yolculuk sayısına etkisi, hangi ulaşım türlerinin yerini aldığı, hangi şart ve koşullarda tercih edilirken, hangi gerekçelerle tercih edilmediği ve bu hizmeti kullanmayanların hangi durumlarda bu hizmeti kullanabileceği gibi sorulara cevap verilmiştir.

Anahtar Kelimeler: Seyahat davranışı, kentsel hareketlilik, yenilikçi ulaşım hizmetleri, mobilite

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1. Introduction

In an era characterized by rapid technological evolution, urban mobility services are undergoing significant development and transformation. Historically, travel involved various modes including animal riding, which has now been superseded by more comfortable, rapid, and innovative mobility services. Examining the evolution of transportation services in Turkey reveals that until the 1950s, railway transportation received priority in investment strategies. However, beginning in that decade, with the influence of the Marshall Plan on road transportation and the concurrent establishment of the General Directorate of Highways, a marked shift towards road transportation investments emerged. The initial objectives of the General Directorate of Highways, founded in 1950, encompassed ensuring year-round navigability of roads, implementing asphalt surfacing, and enhancing accessibility between communities to unlock previously inaccessible resources. Nonetheless, from 1985 onwards, the focus shifted towards facilitating more comfortable and safe intercity travel via the construction of motorways, subsequently divided highways, and, post-2013, the introduction of smart roads and mega transportation projects (KGM, 2020). Consequently, while railways complemented highways in the 1950s, highways have now ascended to the primary mode of transportation, receiving support from various other transport means. Entering the 2020s, it is observable that while road transportation investment is moderating, railway investments have surged. Figure 1, depicting the sectoral investment distribution by the Ministry of Transport and Infrastructure, Republic of Turkey, from 2013 to 2022, illustrates an increase in the railway investment share from 33% to 52%, substantiating the aforementioned thesis (UAB, 2022).

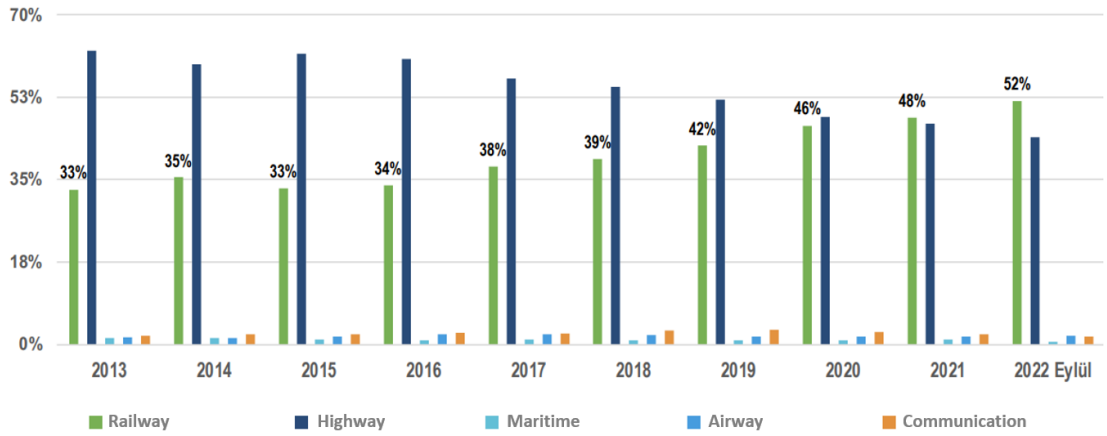

Figure 1. The sectoral distribution of investments between 2013 and 2022 by the Ministry of Transportation and Infrastructure

The transformation of intercity transportation services in Turkey mirrors changes observed in urban mobility. Delving into the historical backdrop of urban mobility in Istanbul reveals that the Istanbul Electric Tramway and Tunnel (IETT) commenced operations in 1869, followed shortly by the introduction of horse-drawn trams in 1871. By 1875, the Karakoy-Beyoglu tunnel, the world's second-oldest subway, was operational (IETT, 2022). A review of public transportation services in Istanbul over the years showcases the evolution from horse-drawn trams to modern buses, driverless metros, and trams as stark indicators of this development. Istanbul's transportation history is marked by continual hosting of new mobility services and innovations, a trend persisting through the years. Notably, Istanbul was the site of one of the world's earliest subways in 1875, and today, it pioneers in introducing new mobility services such as individual and shared micromobility services, vehicle sharing, and ride-sharing services, the impacts of which on urban mobility and individual travel behaviors are burgeoning research topics.

The array of new mobility services in Istanbul includes shared bicycles, mopeds, and scooters, encompassed within shared micromobility services. The management of shared bicycles falls under the Istanbul Metropolitan Municipality, while shared scooters and mopeds are overseen by private entities. Key players in Istanbul's vehicle sharing systems include Moov Car Rental, TikTak Car Rental, YOYO

Car Rental, and Ziptrip Car Rental applications (Kiralama, 2022), distinguished by offering not just daily rentals and fixed pick-up/drop-off points but also hourly rentals and flexible locations. The burgeoning vehicle sharing sector is exemplified by Moov, which reported over 100,000 users and 2 million rentals within two years of operation, highlighting the sector's growth potential in Turkey (Moov, 2022). In the realm of ride-sharing, BlaBlaCar stands out as a globally and locally popular service, matching vehicle owners and passengers for shared journeys, thus optimizing vehicle occupancy, reducing the number of vehicles on roads, and contributing to lower carbon emissions. Despite facing initial legal challenges, the urban model of this ride-sharing concept was introduced in Istanbul in October 2022 by Martı, a scooter service provider, eventually overcoming access restrictions (Martı, 2023). These developments underscore the significance of evaluating the influence of such applications on user travel choices and the overall transportation ecosystem.

As previously mentioned, in Istanbul, the daily increasing use of services, which are transitioning from serving merely as an alternative mode of transportation to potentially becoming a fundamental component of the city's main transportation infrastructure, necessitates an understanding of how these services influence the travel behaviors and daily activity preferences of Istanbul residents. Recognizing the impact of these services is crucial for grasping urban transportation trends and the dynamics of passenger and freight mobility. This study investigates new mobility services such as micromobility, car, and ride-sharing services utilized in Istanbul within the framework of their impact on travel behavior, the relationship between individuals' demographic, socioeconomic status, and their use of new transportation services, and the conditions that foster higher adoption rates of these services.

This research comprises five sections. The Introduction outlines the study's background, provides general information, and sets the overall framework and the questions that the study seeks to answer. Following the introduction, a Literature Review on the impact of innovative mobility services on travel preferences is conducted. The Data and Methodology section describes the data collection methods and statistical analysis techniques employed in the study. In the Results section, both exploratory analyses and chi-square independence test results are presented. The Conclusion evaluates the study's outcomes and offers recommendations for future research.

2. The Impact of New Mobility Services on Travel Preferences

New Mobility Services are poised to significantly decrease transportation-related emissions and the necessity for personal vehicle ownership. McKinsey report highlighted that in Munich, Germany, micro-mobility journeys, representing a mere fraction under 0.1% of total trips in 2019, are forecasted to surge to 250 million by 2030, accounting for about 8% to 10% of all Munich trips in that year (Heineke et al., 2019). According to the 2021 European Shared Mobility Index by Fluctuo, which drew on data from 16 significant European cities, there was a notable increase in shared mobility usage: station-based shared bicycles grew by only 0.5%, while free-floating bicycle usage saw a 32% increase, shared scooters by 124%, shared mopeds by 38%, and shared cars by 11% (Fluctuo, 2021).

In Turkey, recent years have marked a rise in the adoption of car-sharing, ride-sharing, and shared micro-mobility services. For instance, MOOV by Garenta, a car-sharing service in Turkey, reported over 100,000 active users and 2 million vehicle rentals within its first two years. They also noted that 69% of car rentals during the COVID-19 pandemic were for commuting purposes (Moov, 2022). The scooter rental service launched in Istanbul by Martı in February 2019 has expanded, with over 20 companies offering services in 27 Turkish cities over three years. BlaBlaCar, offering ride-sharing services in Turkey and 22 other countries, announced it had reached 100 million users by the end of 2021 (Blablacar, 2022). These novel transportation solutions are increasingly becoming primary travel options in urban settings, as opposed to mere alternatives.

Literature is abundant with studies examining the impacts of these new mobility services on travel choices. Sengül (2021) delved into e-micromobility's role within the transportation ecosystem of Istanbul, focusing on its effects on travel habits, energy use, environmental impacts, safety, and regulation, benchmarking findings against other relevant studies. A survey of 240 individuals in Istanbul revealed that 60% favored e-scooters over walking for short trips, and 62% utilized these services for leisure activities. The study employed the student's t-test to analyze gender differences in

e-scooter usage. Research in Riyadh, Saudi Arabia, assessed the viability of an e-scooter sharing scheme as a new micromobility option, finding that ride-hailing service users were more inclined to adopt e-scooters. The study identified inadequate infrastructure, adverse weather conditions, and safety concerns as the primary hurdles to e-scooter implementation in Riyadh, with logistic regression analysis highlighting the significant roles of gender, age, and ride-hailing usage in willingness to use e-scooters (Almannaa et al., 2021). A Belgrade case study investigated e-scooter users' travel behaviors and their readiness to switch to alternative e-scooter options under different hypothetical scenarios. The study aimed to uncover determinants of such transitions, with infrastructure availability being a key factor. Surveys involving 1143 participants were analyzed using descriptive statistics, the McNemar–Bowker test, and multinomial logistic regression, showing a strong preference for e-scooters, especially for commutes to work or school, given dedicated infrastructure. Consistent with previous research, environmental benefits, congestion reduction, cost savings, and shorter travel times were identified as the most influential factors encouraging e-scooter adoption (Glavic, 2021). Another research examined the effects of e-scooters on modal shifts, land use, and the rental process, offering insights into rental pricing strategies based on survey data, indicating that studies on e-scooters and modal shifts predominantly rely on survey-based research (Glavic et al., 2023).

In a study examining the differences and characteristics of travel behaviors among users of e-bike sharing systems and e-scooter sharing systems in Tricity, Poland, it was found that individuals utilizing e-scooter sharing systems tend to be younger than those who use e-bikes. It was also observed that men prefer these services more than women, and while e-bikes are more frequently used for commuting to work, e-scooters are predominantly used for leisure purposes. Additionally, the study explored reasons for non-use among individuals, finding that non-users of e-scooters cited high costs, availability issues (insufficient number of scooters in the right locations or complete absence), and safety concerns as their main reasons for not using the service. On the other hand, non-users of e-bikes pointed to the lack of sufficient bicycles, ownership of personal bicycles, and the perceived lack of durability of the bikes as their reasons for not opting for this service (Bieliński and Wazna, 2020). A further case study conducted in Toronto and selected Canadian neighborhoods explored the socio-demographic, attitudinal, and built environment attributes among potential users of shared e-scooters. Findings reveal that 21% of respondents expressed willingness to contemplate e-scooters for certain current journeys, with the majority intending to substitute their present walking (60%) and public transit (55%) trips with shared e-scooters. Additionally, no discernible disparity in e-scooter preferences was noted between urban and suburban areas (Mitra and Hess, 2021). The findings of the research conducted by Mehzabin Tuli et al found that places in densely populated regions characterized by higher median income levels, diverse land utilization, abundant parks and open areas, public bicycle sharing facilities, increased parking rates, and reduced incidences of criminal activity generate more e-scooter trips. On the other hand, the outcomes derived from the model estimation indicate that travel purpose, travel modality, and time allocation significantly impact the trend to use shared dockless e-scooter services. Furthermore, these effects are subject to variations contingent upon socio-demographic attributes (e.g., years of advertising exposure) and contentment with prevailing public transportation modalities (Lee et al, 2021)

When examining the studies in the literature related to car-sharing services, a study investigating the impact of car-sharing services on individuals' car ownership was conducted with over ten thousand individuals in 11 different European countries. The research results revealed that in Copenhagen (followed by Rome, Hamburg, and London), one shared car in the car-sharing system replaces approximately 20 car trips, which is about twice as much as the city with the lowest number of shared cars, Madrid. Additionally, the presence of car-sharing services shows that the main non-city-specific factor influencing the non-use of private cars is the frequency of service usage (Jochem et al., 2020). In the literature regarding ride-sharing services, there are studies examining the effects of these services on travel preferences and travel frequency. Yu et al. (2017) evaluated the direct and indirect environmental benefits of ride-sharing and stated that from a long-term perspective, changes in travel preferences triggered by ride-sharing contribute significantly to emission reductions. Findings from an empirical study conducted in Beijing, China, indicate that ride-sharing services can encourage individuals to reduce private car usage and alter their decisions regarding purchasing new vehicles (Tang et al., 2020). Furthermore, shared scooters can be considered a significant alternative to private

car travel in the transformation process that started with car rentals. As illustrated in Figure 2, shared micro-mobility services are highlighted as an alternative to private car travel for short-distance trips, car-sharing for medium-distance trips, and peer-to-peer car-sharing services for long-distance journeys.

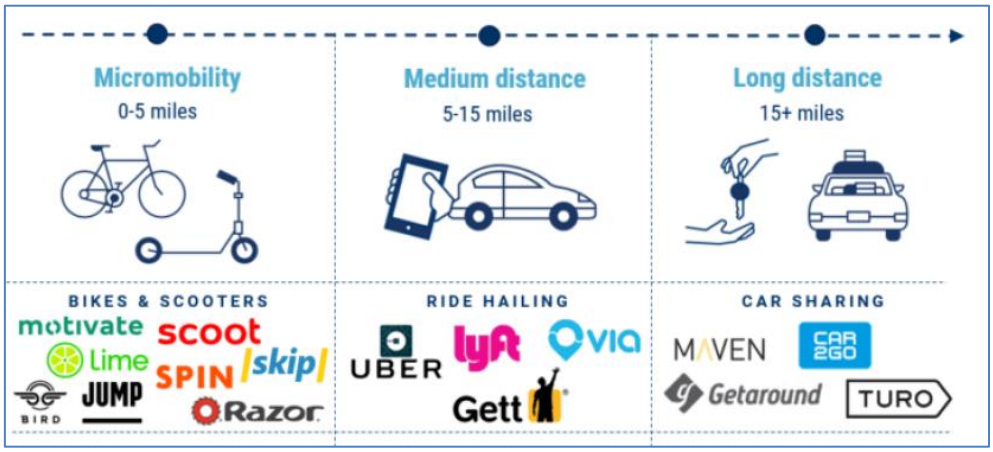

Figure 2. Alternatives to private vehicle travel for Short, Medium, and Long-Distance Journeys (Cbinsights, 2022).

In the United States, trips within the range of 0-5 miles account for 60% of total travel, while trips between 5-15 miles constitute 25% of total travel, and trips of 15 miles or more make up 15% of total travel. This situation suggests that even a shift towards shared micro-mobility services for car trips within the 0-5 mile range alone could result in a significant reduction in car travel, hence reducing traffic and carbon emissions.

3. Data and Method

To collect data for this research, a survey was conducted using Google Forms with a sample of 404 individuals residing in Istanbul. The determination of the research population and sample was an initial step before the development of survey questions. The methodology for calculating the sample size is detailed in Section 3.1, which outlines the rationale behind the chosen research methodology for this study. A more in-depth discussion on this subject is provided in Section 3.2. Following this, the survey questions were devised by examining studies in the existing literature that are similar in nature and aligning them with the aims of this research. Upon achieving the predetermined sample size, the chi-square independence test was identified as the suitable method for analyzing the collected survey data, which was processed using SPSS software. The outcomes of this analysis were then interpreted to extract insights pertinent to the research objectives. The procedural flow of the research is depicted in Figure 3.

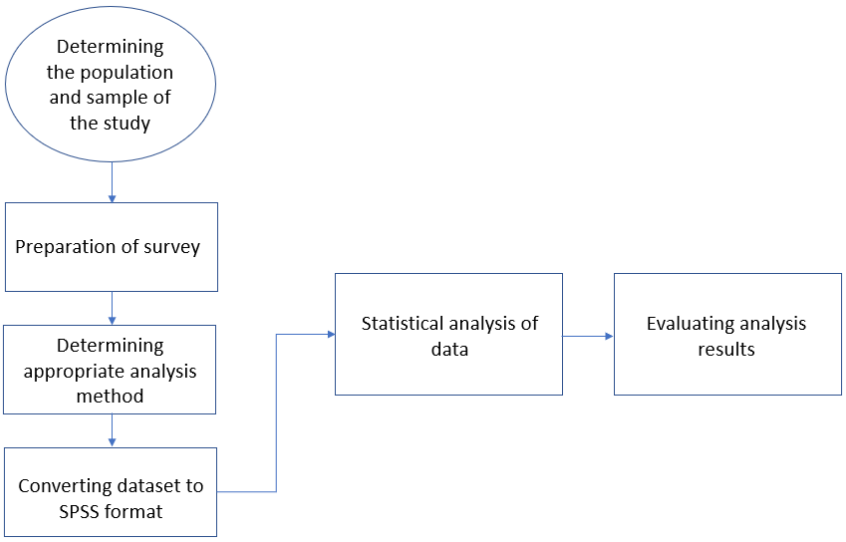

Figure 3. Flow of the research

3.1. Population and sample of the research

The main population of the research consists of individuals aged between 18 and 55 residing in Istanbul. The lower age limit of 18 was determined due to the fact that some of the new mobility services included in this study have a minimum age requirement of 18, which is the legal driving age. The upper age limit of 55 was chosen based on previous studies in the literature, which indicated that users of these services tend to fall within this age range. Furthermore, none of the participants in the survey were above the age of 55, which supporting this selection.

The population comprising individuals aged between 18 and 55 residing in Istanbul was determined based on the data published by the Turkish Statistical Institute (TÜİK) in 2021, specifically the "Population by Province, Age Group, and Gender" report. According to this data, the population of the main population was determined to be 9,928,977 individuals (Figure 4).

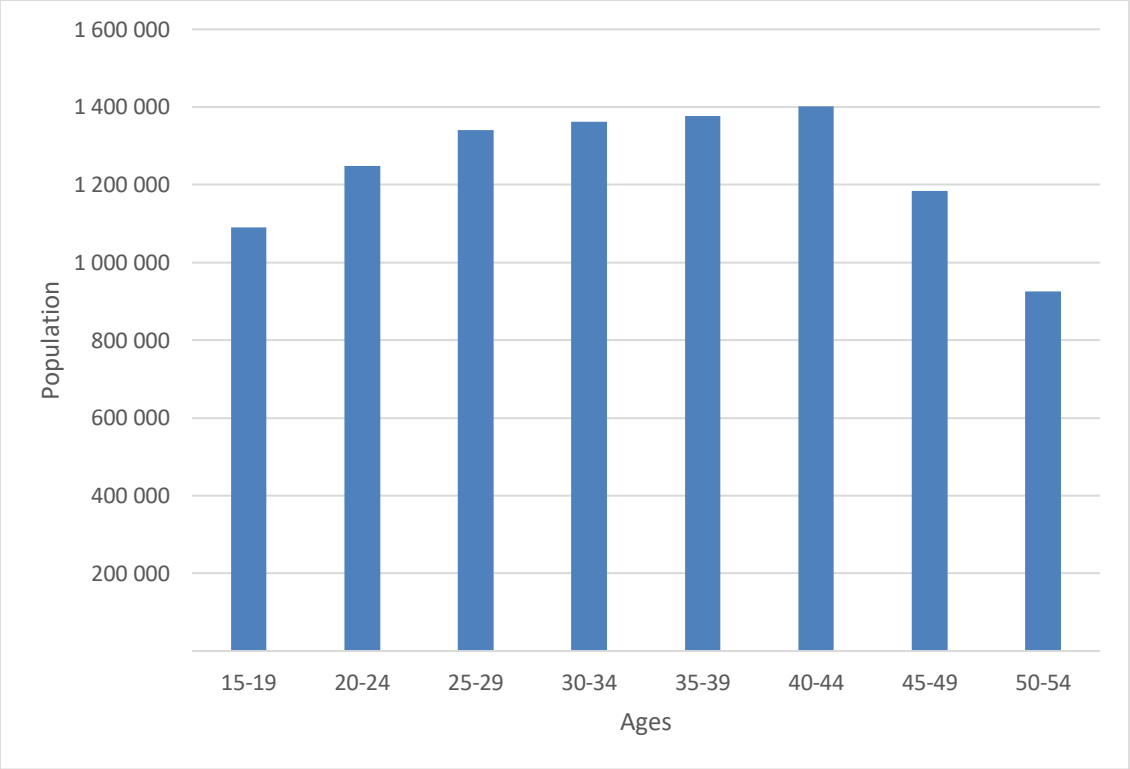

Figure 4. The age distribution of the population in İstanbul (TÜİK, 2022).

Since there was no explicit age range specified in the "Population by Province, Age Group, and Gender" data published by TÜİK, the lower age limit was taken as 15 and the upper age limit as 54 when calculating the population for the study. Thus, a larger population was considered than what would be expected. This situation can be interpreted as the population being larger, resulting in a more representative sample and providing more reliable results in terms of representativeness.

When considering different sample sizes for various sampling errors determined by Yazıcıoğlu and Erdoğan (2004) and based on the probabilities of p=0.5 and q=0.5, a minimum sample size of 384 is required for a population of 10,000,000 with a confidence interval of α=0.05 (Table 1). This study was conducted with a sample size of 404 at a 95% confidence level under the conditions of p=0.5 and q=0.5. In Table 1 “p” represents the estimated proportion of the population with a certain characteristic whereas “q” represents the complement of the p which is 1-p.

Table 1. Calculated sample sizes for different population sizes and sampling error. (Yazıcıoğlu and Erdoğan, 2004)

Population size (person)	0.03 sampling error (d)			0.05 sampling error (d)			0.10 sampling error (d)		
	p=0,5 q=0,5	p=0,8 q=0,2	p=0,3 q=0,7	p=0,5 q=0,5	p=0,8 q=0,2	p=0,3 q=0,7	p=0,5 q=0,5	p=0,8 q=0,2	p=0,3 q=0,7
100	92	87	90	80	71	77	49	38	45
500	341	289	321	217	165	196	81	55	70
750	441	358	409	254	185	226	85	57	73
1000	516	406	473	278	198	244	88	58	75
2500	748	537	660	333	224	286	93	60	78
5000	880	601	760	357	234	303	94	61	79
10000	964	639	823	370	240	313	95	61	80
25000	1023	665	865	378	244	319	96	61	80
50000	1045	674	881	381	245	321	96	61	81
100000	1056	678	888	383	245	322	96	61	81
1000000	1066	682	896	384	246	323	96	61	81
100.000.000	1067	683	896	384	245	323	96	61	81

3.2. Analysis method

In this research, the chi-square test of independence was utilized as the analytical approach. This test assesses the statistical significance of the deviation between observed and expected frequencies. It is widely applied to determine if there is a statistically significant association between two or more categories, to evaluate homogeneity across categories, and to check if the distribution observed in the sample matches an expected theoretical distribution, among other applications (Yazıcıoğlu, 2004). The selection of this analysis method was guided by factors including a review of the literature, the objectives of the research, and the compatibility of the dataset with this particular analytical technique.

The chi-square independence test aims to assess the similarity between observed frequencies (Gij) in 2x2 or r x c matrices and the theoretical frequencies (Tij) calculated based on marginal probabilities. The hypotheses and calculation formula (Eq.1) in the chi-square independence test are as follows (Uzgören, 2007)

H_0: Variables are independent (There is no relationship between variables)

H_1: Variables are dependent (There is a relationship between variables)

The chi-square test is calculated according to the formula below.

$$X^2_{hes} = \sum \frac{(G_{ij} - T_{ij})^2}{T_{ij}} \quad (1)$$

In the chi-square test of independence, cross-tabulation was performed using sociodemographic variables, general travel behavior-related questions and questions related to innovative transportation services to investigate whether there is a significant relationship between the variables.The summary of the results of the chi-square test of independence, indicating the rejection of the null hypothesis (H0) and the presence of a statistically significant relationship between the variables is provided in Table 2. The green cells in Table 2 represent the situations where the null hypothesis is rejected, and the methods used in the chi-square test of independence are represented by the letter "P" for Pearson chi-square test and the letter "F" for Fisher's exact test. Additionally, significance values are provided. Accordingly, a total of 45 hypotheses were found to reject the null hypothesis, indicating a dependent relationship between the variables. Among these hypotheses, Pearson's chi-square test was used for 11 hypotheses, while Fisher's exact test was used for 34 hypotheses. The survey questions are divided into three

groups. The questions in the first group, denoted as S1D, are related to participants' sociodemographic characteristics. The questions in the second group, denoted as S2S, pertain to participants' general travel experiences, preferences, and behaviors. The questions in the third group, denoted as S3Y, focus on innovative transportation services. The question groups and the survey questions are presented in Table 2. In the chi-square test of independence, if the proportion of theoretical frequencies calculated for each cell is less than 5 and less than 20% of the total, the Pearson chi-square test is used; if it is equal to or greater than 20%, the Fisher's exact test is used. Then, the significance value of the selected method is examined. If the significance value is less than 0.05, the null hypothesis (H0) is rejected, while if it is greater than 0.05, the null hypothesis cannot be rejected. The Survey Questions, Question Groups, and Codes are provided in Appendix 1.

Table 2. Chi-square independence test results and significant variables.

	S3Y1	S3Y2	S3Y3	S3Y4	S3Y5	S3Y6	S3Y7	S3Y8	S3Y9	S3Y10	S3Y11	S3Y12
S1D1												
S1D2												
S1D3	P, 0,001	P,0,027					F, 0,027				P, 0,003	
S1D4	F, 0,001		F,0,043			F, 0,007	F, 0,001	P, 0,002			F, 0,001	
S1D5	F, 0,008		F, 0,001				F, 0,028	F, 0,026				
S1D6	P, 0,004					P, 0,039	F, 0,001	P, 0,008		F, 0,011		
S1D7	F,0,017						F, 0,001	P, 0,005			F, 0,042	
S1D8			F, 0,013				F, 0,044	F, 0,004			F, 0,044	
S2S1	P,0,002						F, 0,001	P, 0,035				
S2S2	P,0,045		F, 0,001			F,0,013	F,0,025					
S2S3	F, 0,013					F,0,027				F, 0,014		
S2S4	F,0,004	F,0,025		F,0,021			F, 0,001	F, 0,005	F, 0,001	F, 0,014		
S2S5							F, 0,042					
S2S6												
S2S7												

4. Results

In this section, an overview will initially be provided concerning the 404 participants who were included in the survey study. Subsequently, the survey results will be interpreted through the use of exploratory analysis methods. Lastly, the results of the chi-square independence test will be presented, indicating the rejection of the null hypothesis (H_0) and demonstrating the presence of statistically significant relationships between the variables, thereby presenting the findings of the research.

Descriptive analysis

Analyzing the demographic characteristics of the survey participants, it is observed that 53% of the participants are male, while 47% are female. Looking at the distribution of participants by age group, the 26-40 age range accounts for 48% of the participants, while the 18-25 age range accounts for 41.3%. Regarding employment status, 47.5% of the participants stated that they work full-time, while 35% identified themselves as students. Additionally, 63.6% of the respondents are single, while the remaining participants are married individuals. When asked about income level, 39.6% reported

earning below 5500 TL (minimum wage in 2022), followed by 23% earning between 5500-10,000 TL, and 14.9% earning between 10,000-13,750 TL. Finally, when asked about the highest level of education completed, 38.1% indicated high school, while 31.9% indicated a bachelor's degree.

When looking at the results related to individuals' general travel behavior, it is found that 49.5% of the participants have a vehicle they can use on a daily basis, while 50.5% do not. In terms of driver's license status, a significant portion of 81.2% of the participants are licensed drivers. Furthermore, when participants were asked about the most important criteria they consider in their general travels, 19.3% selected time and comfort, while 17.8% chose the combination of time and cost. The most preferred mode of transportation for daily trips among participants is public transportation, with a rate of 62.9%, followed by private vehicles at 21.5%. When asked about the reasons for choosing these modes of transportation, 9.2% of the participants solely mentioned cost, while the same percentage (9.2%) chose the combination of cost and ease of use. Lastly, 47.3% of the participants reported making 2 to 4 trips per day, followed by 0 to 2 trips, which accounted for 43.8% of the participants. Additionally, when participants were asked about the average duration of their daily trips, 26.5% indicated 30-60 minutes, followed by 22% selecting 60-90 minutes.

Conducting descriptive analyses, the chi-square test of independence was then used to evaluate whether there is a statistically significant relationship between individuals' demographic characteristics, general travel behavior, and the use of innovative transportation services.

Statistical analysis

According to the test results, the null hypothesis (H_0) was rejected, indicating dependent relationships among variables in a total of 45 hypotheses. Of these variables, 27 relate to the demographic-socioeconomic characteristics of individuals and their usage of innovative transportation services. Eighteen variables were identified as statistically significant in relation to individuals' general travel behaviors and their use of innovative transportation services. The analysis concludes that there is a statistically significant relationship between individuals' demographic and socioeconomic statuses such as gender, age, employment status, marital status, income level, and education level and their use of innovative transportation services. Additionally, significant variables correlating individuals' general travel behaviors with their utilization of innovative transportation services include vehicle ownership status, driving license possession, criteria considered important in daily commutes, preferred modes of transportation for daily travels, and the reasons for choosing these modes. The results pertaining to the rejection of the null hypothesis are presented below.

Among the survey participants, 24.5% of those who use new mobility services stated that they use shared micromobility vehicles, while 7.9% reported using vehicle sharing systems. When examining the distribution of these users by age groups, it was found that the 18-25 and 26-40 age ranges heavily favor shared micromobility vehicles, with the latter age group showing a significantly higher preference for personal micromobility vehicles compared to the 18-25 age group. Furthermore, individuals in the 26-40 age range showed a significantly higher preference for vehicle sharing systems compared to other age groups, while the 41-55 age group had a significantly lower usage rate of these services. In terms of gender, a significant proportion of both males and females preferred shared micromobility services, with males showing a significantly higher usage rate of personal micromobility vehicles compared to females. Among employment statuses, both full-time workers and students showed a significantly higher usage rate of shared micromobility vehicles compared to individuals in other employment categories. Full-time workers also exhibited a significantly higher usage rate of personal micromobility vehicles and a higher rate of vehicle sharing system usage compared to other employment groups. Regarding marital status, unmarried individuals had a significantly higher preference for shared micromobility services and a higher preference for vehicle sharing systems. When examining income levels, individuals earning between 0-5500 TL showed a significantly higher usage rate of shared micromobility vehicles or no usage of any of these services compared to other income groups. Additionally, the income group of 10,000-13,750 TL showed a significantly higher preference for personal micromobility vehicles compared to other income groups. Finally, there was a significant relationship observed between individuals' education levels and the usage of innovative

transportation services for their specific trips, as well as the modes of transportation they preferred before using these services.

When examining the impact of innovative transportation services on individuals' general travel behavior and preferences, it is found that before using these services, participants stated that they used public transportation for 44.4% of their journeys, walking for 25.8%, and private vehicles for 15.7% of their same journeys. Accordingly, it is evaluated that new mobility services in Istanbul have replaced public transportation, walking, and private vehicle travel to a significant extent. When participants were asked about the purposes for using these services, 48.3% mentioned to go one places to another with specific objective, 29.8% mentioned entertainment and leisure, and 13.5% mentioned first and last-mile trips. Therefore, the majority (over three-quarters) of those who use these services do so for transportation purposes, while 13.5% use them specifically for first and last-mile trips. Additionally, 51.7% of users stated that they prefer these services for journeys of 0-2.5 km, and 16.9% indicated their preference for journeys of 2.5-5 km in length. This indicates that innovative transportation services are chosen over modes like minibusses, especially for short-distance trips within the service areas of public transportation. Furthermore, these services complement public transportation for longer-distance trips. When participants were asked about their reasons for choosing innovative transportation services, 14% stated its speed, while 9.6% mentioned fun as their main motivation.

Examining the usage of innovative transportation services in different types of trips, it is observed that home based trips account for 36% of all trips, home to work trips represent 20.2%, and home to school trips make up 11% of the trips. Therefore, home-to-work and home-to-school trips, which constitute a significant portion of individuals' daily travels, account for 31% of the trips made using innovative transportation services. This indicates that in areas where home-to-work and home-to-school distances are relatively short, there is a significant potential for these services to be widely adopted.

Analyzing the impact of innovative transportation services on individuals' daily travel frequency, 64.6% of the survey participants stated that these services affect their daily travel frequency. Furthermore, 26.4% agreed that innovative transportation services have led them to make more trips, whereas 43.2% disagreed, and 30.3% were undecided. On the other hand, 10.1% believed that these services have resulted in fewer trips, while 65.1% disagreed, and 24.7% were unsure. Therefore, more than half of the users reported an increase or decrease in their daily travel frequency, and for 26.4% of them, new travel demands have emerged. By enhancing the conditions and circumstances under which users prefer these services and by effectively guiding travel demands, innovative transportation services can provide integrated support to urban mobility systems.

5. Conclusion

This research delves into the effects of new mobility services on the travel habits and daily activity choices of residents in Istanbul, Turkey. These services, which are gaining popularity in urban settings and have the potential to integrate into the primary transportation infrastructure rather than just serving as an alternative, are analyzed for their influence on Istanbul residents. The study further explores the association between individuals' sociodemographic profiles, their general travel patterns, and their engagement with these innovative transportation options. Moreover, it addresses inquiries regarding the situations and motivations behind the selection or non-selection of these services, as well as the factors contributing to their increased adoption.

In this research, the determinants affecting individuals' travel behaviors are scrutinized, both broadly and specifically within the context of new mobility services. The study reviews existing literature on the role of innovative transportation services in shaping urban mobility and individual travel patterns. It outlines the research sample and methodology employed, detailing a survey conducted among 404 individuals in Istanbul. This survey encompassed questions on participants' sociodemographic profiles, general travel behaviors, and their usage of innovative transportation options. The analysis of survey data was performed using descriptive analysis techniques and the chi-square test of independence, identifying variables that demonstrate a statistically significant association with individuals' demographic characteristics, general travel trends, and preferences for innovative transportation.

The research aimed to uncover reasons behind the non-utilization of innovative transportation services by some individuals and the conditions under which they would consider using these services. Participants who had not previously engaged with these services (accounting for 55.9% of respondents) were queried about their reasons for abstention. Among them, 39.4% cited safety concerns, 32.7% indicated a lack of familiarity with operation methods, and 18.6% considered that prices are not affordable. When questioned about potential usage if their concerns were addressed, 18.1% leaned towards shared micromobility, 17.7% towards vehicle sharing systems, and 16.4% towards individual micromobility vehicles, while 21.2% maintained they would not use any such services. However, remaining 78.8% expressed openness to adopting one or more innovative transportation options if their concerns were addressed, highlighting critical insights for the expansion of these services in Istanbul and pinpointing areas for improvement as identified by non-users.

Comprehending the changes, trends and the dynamics of mobility demand and supply in urban areas, alongside current passenger and freight movements, is crucial for integrating these insights into the transportation system's future planning and development. It's vital to understand both current users and potential adopters of new mobility services and how these services influence people's travel habits and daily choices to stay attuned to urban mobility trends.

Future research should delve into panel data analysis on these services and investigate detailed statistics such as trip origins and destinations, travel times, distances, and user satisfaction levels. Additionally, it is suggested that local municipalities and central government entities like ministries enhance research efforts to adapt to changing travel behaviors and preferences and establish dedicated institutional frameworks accordingly. Exploring travel tendencies and behavioral shifts through novel data collection methodologies in transportation is advised. Implementing annual travel behavior surveys by TÜİK, accumulating travel behavior data via central bodies like the National Transportation Data Center, and ensuring data accessibility are recommended strategies within this framework.

Conflict of Interest Statement, if any

The authors have no conflict of interest to declare.

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The authors' contribution rates in the study are equal.

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Appendix 1. Survey Questions, Question Groups and Codes

	Question Code	Questions
Socio-Demographic Characteristics	S1D1	In which district of Istanbul do you live?
	S1D2	In which district is your workplace or school located? (For students, enter the district of their school; for those employed, enter the district where their workplace is located.)
	S1D3	Gender
	S1D4	Age
	S1D5	Employment status
	S1D6	Marital status
	S1D7	Monthly average income?
	S1D8	Highest level of education completed?
General Travel Behavior	S2S1	Do you own or have access to a personal vehicle that you can use daily (e.g., family car, company car, etc.)?
	S2S2	Driving license status?
	S2S3	What is the most important criterion for you when making general trips? (Multiple options can be selected)
	S2S4	What is your preferred mode of transportation for daily trips?
	S2S5	Why do you prefer this mode of transportation? (Multiple options can be selected)
	S2S6	How many trips do you make on average in a day? (For example: commuting from home to work and back is considered as a total of 2 trips)
	S2S7	How much time, on average, do you spend on your trips in a day?
Innovative Transportation Services	S2Y1	Which of the following innovative transportation services do you use the most? (If none, only S3Y11 and S3Y12 are answered)
	S3Y2	How often do you use these innovative transportation services?
	S3Y3	On which trips do you use these innovative transportation services?
	S3Y4	Why do you prefer these innovative transportation services? (Multiple options can be selected)
	S3Y5	What is your main purpose when using these innovative transportation services?
	S3Y6	For what distance of trips do you prefer using innovative transportation services?
	S3Y7	Which mode of transportation were you using for these trips before using innovative transportation services?
	S3Y8	Have the innovative transportation services affected the number of trips you make?
	S3Y9	The innovative transportation services have led me to make more trips
	S3710	The innovative transportation services have led me to make fewer trips
	S3Y11	I do not use innovative transportation services due to the following reasons
	S3Y12	If the conditions mentioned above are met, which of the following innovative transportation services would you use? (Multiple options can be selected)