The Role of Remote Activities in Urban Mobility in the Post-COVID-19 Era

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Abstract. This study examines how remote activities, particularly teleworking and tele-education have been associated with urban mobility patterns in Greece during and after the COVID-19 pandemic. Focusing on shifts in travel behavior and attitudes toward future mobility trends, a questionnaire-based survey was conducted among 1,115 respondents, primarily from Thessaloniki's academic community. The survey assessed mobility habits across three time periods (pre-, during, and post-pandemic), remote activity practices, future intentions, and socio-demographic factors. Descriptive and inferential statistical analyses were carried out to identify key determinants shaping future mobility and remote activity preferences. Results show significant behavioral changes, with walking, private vehicle, and bus use declining sharply during the pandemic. Prior to COVID-19, 80% of employees had no teleworking experience, yet 60% transitioned to working remotely five or more days weekly at the pandemic's peak. Findings highlight strong support for continuing telework and remote learning post-pandemic, indicating lasting shifts in work, education, and urban mobility patterns.

Keywords: tele-working · tele-education · urban mobility · COVID-19 · remote activities

1 Introduction

Globally, the use of transport and mobility systems is heavily influenced by geographical contexts and situational dynamics. Prior to the COVID-19 pandemic, urban transportation systems were widely utilized across the globe [1]. However, during the pandemic's outbreak, the demand for urban transport dropped significantly due to the implementation of restrictive measures in many countries aimed at limiting the virus's spread [2, 3]. Following the easing of travel restrictions, transport usage has largely returned to pre-pandemic levels, though not uniformly across all regions [1].

Travel choices can vary significantly among people, as they are heavily influenced by the area, available infrastructure, regulations, and individual preferences. Before the pandemic, mode choice was a key aspect of transportation decisions [4], the characteristics of which changed dramatically during the pandemic due to regulatory constraints

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and health-related imperatives. In the post-pandemic era, the impact of these factors diminished, but some residual effects continue to play a role in travelers' decision making [5]. Global movement patterns fluctuated significantly, with a notable drop in travel during the peak of the pandemic, followed by a gradual return to pre-pandemic levels as restrictions eased [1].

In Greece, prior to the pandemic, key remote activities, and specifically, remote work (or teleworking) and online education (or tele-education) constituted acknowledged practices but were implemented on a limited scale within the private and public sectors. Technological infrastructure supporting remote work and learning was primarily concentrated on specific sectors or niche contexts [6]. The pandemic, however, accelerated the widespread adoption of remote work and online education, bringing structural modifications to both work and educational environments. These shifts presented opportunities and challenges, especially in situations where physical proximity was infeasible or risky.

Before the pandemic, the majority of the adult population in Greece primarily used various modes of transport (e.g., buses, metro, railway/tram, car/taxi) for commuting to work or school. The COVID-19 pandemic had a profound impact on urban mobility patterns, as the introduction of remote work and online education allowed many individuals to perform their daily activities from home. As expected, this shift to regular, digital activities reduced the need for daily commuting. Even after the easing of restrictions, many people continued remote work or education on a regular routine, further diminishing their reliance on conventional transport modes. As a result, telecommuting and online education were established as viable alternatives to key, in-person activities, reshaping traditional commuting patterns and demonstrating their transformative potential for the Greek lifestyle [7].

This paper investigates how remote activities—particularly teleworking and tele-education—have shaped urban mobility patterns in Greece during and after the COVID-19 pandemic. It specifically focuses on changes in travel behavior, the association between remote activities and travel choices, and evolving preferences toward future mobility trends. By analyzing survey responses primarily from Thessaloniki's academic community, the study captures shifts in commuting habits across three key periods (pre-, during, and post-pandemic) and evaluates the long-term potential of hybrid models combining remote and in-person activity participation. The objective is to provide insights into how remote work and education influence sustainable mobility behaviors, contributing to informed policymaking and urban planning in a post-pandemic context.

This work is divided into five main sections. Section 2 explores changes in commuting habits before, during, and after the COVID-19 pandemic, as evidenced in the recent literature and focusing on the use of various transport modes and users' preferences. Section 3 provides information about the methodology and data collection process of the study. Section 4 provides the results of the descriptive and inferential statistical analyses of the collected data. Finally, Section 5 presents the conclusions from the research, along with recommendations for future interventions in terms of policy and infrastructure, while also acknowledging the limitations of the study.

2 Literature Review

The use of transportation and mobility systems is influenced by geographical contexts and situational dynamics. Prior to the COVID-19 pandemic, urban transportation systems were extensively used worldwide. Motorized transport modes such as cars, taxis, and buses, were in high demand in urban settings, while alternative, non- (or semi-) motorized modes such as, walking, cycling, and electric scooters were less frequently used [1]. During the peak of the pandemic, the demand for urban transport declined significantly due to the implementation of restrictive measures aimed at limiting the spread of the SARS-CoV-2 [2]. Public transport was largely avoided, with individuals mostly preferring personal modes of transport such as cars, bicycles, and walking [2, 3]. With the easing of travel restrictions, transport usage has nearly returned to pre-pandemic levels, although this recovery is not uniform across all geographical settings. People resumed their usual patterns of traveling through cars, taxis, and buses, with the characteristics of such a recovery varying across different contexts; however, the increase in the adoption of active transport modes continued to be observed even in the post-pandemic period [1].

Transport-related choices are typically shaped by area-specific factors, regulations, and individual preferences. Before the pandemic, factors such as time, cost, comfort, and reliability heavily influenced transport decisions. Most individuals preferred modes that offered speed, comfort, and economy, with parking availability being a key consideration among car users. During the pandemic's outbreak (i.e., between 2020 and 2021), safety, health, privacy, and the possibility of avoiding major crowds served as key factors influencing transport choices [3, 8]. These factors are still relevant for some travelers in the post-pandemic era, as their risk perceptions, habitual preferences or mode choice criteria may have changed.

In Greece, prior to the pandemic, remote work (or teleworking) and online education (or tele-education) were recognized practices, but their implementation in both the private and public sectors was quite limited. During the pandemic, these practices became essential and were widely adopted. Although some workers saw increased or unchanged hours and greater flexibility in their schedules, many others lost their jobs or faced work suspensions due to the economic impact of the pandemic [6]. Despite challenges in the implementation of online activities, such as reduced human interaction, technical issues, and limited remote working or educational options, the benefits included greater flexibility, improved productivity, and savings in time and cost [9]. In the post-pandemic era, remote work and online education continue to be widely used, particularly under the influence of extenuating circumstances (e.g., adverse weather, natural disasters and so on). However, adoption levels vary globally, depending on socio-economic conditions, cultural factors, and working environments in each country [10].

Remote work and online education, once peripheral, have become central to daily routines, with widespread satisfaction suggesting these changes may endure well into the future. Simultaneously, global disruptions such as pandemics have catalyzed shifts in consumer behavior, notably driving a surge in online shopping. While this digital transition offers increased convenience and efficiency, its long-term implications for traditional urban infrastructures (e.g., local amenities, shopping centers) remain ambiguous.

Collectively, these transformations illustrate a broader reconfiguration of social and economic practices, presenting both challenges and opportunities as societies adapt to an increasingly digital environment [11].

The forces supporting remote work and online education continue to strengthen, driven by increased digitization and reduced telecommunications costs. These trends are expected to lead to gradual shifts in work and education practices, including the integration of these activity patterns into everyday life. Additionally, the rise of flexible working arrangements along with a greater independence from traditional workplaces and educational institutions is likely to become more prominent in the future [12]. As societies adapt to these evolving dynamics, the redefinition of workplaces, educational settings, and overall urban spaces and accessibility will present both opportunities and challenges, which need to be better understood and addressed.

In an international context, comparative findings highlight how the COVID-19 pandemic led to widespread disruptions in mobility patterns, though the scale and nature of these shifts differed depending on regional and socio-economic conditions. Overall, the international evidence confirmed a general decline in public transport usage, accompanied by a parallel rise in active and private transport modes, especially in urban areas [13]. Interestingly, in Australia, a significant shift towards walking was observed, with potentially long-term implications for travel behavior [14]. The rise of remote work, as examined across G7 countries, contributed to a significant reduction in daily commuting and a broader reconsideration of transport needs and infrastructure investments [15, 16]. Simultaneously, cycling emerged as a resilient and increasingly used mode of travel during and after the pandemic, gaining an increasing policy support and public interest in several European cities [17]. Such international insights highlight the importance of carefully examining transport and mobility trends within a globalized yet locally adaptive framework, recognizing that despite the common challenges, the transport interventions and adaptations should be context-specific.

3 Methodology and Data Collection

3.1 Overview

To explore the impact of remote work and online education on urban mobility in the post-COVID-19 era, an online survey was conducted between May and June 2023. The survey was distributed to the community of the Aristotle University of Thessaloniki as well as to a broader national population. The invitation to participate was sent via email to the University community, following approval from the University leadership.

The main objective of the survey was to collect data on travel behavior and activity patterns of Greek citizens and to assess the influence of remote work and online education on their mobility patterns. Specifically, the survey aimed to examine how the changes brought about by the pandemic have affected citizens' mobility choices as well as their remote activity patterns. The questionnaire served as a means to gather both qualitative and quantitative data on travel habits and the use of remote work and online education, covering periods before, during, and after the outbreak of the COVID-19 pandemic, while also exploring expectations for future behaviors.

The online questionnaire was developed and administered using the LimeSurvey software and was reviewed and approved by the Research Ethics Committee and the Data Protection Service of the Aristotle University of Thessaloniki. The data collected from the questionnaire were analyzed using IBMSPSS Version 29, a statistical software package that allowed for thorough data analysis and subsequent interpretation [18]. A range of statistical methods were applied to extract meaningful insights from the data. Specifically, a descriptive statistical analysis was performed to highlight the primary patterns within the dataset, focusing on variables related to travel behavior and engagement in remote activities. Subsequently, inferential statistical tests—such as Spearman Rho and Kruskal Wallis—were employed to detect statistically significant associations between key variables, capturing the multi-level dimensions of individuals' travel choices and their participation in remote activities.

3.2 Survey Questionnaire

The survey questionnaire was divided into four sections encompassing a total of thirty questions [19]. Each section was devoted to a particular range of topics, as follows:

- **Section 1:** This section contained ten questions aimed at understanding citizens' mobility patterns. Specifically, it examined the frequency of usage of different travel modes across three distinct time periods: before, during the peak of the pandemic, and at present (post-pandemic period). The section also explored the frequency of travel for specific purposes during these periods.
- **Section 2:** This section consisted of eleven questions focused on remote work and online education activities. It sought to elicit attitudes and perceptions relating to the most significant benefits and challenges faced by respondents while engaging in these practices. Additionally, this section assessed the frequency of remote work and online education participation across the same three time periods.
- **Section 3:**It included three questions focused on anticipated future trends, specifically examining expected changes in the frequency of transport use, shifts in the purposes of travel compared to pre-pandemic patterns, and the likelihood of continued engagement in remote work (teleworking) and online education (tele-education) in the long term.
- **Section 4:** The final section included six questions related to the socio-demographic profile of the respondents, such as gender, age, employment status, educational level, marital status, and annual household income.

All the questions were closed-ended, and those concerning the frequency of transport use were formulated using a five-point Likert scale. For data processing, responses were encoded numerically using the SPSS software, enabling the development of charts and Table for key questions [20, 21].

4 Results and Key Findings

4.1 Descriptive Analysis

4.1.1 Socio-Demographic Characteristics

A total of 1,665 respondents completed the online survey, out of which 1,115 complete responses were used for the statistical analysis. The socio-demographic characteristics of the respondents are summarized in Table 1.

Table 1. Sociodemographic characteristics of the sample

Traits	Category	Frequency	Percent (%)
Gender	Male	387	34.7
	Female	706	63.3
	Prefer not to say	13	1.2
	Other	9	0.8
Age	18–27	674	60.4
	28–35	134	12.0
	36–44	118	10.6
	45–54	110	9.9
	55–64	66	5.9
	≥ 65	5	0.4
	Prefer not to say	8	0.7
Employment	Student	658	59.0
	Private employee	114	10.2
	Public servant	172	15.4
	Self employed	122	10.9
	Retired	7	0.6
	Unemployed	15	1.3
	Prefer not to say	11	1.0
	Working student	16	1.4
Education level	Primary school	1	0.1
	Middle school	2	0.2
	High school	348	31.2
	Post-secondary education	70	6.3
	Higher education	371	33.3
	Postgraduate degree	313	28.1
	Prefer not to say	10	0.9

(*continued*)

Table 1. (*continued*)

Traits	Category	Frequency	Percent (%)
Marital status	Married	224	20.1
	Unmarried	838	75.2
	Prefer not to say	31	2.8
	Other	16	1.4
	Divorced/separated	6	0.5
Annual household income	< 7.000 €	193	17.3
	7.000 €–12.000 €	203	18.2
	12.001 €–24.000 €	271	24.3
	24.001 €–36.000 €	134	12.0
	>36.000 €	72	6.5
	Prefer not to say	242	21.7

Among the respondents, 63.3% were female, with 60.4% falling in the age group of 18–27 years. This overrepresentation of younger participants can be attributed to the University community's higher involvement in the survey, especially among students. In terms of annual household income, a higher percentage of respondents reported earning between €12,000 and €24,000, which aligns with recent national statistics on Greece's average disposable income. Further details on respondents' educational background and marital status are as follows: 59% were students, and over 60% held a tertiary education degree (Bachelor's, Master's, or PhD) [22].

4.1.2 Travel Choices Before, During, and After the COVID-19 Pandemic

The "lockdown" restrictions imposed by the Greek government resulted in unprecedented numbers of people being furloughed or working from home, while most out-of-home leisure activities were prohibited. Survey responses confirmed that there had been significant reductions in weekly car/taxi travel, city bus use at the peak of the pandemic, compared to pre-pandemic levels. Table 2 shows the frequency with which respondents reported using different travel modes before, during the COVID-19 pandemic and today. Before the COVID-19 pandemic, at least 5 days a week, 52.65% of respondents walked, 30.49% drove a car or used a taxi, 30.04% used a city bus, and 2.6% rode a bicycle. However, during the outbreak of the pandemic, the usage rates of cars or taxis, and city buses saw significant declines. This suggests that COVID-19 had a considerable impact on people's daily commuting habits, particularly reducing reliance on different modes of public transportation. In the post-pandemic era (i.e., at the time of data collection), car usage remained lower but quite close to pre-pandemic levels, while the use of walking and city buses slightly increased. Additionally, no significant differences were observed in the usage rates of the other travel modes.

Table 2. Use of travel modes before, during, and after the peak of the COVID-19 pandemic

Travel mode	Frequency	Prior to the pandemic (%)	During the peak of the pandemic (%)	After the pandemic (%)
Car/taxi	5 or more days/week	30.49	13.45	26.46
	3 or 4 days/week	14.26	9.33	14.98
	1 or 2 days/week	16.32	20.18	17.49
	1 to 3 times a month	16.14	19.01	18.57
	Less than once a month	13.81	20.99	14.8
	Never	8.97	17.04	7.71
City bus	5 or more days/week	30.04	3.86	31.84
	3 or 4 days/week	13.36	3.23	12.47
	1 or 2 days/week	12.65	9.96	11.12
	1 to 3 times a month	9.24	9.24	11.03
	Less than once a month	12.58	16.5	11.21
	Never	22.15	57.22	22.33
Moped/motorcycle	5 or more days/week	3.14	2.51	3.32
	3 or 4 days/week	1.53	0.99	1.44
	1 or 2 days/week	1.7	1.44	1.44
	1 to 3 times a month	2.87	2.51	2.51
	Less than once a month	3.14	2.69	3.05
	Never	87.62	89.87	88.25
Walking	5 or more days/week	52.65	41.08	54.62
	3 or 4 days/week	18.65	21.08	19.73
	1 or 2 days/week	15.96	19.82	13.90
	1 to 3 times a month	7.44	8.07	6.91

(*continued*)

Table 2. (*continued*)

Travel mode	Frequency	Prior to the pandemic (%)	During the peak of the pandemic (%)	After the pandemic (%)
	Less than once a month	2.51	4.75	2.24
	Never	2.78	5.20	2.60
Bike/electric bike	5 or more days/week	2.60	2.42	2.33
	3 or 4 days/week	2.51	3.14	1.26
	1 or 2 days/week	2.96	4.57	2.33
	1 to 3 times a month	4.84	4.58	4.40
	Less than once a month	8.70	5.83	7.44
	Never	78.37	79.55	82.24

4.1.3 Future Use of Travel Modes

As shown in Fig. 1, survey responses showed that after the end of the COVID-19 pandemic, 39% of respondents expect to walk the same amount as before the pandemic, and 30% expect to use the city bus less compared to before the pandemic. Overall, a greater proportion of respondents intend to reduce the public transport usage rather than increase it. In contrast, for commuting by car, walking, and cycling, most people believe they will either maintain or increase their usage compared to pre-pandemic levels. It is also interesting to note that nearly 30% of respondents did not express specific views for certain modes of transport, such as bicycles and motorcycles.

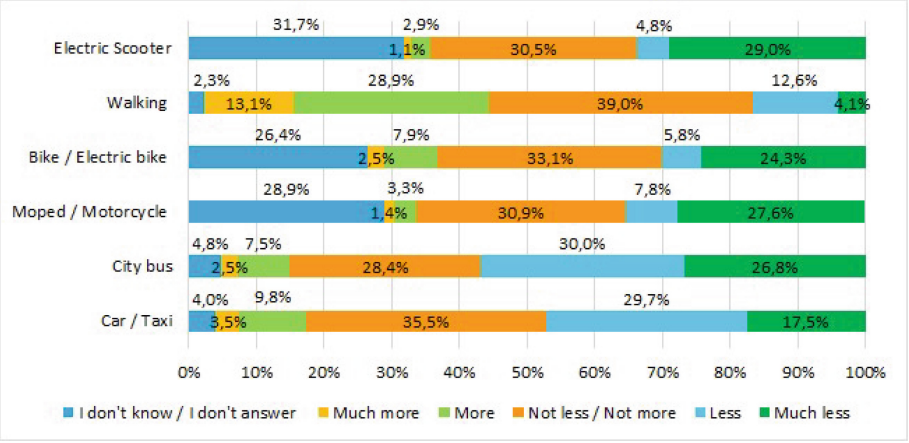

Fig. 1. Expectations for the future use of travel modes

4.1.4 Travel Purposes Before, During, and After the COVID-19 Pandemic

Table 3 presents the frequency of commuting reported by respondents before the COVID-19 pandemic, during the pandemic, and at present (i.e., post-pandemic). Prior to the pandemic, 31.4% commuted for work at least five days a week, 74.9% commuted to or from educational institutions, and 12.6% commuted for leisure. At the peak of the pandemic, these percentages decreased notably, indicating a substantial reduction in commuting for work, education, and leisure due to COVID-19 restrictions. Post-pandemic, the rate of commuting for work has recovered and even increased compared to pre-pandemic levels. However, for other travel purposes, no significant differences are observed across the three periods.

Table 3. Frequency of travel purpose before, during, and after the COVID-19 pandemic

Travel purpose	Frequency	Prior to the pandemic (%)	During the peak of the pandemic (%)	After the pandemic (%)
Business	5 or more days/week	31.4	8.90	33.90
	3 or 4 days/week	9.10	7.20	11.70
	1 or 2 days/week	9.50	9.50	9.00
	1 to 3 times a month	10.4	9.90	10.40
	Less than once a month	8.40	13.70	8.80
	Never	31.10	50.90	26.20
From/to the place to work/education	5 or more days/week	74.90	14.70	65.90
	3 or 4 days/week	14.50	9.10	19.10
	1 or 2 days/week	3.90	11.50	7.00
	1 to 3 times a month	2.00	7.40	2.50
	Less than once a month	1.30	13.50	2.00
	Never	3.50	43.80	3.50
Personal reasons	5 or more days/week	18.7	3.7	15.7
	3 or 4 days/week	22.20	7.10	19.90
	1 or 2 days/week	28.20	25.80	27.00

(*continued*)

Table 3. (*continued*)

Travel purpose	Frequency	Prior to the pandemic (%)	During the peak of the pandemic (%)	After the pandemic (%)
	1 to 3 times a month	18.30	28.60	23.40
	Less than once a month	10.60	22.60	11.50
	Never	2.20	12.20	2.50
Shopping	5 or more days/week	6.90	1.30	7.30
	3 or 4 days/week	11.50	5.10	13.20
	1 or 2 days/week	38.00	24.40	36.60
	1 to 3 times a month	30.70	23.90	28.90
	Less than once a month	11.20	21.10	11.40
	Never	1.70	24.20	2.70
Recreation	5 or more days/week	12.60	5.50	14.50
	3 or 4 days/week	21.20	9.70	23.70
	1 or 2 days/week	39.50	19.60	35.20
	1 to 3 times a month	16.80	20.40	14.50
	Less than once a month	8.30	22.90	9.70
	Never	1.70	22.10	2.40

4.1.5 Travel Purposes in the Future

As shown in Fig. 2, the survey responses reveal that, following the end of the COVID-19 pandemic, the majority of participants selected the "neither less nor more" category for leisure, shopping, and personal trips, indicating stable commuting patterns for these purposes. In contrast, for commuting to/from work or education, a higher percentage of respondents chose the "less" category. Similarly, for work-related trips, the largest share of respondents indicated "less," closely followed by those selecting "neither less nor more." The distribution of responses, as illustrated in Fig. 2, suggests future commuting trends: a projected increase in leisure trips, alongside a slight decrease in commuting for work and education purposes. This shift may reflect lasting changes in remote working practices and lifestyle adjustments adopted during the pandemic.

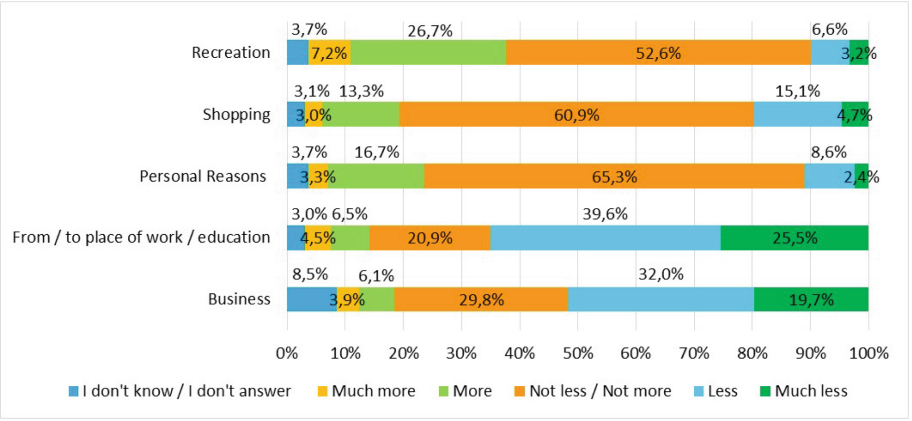

Fig. 2. Expectations about travel purposes in the future

4.1.6 Remote Activities Before, During, and After the COVID-19 Pandemic

Figure 3 illustrates the frequency of working from home before the pandemic, during its peak, and at present (i.e., post-pandemic period). Prior to the pandemic, approximately 80% of employees never worked remotely, 10.3% worked from home less than once a month, and only 1% worked from home three or more days per week. However, during the outbreak of the pandemic, due to government-imposed restrictions, around 60% of employees reported working from home five or more times per week, while only 4.8% never worked remotely. Currently, the distribution of remote work frequency appears more balanced, with almost 23% of the respondents working remotely at least one day per week or more. This suggests that teleworking and online education have evolved into hybrid models, combining remote participation with physical presence in workplaces and educational settings.

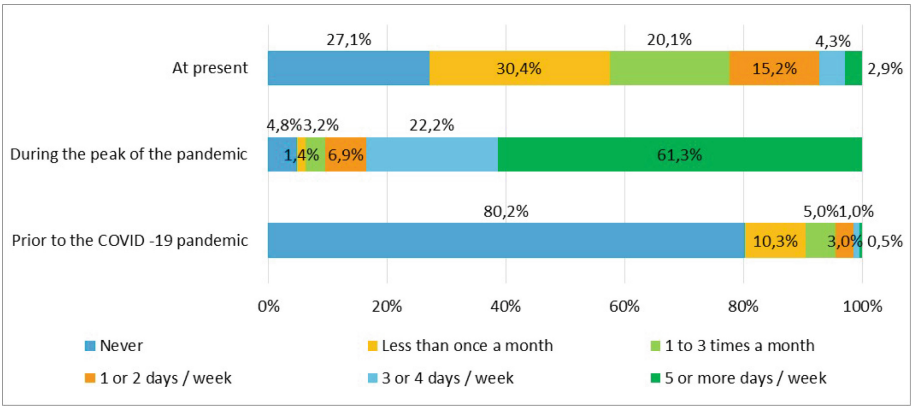

Fig. 3. Frequency of remote activities before, during, and after the COVID-19 pandemic

4.1.7 Remote Activities in the Future

The survey also explored respondents' personal inclination toward continuing remote work post-pandemic. As shown **in** Fig. 4, approximately 30% of employees and students indicated that they are likely to continue engaging in remote work (teleworking) and online education (tele-education) in the future. This demonstrates a considerable interest in maintaining flexible remote activities, particularly for tasks that can be effectively performed without physical presence. The findings suggest that while the widespread adoption of remote activities was initially driven by necessity, a portion of the workforce and student population has fostered the benefits of teleworking and tele-education, mainly relating to work-life balance and time savings. Such attitudes re-iterate the potential for employers and educational Institutions to integrate hybrid models that accommodate evolving preferences and promote flexibility. Such hybrid models can also lead to mobility patterns that are not that reliant to the sole use of the private car, especially for commuting purposes [23].

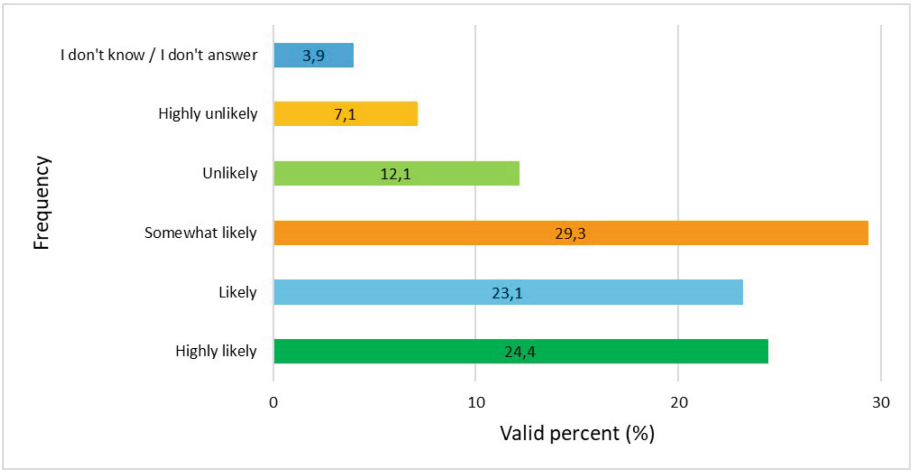

Fig. 4. Likelihood of engaging in remote activities in the future

4.2 Inferential Statistical Analysis

Inferential analysis constitutes an established statistical approach to making generalizations about a larger population based on data collected from a sample. It enables researchers to test hypotheses, determine relationships between variables, and predict future outcomes with a certain degree of confidence. Unlike with the descriptive statistical analysis, which summarizes data and key trends, the inferential analysis focuses on drawing conclusions that extend beyond the immediate dataset. In this analysis, statistical techniques are used to examine the relationships between selected variables, allowing us to identify significant patterns, test for correlations, and infer broader trends that reflect the overall behavior of the population as to post-COVID mobility and remote activity trends.

Numerous tests were conducted to identify potential associations between mobility patterns and remote activities across diffferent periods before and after the COVID-19 pandemic. The type of the statistical test was decided upon evaluating the nature of the compared variables. Specifically,the Spearman Rho correlation was estimated for variables formulated on an ordinal scale, whereas Kruskal Wallis tests were conducted for comparing ordinal with categorical variables. Statistically significant associations at a 95% level of confidence are observed when p-values are lower than 0.05.Table 4 provides results of key statistical tests.

Table 4. Overview of the statistical tests and their results

Dependent Variable	Independent Variable	Statistical Test	P-value	Coefficient/Statistic
Future car/taxi usage compared to before the pandemic	Pre-pandemic car/taxi use frequency	Spearman Rho	0.018	0.071
Future car/taxi usage compared to before the pandemic	Pre-pandemic bus use frequency	Spearman Rho	0.005	−0.084
Future car/taxi usage compared to before the pandemic	Pre-pandemic walking frequency	Spearman Rho	0.144	−0.044
Future city bus usage compared to before the pandemic	Pre-pandemic car/taxi use frequency	Spearman Rho	0.105	0.049
Future city bus usage compared to before the pandemic	Pre-pandemic bus use frequency	Spearman Rho	0.546	−0.018
Future city bus usage compared to before the pandemic	Pre-pandemic walking frequency	Spearman Rho	0.034	−0.064
Future car/taxi usage compared to before the pandemic	Current car/taxi use frequency	Spearman Rho	0.737	0.010
Future car/taxi usage compared to before the pandemic	Current bus use frequency	Spearman Rho	0.001	−0.101
Future car/taxi usage compared to before the pandemic	Current walking frequency	Spearman Rho	0.278	−0.032

(*continued*)

Table 4. (*continued*)

Dependent Variable	Independent Variable	Statistical Test	P-value	Coefficient/Statistic
Frequency of future commuting to/from work/education	Pre-pandemic frequency of commuting to/from work/education	Spearman Rho	0.004	−0.087
Frequency of future commuting to/from work/education	Age	Kruskal-Wallis H	<0.001	H = 34.436
Frequency of future commuting to/from work/education	Income	Kruskal-Wallis H	<0.001	H = 31.446

Overall, the results of the statistical tests show weak correlations between future travel habits and pre-pandemic transportation patterns. Future car/taxi usage is significantly correlated with pre-pandemic usage but with a weak correlation coefficient ($\rho = 0.071$), suggesting that individuals who used cars or taxis more frequently before the pandemicare slightly more likely to continue doing soin the future.In contrast, future bus and walking usage show weak, non-significant correlations with the same pre-pandemic behaviors.Conversely, pre-pandemic bus usage shows a significant negative correlation with future car/taxi use ($\rho = -0.084$), indicating a potential shift away from private vehicle use among pre-pandemic bus users.Current bus usage frequency negatively correlates with future car/taxi usage ($\rho = -0.101$), highlighting a possible sustained preference for public transit among current bus users.

Furthermore, the frequency of future commuting to/from work or education is significantly related to both pre-pandemic commuting habits ($\rho = -0.087$) and sociodemographic factors. Specifically, age and income show strong associations with future commuting frequency, as indicated by the highly significant Kruskal-Wallis test results ($H = 34.436$, p-value<0.001 for age; $H = 31.446$, p-value<0.001 for income), suggesting that younger individuals and those with different income levels may adjust their commuting patterns differently post-pandemic [24].

5 Conclusions, Recommendations and Limitations

This study highlights the lasting impact of the COVID-19 pandemic on mobility patterns and commuting patterns in Greece, revealing shifts in user behavior, evolving preferences, and changing demands for transportation and activity arrangements—changes expected to persist over time. The pandemic triggered significant long-term transformations in how people commute and work, setting the stage for new trends in urban mobility. While many pre-pandemic commuting behaviors are gradually returning to the pre-pandemic status, certain structural shifts are evident as citizens adapted to imposed restrictions and remote activities.

Before the pandemic, private vehicles and urban buses dominated travel choices. However, concerns over virus transmission during the pandemic led to a sharp decline in their usage. Interestingly, pedestrian mobility experienced only a slight decrease, contrary to expectations of an increase. Today, public transportation use is gradually recovering, though lasting behavioral changes remain visible. The study confirms that commuting for work and education has consistently been the primary reason for mobility, reaffirming the critical role of public transportation in supporting daily life, particularly during periods of disruption. This underlines the need for continuous investment in transportation infrastructure.

The pandemic also accelerated the adoption of remote work (teleworking) and online education (tele-education), despite some initial technical challenges. It is expected that teleworking and tele-education will continue to play an important role in the future, most likely through hybrid models that combine remote and in-person participation. In addition to these shifts, there is a growing interest in recreational activities, reflecting a broader trend towards wellness and sustainability. Individuals appear more inclined toward environmentally friendly modes of transport, such as walking and cycling, which can also bear significant public health benefits.

Age and income were found to play significant roles in shaping future mobility preferences. Younger individuals are more open to adopting sustainable options, while older generations tend to prefer more traditional travel modes. In addition, high-income travelers may be more reluctant to use public transportation in the future [18].

Overall, the pandemic has induced lasting changes in mobility and activity habits in Greece, leading to notable shifts toward teleworking, flexible commuting patterns, and sustainable transportation choices. While commuting for work and education has decreased, recreational mobility remains stable. These findings emphasize the need for continued infrastructure development, policy support, and promotion of innovative, sustainable urban mobility solutions. Given the observed changes in commuting and working patterns, several recommendations arise to support sustainable mobility in Greece. First of all, broader, more detailed studies are essential to further understand citizens' evolving transportation and commuting habits, particularly regarding remote work and online education. Future research should include diverse demographic groups to ensure more comprehensive findings and inform policy decisions. Additionally, investing in safer and more accessible infrastructure for pedestrians and cyclists is key to supporting the continued growth of sustainable mobility. Developing such infrastructure can reduce reliance on private vehicles and enhance overall urban quality of life. Public transportation systems should also be improved by leveraging smart technologies (such as electronic ticketing, and integrated mobility services), improving efficiency, reducing congestion, and increasing accessibility.

Further investments in digital infrastructure are necessary to sustain teleworking and tele-education practices, especially in remote or underserved areas. Supporting hybrid work and education models will reduce commuting demands while promoting productivity and work-life balance. Raising awareness about sustainable mobility options—including public transportation, walking, and cycling—is also essential. Special efforts should target elderly individuals to encourage broader adoption of alternative travel modes.

The implications of the study extend across multiple stakeholder groups. Public authorities and policymakers can utilize the findings to shape inclusive mobility policies and prioritize infrastructure investments. Researchers and urban mobility experts are provided with some initial evidence for further investigations into post-pandemic behavior. At the same time, employers and educational institutions can leverage insights on teleworking and tele-education to design more flexible, hybrid participation models. Finally, transportation service providers may use these results to better align their services with user expectations and needs, fostering a more adaptive and sustainable mobility ecosystem.

While the study offers valuable insights, it is important to acknowledge its limitations. The sample is primarily composed of individuals from the academic community and younger demographic strata, which restricts the generalizability of the findings to other socioeconomic groups. Future research should aim for broader representation, including public and private sector employees and residents from rural areas. Additionally, the reliance on self-reported data introduces the possibility of inaccuracies due to subjective perceptions or biases. To improve data reliability, future studies could incorporate the use of purely observational data rather than self-reported data. The study also focuses on changes observed during and after the pandemic; however, long-term trends may differ as society continues to evolve. Longitudinal research and repeated data collection would offer a clearer picture of evolving mobility patterns. Finally, the questionnaire design may not have fully captured the complexity of commuting and teleworking behaviors. Refining the survey with more targeted questions on the multi-nuanced aspects of remote activities could enhance the breadth and depth of the empirical investigation.

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