

Modelling Determinants of Sustainable Travel Behaviour: A Multivariate Regression Approach

Eleni Maria Theodoraki^{1*}[0009-0001-6033-0728], Paraskevi Koliou¹, Alexandra Ntarla¹,
George Yannis¹

¹ National and Technical University of Athens, Iroon Polytechniou 5-9, 15772 Athens, Greece
*e_theodoraki@mail.ntua.gr

Abstract. Promoting green travel behaviour is essential for advancing sustainable urban mobility. This study explores the behavioural, perceptual, and socio-demographic factors that influence individuals' adoption of environmentally friendly travel modes. Drawing on structured survey data, two outcomes were analysed: (1) self-reported frequency of green travel and (2) scenario-based willingness to switch to green transport options.

To address multicollinearity and enhance model interpretability, both binary logistic and multinomial logistic regression techniques were employed across reduced variable sets. Significant predictors include infrastructure quality (e.g., road and parking conditions), perceived accessibility, travel time sensitivity, health-related motivations, and demographic attributes such as age, income, and bike ownership. The models demonstrate strong predictive performance according to standard statistical evaluation indicators.

Findings underscore the importance of both contextual infrastructure and individual-level factors in shaping sustainable travel behaviour. This dual modelling framework offers actionable insights for urban planners and policymakers aiming to promote green mobility through user-centric design and targeted behavioural interventions.

Keywords: Green mobility, travel behaviour, sustainable transport, logistic regression, urban planning.

1 Introduction

Cities aim to reduce car dependency and emissions, still last-mile delivery and individual mobility needs are dominated by automobiles [1]. Although shared cargo bikes (SCB) have emerged as a sustainable alternative, offering both functional capacity and environmental benefits, their introduction into everyday mobility systems has been slow and uneven [2]. Evidence shows that cargo bike sharing can displace car use and even reduce car ownership [3], but results depend on user motives and perceived performance. Transport constitutes one of the most significant sources of urban emissions; thus, the encouragement of walking, cycling, and public transport is at the core of the sustainable mobility sphere [1,2]. Socio-demographic characteristics such as age, income, and vehicle ownership significantly influence travel mode choice, with younger

individuals and non-car owners more likely to adopt environmentally friendly transport options [3,4].

Sustainable public transportation is evaluated across social, economic, environmental, and technical dimensions, with travel time, ticket prices, and emissions prioritized as the most critical indicators through Multi-Criteria Decision-Making (MCDM) tools like the Parsimonious Analytic Hierarchy Process (PAHP) [5]. These costs often exceed municipal budgets, as current operator compensation frequently covers only about half of the real operating expenses. Additionally, the state of the city's infrastructure, such as the sidewalks and road quality, as well as the green spaces, also contributes to the attractiveness of active mobility [6,7]. Environmental awareness and health motivation can also contribute to the practice of sustainable travel behavior [8,9,10]. Discrete choice modelling and logistic regression modelling are commonly used to measure the effects of various demographic attributes, perceptions, and infrastructures on travel behavior and policy interventions [11,12,13]. Athens is a city that can be used to illustrate the relevance of the above issues. Despite the city's investment in public transport infrastructure, the city is car-dependent, with limited active mobility infrastructure.

This study investigates the determinants of sustainable travel behaviour using survey data collected in Athens. A multivariate modelling framework is applied to identify the key socio-demographic, perceptual, and behavioural factors associated with sustainable mobility choices.

2 Methodology

2.1 Data Collection and Survey Design

A structured online questionnaire was distributed to adult residents of Athens using Google Forms. A total of 178 valid responses were collected. The survey included questions on travel behaviour, perceptions of the urban environment, willingness to support sustainable mobility policies, and socio-demographic characteristics such as age, gender, income, employment status, and vehicle ownership.

2.2 Variables

There were two primary dependent outcomes considered. First, the frequency of green travel indicates how frequently respondents reported they used sustainable modes of transportation as part of their daily mobility. The variable was coded with 1 denoting frequent use and 0 denoting infrequent use. Second, the willingness to switch (multinomial) was derived from the scenario-based preference tasks. The respondents selected three options. The first option is 0= No change (status quo), the second is 1= Few pedestrianization/green projects, and the third is 2= Many pedestrianization/green projects.

Three domains were used to group the explanatory variables: socio-demographic attributes (e.g., age, gender, education, employment, income, household size, and vehicle ownership); mobility-related indicators (e.g., trip purpose, travel time, cost sensitivity, parking availability, and trip frequency); and perceptions and attitudes, including comfort, safety, accessibility, health and environmental benefits, barriers to walking and cycling, and evaluations of urban infrastructure (e.g., roads, sidewalks, greenspace, slope, and traffic speed).

2.3 Modelling Framework

Logistic regression models have been widely applied in transportation behaviour research to analyse decision-making processes and policy responses. Two regression approaches were applied, Binary logistic regression (BLR) to estimate the probability of frequent green travel, and multinomial logistic regression (MNL) to analyse willingness to switch between policy scenarios. Models were estimated in R using maximum likelihood estimation.

Both models were estimated in the R statistical environment. The binary model was estimated using the `glm()` function, while the multinomial model was estimated using `nnet::multinom()`. The `glm()` function applies maximum likelihood estimation within the generalized linear modelling framework, making it suitable for analysing binary outcomes such as the probability of frequent sustainable travel.

2.4 Variable Selection and Multicollinearity Control

The independent variables that were considered were demographics, mobility features, and indicators of attitudes. In order to prevent excessive fitting of the model, stepwise selection (both forward and backward) was used, guided by the Akaike Information Criterion (AIC), keeping only those predictors that enhanced the model. The Variance Inflation Factor (VIF) was used to check for collinearity between the variables, and those that were above the standard limit of 10 were dropped. This method made sure that the models were minimal with understandable coefficients.

2.5 Model Evaluation

Model performance was evaluated using Akaike Information Criterion (AIC), McFadden's pseudo- R^2 , Receiver Operating Characteristic (ROC) curves with Area Under the Curve (AUC), and the Hosmer–Lemeshow goodness-of-fit test.

These metrics were selected because they jointly assess model fit, explanatory power, and predictive accuracy. The Akaike Information Criterion allows comparison between model specifications while penalising complexity, McFadden's pseudo R^2 provides an indication of explanatory power, and ROC/AUC evaluates predictive performance. The Hosmer–Lemeshow test assesses goodness-of-fit by comparing observed and predicted probabilities.

3 Results

3.1 Descriptive Statistics of the Sample

The sample mainly consisted of individuals aged 25–35, with a high proportion holding tertiary education. Most respondents reported owning a private car, while smaller shares owned bicycles or electric scooters. Travel behaviour patterns indicate continued reliance on private vehicles, although walking and public transport are frequently used for short-distance trips.

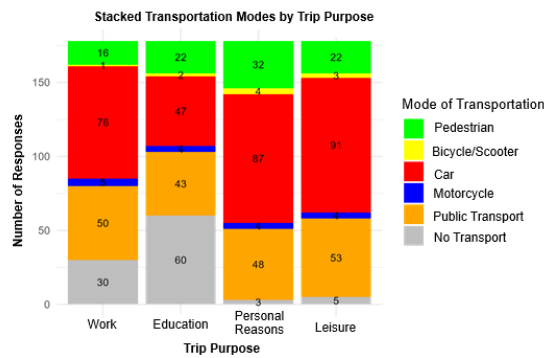


Fig. 1: Stacked Transportation Modes by Trip Purpose

Table 1. Descriptive characteristics of the survey sample (N = 178)

Characteristic	Categories (% of respondents)
Gender	Female: 66%, Male: 34%
Age group	18–24: ~15%, 25–34: ~45%, 35–44: ~20%, 45+: ~20%
Education level	Secondary or below ~10%, Undergraduate ~50%, Postgraduate/PhD ~40%
Annual income	< €15,000 ~60%, €15,000–30,000 ~25%, > €30,000 ~15%
Employment status	Private sector ~40%, Self-employed ~20%, Student ~20%, Public sector/Other ~20%
Household size	1 member ~15%, 2–4 members ~65%, 5+ members ~20%
Car ownership	At least one vehicle ~65%
Bicycle/e-scooter ownership	Yes ~20%, No ~80%

3.2 Binary Logistic Regression: Frequency of Green Travel

The binary logistic regression model examined the probability of being a frequent green traveller. Several predictors emerged as statistically significant. The employment status and age were associated with variations in sustainable travel frequency, suggesting that younger and student populations are more inclined toward green mobility. Infrastructure quality variables, including road conditions and accessibility, were positively associated with green travel frequency. Attitudinal indicators, such as health benefits and environmental concerns, also played a role, albeit with lower statistical significance compared to infrastructure-related variables.

The model achieved strong predictive performance, with an AUC of 0.82 and a McFadden's pseudo- R^2 of 0.24, indicating reliable explanatory power.

Table 2. Binary logistic regression results for frequency of green travel (dependent variable: frequent use of sustainable modes = 1)

Variable	Coefficient (β)	Std. Error	z-value	p-value	Significance
Constant	-0.842	0.314	-2.68	0.007	P<0.05
Age (younger groups)	0.421	0.185	2.27	0.023	P<0.05
Employment (student)	0.516	0.201	2.56	0.011	P<0.05
Accessibility	0.338	0.148	2.28	0.022	P<0.05
Road quality	0.295	0.142	2.08	0.037	P<0.05
Health benefits	0.276	0.132	2.09	0.036	P<0.05
Environmental concern	0.242	0.120	2.01	0.044	P<0.05

3.3 Multinomial Logistic Regression: Willingness to Switch

The multinomial model examined willingness to shift to greener mobility under policy scenarios, using "no change" as the baseline. Results showed that both infrastructure and attitudes were key drivers. Perceived barriers and low comfort significantly reduced support for pedestrianisation, while better road quality increased willingness to switch. Greenspace availability had a negative effect, indicating dissatisfaction with current urban greenery. Socio-demographic factors, such as employment status and relaxation motives, also influenced preferences.

The model demonstrated strong predictive performance, with an AUC of 0.86 and a pseudo- R^2 above 0.30, confirming substantial explanatory power.

Table 3. Multinomial logistic regression results for willingness to switch (base outcome: No change, choice = 0)

Variable	Coefficient (β)	Std. Error	p-value	95% CI (Lower, Upper)
Barriers (b1_barriers)	-0.827	0.256	0.001 **	(-1.328, -0.326)
Comfort (a5_comfort)	-0.739	0.199	<0.001 ***	(-1.130, -0.349)
Road quality (b1_roads)	0.718	0.204	<0.001 ***	(0.319, 1.117)
Greenspace (b1_greenspace)	-0.646	0.192	<0.01 **	(-1.022, -0.270)
Trips: Relaxation (a6_relax_num)	0.785	0.250	0.002 **	(0.295, 1.274)
Trips: Personal (a6_personal_num)	-0.494	0.229	0.031 **	(-0.944, -0.045)
Trips: Relaxation (a2_relax_num)	-0.386	0.179	0.031 **	(-0.738, -0.035)
Trips: Employment (a3_employ- ment_num)	0.384	0.149	0.010 **	(0.092, 0.676)
Trips: Employment (a6_employ- ment_num)	0.417	0.186	0.025 **	(0.052, 0.782)
Safety/Speed (b1_speed)	-0.461	0.191	0.016 **	(-0.836, -0.086)
Trips per week (b3_num)	-0.530	0.159	<0.01 **	(-0.842, -0.219)
Household size (d9_num)	0.463	0.170	0.007 **	(0.129, 0.796)
Neighborhood factor (b4)	0.375	0.179	0.036 **	(0.024, 0.727)

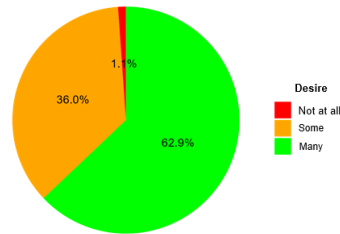


Fig. 2: Desire of Pedestrianization in Athens

The multinomial regression results further confirm the importance of infrastructure quality and perceived barriers in shaping support for sustainable mobility policies. Individuals who perceive greater obstacles to walking or cycling are significantly less likely to support extensive pedestrianisation initiatives. Similarly, lower perceived comfort reduces support for green mobility policies. In contrast, better road quality increases public acceptance of sustainable mobility initiatives, suggesting that citizens are more willing to support such policies when the urban environment is well maintained and suitable for active travel.

4 Discussion and conclusions

The study highlights how infrastructure, perceptions, and socio-demographic factors interact to shape sustainable travel behaviour. Infrastructure quality emerged as the most influential factor: good road conditions and accessibility supported environmentally friendly modes, while poor sidewalks and barriers discouraged walking and cycling, confirming previous research. Greenspace availability showed a negative relationship with attitudes toward sustainable mobility, suggesting dissatisfaction with its quality or integration. Overall, safe and accessible infrastructure encourages sustainable travel, whereas poor conditions deter it. Subjective perceptions were also important. Lower comfort and high traffic speeds reduced support for sustainable transport, while health and environmental motivations had a weaker positive effect. Socio-demographic factors, particularly age and employment status, were significant: younger individuals and students were more likely to use and adopt green transport.

Trip characteristics influenced behavior as well. Flexible trips (e.g., leisure) increased openness to sustainable options, while work-related trips reduced willingness to switch due to time constraints. Improving safety, comfort, and infrastructure, such as sidewalks, road quality, and speed management, could promote greener travel. Policymakers should adopt user-centered strategies, including better pedestrian and cycling networks, improved urban greenery, lower traffic speeds, and targeted behavioural incentives.

The study contributes by combining revealed behaviour and stated preference models, but is limited by a small sample (178 respondents) and potential bias toward

younger, digitally active individuals. Future research should use larger, more representative samples.

5 Conclusion

Furthermore, socio-demographic and trip-related factors, such as age, employment status, and leisure travel frequency, contribute to a more detailed explanation of the behaviour. The dual modelling framework results confirmed that connecting present travel patterns with scenario-based willingness to shift (AUC up to 0.86; pseudo- $R^2 > 0.30$). The findings suggest the necessity of user-centric policy measures, such as infrastructure upgrades, the utilization of green spaces, and speed management, as well as the implementation of incentive schemes targeting young people who are more willing to change their modes of transportation. This, however, is not only a case for Athens but also a contribution of these results to the global debate on sustainable mobility, where the joint role of objective infrastructure and subjective perceptions is highlighted. Future research should aim to expand the dataset to include larger and more representative samples across different urban areas. In addition, the integration of revealed mobility data and advanced modelling techniques such as machine learning could provide deeper insights into sustainable travel behaviour.

6 References

1. Banister, D.: The sustainable mobility paradigm. *Transport Policy* 15(2), 73–80 (2008)
2. Creutzig, F. et al.: Transport: A roadblock to climate change mitigation? *Science* 350, 911–912 (2015). Available at: <https://www.science.org/doi/10.1126/science.aac8033>
3. Beirão, G., Sarsfield Cabral, J.A.: Understanding attitudes towards public transport and private car: A qualitative study. *Transport Policy* 14(6), 478–489 (2007).
4. Beckx, C., Panis, L.I., Vankerkom, J., Janssens, D., Wets, G., Arentze, T.: An integrated activity-based modelling framework to assess vehicle emissions: Approach and application. *Environment and Planning B: Planning and Design* 36(6), 1086–1102 (2009).
5. Al-lami, A., Török, Á.: Assessing sustainability indicators of public transportation using PAHP. *Sustainable Futures* 9 (2025).
6. Pucher, J., Buehler, R.: Walking and cycling for healthy cities. *Built Environment*, 391–414 (2010). Available at: <https://doi.org/10.2148/benv.36.4.391>
7. Willis, D.P., Manaugh, K., El-Geneidy, A.: Cycling under influence: Summarizing the influence of perceptions, attitudes, habits, and social environments on cycling for transportation. *Transport Reviews* (2015). Available at: <https://doi.org/10.1080/15568318.2013.827285>
8. Kaparias, I., Bell, M.G.H., Miri, A., Chan, C., Mount, B.: Analysing the perceptions of pedestrians and drivers to shared space. *Transportation Research Part F: Traffic Psychology and Behaviour* 15(3), 297–310 (2012).
9. Gatersleben, B., Appleton, K.M.: Contemplating cycling to work: Attitudes and perceptions in different stages of change. *Transportation Research Part A: Policy and Practice* 41(4), 302–312 (2007).
10. De Nazelle, A. et al.: Improving health through policies that promote active travel: A review of evidence to support integrated health impact assessment. *Environment International* (2011).
11. Ben-Akiva, M., Lerman, S.R.: *Discrete choice analysis: Theory and application to travel demand*. MIT Press, Cambridge (1985).

12. Kroes, E.P., Sheldon, R.J.: Stated preference methods: An introduction (1988).
13. Ewing, R., Cervero, R.: Travel and the built environment. *Journal of the American Planning Association*, 265–294 (2010). Available at: <https://doi.org/10.1080/01944361003766766>