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Free Public Transport in Athens: a stated preference approach

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Abstract

In recent years, free public transport has been proposed as a way to attract more passengers, in order to reduce congestion but also to reduce pollution. This study aims to explore the attitudes of passengers living in Athens towards free public transport. The method of stated preference and hypothetical cost, time and route comfort scenarios were used to collect the required data, which were included in a specially designed questionnaire answered by 234 Athenians. Subsequently, logistic regression models (binary and multinomial) were developed, which showed that the probability of changing means of free public transport depends largely on the cost, time, comfort, beliefs, transportation characteristics and demographic characteristics of the respondents. The faster and more comfortable the journey, regardless of cost reduction, the more likely it is to opt for free public transport instead of staying in the existing means of transport.

Keywords: public transport, free public transportation, stated-preference, logistic regression models

1. Introduction

The term "public transport" describes a wide range of systems and means of transport, referring to both long-distance and urban transport, as well as all land, sea and air transport. Public transport offers transportation services to a public, which makes frequent use of various means of public transport. At this point it should be mentioned that the term "public" refers to the fact that these means are offered for public use, and not that they necessarily belong to a public body (Gavanas et al., 2015).

The transport in metropolitan area of Athens consists of the means of road transport (City Buses and Trolley) and the means of fixed track (Metro, Tram, Suburban). The Athens Urban Transport Organization (OASA) is responsible for the operation of all the aforementioned means, except for the Suburban Railway, the operation of which is supervised by TRAINOSE.

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The continuous growth of transport demand along with the increased traffic congestion has potential detrimental impacts, which threaten the environment, the economic competitiveness and the social cohesion in Europe. The new mobility requirements motivated the European Commission to take radical steps for the development of sustainable urban transport systems. Providing a reliable public transport service is considered to be an important element for creating sustainable mobility (European Commission, 2004). The key policy issue of an efficient and sustainable urban transport system lies in reconciling two major objectives: minimizing traffic and its detrimental impacts, while fulfilling the demand for accessibility in support of economic and social goals. Public transport can serve both of them (De Witte et al., 2008, Cats et al., 2017).

1.1. Previous research

So far, free public transport has been implemented in many countries such as Germany, Japan, the United Kingdom, Denmark, and Sweden as well as in the USA. U.S. examples include the Ride Free Transit program in Illinois, the Golden Pass program in Miami-Dade County, Florida, and the Pennsylvania Free Transit Program (Mah and Mitra, 2017). In some of the studies, the researchers study the change in the middle of the trip before, during and after the implementation of the pilot project. While in other studies the data are recorded and analyzed during and after the implementation of the plan (Friman et al., 2019). In the United Kingdom, an action plan is in place, allowing seniors to take all local buses free of charge during fixed hours on weekdays and all day on weekends and public holidays. The positive effect of the free bus program has been demonstrated through a cost-benefit analysis based on data from the Ministry of Transport (Jones et al., 2013). Unlike the free shuttle policy in the United Kingdom, Canada offers free public transportation only for one day of the week and sometimes for a specific period. According to Mah and Mitra, in 2017 a survey was conducted to investigate the travel behaviors of seniors in relation to a free bus program in Canada. From this study it was found that the reasons for using the free bus were related to improving health, cost savings, social participation and daily planning (Zhang et al., 2019).

Based on the aforementioned, the objective of the present study is to investigate the preferences towards free public transport in Athens and to identify the most important factors that affect the choice of the Athenians towards transport means.

2. Methodology

The present research is aiming to document the response of passengers living in Athens, Greece, metropolitan area towards free public transport. More specifically, the study is trying to imprint the sensitivity of passengers' stated preference towards the new travelling conditions that occur after the implementation of free public transport and whether they would opt for free public transport instead of staying in the existing means of transport. Based on that objective, stated preference method was selected as an appropriate analysis method. In order to conduct such an analysis, a specially designed questionnaire was developed and answered in the form of an e-survey by 234 Athenians.

The following subsections present the design of the questionnaire survey and the theoretical framework of the statistical models used for the analysis.

2.1. Questionnaire survey structure

The questionnaire was divided into four sections and includes a total of 27 questions. The time required to complete it is about 8 - 10 minutes. The questionnaires were collected exclusively in the form of an online survey. The first question constitute a screening question, keeping only the respondents that live and move around Athens. This is followed by the second screening question of whether public transport is used as the main mean of transportation, leaving out the positive responses, as the specific respondents do not correspond at the target group of the survey. Thus, a total of 234 questionnaires were collected, a sufficient number for such surveys, so that the results of their analysis can be considered reliable.

The first section of the questionnaire consisted of questions with respect to mobility and driving behavior habits of the participants. In this way the respondents are gradually introduced to the framework of the research by answering questions, which will later be particularly useful in drawing conclusions. Subsequently, participants are asked about

their views on the means of transportation, e.g. “In a scale of 1-5, how important do you find the following aspects of transportation: cost, duration, comfort, availability?”.

The third section of the questionnaire survey constitutes basically the main part of the stated preference approach. Participants were asked to declare their preference in ten hypothetical scenarios. Explicitly, they were required to choose between the existing means of transport and switch to free public transport (PT) based on 3 parameters: time, cost, and comfort. Table 1 shows the ranges of the respective values.

Table 1. Description of the 3 parameters used in the scenarios

Variables	Change mode to PT	Stay at existing mode
Cost variation	-100% -75% -50%	0%
Time variation	-20% 0% +20%	0%
Comfort variation	high unvaried low	0%

The fourth section of the questionnaire regards participants’ demographic and socioeconomic characteristics, namely gender, age, annual income, education background, occupation etc.

2.2. Theoretical background

Logistic regression models are used when the dependent variable is distinct (such as whether or not to opt for free public transport instead of staying in the existing means of transport). Logistic regression is used to create models for predicting the influence of the presence or absence of certain characteristics in the selection of a particular alternative. In that context, utility function is used as a function of the attributes and other factors that affect the choice of the respondent, i.e. to opt for free public transport or stay in the existing means of transport.

More specifically, the utility function is defined as a mathematical model that describes the probability of the choice of each individual among alternatives based on the attributes. Based on the utility maximization context, as described by McFadden (1974) and Ben-Akiva and Lerman (1985), the utility of an alternative i (U_i) consists of a systematic part V_i and an error term ϵ, where the systematic part consists of (a) a vector of attributes α with attribute values Xiα for a given alternative i, and (b) their marginal effect on utility βiα and an Alternative Specific Constant ASC that captures systematic but non-explained variability in the data:

$$U_i = V_i + \varepsilon \quad (1)$$

Where V_i is given by:

$$V_i = \beta' X_i + ASC_i \quad (2)$$

Following Joseph Hilbe, (Hilbe, 2009) logistic regression analysis can be used both for the development of a binary model (where there are two possible probabilities) and for the development of a model with more alternatives - a multinomial logit model (MNL-model) model. The present analysis examines both models. The binomial model answers to the question "would you use free public transport?" with possible answers "yes" or "no", while the MNL model quantifies respondents’ choice related to the means of transport (PT or existing), as a function of travel cost, travel time, trip comfort and a set of independent variables from the first, second and fourth section of the questionnaire survey.

3. Results and Discussion

3.1. Sample descriptive statistics

The descriptive statistics show that the majority of the participants belong to the age range of 18-29 years, with an average annual income and most of them are private employees. Finally, by a small margin, most of the participants

who completed the questionnaire are women. Table 2 illustrates the percentage distribution of the sample by gender, age, income, and occupation.

Table 2. Percentage distribution of the sample by gender, age, income and educational level

Variables	Percentage %
Gender	
Male	45.30
Female	54.70
Age	
18-29	48.29
30-44	41.03
>45	10.68
Income	
<15.000	40.60
15.000 – 30.000	50.43
>30.000	8.97
Occupation	
Private Sector	47.44
University Student	12.82
Freelancer	29.91
Other	9.83

3.2. Binary Logistic Model

Considering the participants' response to the question "Would you prefer free public transport in Athens?", the model is presented below. Following a backwards elimination process as well as trying to include independent variables from all sections of the questionnaire survey, the following appropriate set of independent variables was used to specify the final model. Table 3 shows the binary logistic regression model results.

Table 3. Binary logistic regression model

Parameters	**βi**	**p-value**	**Odds Ratio**
(Intercept)	-0.522	<0.001	0,593
WORK1	0.755	<0.001	2,128
USE_C62	2.436	<0.001	11,427
CHAR_COST74	-0.882	<0.001	0,414
AGE2	-0.053	n/a	n/a
AGE3	1.012	<0.001	2,751
GENDER1	0.562	<0.001	1,754
AIC	2871		
X-squared	11.44	0.178	

The variables included in the model are defined below:

- WORK1, the option "For work" in the question "What is the purpose of your transportation?"
- USE_C62, the "Rarely and never" option in the question "How often do you use the car in your daily commute?"
- CHAR_COST74, the option "Slightly important and not at all important" in the question "How important do you consider the cost as a feature of your travel?"

- AGE3, the age variable for level over 45 years, in relation to the level of ages 18 - 29
- GENDER1, the option "Woman" in the question "Choose your gender"

The aforementioned parameters are reasonable and statistically significant at the 95% confidence level or above that. In addition, according to the Hosmer – Lemeshow goodness of fit test (Hosmer et al., 1988), chi-squared is equal to 11.44 (p-value = 0.178) indicates that the model fits the data.

The results could be further interpreted when calculating the risk ratios of the independent variables. More precisely, the answer "For work" (WORK1) when asked the question "What is your travel purpose?" seems to increase the probability of preferring free public transport in Athens by 2.1 times. Estimating that commuting to and from work is a permanent expense for respondents, the case of free public transport would serve them more efficiently.

When the answer to the question "How often do you use the car as a means of transportation?" is "Rarely and never" (USE_C62), then there is an increase in the probability of choosing free public transport by 11.4 times. A possible explanation might be that the lesser the commuters use their car as a means of transportation, the stronger their desire for free public transport in Athens.

Moreover, when asked the question "How important do you consider the cost of your travel?", the answer is "Slightly important and not at all important" (CHAR_COST74), the probability of choosing free public transport is reduced by 0.4 times or 60%. This result may reflect the sample of the respondents that have a higher annual income.

Regarding the demographic characteristics of the participants, two were the parameters to be found statistically significant in the model. More precisely, when the age range is higher than 45 years (AGE3) in relation to the age range 18 - 29 years old, then there is an increase in the probability of choosing free public transport by 1.8 times. The preference of free public transport by the age group of> 45 years old serves their needs and automatically facilitates their daily life, as certain problems are avoided, such as parking and traffic jams. With respect to the participants' gender, the results reveal that females have an increased probability of choosing free public transport by 2.7 times compare to men.

3.3. Multinomial Logistic Model

This section presents the findings of the statistical analysis on participants' choice of means of transport, based on the data collected in the third section of questionnaire survey. As explained above, participants were asked to choose whether they would opt for free public transport instead of staying in the existing means of transport, as a function of travel cost, travel time, and comfort. In the following Table (Table 4), the final multinomial logistic model is presented. It is noted that all variables are statistically significant at the 95% or 99% confidence levels.

Table 4. Multinomial Logistic Model

Parameters	**βi**	**p-value**	**Odds Ratio**
(Intercept):1	-0.011	0.966	-
Cost	-0.799	<0.001	0.450
Time	-1.648	<0.001	0.192
Comfort1	-0.188	<0.001	0.829
Comfort2	0.692	0,577	1.997
OTHER1	-0.652	<0.001	0.521
USE_PT72	-0.428	<0.001	0.652
DIS_PAC/GE84	0.428	<0.001	1.534
LOW_COST86	-0.371	<0.001	0.690
IN2	-0.057	0.577	-
IN3	-0.654	<0.001	0.520
AGE2	-0.124	0.229	-
AGE3	0.335	<0.001	1.398

Log-Likelihood	-1328.8
McFadden R^2	0.182
Likelihood ratio test : chisq	562.55

The variables included in the model are defined below:

- Cost, the travel cost
- Time, the travel time
- Comfort1, low level of the trip comfort variable, relative to the constant comfort level
- Comfort2, high level of the trip comfort variable, relative to the unchanged comfort level
- OTHER1, the option "Other issues" in the question "What is the purpose of the transportation?"
- USE_PT72, “Rarely and never” option in the question “How often do you use public transport for your transportation?”
- DIS_PAC / GE84, the option "Slightly satisfactory and not at all satisfactory" in the question "Do you consider the existing fare discount packages satisfactory?"
- LOW_COST86, the option "Slightly satisfactory and not at all satisfactory" in the question "What is your opinion on reducing public transport costs?"
- IN3, the variable of high income, in relation to low income
- AGE3, the age variable for level over 45 years, in relation to the level of ages 18 – 29

The results could be further interpreted when calculating the risk ratios of the independent variables. Specifically, when the cost of travel (Cost) increases by one unit, there is a reduction in the probability of choosing free public transport by 0.45 times or 55%. In the same context, when the travel time increases by one unit, there is a reduction of the probability of choosing the free public transport by 0.19 times or 81%. These results seem to be expected, as both travel cost and time are highly important when choosing a transport mode (Cools et al., 2016; Fearnley, 2013).

As for the comfort level of the trip, it is found that when the level of commuting comfort is low (Comfort1) in relation to the unchanged level of comfort, then there is a reduction of the probability of choosing free public transport by 0.83 times or 17%. On the contrary, as expected, when the level of commuting comfort is high (Comfort2) in relation to the unchanged level of comfort, then there is an increase in the possibility of choosing free public transport by 2 times.

Furthermore, when respondents answer “Other issues” to the question "What is the purpose of the transportation?" (OTHER1), there is a reduction of the probability of choosing free public transport by 0.52 times or 48%. The reduction of the possibility of choosing the free public transport may be explained by the fact that the purpose of the transportation may not require daily and costly need.

On the same note, when asked the question "How often do you use public transport for your transportation?" the answer is “Rarely and never” (USE_PT72), then there is a reduction of the probability of choosing free public transport by 0.65 times or 35%. Expected result, as the free use of public transport is not a major incentive, in the case that there is little or no use of them.

When respondents answer "Slightly satisfactory and not at all satisfactory" (DIS_PAC / GE84), to the question "Do you consider the existing fare discount packages satisfactory?" then there is an increase in the probability of choosing free public transport by 1.5 times. A similar statistically significant variable was found the answer “Slightly important and not at all important” (LOW_COST86) to the question "What is your opinion on cost reduction as a proposal to improve public transport?". The specific answer seems to reduce the probability of choosing free public transport by 0.69 times or 31%. Therefore, respondents who do not seem to be really interested in cost reduction as a proposal to improve public transport, are not prone for a change of their means of transport to free public transport. The present result is consistent with the previous one, claiming that respondents who do not find cost impostant, prefer to stay at their existing means of transport.

Regarding the demographic characteristics of the participants, two were the parameters to be found statistically significant in the model. More precisely, when the level of annual income is high (IN3) compared to the low level of annual income, then there is a reduction in the probability of choosing free public transport by 0.52 times or 48%. This is explained by the fact that high-income respondents are not willing to leave the means of transportation they

use, even if they are offered free use, again consistent with the previous variables. Regarding the independent variable of age, it seems that when the age range is higher than 45 years (AGE3) in relation to the age range 18 - 29 years old, then there is an increase in the probability of choosing free public transport by 1.4 times. The preference of free public transport by the age group of> 45 years, a consistent result with the binary logistic model.

4. Conclusions

With the idea of free public transport remaining a subject of political and policy making debate, it is important that public, professionals, decision makers and researchers shed more light on this field. This study analyses the opinion of Athenians with respect to a potential modal shift from different means of transport to free public transport. This stated preference analysis is expected to be of interest not only to Athens but would also be instrumental in supporting relevant stakeholders in other cities which discuss the introduction of similar policies.

More research is needed to understand the implications of free public transport for urban transport systems. Specifically, future research could focus on the expansion of the sample of the present survey. Additionally, it is suggested that a larger survey that includes more scenarios and alternative statistical models (e.g. latent class models) should be carried out targeting specific geographical areas and population groups.

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