

Factors influencing car user propensity to shift to other modes and their impacts on demand for airport parking facilities

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Abstract

Purpose The aim of this paper is to analyse the factors influencing car user behaviour and examine the possible impacts of public transit improvements on the demand for airport long-term parking facilities. The case of the Athens International Airport (AIA) is considered for the analysis.

Design/methodology The followed approach comprises three steps: First the related literature is reviewed and the method is presented. Then data collection is carried out through a survey questionnaire comprising a revealed preference and a stated preference part. The compiled data is processed using factor analysis. Finally, the results are assessed leading to the drawing of final conclusions.

Findings The results of the analysis enable: (a) to determine different user groups with different demand elasticities and likelihoods to shift to public transport, and (b) to conclude from the quantitative representation of the different user groups the real impact on the car parking demand.

Research limitations The analysis gives no consideration to the mix of measures that can possibly increase competitiveness of parking services such as real-time information about availability of parking space to users; online booking and discount rates for early birds, etc.

Originality/value The paper includes original work based on primary data from a field survey, similar of which has not been published for the AIA. The results are important for airport authorities to keep a balance between parking demand and supply by formulating the right marketing policies.

Keywords Car parking demand; airport surface access; airport business; modal shift; revealed preferences; stated preferences; factor analysis; surface access trip, user behaviour.

1. Introduction

Air transportation market has undergone significant changes in the recent years. A non-exhaustive list includes the liberalization of the aviation market, the emergence of wide regulatory reforms, the increasing airport competition, the various forms of privatization replacing government ownership, the management of airports as commercial enterprises, etc. One potential barrier to airport competition and efficiency is related to limited capacity of the airside infrastructure. To solve these limitations airport authorities can choose to move airports to new locations. But building big infrastructure requires heavy investment which makes this option feasible only if they have first exhausted every possible means of utilizing existing infrastructure (Fernandes & Pacheco, 2002). Another potential barrier to airport efficiency is related to car parking provision and pricing regimes. Being strategically important for airports, car parking requires efficient and long term planning, which becomes even more important when strong competition exists among the different transport modes connecting the airports.

In general, parking is one of the first questions that people have in mind when traveling with private car to an airport. Convenient and affordable parking is considered a sign of satisfaction. Parking that is difficult to find, inadequate, inconvenient or expensive make users frustrated and can contribute to the change of travel mode (Transportation Research Board (TRB), 2010). Car parking facilities are also an important source of income for an airport. The significance of these revenues to airports was recently demonstrated by Jacobs Consultancy (2010) who determined that, for US airports, as much as 26% of total airport revenues can be accounted for by parking revenue alone. A decade earlier Button and Taylor (2000) have found that the average parking-generated revenue for European airports was about 14% and that at the largest airports this figure might sum up to one-fifth of the overall revenue stream. The provision of car parking is therefore a significant element of airport operations as it contributes to the improvement of airports' competitiveness and profitability (Ison, Francis, Humphreys & Rye, 2008; Ashford, Stanton & Moore, 1997). Moreover, the addition of off-site parking to the more traditional onsite airport parking is increasingly resulting in the development and refinement of a local market-oriented parking system similar to that which Barter (2010) has described.

To provide quality parking services to their users airports are faced with the dual problem of when to build additional parking and how much to build, since the provision of parking can be very expensive. At airports where increased service is being provided by low cost commercial air carriers, discretionary air travel has increased. This has resulted in an increased number of vehicles picking up and dropping off at the curb, as well as an increase in demand for short-term parking and economical long-term parking. Airports experiencing parking shortages related to this type of travel are compelled to meet this demand, while distinguishing between

temporary parking demands and long term trends so as not to be burdened with additional, unnecessary, and expensive infrastructure that may not meet revenue goals. In order to guarantee a balance between parking demand and supply and to ensure important revenue sources, some actions may be needed by the parking operators aiming to provide improved customer experience to their users. For this purpose the better understanding of the differing characteristics and drivers of demand is essential. It was this knowing that prompted our research.

This paper analyses the user characteristics and examines the possible impacts of public transit improvements on the demand for airport long-term parking facilities. The case of the Athens International Airport (AIA) is considered which has been re-located in 2004, from a rather central location to a site about 35 km away from the Central Business District (CBD). Built under a BOOT (Built-Operator-Transfer-Scheme) for a concession period of 30 years, the new AIA has been described as one of the most important PPP-infrastructure projects in Greece (Tsamboulas, Panou & Abacoumkin, 2000). Being aware of the fact that its efficient operation means important revenues for the public and private stakeholders, the good accessibility of the site can be seen as a key issue. On the parking operator's side, it has to be examined how and in which degree the public transit supply especially the improved fixed track modes affect the demand for the long-term parking facilities.

To address these issues the present paper is organized as follows. After a review of the related literature (section 2), the methodological approach is presented (section 3) which includes: data collection through a survey questionnaire comprising a Revealed Preferences (RP) and a Stated Preference (SP) part and processing of the compiled data using factor analysis. The methodological section is followed by a comparative analysis of results (section 4) leading to the drawing of the final conclusions (section 5).

2. Theoretical background

One major issue related to the efficient operation of airports is surface access. Major airports attract daily a large number of surface access trips which can be grouped into three main categories: passengers, employees and 'meeters-greeters' (de Neufville & Odoni, 2003). The quota of these trips varies among airports depending on factors like airport size, geographical location, type of airline operations, the time of day, week or season, etc. (Humphreys & Ison, 2005). For instance, airports serving mainly international flights tend to attract a larger proportion of meeters-greeters, while airports that serve domestic and business operations have a relatively low percentage of visitors as compared to travelers (Kazda & Caves, 2000).

Private car continues to dominate the means that travelers and employees use to reach the

airports. Private cars are typically considered to be the most convenient and flexible transport mean for time critical journeys and as such remain the dominant mean to reach airports worldwide (Humphreys & Ison, 2005). Given the volume of airport access trips made by private cars and the differing demands and trip characteristics of passengers and employees, it is not surprising that airport parking has become an increasingly complex issue. Meeters and greeters and passengers being dropped off at an airport present less of an issue in terms of parking provision. However, as the price of parking increases, it is possible that more passengers will choose to use public transport or to be dropped off and picked up at the airport by friends or relatives rather than pay to leave their vehicle on site. This would result in four vehicle trips being undertaken to and from the airport rather than two. In addition to the impact on traffic congestion, increased 'kiss-and-fly' traffic would also result in reduced parking revenues. As parking facilities are expensive to construct many airports have embarked on the idea to develop additional parking facilities as and when demand requires it (BAA London Stansted, 2008). The balance between supply and demand for different user categories is therefore crucial and requires a deeper look in the demand characteristics and drivers of user behaviour. These may vary significantly from case to case, depending on a set of internal and external characteristics.

Harvey (1986) has investigated the factors influencing travelers' parking behavior. His findings suggest that passengers' choice depends mainly on their inherent characteristics and trip purpose. Some other features such as who pays for the trip, departure time and length of trip may significantly influence the choice of the airport access mode and thus, the demand for parking.

On the supply side, parking management and pricing strategies encourage more efficient use of existing parking facilities (Shoup, 2008; 2006). Passengers usually prefer the closest parking location, but given a choice some will park further away to save on parking fees. In these cases, bus shuttle services may allow longer distances between parking facilities and the airport terminal. Some researchers stress that real-time information on parking availability and prices as well as online advance booking capabilities may help increase the demand for parking at longer distances from terminal (Calthrop, Proost & Van Dender, 2000; Calthrop, 2002).

According to Griffioen-Young, Janssen, Van Amelsfoort and Langefeld (2004), the factors that drive user parking behaviour can be classified in four categories: The users' attitude, situation, intention and habits (Figure 1).

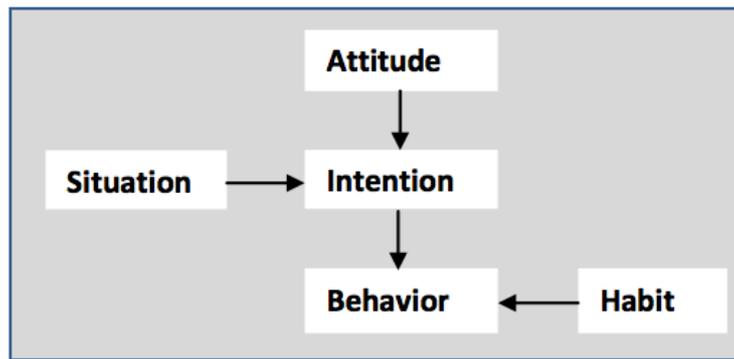


Figure 1. Factors that influence parking behavior (Griffioen-Young et al., 2004)

The above model builds on the tradition of Ajzen's (1991) Theory of Planned Behavior (TPB). Its main goal is to explain actual and intended parking behavior better than could the original construct of the TPB and to help build a more specialized framework for understanding this behavior. Central factor of the model is the individual's intention to perform a given behavior. Intentions are assumed to capture the motivational factors that influence a behavior and have three main determinants (Ajzen, 1991; 1985). The first determinant is the 'attitude' toward the behavior reflecting the degree to which a person has a favorable or unfavorable assessment of the behavior in hand. The second determinant of intention is a social factor termed 'subjective norm' which reflects the perceived social pressure to adopt or not the behavior. The third determinant is the degree of 'perceived behavioral control' which corresponds to the perceived ease or difficulty of adopting a behavior and it is associated with past experience and/or anticipated impediments.

Heath and Gifford (2002) have expanded the original model of the theory of planned behavior by adding the interaction effect between perceived behavioral control and intention and some additional variables like the descriptive and moral norms, the environmental values, and perceived responsibility for and awareness of the problems caused by car use.

Customizing further to the needs of parking users Griffioen-Young et al. (2004) have refined the 'attitude' determinant to reflect the user's positive or negative evaluation of car parking. The authors stress that this (attitude) is mainly associated with socioeconomic characteristics like income, gender and age, perception and value of time, car ownership, and education level and less with the social factor and the perceived behavioral control which can, in this case, be 'hidden' behind the intention. Moreover, they have highlighted two other factors of particular importance i.e., 'situation' and 'habits'. The 'situation' reflects the contingency and is related to external characteristics that may influence a parking choice, including weather, traffic conditions, availability of alternative modes, time to destination, number and type of passengers, cost, safety and location of parking lots. Habits are types of 'automatic' behavior

that depend neither on conscious nor intention. They need rather little attention when they are performed and for that reason they may influence parking behavior directly.

It should be noted that habits are not referred to directly in Ajzen's theory of planned behavior. The main reason for this is that the TPB addresses primary sources of behavior, i.e. those root causes that interact with each other to create a behavior. Habits on the other side are manifested secondarily as a result of the repeated action of primary causes and the 'addiction' to the recurring behavior this might create. To put it in physics terms, habits influence the behavior of a user in the same way that the force of inertia acts on a moving body, i.e. contributing to preserve established past behaviors.

Several researchers (e.g., Bentler & Speckart, 1979; Fredricks & Dossett, 1983) acknowledge that repeated performance of a behavior results in the establishment of a habit; behavior at a later time then occurs at least in part habitually, without the mediation of attitudes, subjective norms, perceptions of control, or intentions. For this reason habits are considered a substantive determinant of parking behavior, equivalent to the other determinants suggested by the TPB. They might interact with the other determinants either by strengthening the perception of behavioral control, in which case any intention to change behavior is degraded, or by weakening the influence of external factors such as for example acquired environmental concerns or social norms (Heath & Gifford, 2002).

In order to identify the different influence factors and user groups, this paper follows a deductive approach, presented in the following.

3. Method

The followed approach comprises three consecutive steps (figure 2).

Starting point of the analysis is a good understanding of state-of-art research, particularly in the areas of parking demand, user behavior & characteristics and methods of analysis. The second step deals with the collection of data, which is realized by means of a questionnaire survey including revealed preferences and stated preferences experiments. The analysis of the results is performed by means of the Factor Analysis (FA). Finally the various user characteristics and attitude towards public transit are determined and the impact on airport's car parking demand is assessed.

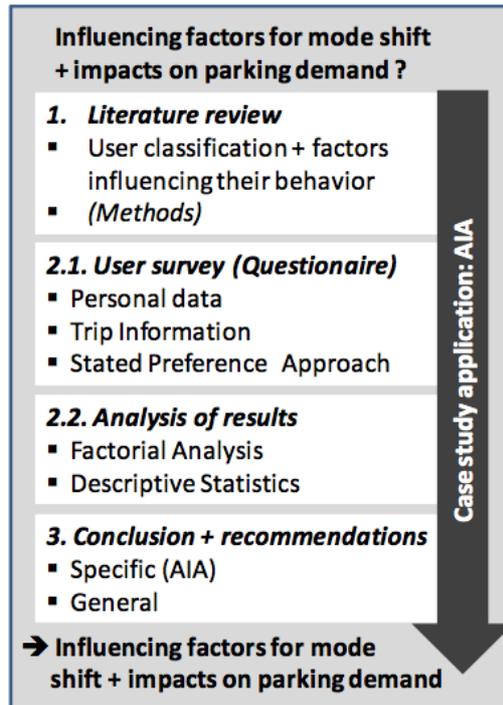


Figure 2. Deductive methodological approach and working steps

3.1 Location and sample

The AIA is located 33 km southeast of the Athens CBD in a previously rural area currently under development. By road, the airport can be reached over the new urban highway 'Attiki Odos', a six-lane tolled ring-road which connects with the north side of the city of Athens. The airport is also accessible from the city center by public transit i.e. bus, and since 2004, by the new metro and sub-urban railway. There is also a taxi rank situated outside door 3 on the arrivals level. The trip by taxi to the Athens' city centre costs about 40 to 50€. Six public bus routes connect the airport with various locations in Athens and Piraeus. One-way bus fare is €5.00. The interurban trains run from the airport every 30 minutes for Athens central station and other metropolitan destinations. The journey time to downtown Athens is about 35 minutes, and the fare is 8.00€ one way. The travel time by Metro line 3 to the city centre is 27 minutes, and to Piraeus 60 minutes; the fare is 8.00€ one way. It also runs in a 30 minutes frequency.

The Athens International Airport has served in 2012 4.5 and 8.4 million domestic and international passengers, respectively (AIA, 2012). Passengers that access the airport by their private car have a choice of using either the short or the long term parking services. Visitors to AIA who intend to stay for less than five hours, can park at the two 'short-term parking areas' called P1 and P2. Visitors who intend to stay at AIA for a period longer than five hours can park at the 'long-term parking area' P3, in which there are 5,800 available parking spaces.

According to the 2011 annual report parking generated revenues of the AIA, amounting to 15.7 million €, show an increase of 13% as compared to 2010 figures. Long-term parking contributed to these revenues by 63% and short-term parking by 30%. Additional parking services such as the Executive Valet Parking and the tour bus parking represent the remaining 7% of the total passenger parking revenues (AIA, 2011).

Given these characteristics, the sample size was determined based on the market research common practice of using a minimum total sample size of 200 for simple surveys as this represents a reasonable balance between robustness of results and cost of fieldwork. A total of 204 user's views were collected with personal interviews in working days from 08.00am to 08.00pm. The survey was carried out within a period of 3 weeks during high demand summer season at the long term parking area of P3 at AIA. 20% of the interviews were taken in weekends. The collected interviews represent 4% of the long term parking lot's capacity (5.800 spaces). 65% of the respondents have flown on international flights and 35% on domestic flights. 78% of the passengers were Athens metropolitan area residents (with the majority coming from the city center) and 22% were residing elsewhere in Greece.

3.2 Questionnaire design

The design of the survey questionnaire was based on different factors including nature of required data, data collection procedure, methods of analysis, etc. To assess the impact of improved public transit on airport parking demand a joint revealed preference and stated preference approach was followed.

Historically, researchers have seen revealed and stated preferences as substitutes when considering the choice of valuation methods. Empirical evidence about the validity of stated preference methods and the fact that the strengths of revealed preferences are the weaknesses of stated preference approaches have led to a new paradigm for combining revealed and stated preferences. The joint estimation of revealed and stated preference data was originally proposed by Morikawa (1989), whose motive was to use the stated preferences to identify parameters that would not be recognized under the revealed preference approach. Morikawa's original research was further developed in the work of Ben-Akiva and Morikawa (1990), Ben-Akiva, Morikawa and Shiroshi (1991), Brandley and Daly (1994), Hensher, Barnard and Truong (1998), Adamowicz, Louviere and Williams (1994), Adamowicz, Swait, Boxall, Louviere & Williams (1997), Hensher (1998), etc. Common element in the above research is that the revealed data refers to the observation of preferences revealed by actual market behaviour, while the stated preference data has both non-use value and option value which widens their use as they can be employed to value potential future or hypothetical scenarios.

While the combination of RP and SP data presents a number of advantages over the use of RP or SP data alone, a number of challenges include: how to reconcile potential differences between stated and actual preferences in assessing user behavior for new scenarios; longer and intensive questionnaires may result in lower response rates, lower quality of responses, etc.

To mitigate these problems the questionnaire was structured in a way that the RP and SP parts are concise (not more than 20 minutes in length) and distinguishable. More specifically:

- The RP part comprises eighteen (18) questions about passenger classes, airport access modes, travel costs and trip purpose. The economic, social and cultural background of the users is also considered.
- The SP part includes three (3) Discrete Choice Experiments (DCE) or scenarios:
 - Trend Scenario: where same prices and frequencies (30 min) of rail services continue to apply.
 - Best-case Scenario: where rail prices increase by 20% to compensate for higher frequencies (20 min) and lower travel times (-20%).
 - Worst-case Scenario: where rail prices plunge 20% as travel times get 20% longer while frequencies remain the same (30 min).

The first scenario (named trend) assumes business-as-usual levels of tariffs, travel time, waiting time (in terms of frequency) and park-and-ride capabilities for the two transit alternatives of metro and suburban rail. The other two scenarios represent best and worst-case situations, as seen from the perspective of a typical parking user with a high value of time (see table 2). To be as realistic as possible, the scenarios were designed so that a change in one attribute is followed by a relative change on the other attributes and vice-versa. For example, in the worst-case scenario tariffs are reduced by 20% to compensate for a 20% increase in travel time. In the best-case scenario a 10min reduction of waiting time and a 20% shortening of travel time have resulted in a 20% tariff increase. It should be noted that the absolute values of travel time and tariffs presented to the respondents were calculated according to their zone of origin, the monetary costs declared in the RP part of the questionnaire, and the corresponding attribute level of the respective scenario.

Using the above, participants in the discrete choice experiments were asked to make trade-offs between changes in the levels of the considered attributes. This trade-off data have allowed us to gain insight into users' willingness to shift to public transport. In terms of the theoretical

basis, DCEs only collect information about the alternative chosen, and not the full ranking of alternatives. Therefore, the data are considered weakly ordered.

3.3 Data analysis

To analyse the data compiled by the survey, the factor analysis method was used. This method aims to identify unobserved random variables, the so-called 'factors' or latent variables, explaining the pattern of correlations within the sample population. Applied in social sciences, these correlations may be related to unobserved characteristics of passengers who differ from each other by underlying attributes which are often more fundamental than observed attributes. Since the method can also be used as a statistical data reduction technique, it allows considering a broad set of variables and reducing the main information to some explanatory factors (Tucker & Mac Callum, 1997).

The general idea of the factor analysis is to divide the observed variables in a correlative part with common variance, and an additional statistically independent one, with specific variance. In doing so, each variable can be mathematically expressed by a linear combination of a reduced number of factors which are shared by all variables and an additional unique factor which is represented by specific uncorrelated error terms (Tucker & Mac Callum, 1997).

On a technical level, the factor analysis follows a process comprising three steps: (1) development of the input data set, (2) estimation of the factors and rotation of the correlation matrix, and (3) analysis of results, including factor labeling and interpretation of factor loadings and scores.

4. Results

4.1 Revealed preferences

In the RP part of the questionnaire respondents were asked to provide details about their current access trip to the airport. The analysis of the results shows that the larger user group comprises male passengers, traveling for business purposes (72%), are between 36-55 years of age (54%), with relatively high income >2.000 € (67%), owning two or more cars (59%) and work mainly in the private sector (79%). The majority of these users visits the AIA two to three times per month (54%) and is responsible for generating a significant part of revenues for the private parking operator.

Decisive role in the assessment of parking demand plays also the relation between costs and who pays for it (see figure 3 below). Because 2/3 of all business trips are paid by employers, one would expect lower price sensitivity by the business travelers. Surprisingly, the same kind

of behavior is observed in users who travel for personal reasons and are willing to spend up to 150 € per trip.

Payment of trip in relation to travel costs (abs.)

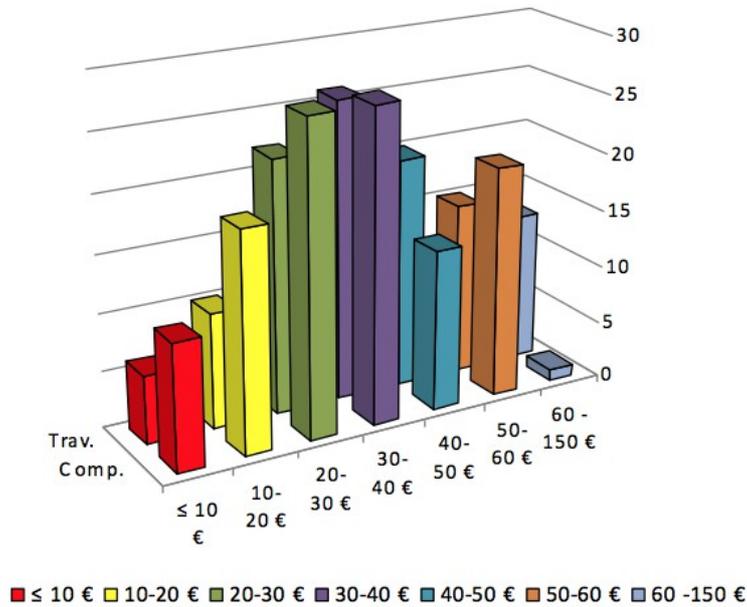


Figure 3. Payment of trip in relation to travel costs (absolute figures)

Figure 4 demonstrates the possible maximum parking days at AIA before high costs mandate a change of attitude towards public transit. It shows that 34% of the respondents are willing to use their car irrespective of the involved cost. Another 50% appear quite inelastic for a stay up to 5 days (parking costs are around 50 €). For longer stays (> five days), time-cost sensitivity seems to be low, probably because of the flat rate that applies for long stays.

In response to the question of 'alternative modes considered in case of a long stay', the answer is mainly taxi.

Max. days in parking beyond AIA is accessed by other modes

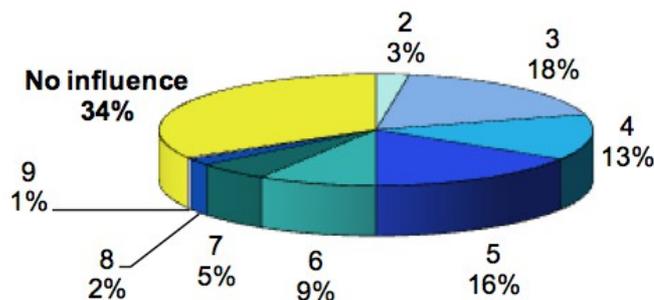


Figure 4. Parking days before shifting to other modes

The majority of the respondents perceive parking fees and tolls on the Attiki Odos motorway as the main costs. Fuel and other related costs are hardly or not at all considered (see figure 5 below). To assess the consistency of these responses, the perceived costs were mapped against the declared total transport costs. The results show that for the cheapest trips, tolls seem to be neglected despite the flat toll rate of the Attiki Odos Motorway. Clearly, low declared cost are related to underestimated travel cost by car, whereas, travelers who declared higher travel costs (>40 €) seem to take into account the parking, toll and fuel costs and consider less other expenses like vehicle depreciation and maintenance costs.

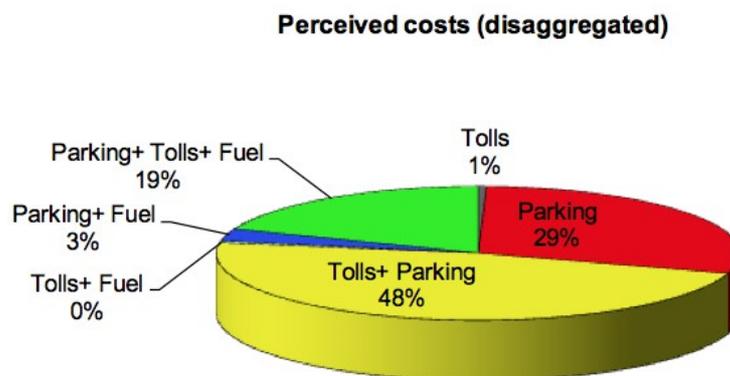


Figure 5. Perceived cost components

In a similar vein, a better look at the variable expressing reasons for car preference (right-side of figure 6) shows that 'speed', 'flexibility' and 'comfort' are the main reasons that the respondents prefer the car, while 'safety', 'speed' and 'low costs' seem to contribute less in that decision. To better understand the importance of the above one needs to know the percentage of users who are 'hooked' on their car regardless of public transit improvements. Figure 7 (left-side) shows that over 50% of the interviewees will keep on relying on their private vehicle for traveling to the AIA, a 29% will use taxi, and only a 20% is willing to shift to public transit.

The competitive advantage of public transit, especially rail, is related to probable cost savings in the case of longer stays and also to possible time savings during peak hour and congestion on the urban highway (depending on the individual waiting times for the metro or train). Because this advantage is perceived as of little importance by P3 users, the risk of demand reduction due to the improvements of the transit services seems to be rather low. Besides, 'comfort' and 'flexibility' are service criteria which are relatively poor in public transit as compared to private means; these features, of course, become more important when a passenger carries heavy luggage.

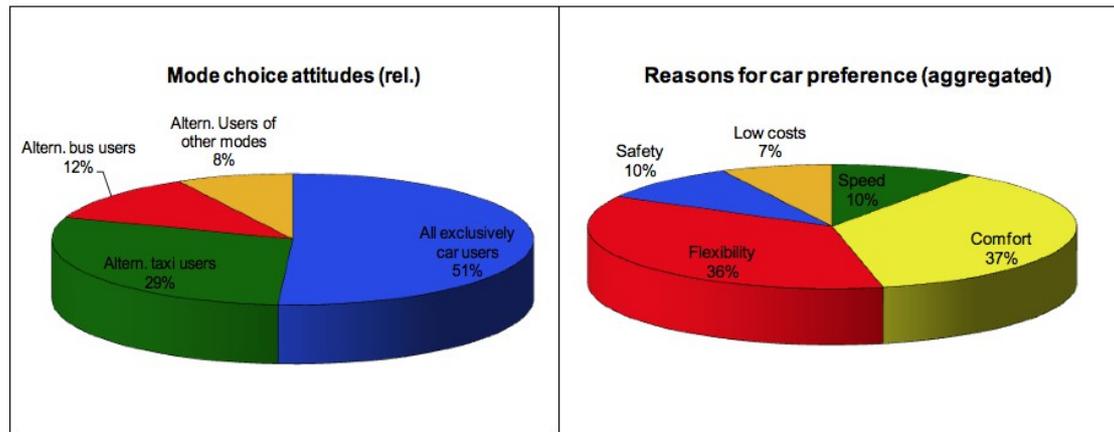


Figure 6. Mode choice attitudes (left) and reasons for preferred car use (right)

The taxi, as a convenient compromise between the freedom to go directly to the terminal and a non door-to-door trip, is a source of possible competition for the parking operator. The survey shows that mode choice behavior is strongly linked to individual habits which are difficult to change in case of major public transit improvements.

4.2 Stated preferences

The SP experiments that were carried out within this research describe the users' attitudes towards public transit by a set of four attributes; waiting time (expressed as average frequency) with two attribute levels (30 and 20min), transit time with three attribute levels (-20%, null and +20% of change), transit tariff also with three attribute levels (-20%, null and +20% of change) and park-and-ride capability (on the city side of the transit lines), with two levels (business-as-usual and new developed facilities).

One or two SP experiments were given to all respondents depending on the time available and their original responses. The first experiment involved a choice between a public transit alternative and the continued use of the car under a choice situation drawn at random from the 3 possible scenarios (trend, best-case, worst-case). The second experiment involved a choice between a public transit alternative and the car, this time under a situation corresponding to a better or worse scenario as compared to the one presented in the first experiment. To check the robustness of original responses the 'worse' scenario option was given to respondents who answered positively in the first experiment, while the 'better' option to respondents who answered negatively. In addition, a third SP experiment was given to the respondents who have replied negatively in the first two experiments, which differed according to the car cost they paid to access the airport. This cost was assumed to have increased by 20%.

Experiment	Response	Sample size (%)
Trend scenario: same prices and frequencies (30min) of metro and suburban train continue to apply, as well as use of existent park and ride facilities	Yes No	19 (9%) 8 (4%) (Σ 13%)
Best-case scenario: 20% higher prices apply for higher frequencies (20min) and lower travel times (-20%); use of new park and ride facilities	Yes No	33 (16%) 4 (2%) (Σ 18%)
Worst-case scenario: 20% price decrease for same frequencies (30min) and 20% longer travel times; use of new park and ride facilities	Yes No	47 (23%) 28 (14%) (Σ 37%)
Auxiliary scenario: given only to respondents who answered no in two previous experiments: examines possible change of attitude should an additional 20% in car costs apply.	Yes No	0 (0%) 65 (32%) (Σ 32%)

Table 2. Stated preference experiments

As shown in table 2, 9.0% of the respondents (19 persons) have a positive attitude towards public transport under the trend scenario, 16% (33 respondents) answered positively under the best-case scenario and 23% (47 persons) replied 'Yes' under the worst-case scenario. Further, 4.0% of the respondents (8 persons) have a negative attitude towards public transport under the trend scenario, 2.0% (4 persons) answered negatively under the best-case scenario and 14% (28 persons) replied 'No' under the worst-case scenario. The figures shown next to the 'Yes' response of table 2 (with the exception of the auxiliary scenario) represent the number of interviewees that replied positively to all experiments they were given.

Similarly, the numbers next to the 'No' response represent negative replies to at most one given experiment. It appears that some of the respondents of this group have changed their original answer, which might be attributed either to lower cost elasticity to the 'better' scenarios given in the second experiment or to a higher value of time as compared to the 'worse' scenarios. Finally the figures next to the auxiliary scenario represent respondents who had two negative replies. 32% of them (65 persons) insisted on their original negative response even if the car costs increase by 20%, suggesting a fully inelastic behavior.

All the considered attributes were found to be significant: parking users are willing to give up some of the convenience of their car for a faster, though more expensive, transit service. They also value total journey time higher than cost which is considered to be the least important attribute for them. Seen from the commercial side, this implies stable parking demand should frequencies of the public transit services remain within the frame of the SP experiments.

4.3 Factor analysis

Using the collected RP and SP data, factor analysis was applied to reveal underlying attributes and user behavior. First, the entire set of variables was checked for correlations. This required building a correlation matrix based on Pearson's correlation coefficients and the application of a Kaiser-Meyer-Olkin test to check the sample adequacy for the application of a factor analysis. A yielded value of 0.6 indicates acceptable conditions for the method.

For the extraction of the factors, the Principal Components Analysis (PCA) has been used. The first component is responsible for the largest portion of the variance, and the subsequent components explain progressively smaller portions until the total variance is explained. All principal components are uncorrelated with each other (initial factor solution). A prerequisite is a singular, non-invertible correlation matrix.

For deciding on the number of factors the Geometric Mean of the correlation matrix was used. It is a measure of the relative importance of each factor with respect to the considered variables (e.g. a factor with a low mean contributes little to the variables' variance and may be ignored as redundant). Generally, factors explaining more than 75% of the total variance are considered adequate and can be retained (Garson, 2007).

To facilitate the interpretation of the factors an additional transformation was made. This is called axes rotation and it aims in increasing the contrast between the retained factors. The rotation method applied here is the (most common) Varimax method where factor axes are orthogonally rotated to maximize the variance of the squared loadings of a factor on all the variables in the factor matrix.

The output of the above analysis consists of a rotated component matrix where the rows represent the variables and the columns the factors. Each value of a factor vector is called 'factor loading', and it depicts the contribution of each variable to the factor's definition. Following this method, 10 factors were retained from the considered AIA data set, explaining together a cumulative variance of 78%. The rotated component matrix is presented below (table 3); the factor loadings with the highest impact on factor definition are highlighted in yellow (>0.8), green (>0.7) and blue colors (>0.3), respectively.

	Rotated Component Matrix(a)									
	Component									
	1	2	3	4	5	6	7	8	9	10
TR_PR	0,786	-0,181	0,105	-0,035	-0,074	0,013	0,134	0,020	-0,160	-0,006
EXP_PAY	-0,723	-0,004	-0,146	0,400	0,053	-0,032	-0,201	-0,035	0,119	0,158
SEX	0,706	-0,110	-0,002	0,174	0,009	-0,055	-0,223	-0,161	-0,029	0,029
MON_INC	-0,178	0,809	-0,018	0,040	-0,152	0,047	0,007	-0,190	0,052	0,090
OWN_CAR	-0,079	0,761	-0,089	0,054	0,196	0,039	-0,073	0,335	0,123	-0,144
AGE	-0,055	0,680	-0,043	-0,384	0,062	-0,095	0,221	-0,172	-0,177	0,165
CH_OT_MO	0,030	-0,040	0,920	-0,048	-0,079	-0,101	0,030	0,011	-0,110	0,005
PREF_CAR	-0,140	0,053	-0,900	-0,006	0,024	0,054	-0,069	-0,016	-0,076	0,144
EDU_LEV	0,034	-0,005	0,014	0,851	0,115	0,028	0,124	-0,073	-0,043	0,176
PROFFES	0,291	0,317	0,202	-0,504	0,343	0,215	-0,013	0,152	0,224	-0,033
ROAD_AIR	-0,105	0,004	-0,042	-0,002	0,816	0,019	-0,112	-0,163	-0,192	-0,076
TIME_AIR	0,021	-0,026	0,201	-0,190	-0,569	0,189	-0,342	0,057	-0,339	-0,163
PARK_DAYS	-0,056	0,007	-0,156	-0,052	-0,018	0,906	0,042	-0,115	-0,056	0,105
MOV_COST	0,474	0,052	0,001	0,221	-0,072	0,507	-0,179	0,377	0,081	-0,220
ST_PREF	0,027	0,046	0,098	0,081	-0,024	0,014	0,903	0,038	0,030	-0,057
REAL_COST	-0,086	-0,065	0,030	-0,123	-0,182	-0,080	0,059	0,845	-0,143	0,109
TRIP_FRE	-0,216	0,036	-0,022	-0,077	-0,084	-0,028	0,031	-0,117	0,859	-0,013
CLASS	-0,074	0,061	-0,126	0,182	-0,024	0,065	-0,056	0,085	-0,001	0,914

Table 3. Results of the factor analysis in the AIA case

It can be seen from the above matrix that the first factor (column 1 in table 3), representing 16% of the total variance, shows high loadings on the variables 'trip purpose' (TR_PR), 'trip sponsor' (EXP_PAY) and passenger sex (SEX). This factor represents a typical sporadic traveler group, which has all the characteristics of a 'tourist'. Since the 'labeling' of the factors might be a rather subjective procedure, a further look to the 'factor scores' helps to avoid mistakes in the interpretation process. The factor scores show for each sample record how much value of each factor it represents which helps understand the specific underlying variables. High positive factor scores demonstrate a strong representation on that record of the considered factor; high negative factor scores state the opposite. Looking at the scores of the first factor one may see that high positive factor scores present mainly female passengers, who travel (primarily) for personal purposes (tourism) and pay for airport access an average of 45 €.

The second factor (column 2 in table 3), explaining an additional 12% of the total variance, is marked by the variables 'monthly income' (MON_INC) and 'car ownership' (OWN_CAR) and less by the 'age' (AGE) and 'profession' (PROFFES). The high positive loadings on these variables represent individuals with high income, two or more cars, are at the age of 30 to 56 and work mainly for the private sector (corporate executives, self-employed, etc). This user class can be labeled as 'elite travelers' who prefer their own cars for most of their mobility needs.

The third factor (column 3 in table 3) is responsible for 9.7% of the variance, indicating a user group with a clear positive attitude towards public transit. With a high positive loading on 'alternative modes used' (CH_OT_MO) and a high negative loading on 'reasons for car preference' (PREF_CAR) this factor represents the 'alternative rider' which is perhaps the user class most likely to shift to public transport.

The fourth factor (column 4 in table 3), explaining an additional 8% of the variance, shows high variable loadings on 'education level' (EDU_LEV), 'profession' (PROFFES) and 'age' (AGE), and puts less weight on 'trip sponsor' (EXP_PAY). This factor seems to represent young, highly educated people, working (primarily) for the private sector, whose trips are paid by their employers. They are typical 'young professionals' who seem to be rather cost insensitive and prefer their own cars for accessing the airport.

The fifth factor (column 5 in table 3) emphasizes on the 'trip length' (ROAD_AIR) and 'access time' (TIME_AIR) to the airport. The factor is responsible for a 6.9% of the sample variance and represents users with trip origins at the CBD (junctions 8 and 11 of Attiki Odos) who pay tolls in the Motorway because they are rather sensitive on time savings. This user group is called the 'time conscious'.

The sixth factor (column 6 in table 3) shows a high positive loading on the variable 'parking days' (PARK_DAYS) and a lower factor loading on variable 'transport costs' (MOV_COST). It explains about 5.9% of the overall variance and indicates a user group with average long stays in the parking that cares less about the cost of stay. These users would still prefer their own car even if the cost of using it would considerably increase. They are called the 'cost insensitive' users.

A better look is required for factor 7 (column 7 in table 3), which summarizes the results of the stated preference survey. It explains about 5.8% of the total variance and reflects users' anticipated behavior should improvements in public transit occur. Because three different scenarios were tested, it is difficult to identify one single user group with common characteristics. The only thing that respondents seem to have in common is their overall negative evaluation of the public transit, as reflected in the SP experiments. Hence they are denoted here as 'inflexible' car users.

Factor 8 (column 8 in table 3) explains only a 5.3% of the variance and relates to users who lay more emphasis on 'car ownership' (CAR_OWN) and transport costs, be it perceived (REAL_COST) or actual (COST_MOV). The user class associated with this factor is car owners more sensitive to 'pocket money', so they are called the 'individualistic' users.

Factor 9 (column 9 in table 3), explains 4.7% of the overall variance and emphasizes on 'trip frequency' (TRIP_FRE), 'access time' (TIME_AIR) and less on travelers' 'profession' (PROFFES).

The factor highlights the frequent-flyer class as it's associated with average frequencies of more than 3 times per month and average ingress/egress times of 30 to 50 minutes. They are labeled as the typical 'frequent flyers' who show low willingness to use public transit; they usually prefer car or taxi as time is more important.

The last factor 10 (column 10 in table 3), explains an additional 4.2% of the variance. It points to the distinguished class flyers (high positive loading on the variable CLASS). They seem to prefer their own car and, alternatively, taxi mainly for comfort and flexibility reasons. They can be called the 'luxury travelers'.

Summarizing, tourists, alternative riders, high value-of-time professionals, elite and luxury travelers, inflexible and individualistic users compose the canvas of user groups of the AIA long term parking facility. They all have divergent attitudes, habits and expectations towards public transit.

5. Conclusions

This paper has analysed the user characteristics and examined the possible impacts of public transit improvements on airport long-term parking facilities. To address these issues a factor analysis was applied on RP and SP data from a questionnaire survey in the Athens International Airport. The analysis shows that trip purpose, profession and trip sponsor are among the most important variables underlying mode-choice decisions. Businessmen and private sector employees, traveling for business purposes and having their trips paid by their employers are the most typical users of the long term parking facilities. The users also show low price elasticity and have high average value of time.

Compared to data from the old Athens International Airport, two things become apparent:

- There is more demand originating from the city of Athens rather than from other metropolitan origins as was the case with the old airport; and
- The taxi becomes more important from public transit to travel from/to the airport; probably due to the relatively low taxi fares in the Greek capital region. Moreover, the share of air passengers who get a lift or are dropped-off at the airport has been lowered as the distances became relatively longer.

Figure 7 summarizes the findings of the analysis with respect to the main factors of the Griffioen-Young model that drive user parking behavior.

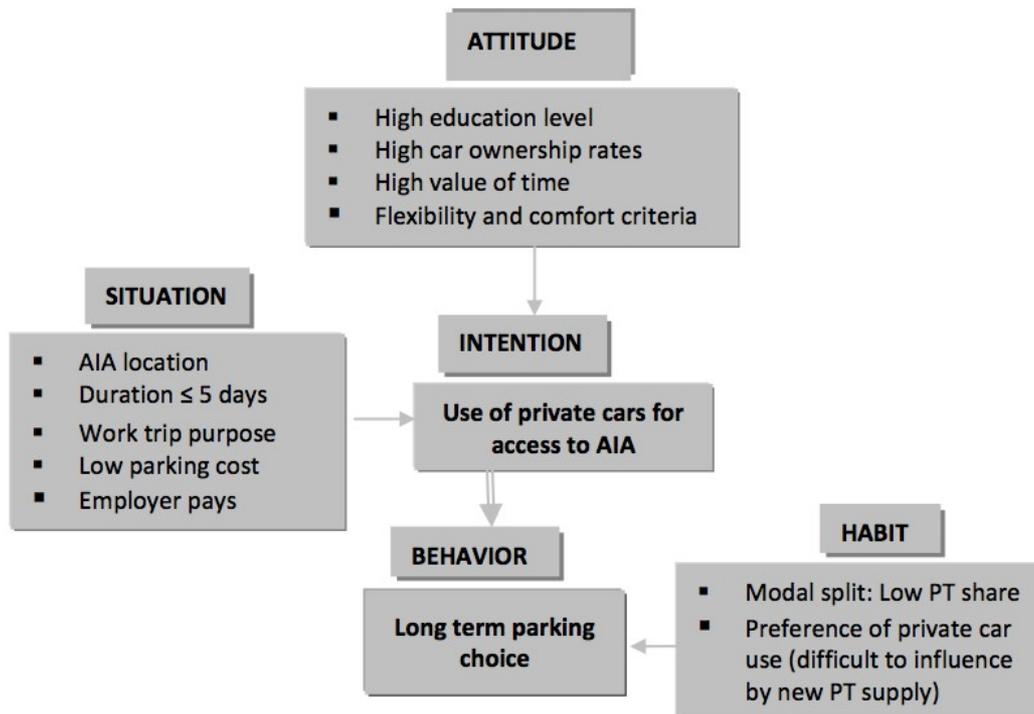


Figure 7. Factors influencing parking behavior in the AIA

Compared to the modal split with other airports in Europe, the hypothesis of car-dependent travelers of AIA can be acknowledged. In UK cities for example that are comparable in size to Athens such as Manchester, Liverpool and Glasgow, public transport shares for airport access range between 10-11% (Entec, 2006), which is almost double than the figure in Athens. As in the UK, people are more likely to go to work by public transport than to go to the airport, but in Athens the airport modal split shows a significantly lower share for public transport than in the corresponding UK cases; a fact probably attributed to the relatively low AIA parking rates. Despite lower prices, the parking generated revenue for the Athens airport sums up to 14%, while the parking income in Manchester is less than 12% (Manchester airport, 2011).

It can therefore be concluded that the risk of future demand reduction and thus, reduced income for the private parking operator is relatively low. Due to the generally high car ownership rate, the low parking costs and the high importance of the flexibility and comfort criteria in the users value system (higher than cost), the improved metro and suburban train services are more likely to attract a small portion of the demand, mainly those passengers traveling for private purposes (tourists) or with a lower value of time.

One limitation of this paper must be mentioned. The analysis gives no consideration to the mix of measures that can possibly increase competitiveness of parking services such as real-time information about availability of parking space to users; online booking and discount rates for early birds.

There are also two key topics associated with the findings of this research that require further investigation. The first is related to the need to expand the survey to the short term parking lots. The second requires customization of the SP experiments to address different trip purposes. This would entail the creation of two divisions of the dataset, grouping respondents by location (short and long terms parking lots) as well as by trip purposes, where two groups will be needed for work trips and personal trips.

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