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An Analysis of Resident and Non- Resident Air Passenger Behaviour of Origin Airport Choice

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Abstract

Increasing number of air travellers in recent years and the emergence of multi-airport cities throughout the world has made the behaviour of travellers regarding the choice of the origin airport even more important. Analysis of this behaviour helps for a better future planning and development of competing airports as an important element of their demand prediction. In this paper, particular emphasis is stressed on the behaviour of resident and non-resident passengers in choosing between the origin airport through the empirical case study of the two airports of Tehran multi-airport system, namely Imam Khomeini (IKIA) and Mehrabad International Airport (MIA) in Iran. The 24-hour and one-week survey was conducted in May 2011 and a total number of 2980 questionnaires were collected from the two airports. Binary Logit was used to model the origin airport choice of resident and non-resident travellers from the city of Tehran. Results show that the difference in the two groups is affected by "age", "Income", "Travel Destination", "Trip Purpose" and "Marital Status". Further model results show that variables "Public Access", "Flight Frequency" and "Airport Tax" are more important for non-resident air travellers in choosing their origin airport.

Keywords: Discrete choice, Binary Logit Models, multi-airport cities, stated preference, air passenger behaviour.

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1. Introduction

Growth of air passenger demand and development of cities have caused dramatic problems for the main airports, especially those in big cities. Such problems include capacity problems for airport and noise and air pollution for residents in their neighbourhood. Mehrabad International Airport (MIA) as the main airport of Tehran, capital city of Iran, has long suffered from these problems, emphasizing the need for a new airport outside the city. Various reasons have been identified for constructing this new airport, Imam Khomeini International Airport (IKIA), by international and domestic studies [PTRI, 2011]:

1- Capacity limitation of MIA
2- Interference with military flights
3- City development and environmental problems
4- Existence of a competitive market in the region
5- Goal of an international hub airport

In addition to these reasons, lack of flight space can also be mentioned. Despite these problems, Tehran residents may prefer this airport due to the less ground travel time and cost to this airport because of its location and proximity to the city (Figure 1), leading to a higher attraction. It is, however, possible to alleviate these problems by price policies, like increasing MIA different kinds of limitations and restrictions (e.g. flight time or flight frequency) and improving public transportation like developing metro lines to IKIA, fast bus lines development or airline shuttle. For non-residents of Tehran, the situation can be much different since the travel time difference

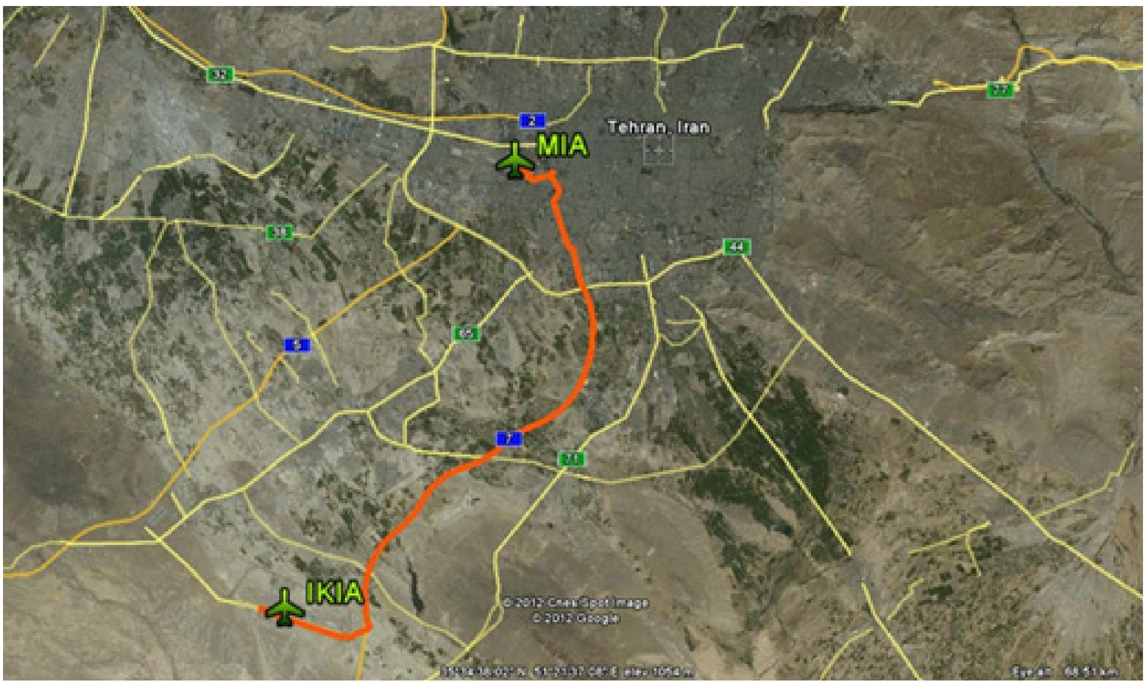

Figure 1. Location of IKIA and MIA relative to Tehran city [adopted from Google]

is trivial. What constitutes these behaviours is an important issue to policy makers in their planning, since identifying the different behavioural mechanisms of residents and non-resident in choosing origin airport can assist in their prediction.

In the current condition of the two airports, each has a separate role: MIA handles internal and Haj flights and IKIA handles only international flights. Thus, passengers select between these two airports according only to their travel destination and no other criteria is in mind. In this situation, there is no possibility to observe the role of other policies, so the stated preference (SP) method is used in the design of the questionnaires to ask about passengers' decisions in different hypothetical scenarios.

For the first time, this study used (SP) method and tries to investigate the behaviour of air travellers to identify the most effective variables for resident and non-resident air passengers of Tehran multi-airport system. Using data collected from surveys performed for this purpose; Binary Logit models are calibrated to identify the potential differences between the choices of these two groups of air passengers.

The rest of the paper is organized as follows: next section reviews the literature related to air passengers' airport choice, followed by a discussion on data collection and stated preference survey. The next section presents the methodology of airport choice modelling and the last section, sets forth the results and conclusion.

2. Literature Review

One of the earliest works in this field is an empirical study in which three major airports in the Baltimore-Washington bi-region area were studied using a multinomial logit model (MNL). The accessibility and flight schedule found to be more important than flight frequency [Skinner, 1976]. Innes and Doucet developed a MNL model to examine the importance of airport proximity as well as the effects of level-of-service factors on alternate airport choice in northern New Brunswick, Canada. Results showed that air travellers had a strong preference for jet aircraft and travelled significant distances to reach an airport offering such service. Other levels of service variables were flying-time difference and, whether a direct flight to destination was available [Innes and Doucet, 1990]. Windle and Dresner developed a MNL model to predict airport choice in a multiple-airport region and estimated using passenger data from the Washington, D.C./Baltimore area. They found that airport access time and flight frequencies were significant variables in airport choice [Windle and Dresner, 1985]. Furuichi and Koppelman developed a nested logit model using survey of international air travelers departing from Japan in 1989. Results indicated the importance of time for both business and non-business travellers [Furuichi and Koppelman, 1994]. Monterio and Hansen developed Nested and Multinomial Logit models to investigate the effect of an extension of a Bay Area Rapid Transit rail link into the San Francisco International Airport (SFO) on airport use [Monterio and Hansen, 1996]. Ashford and Bencheman developed a Multinomial Logit model to analyse air passengers' choice in central London. Results showed that for business and inclusive tour travel, the most important variables of choice were access time to the airport and frequency to the chosen destination. For domestic and leisure trips, there were three factors: airfare, access time, and frequency of available flights, in that order of importance [Ashford and Bencheman, 1987]. Bradley performed a Binary Logit modelling in airport choice in which the air fare was the most meaningful variable whereas the travel time was the second one [Bradley, 1998]. Hess and Polak extended a mixed multinomial logit model to analysis of the choice of airport, airline and access-mode for travellers living in the San Francisco bay area. Results indicated that the most important variables affecting traveller's choices were in-vehicle access time, access-cost and flight frequency [Hess and Polak, 2005]. Another study uses Mixed Logit model for airport choice in which all of the service features included in the model are significant [Adler, falzarano and Spitz, 2005]. Suzuki used the data collected in central Iowa, USA to develop and estimate a Nested Logit model of airport-airline choice. The model assumes that a traveller first eliminates certain choice alternatives that do not satisfy his/her minimum acceptable standards (first step), and then chooses the utility-maximizing alternative from the set of screened choice alternatives (second step). He found better results for tow-step model rather than one-step model [Suzuki, 2007]. Another study uses the Binary Logit model for airport selection in which the most meaningful variables were airfare, access time and frequent flyer benefits [Hess, Adler and Polak, 2007]. Loo created the Multinomial Logit model to study the airport that in the estimated model, the airfare, access time, flight frequency and the number of airlines were statistically meaningful [Loo, 2008]. Another study developed a Nested Logit model to investigate low-cost airline and airport competition in greater London. They analysed most important factors affecting air travellers' choices such as airfare, surface-access costs and frequency [Pels, Njegovan and Behrens, 2009]. Another study used data collected in Bay area airports and developed conditional logit model to measure the impact of airport and airline supply characteristics on the air travel choices. Non-price characteristics like airport access time, airport delay, flight frequency, the availability of particular airport-airline combinations, and early arrival times are found to strongly affect choice probabilities [Ishii, Jun and Van Dender, 2009]. Edoardo Marcucci estimated several Mixed Logit models with different specifications including heteroscedastic-

Table 1. Some significant airport choice studies

Work	Case of Study	Model	Main Results
Skinner (1976)	the Baltimore-Washington bi-region area	Multinomial logit	The accessibility and flight schedule found to be more important than flight frequency
Ashford (1987)	England - London	Multinomial logit	For business and inclusive tour travel, the most important variables of choice were access time to the airport and frequency to the chosen destination. For domestic and leisure trips there were three factors: air fare, access time, and frequency of available flights, in that order of importance
Innes (1990)	Canada - New Brunswick	Multinomial logit	Air travelers had a strong preference for jet aircraft and travelled significant distances to reach an airport offering such service. Other level of service variables were flying-time difference and whether a direct flight to destination was available or not.
Suzuki (2007)	USA - central Iowa	Nested Logit	The accessibility and flight schedule found to be more important than flight frequency
Hess et al. (2007)	San Francisco bay area	Binary logit	Variables with the most explanatory power are: air fare, access time and frequent flyer benefits. Non-linear transformations, interactions and segmentation lead to significant improvements in model performance
Loo (2008)	Hong Kong International Airport (HKIA)	Multinomial logit	Airfare, access time, flight frequency, and number of airlines are found to be statistically significant. Substantial insights through segmentation although the first three attributes are the common ones for all groups of passengers take different hauls of flights
Ples et al. (2009)	England - London	Nested Logit	most important factors affecting air travelers choices were air fare, surface-access costs and frequency
Ishii et al. (2009)	San Francisco bay area	conditional logit	Non-price characteristics like airport access time, airport delay, flight frequency, the availability of particular airport-airline combinations, and early arrival times are found to strongly affect choice probabilities
Stefano (2012)	southern Italy - Campania	Multinomial Logit, Mixed Multinomial Logit and Cross-Nested Logit	access time, airfare, age, experience and income were the most significant variables

ity and error component [Edoardo Marcucci, 2011]. Finally, Stefano used discrete choice random utility models (Multinomial Logit, Mixed Multinomial Logit and Cross-Nested Logit models) to investigate and model airport choice behaviour in a multi-airport region in Campania, southern Italy. He found that access time, airfare, age, experience and income were the most significant variables [Stefano, 2012].

Some significant previous studies related to airport choice presented in Table 1. As seen in the study of similarity and dissimilarity of resident and non-resident air passengers is relatively low among previous studies. This research will investigate the airport choice of these two populations separately by the use of Binary Logit models.

3. Data Collection

For conducting the empirical part of this study, a rather comprehensive questionnaire including socio-economic characteristics, trip characteristics, and stated preferences toward the origin airport were designed for gathering the necessary data for determining the effective factors related to origin airport choice by face-to-face interview. A set of effective factors was identified based on the many previous studies conducted in the field, which were incorporated as important factors in the design of the stated preference data questionnaire. It was aimed to hold the survey standards and parameters (location, duration, sample size) suggested by Airport Corporative Research Program (ACRP report 26). The 24-hour and one-week survey was conducted in May 2011 and a total number of 2980 questionnaires were collected from the two airports. Binary Logit was used to model the origin airport choice of resident and non-resident travellers from the city of Tehran. An example of questionnaire presented in Table 2.

Table 2. An example of questionnaire used in this study

If you want to trip to **Mashhad** with **leisure** purpose, which airports do you select for your trip according to the attributes below.		
Attributes	MIA	IKIA
Time of flight	7 Am to 10 Pm	Without limitation
Public access	Current conditions	Shuttle airline
Aircraft type	Wide body	Wide body
Frequency of flight to Mashhad	Once per day	Eight times per day
Airport Tax	30$	10$
Your Choice	☐	☐

4. Data Characteristics

After about one week of surveying in each airport, around 1300 samples from MIA and 1700 from IKIA were collected, a summary of which (some important socio-economic variables)is reported in Table 3.

Figures 2 to 5 reveal the frequency distribution of respondents by salary, gender and age separately for resident and non-resident air passengers. From these figures, it can be understood that the age distribution of these two groups are somehow the same, while the salary patterns for men and women are different. Most non-resident women passengers have a salary under $500 per month, while resident women passengers with a salary ranging from $500 to $1000 per month make the majority.

Table 3. Some important socio-economic characteristics of the sample

Characteristics	Mehrabad Airport (MIA)	Imam Khomeini Airport (IKIA)
No. of respondents	1697	1279
Gender	N = 1695	N = 1275
Female	193 (11.4%)	308 (24.2%)
Male	1502 (88.6%)	967 (75.8%)
Age	N = 1690	N = 1264
30 or younger	703 (41.6%)	348(27.5%)
31-50	833(49.3%)	582(46%)
51 or more	154(9.1%)	334(26.5%)
Marital status	N = 1694	N = 1277
married	1187(70.1%)	377(29.5%)
Single	507(29.1%)	900(70.5%)
Monthly income	N = 1621	N = 1174
Less than $500	241(14.9%)	203(17.3%)
$500-$999	652(40.2%)	353(30.0%)
$1000-$1499	419(25.9%)	243(20.7%)
$1500-$2499	162(10.0%)	187(16.0%)
$2500 or more	146(9.0%)	188(16.0%)
Purpose of trip	N = 1684	N = 1266
Business	1170(69.5%)	575(45.4%)
Leisure	514(30.5%)	691(54.6%)
Airport choice	N = 1693	N = 1271
IKIA	934(55.2%)	575(45.4%)
MIA	759(44.8%)	691(54.6%)

Salary pattern for resident and non-resident follow the same pattern, except that the salary for a third of the residents is $1000-1500 per month but for non-resident it is under $500 per month.

Figure 2. Salary of men (coded 1) and women (coded 0) for non-resident air passengers

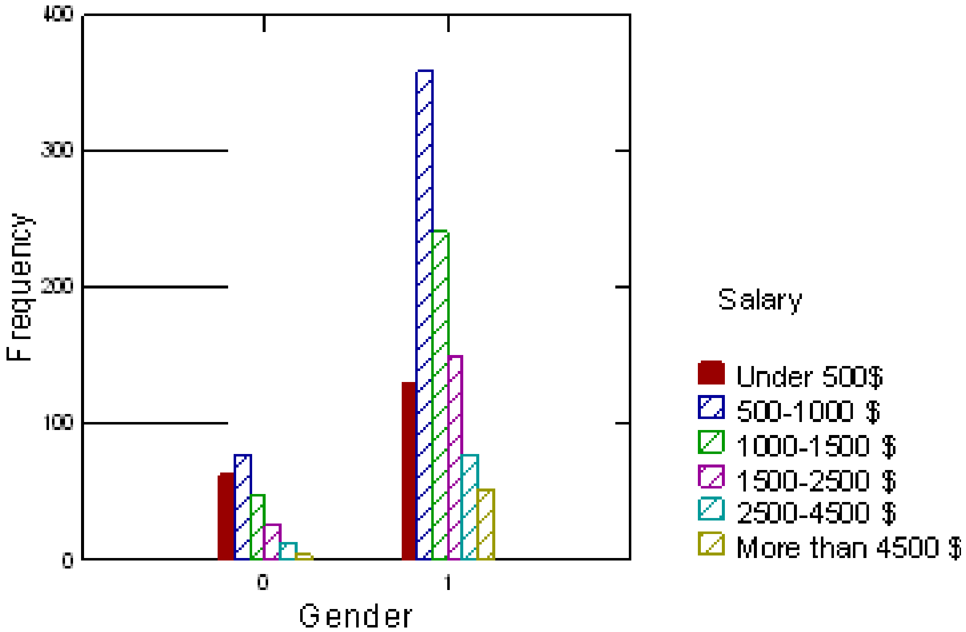

Figure 3. Salary of men (coded 1) and women (coded 0) for resident air passengers

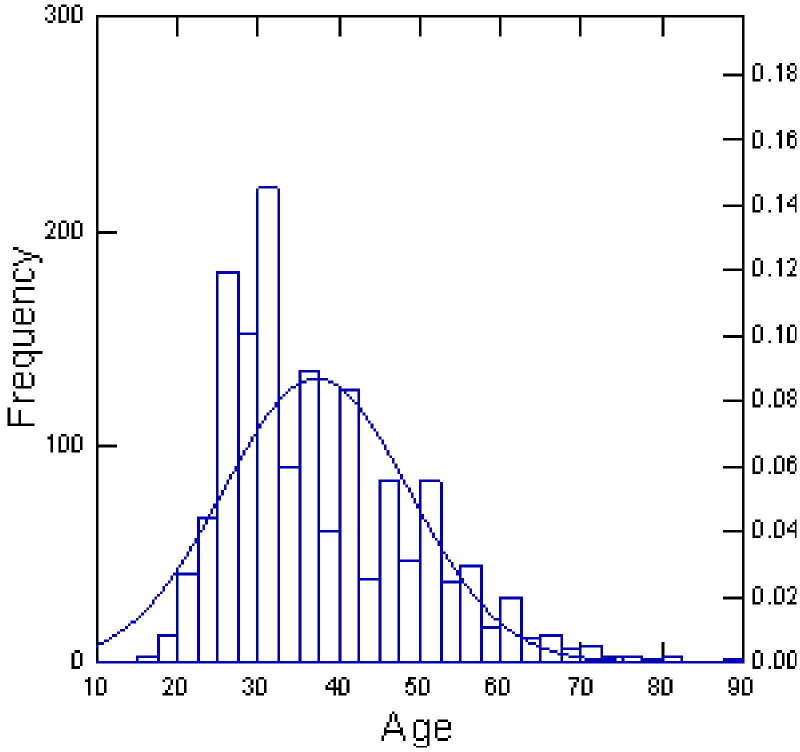

Figure 4. Age distribution for non-resident passengers

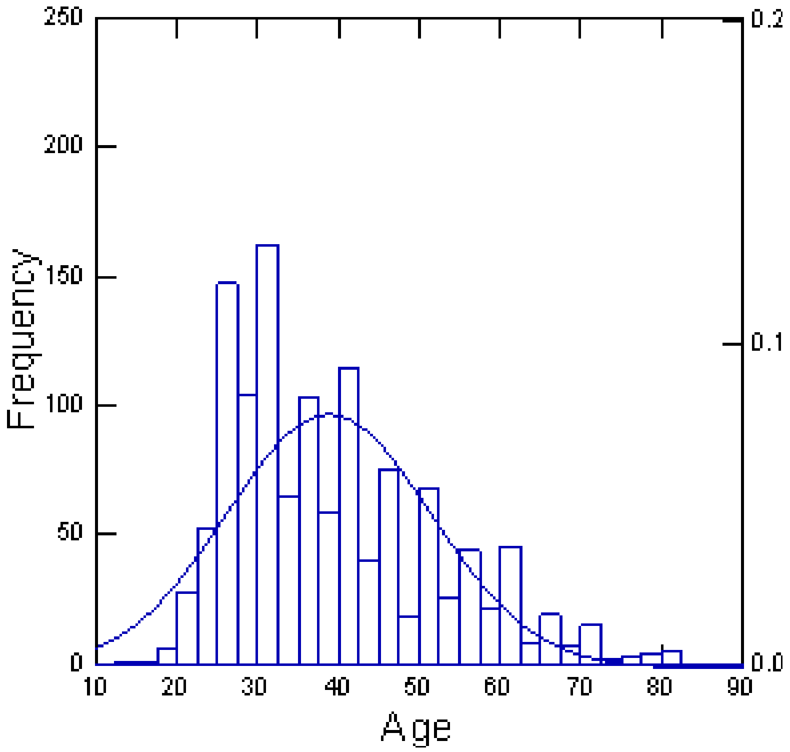

Figure 5. Age distribution for resident passengers

5. Airport Choice Modelling

5.1 Methodology

This paper uses Binary Logit model for the estimation of air passengers' behaviour in airport choice which is performed using the Stated Preference data collected from departing passengers of the two airports.

According to random utility theory, the probability of an individual choosing alternative i is equal to the probability that the utility of alternative i is greater than (or equal to) the utility associated with alternative j after evaluating each and every alternative in the choice set of j = 1,...i,...J alternatives [Hensher, Rose, and Greene, 2005].

$$prob_i = prob(U_i \geq U_j) \forall j \in j = 1, \ldots, J ; i \neq j) \quad (1)$$

Methodology of Binary Choice for this paper simply is governed by the following equations:

$U_{n1}=\beta Z_{n1}+\varepsilon_{n1}$, (2)

$U_{n1}=\beta Z_{n1}+\varepsilon_{n1}$, (3)

$\varepsilon_{n1},\varepsilon_{n2}$~iid extreme value

U_{ni} is the utility person n obtained from choosing alternative i. The utility of each alternative depends on the attributes of the alternatives interacted perhaps with the attributes of the person, which gives this expression for the probability:

$$P_{n1} = \frac{\exp(\beta Z_{n1})}{\exp(\beta Z_{n1})+\exp(\beta Z_{n2})} = \frac{1}{1+\exp(\beta Z_{n2}-\beta Z_{n1})} = \frac{1}{1+\exp(\Delta U)} \quad (4)$$

$$\Delta U = \beta Z_{n2} - \beta Z_{n1} = \sum (a_i - b_i) X_i \quad (5)$$

Where P_{n1} is the probability that person n chooses alternative 1; βZ_{n1} is the utility function of person n choosing alternative 1; βZ_{n2} is the utility function of person n choosing alternative 2; X_i is the ith variable; a_i is the coefficient of the ith variable in βZ_{n1}; b_i is the the coefficient of the ith variable in βZ_{n2} and ΔU is the difference between βZ_{n2} and βZ_{n1}.

For determining overall model significance, log-likelihood function (LL) is used because MLE (Maximum Likelihood Estimation) and not ordinary least squares (OLS) is the calibration method. Hence, we cannot rely upon the use of statistical tests of model fit commonly associated with OLS regression. We cannot use the F-statistic to determine whether the overall model is statistically significant or not [Hensher, Rose, and Greene, 2005].

In logit for determining model, fit the analyst uses PseudoR^2, which is determined as follows:

$$\rho^2 = 1 - \frac{LL_{Estimated\ model}}{LL_{Base\ model}} \quad (6)$$

Where:

$$LL_{Base\ model} = N * Ln(0.5) \quad (7)$$

$$LL_{Estimated\ model} = \sum_{i=1}^{n} Lnf(x_i|\theta) \quad (8)$$

And x_i are individual observations, θ is parameters estimated by the model and f is the probability density function.

5.2 Results of Binary airport choice for non-resident and resident air passengers

This part is devoted to the analysis and research of modelling result between two groups of resident and non-resident people of Tehran. Statistically significant variables are presented in Table 4.

Table 4.Variable description and coding

Variable	Description (Variable Type)	Coded as
D1-Age	Age of Passengers (Dummy)	Less than 20 years old= 1 Otherwise= 0
D2-Age	Age of Passengers (Dummy)	From 20 to 30 years old = 1 Otherwise = 0
D3-Age	Age of Passengers (Dummy)	More than 50 years old = 1 Otherwise = 0
D-Marriage	Marital Status (Dummy)	Single=1 Married=0
D1-Salary	Monthly Salary (Dummy)	Monthly salary less than 500$ = 1 Otherwise = 0
D2-Salary	Monthly Salary (Dummy)	Monthly salary 2500$ to 4500$ = 1 Otherwise = 0
D1-Edu	Level of Education (Dummy)	Under diploma=1 Otherwise=0
D2-Edu	Level of Education (Dummy)	Diploma=1 Otherwise=0
D-Pur	Trip Purpose (Dummy)	Business=1 Otherwise=0
D1-Des	Trip Destination (Dummy)	To Mashhad=1 Otherwise=0
D2-Des	Trip Destination (Dummy)	To Rasht=1 Otherwise=0
D-AT	Type of Aircraft (Dummy)	Wide Body=1 Otherwise=0
D-ACC	Public Access to the Airport (Dummy)	Shuttle Airline to IKIA=1 Otherwise=0
I-Nf	Number of Flights per day (Integer)	Number of Flight by IKIA Minus Number of Flight of MIA
I-Tax	Airport Tax (Integer)	MIA Tax Minus IKIA Tax

For modelling in this research, NLOGIT4 software was used. To achieve the predicted model of resident and non-resident behaviour, sample is divided into two groups and a model was calibrated for each one. In the following model, MIA is the base option with zero utility, so variables with positive coefficients in this model indicate more suitability derived from IKIA selection than MIA (MIA utility is assumed zero).

Through a modelling phase of calibrating more than 100 models to identify the resident and non-resident behaviour of IKIA and MIA, the final models are presented in tables 5 to 9. In addition, measures of log-likelihoods and goodness of fit, used to assess how well a model fits into the data, are indicated in the following tables. However, the likelihood index was relatively low.

Table 5. Binary Logit model results for non-resident air passengers

Variable	Coefficient	t-value	Marginal Effect
Constant	-2.89632	-4.748	-0.70226
D3-Age	-0.35110	-2.247	-0.08647
D1-Salary	0.30701	1.992	0.07278
D2-Salary	-0.89761	-3.906	-0.22061
D1-Edu	0.42373	1.829	0.09840
D2-Edu	0.36351	2.769	0.08628
D-Pur	-0.90218	-3.219	-0.21037
D1-Des	0.41594	2.623	0.10202
D-Acc	0.57339	4.088	0.13465
I-Nf	0.09487	4.805	0.02300
I-Tax	0.15595	4.650	0.03781

Sample size = 1515

$\rho^2 = 1 - \frac{LL(\hat{\beta})}{LL(0)}$ =0.05647

$\rho_c^2 = 1 - \frac{LL(\hat{\beta})}{LL(C)} = 0.03670$

LL (0)= -1050.117 (log-likelihood at equal shares)

LL (c)= -1028.555 (log-likelihood at market shares)

LL (β)= -990.807 (log-likelihood at convergence)

Percent correctly predicted: 62.6%

* Mehrabad International Airport (MIA) is considered as reference point

Table 6. Predictions for non-resident binary choice model

Actual Value	Predicted value		Total Actual
	0	1	
0	149 (9.8%)	481 (31.7%)	630 (41.6%)
1	85 (5.6%)	800 (52.8%)	885 (58.4%)
Total	234 (15.4%)	1281 (84.6%)	1515 (100%)

* Predicted value is 1 when probability is greater than 0.5, 0 otherwise.

The results of binary Logit model for non-resident air passengers indicate that elderly passengers (more than 50 years old), passengers with high monthly salary (between 2500$ to 4500$) and with a business purpose have a tendency to choose MIA. While passengers with low monthly income (less than 500$) and those who have under diploma or diploma degree have a tendency to choose IKIA.

If the destination of air passengers is Mashhad, they have a tendency to choose IKIA. With increasing in number of flight per day for IKIA in comparison to MIA and with decreasing the tax of IKIA relative to MIA, the passengers have a tendency to choose IKIA. In addition, the variable of public access to the airport shows that if the access to IKIA is provided by shuttle airline, the probability of choosing IKIA increases.

Table 7. Binary Logit model results for resident air passengers

Variable	Coefficient	t-value	Marginal Effect
D1-Age	1.17575	1.933	0.26065
D2-Age	0.53912	3.761	0.13318
D-Marriage	-0.28221	-1.908	-0.07043
D1-Edu	0.77214	2.752	0.18312
D2-Edu	0.30215	2.156	0.07501
D1-Des	-1.06715	-4.142	-0.25000
D2-Des	-0.98192	-2.937	-0.23492
D-AT	-0.31818	-2.148	-0.07905
D-Acc	0.37738	2.249	0.09349
I-Nf	0.05675	4.812	0.01417
I-Tax	0.02507	2.209	0.00626

Sample size = 1242

$\rho^2 = 1 - \frac{LL(\hat{\beta})}{LL(0)} = 0.0321$

$\rho_c^2 = 1 - \frac{LL(\hat{\beta})}{LL(C)} = 0.0315$

LL (0)= -860.888 (log-likelihood at equal shares)

LL (c)= -860.366 (log-likelihood at market shares)

LL (β)= -833.194 (log-likelihood at convergence)

Percent correctly predicted: 58.1%

* Mehrabad International Airport is considered as reference point

Table 8. Predictions for resident binary choice model

Actual Value	Predicted value		Total Actual
	0	1	
0	234 (26.9%)	269 (21.7%)	630 (48.6%)
1	252 (20.3%)	387 (31.2%)	885 (51.4%)
Total	234 (47.2%)	1281 (52.8%)	1242 (100%)

* Predicted value is 1 when probability is greater than 0.5, 0 otherwise.

The results for resident air passengers show that, teenagers and adults (less than 30 years old) and the air passengers that have diploma or under diploma degree have a tendency to choose IKIA. While married passengers have a more probability to choose MIA. Resident air passengers whose destination is Rasht or Mashhad and their aircraft type will be wide body, tend to choose MIA (the near city airport).

The results of public access type to airport, number of flight per day and airport taxes are similar to Non-resident air passengers, although the airport tax is more important for Non- resident air passengers.

6. Discussions

As it can be observed from the calibrated models of Tehran multi-airport region, the behaviour of resident and non-resident passengers is not very different from each other but there exists some dissimilarities. The results are discussed as follows:

Resident passengers under 20 have a tendency to choose IKIA and this tendency is lower for those with an age range of 20 to 30 years, Non-resident passengers with 50 years do not have a tendency to choose IKIA. Marital status variable is significant too; if they were single then they would not have a tendency to choose IKIA. Salary variable is significant just for non-resident air passengers and it indicates that low-income passengers have a willingness to choose IKIA while high-income non-resident passengers show a reverse tendency. The Education variable shows that under diploma and diploma passengers are more likely to choose IKIA. Tehran resident air passengers with business purpose have no interest to choose IKIA. Public access, number of flights and airport taxes are positively significant for both resident and non-resident passengers indicating that an increase in these variables (better public access, more flight number and lower airport taxes for IKIA), causes an increase in both resident and non-resident passengers' tendency to choose IKIA. From the calibrated models, it can also be understood that the coefficients of the three variables: Public access, number of flights, and airport tax) have a greater value for non-resident air travellers which can assert that these attributes are more important for them than resident passengers of Tehran.

7. Conclusions

The prediction of the way that air passengers choose an airport is a key point in transportation planning and can have basic role in planning and city transportation policies. In this study, two Binary Logit models were calibrated to investigate the choice of airport for two groups of resident and non-resident passengers in Tehran, Iran. Based on a 24-hour and one-week survey conducted in May 2011 and a total number of 2980 questionnaires, the main differences between these two groups were analysed.

Results show that the difference in the two groups is affected by “age”, “Income”, “Travel Destination”, “Trip Purpose” and “Marital Status”. Further model results show that variables of “Public Access”, “Flight Frequency” and “Airport Tax” are more important for non-resident air travellers in choosing their origin airport.

From a planning and developmental point of view, air travellers’ behaviour of airport choice is critical in the recommendation of a better air transportation system. Understanding this behaviour becomes more necessary when a multi-airport system is used. Multi-airport system of Tehran as the first and only multi-airport in Iran has not been investigated, particularly from this respect. Results of this paper can help policy-makers for making better decisions for such important and expensive transportation facilities.

In this research, binary logit model was used to model passenger behaviour of origin airport choice for both residents and non-residents separately. The heterogeneity of the resident and non-resident passengers can be further estimated by mixed logit model to analyze the issue of heterogeneity in more detail.

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