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A study on passengers' airport choice behavior using hybrid choice model: A case study of Seoul metropolitan area, South Korea

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ABSTRACT

Improving explanatory power is significantly important to understand variables that affect attitudes and perceptions in the decision process. This paper estimates not only tangible attributes but also intangible perceptions and attitudes using a hybrid-choice model to study air passengers' flight choice behavior. The empirical study was conducted for the choice behavior of air passengers at Seoul Metropolitan Area, South Korea. The analysis uses a two-level Nested Logit model in order to examine which factors have more effect on passengers' choice of airport and airline simultaneously by using airport and airline choice attributes. The study also estimated the parameters in the equations relating the latent variable by using Structural Equation Model (SEM). The results indicate that the models with latent variables have improved Goodness-of-Fit when compared to classical discrete choice models and effectively capture psychological factors that affect choice behavior of passengers.

1. Introduction

Since 2005, the emergence of Low Cost Carriers (LCCs) in South Korea's aviation industry have brought about a shift in its structure that had previously been dominated by two major airlines. On international routes, LCCs operated 68 flight movements along with 11,360 passengers per annum in 2008and 23,871 flight movements with 652 million passengers in 2014. The market share of LCCs in South Korea's international flights shows continuous growth as it increased from .03% in 2008 to 11.41% in 2014. The lower air fare by LCCs has contributed to significant traffic leakage from full service carriers (FSC). This is because travelers are willing to spend several hours on access to airports in order to take advantage of lower fares and more convenient airport services (Fuellhart, 2007).

The growth of LCCs in multi-airport regions give air passengers more diverse flight alternatives by combining multiple departure airports and flight routes (Yang et al., 2014). Travelers have the option to use different airports to take advantage of lower fares and more convenient airline services rather than using their local airports (Suzuki and Audino, 2003).

Each of South Korea's airports are trying to boost its performance by expanding existing infrastructure to increase potential demand for air travel and by improving the quality of service. With LCCs focusing on increasing international routes, competition among airports in the Seoul metropolitan area will increase significantly. Passengers will have more alternative airports when traveling. For local authorities, airport planners and airlines, it is important to know how passengers decide on their preferred method of travel in such market competition condition (Pels et al., 2003). It is significantly important to improve explanatory power that combines explanatory variables and latent psychological factors that affect attitudes and perceptions in the decision process.

2. Literature review

Metropolitan regions often have more than one commercial airport. Where multiple airports serving a similar market exist, it is important to understand how airlines and air travelers choose their origin and destination airports within a regional airport system. As airports compete with one another for passengers, substitution or market area "leakage" occurs when travelers avoid using the local airports in their regions, and use other (out-of region) airports to take advantage of lower fares and more convenient airline services (Suzuki and Audino, 2003).

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The issue of airport choice in metropolitan areas with multiple airports has been addressed in a number of studies, where the objectives have been to investigate the primary determinants of travelers' airport-choice decisions, such as airport access time, flight frequency, differences in air fare, type of aircraft, and purpose of travel. Many of the papers on airport choice have been studied in multi-airport regions because of the high frequency of service that they offer. Some of these papers adopted more sophisticated choice models to improve statistical power. Pels et al. (2003) recognized that passengers make a number of decisions including which airport and airline and the airport access mode that they can choose from. In this paper, a two level nested logit (NL) model is used for combined estimation of access mode and airport choice model. The authors found that business travelers have a higher value of time (i.e., access time and frequency) than leisure travelers while leisure travelers are more sensitive to fare and airport access cost than business travelers (Pels et al., 2003). Harvey (1987) found that airport access time and flight frequency were significant factors affecting origin and destination airport choice for both leisure and business travelers in a multi-airport urban region, but the access time elasticity seems to be relatively more important in the airport choice model in the business samples. Basar and Bhat (2004) estimated business travelers' airport choice behavior in the San Francisco Bay Area using multinomial logit model (MNL) and probabilistic choice set multinomial logit (PCMNL) model. A PCMNL model can more sensitively estimate the access time effects at its stage. The authors further emphasize that a good understanding of the factors underlying passenger's origin airport choice in multi-airport urban regions is crucial because it can enable airport management and airline carriers to attract passengers, upgrade airport facilities and equipment to meet projected air travel demands, and determine airport staffing needs (Basar and Bhat, 2004). Hess and Polak (2005) adopted a cross-nested logit for a combined choice of airport, airline and access mode. They supported the earlier findings of fare, frequency and access time being significant variables in choice among airports in the same area; and of business travelers being more sensitive to access time than leisure travelers in San Francisco Bay. Ishii et al. (2009) studied the airport choice in the San Francisco Bay area using a mixed logit (ML) model. The results revealed that access time, frequency, airport delays, flight frequency, availability of particular airport-airline combinations, and early arrival times strongly affect choice of airport. Zhang and Xie (2005) used a Logistic Regression model to examine the influences of a few variables on passenger's choice of airports in the Golden Triangle Regional (GTR) airport. The paper found that ticket prices, experience with the GTR airport, and flight schedules were the most important factors influencing choice of airports in small cities. Marcucci and Gatta (2011) explicitly treat both compensatory and non-compensatory decisions in multi-airport regions. The paper used not only MNL but also ML model to improve the explanatory power of the model. Marcucci and Gatta (2012) proposed a structured way to investigate alternative methods to account for preference heterogeneity in airport choice. ML model and latent class models are used for capturing preference heterogeneity as the first way. The NL model represents a partial relaxation of the Independence of Identically Distributed (IID) and IIA assumptions of the MNL model. The NL model is relatively straightforward to estimate and offers more effect of being of a closed-form solution (David et al., 2007). Yoshinori (2007) developed the two-step NL model that includes airport-airline choice. The author mentions that airport and airline choices are seemed to be made simultaneously by travelers in their decision process. The results indicate that the model fit of the two-step NL model is better than that of a one-step nested logit model.

Traditionally, discrete choice models (DCMs) have considered only objective attributes from the alternatives and socio-economic characteristics of the individuals as explanatory variables. Latent variables strengthen traditional DCMs by enabling it to more effectively capture psychological factors that affect purchase behavior of customers and facilitate the understanding of the relationship between customers' desires and product features (Johansson et al., 2006; Chen et al., 2004).

Latent variable modeling is a technique that can capture the customer's perception through the use of psychometric data obtained through conducting surveys. Psychometric survey questions ask consumers to indicate how satisfied or dissatisfied they are with respect to aspects of latent variables (Loehlin, 1998). The psychological factors lead to a more behaviorally realistic representation of the choice process, and consequently, better explanatory power (Johansson et al., 2004).

Some of these papers include Loehlin (1998); Johansson et al. (2004); Yanez et al. (2010). Loehlin (1998) indicates that latent variable modeling is a technique that can capture customers' perceptions through the use of psychometric data, obtained through conducting surveys. Johansson et al. (2004) found that latent variables strengthen discrete choice model to outperform the traditional discrete choice model and that the construct reliability of the attitudinal latent variables is higher than that of the behavioral latent variables. Yanez et al. (2010) indicates that latent variables are intangible attributes, the aim of which is to represent subjective elements in choice behavior. Thus these variables, which normally do not have a measurement scale, try to represent factors that although influencing individual behavior and perceptions, cannot be quantified directly in practice.

Many papers on hybrid choice model have been studied, because the latent variable approach better captures psychological factors that affect purchase behavior of customers and facilitates the understanding of the relationship between customers' desires and product features (Chen et al., 2004). The use of hybrid choice model will improve explanatory power by combining discrete choice and latent variables models that consider the impact of attitudes and perceptions on the decision process (Ben-Akiva et al., 2002). However, there is little study about passengers' airport choice behavior which utilizes a hybrid choice model in South Korea. This paper aims to investigate the air passengers' choice behavior at Seoul Metropolitan Area with latent variables and its influence on the discrete choice model.

3. Research methodology

3.1. Standard discrete choice modeling

The most common approach of discrete choice modeling is based on random utility theory. The utility function indicates the individual preferences where the explanatory variables are the alternative attributes and individual characteristics (Bolduc and Daziano, 2009).

The MNL model is a generalization of the binary logit model and is used to describe how an individual chooses among three or more discrete alternatives. The MNL model indicates independence from irrelevant alternatives (IIA) that enhance proportional substitution across alternatives. However, often researchers are unable to capture all sources of correlation, a major cause of correlation of the unobserved portions of utility, and IIA does not hold. McFadden (1977) proposed the distribution of the NL as a type of Generalized Extreme Value (GEV) distribution which exhibits generalization of the distribution that gives rise to the logit model and a variety of substitution patterns. Both MNL and NL offer closed forms for choice probabilities but rely on restrictive simplifying assumption.

Yoshinori (2007) indicates that individuals make choice decisions in two steps. Individuals eliminate alternatives in the first step, if not acceptable. In the second step the remaining alternatives are evaluated in more detail by utility maximization. In this paper, the two-step NL model is used to model the joint choice behavior of passengers for airport and airline. We assume a situation that passengers choose airport(h) and airline(j) simultaneously when they decide to fly. The probability of choosing alternative $P(h, j)$ in a model is given as:

$$P(h,j) = P(h) \times P(j|h) \tag{1}$$

$$P(h) = \Pr\left(\max\left(v_h + \varepsilon_{jh}\right) \geq \max\left(v_{h'} + \varepsilon_{jh'}\right), \forall h' \in H,\ h' \neq h\right)$$

$$P(h) = \frac{\exp(v_h)}{\sum_{h' \in H} \exp(v_{h'})}$$

$$P(j|h) = \frac{\exp\left(v_{jh}\right)}{\sum_{j \in j_h} \exp\left(v_{j'h}\right)}$$

3.2. Hybrid choice model

Hybrid choice models have been developed during the last decade to capture the impact of subjective factors over the decision process. The hybrid choice model expands on the standard choice model by considering flexible error structures extensions and a combination of revealed (RP) and stated preference (SP) data. Ben-Akiva et al. (2002) extended the above approaches by formulating a general treatment of the inclusion of latent variables in discrete choice models.

In Fig. 1, indicates the DCM with latent variables that contains unobserved psychometric variables (Brownstone et al., 2001).

Hybrid choice models have two parts including latent classes which explain market segments and the integration of latent constructs according to an integrated choice, and a latent variable model which is inside the Hybrid choice model's conceptual framework. It includes attitudes, opinions and perceptions as psychometric latent variables that improve understanding of passengers through increased power of prediction (Bolduc and Daziano, 2009).

There are currently two approaches to hybrid choice model estimation: sequential and simultaneous. Although experimental software exists for simultaneous estimation, it only allows estimation of MNL models. Consequently, it is not possible to accommodate heterogeneity or correlation among individuals and/or observations through random parameters or error components (Bolduc and Giroux, 2005). The more popular estimation method is the sequential approach where the latent variables are constructed before entering the discrete choice model as further regular variables (Johansson et al., 2004; Ashok et al., 2002). Although the sequential method has the disadvantage of not using all available information jointly, its application is clear and simple (Raveau et al., 2014). To test both explanatory variables and latent variables, the sequential method is used to analyze survey data collected in this paper.

Ben-Akiva et al. (2002); Ashok et al. (2002) used sequential estimation in their study. The sequential method is a two stage approach. In the first stage, the parameters are estimated in the equations, relating the latent variable with explanatory variables and perception indicators as structural equation model (SEM) applications. Then, using these parameters, it is possible to calculate expected values for the latent variable of each individual and alternative, and eventually include them directly in the discrete choice model (Ben-Akiva et al., 2002; Ashok et al., 2002).

The latent variable model consists of two parts, a structural model and a measurement model (Pantouvakis and Renzi, 2016). The structural model consisted of one equation per latent variable, models the latent variable $\boldsymbol{L}$ as a functions of customer attributes $\boldsymbol{A}$ and customer background $\boldsymbol{S}$, as shown in Fig. 2(Loehlin, 1998). The measurement model measures the relationship between latent variables $\boldsymbol{L}$ and indicators $\boldsymbol{I}$. A structural model equation is presented in Equation (2), where the indices for the latent variables, customer attributes and customer background are omitted. The random disturbance μ, which captures the variability of customer's perception, is often assumed to be normally distributed.

$$\boldsymbol{L} = \alpha_1 \boldsymbol{A} + \alpha_2 \boldsymbol{S} + \mu \tag{2}$$

The measurement model contains one equation per indicator as shown in Equation (3). The number of measurement equations was constrained to one per latent variable for identification.

$$\boldsymbol{I} = \gamma \boldsymbol{L} + \nu \tag{3}$$

The structural equation for customer utility U with random disturbance ε can be written, which accounts for unobserved attributes, taste variation, and modeling deficiencies.

$$\boldsymbol{U} = \beta_1 \boldsymbol{X} + \beta_2 \boldsymbol{L} + \varepsilon \tag{4}$$

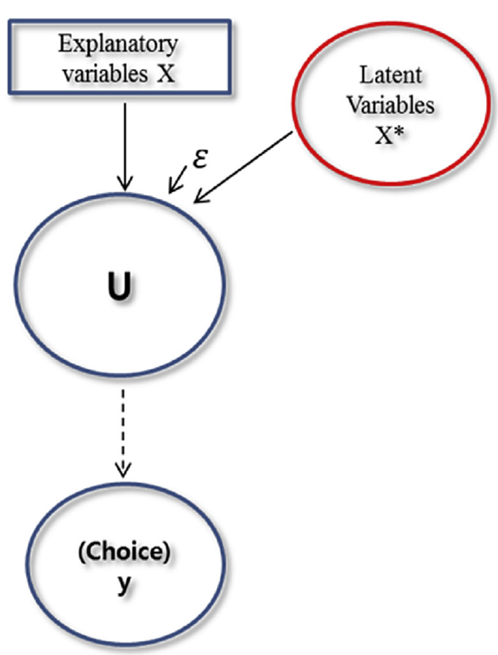

Fig. 1. Latent variables and discrete choice model.

4. Model framework

The empirical application is done on air passengers' choice behavior in the Seoul Metropolitan area in South Korea. There are three airports including Incheon International Airport (ICN), Gimpo Airport (GMP) and Cheongju Airport (CJJ) within 2 h access time in the metropolitan area. The distance between ICN and GMP is 41.5 km and the distance between ICN and CJJ is 153.0 km. This

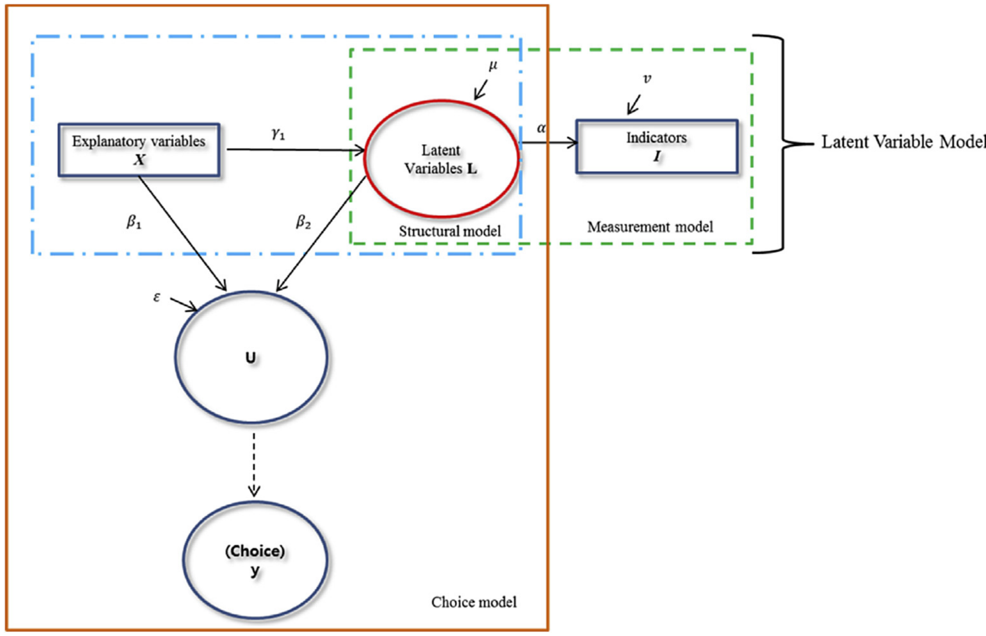

Fig. 2. The latent variable model with structural and measurement models.

paper adopts an approach of analyzing choice behavior for the three airport alternatives, including ICN, GMP and CJJ, located within 2 h (100mile = 160.93 km) from the Seoul metropolitan area described in Fig. 3.

Three airports —Incheon Airport, Gimpo Airport and Cheongju Airport— are located within 2 h of driving distance in the Seoul metropolitan area (Seoul, Incheon, Gyeonggi Province) where half of South Korea's entire population and economic activities are concentrated. The population of the metropolitan area including Seoul, Incheon, Gyeonggi-do and North Chungcheong-do accounted for about 26 million in 2013 which occupied over 52.6% market share of the total population of Republic of Korea in Table 1.

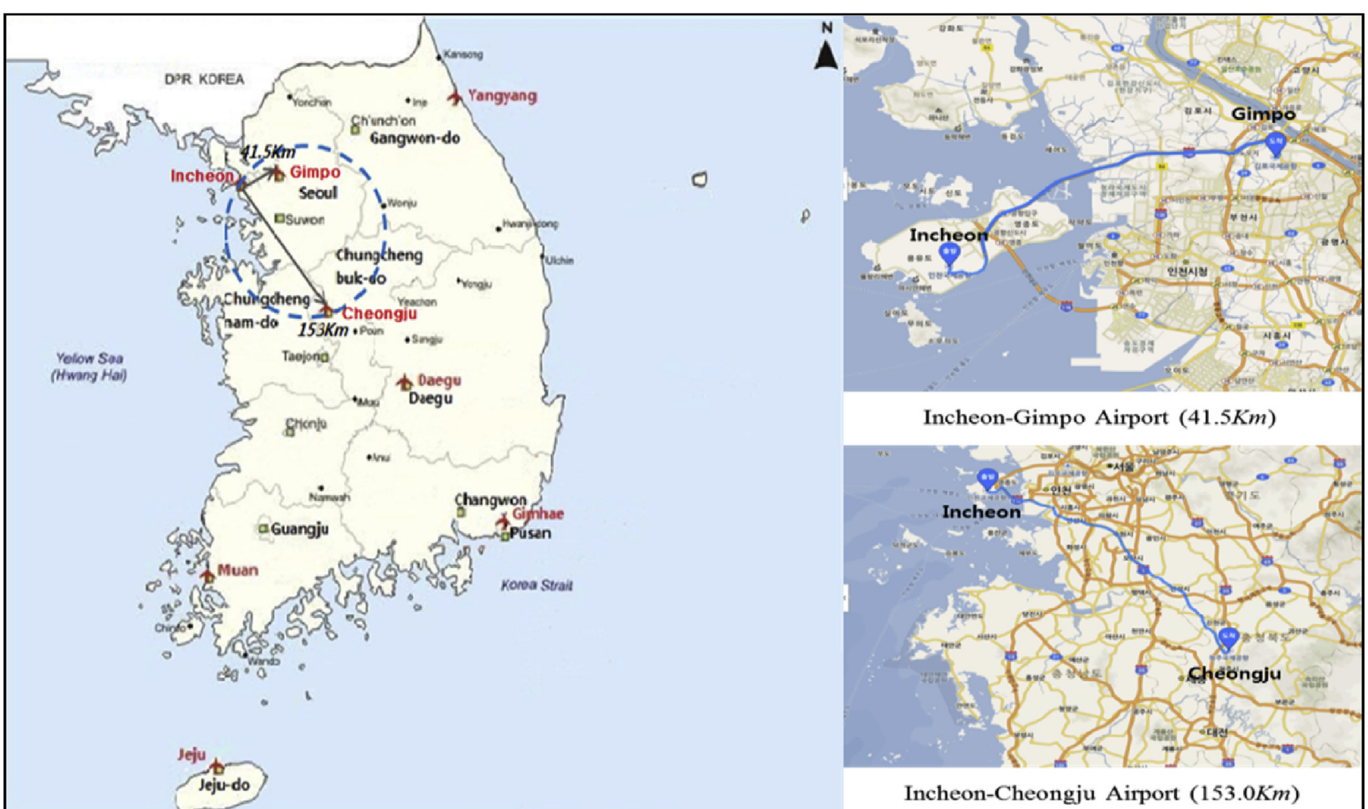

Fig. 3. The alternatives.

MNL and two-level NL models are used to estimate air travelers' airport and airline choice behavior simultaneously in this study (Show Fig. 4.).

To estimate this probability a linear form of the utility function(U_{ij}) is applied. The utility function of the discrete choice model could be written as:

$$V_{ij} = \mathbf{ASC}_{Airport_i \times Airline_j} + \beta_1 \times Fare + \beta_2 \times Flight\ Time + \beta_3 \times Frequency + \beta_4 \times AccessCost + \beta_5 \times Access\ Time$$

where:

$\mathbf{ASC}_{Airport_i \times Airline_j}$ is Constant of $Airport_i$ and $Airline_j$
$\beta_{1..n}$ are parameters of SP attributes.

The model presented in Fig. 5 is the combination of a latent variable model and a discrete choice model. In order for the model system to be estimated, a sequential estimation procedure is used.

The utility function of the hybrid choice model could be written as:

$$V_{ij} = ASC_{Airport_i \times Airline_j} + \beta_1 \times Fare + \beta_2 \times Flight\ Time + \beta_3 \times Frequency + \beta_4 \times Access\ Cost + \beta_5 \times Access\ Time + L_1 \times Airport\ access\ Convenient + L_2 \times Facilities\ service\ quality + L_3 \times Service\ Satisfaction$$

where:

$\mathbf{ASC}_{Airport_i \times Airline_j}$ is Constant of $Airport_i$ and $Airline_j$
$\beta_{1..n}$ are parameters of SP attributes
$L_{1..n}$ are parameters of latent variables

5. Experimental design and survey results

This paper uses the following airline and airport attributes based on a study in advance that considered: air fare, flight-time, service frequency, access cost and access time. Note that depending on the airline or airport attribute, different air fare, flight time, frequency, access cost and access time levels were selected. It should be noted that air fare and frequency levels are composed using the current levels of airlines departing ICN as a base; i.e.15% or 30% and 30% or 50% for lower level, respectively. The flight time attribute levels are considered in terms of indirect flights which take more than 3 h or 6 h. Also, both access time and access fare levels are composed using current levels by calculating the average access time and fare from the metropolitan area to airports (ICN, GMP and CJJ); i.e. 40% for the lower or higher level. The experimental design levels that each attribute could take as part of the experiment are shown in Table 2.

Bliemer and Rose (2005) indicate that efficient designs are significant and useful. To reduce the number of respondents efficient designs are usually performed. Gatta and Marcucci (2014) show the good performance of multi-stage efficient design in the case of small sample. To perform the efficient designs, the factorial design was used. The questionnaires were chosen three different SP survey tables. Table 3 shows the example of it.

Three latent variables: Airport access convenience, Airport facility service quality and service satisfaction are measured on a 5 point Likert-type scale. The airport access convenience from origins and destinations, number of transfers, reliability and safety are important factors affecting individuals' decisions regarding their trips to and from the airports (Akar, 2013). The access convenience indicates emotional state. Airport service quality components that can lead to increased traveler satisfaction are recognized as one of several attributes that contribute to airport attractiveness (Pantouvakis and Renzi, 2016). Airport facilities are the first experiences that travelers encounter. Therefore, airport facilities give them the first impression which can lead to these experiences influencing quality perceptions for the overall itinerary (Pantouvakis and Renzi, 2016; Martín-Cejas, 2006). The perception indicators were used in many previous studies (Akar, 2013; Pantouvakis and Renzi, 2016; Martín-Cejas, 2006). The 12 measurement indicators used in this paper are shown in Table 4.

The main SP survey was conducted over a period of three weeks on airport choice of experienced passengers living in Seoul, Incheon, Gyeonggi or Cheongju areas in March 2014. Interviews and a questionnaire were chosen as survey methods. A pilot study of 120 respondents was performed prior to the main survey. A total of 450 questionnaires were distributed to passengers in the departure lounges. Some 403 completed responses were collected, though 29 questionnaires were incomplete. A total of 2244 choice observations were generated for analysis as in Table 5.

The preference heterogeneity determinants of airport choice are given in Table 6. The results of cross-analysis show that the preference determinants of business travelers is the appropriate flight schedule (58.5%). On the other hand, air fare is the dominant determinant of leisure travelers (54.9%) and VFR(71.8%) in airport choice.

6. The results of analysis

The empirical results of the models estimated via the sequential estimation procedure are presented. A confirmative factor analysis of the indicators for each of the three latent variables is first performed in order to identify correlations between these variables. To assess the fit of the model, Goodness-of-Fit Index (GFI), Adjusted Goodness-of-Fit Index (AGFI), Normed Fit Index (NFI), Root Mean Square Residual (RMR), and Root Mean Square Error of Approximation (RMSEA) are indicated in this paper in Table 7. The various fitness indexes for the model revealed that the theoretical model indicates a good fit (p-$value$ >.000).

The confirmatory factor analysis is estimated using the characteristics of the respondent as explanatory variables by the structure equation model (SEM) in Table 8. The results of confirmatory factor analysis indicate that the latent variables have reliability and the fitted latent variables can be include as explanatory variables in the MNL and two-level NL models.

The MNL and two-level NL models consist of the latent variables with airport access convenience, Airport facility service quality and service satisfaction. Table 9 shows the results of the t-value, the likelihood ratio test, the rho-square value and $Peseudo$-R^2. The results of the MNL model along with the latent variable model show that the log likelihood functions (LL) are −989.69 and −999.69, and the $Peseudo$-R^2 are respectively .101 and .168. The $Peseudo$-R^2 of the NL model along with the latent variable model are respectively .181 and .187, implying that the NL model is a better fit for the data than

Table 1
The population of metropolitan area.

City	Population	Market share%
South Korea	50,219,669	
Seoul(A)	9,991,064	19.9
Incheon(B)	2,816,025	5.6
Gyeonggi-do(C)	12,080,585	24.1
Chungcheongbuk-do(D)	1,561,471	3.1
(A + B + C + D) Total	26,449,145	52.6

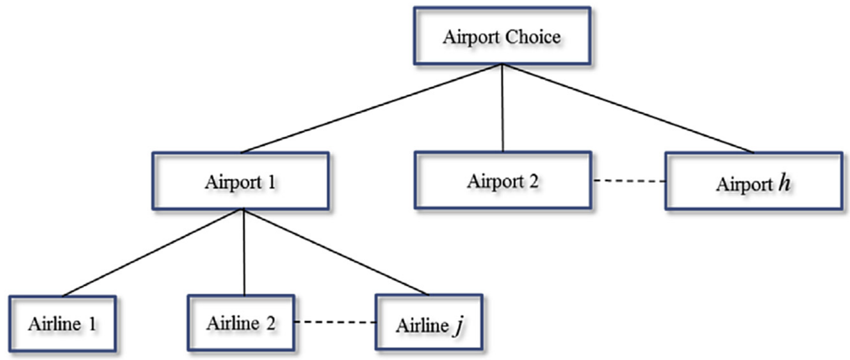

Fig. 4. Two-level nested logit model.

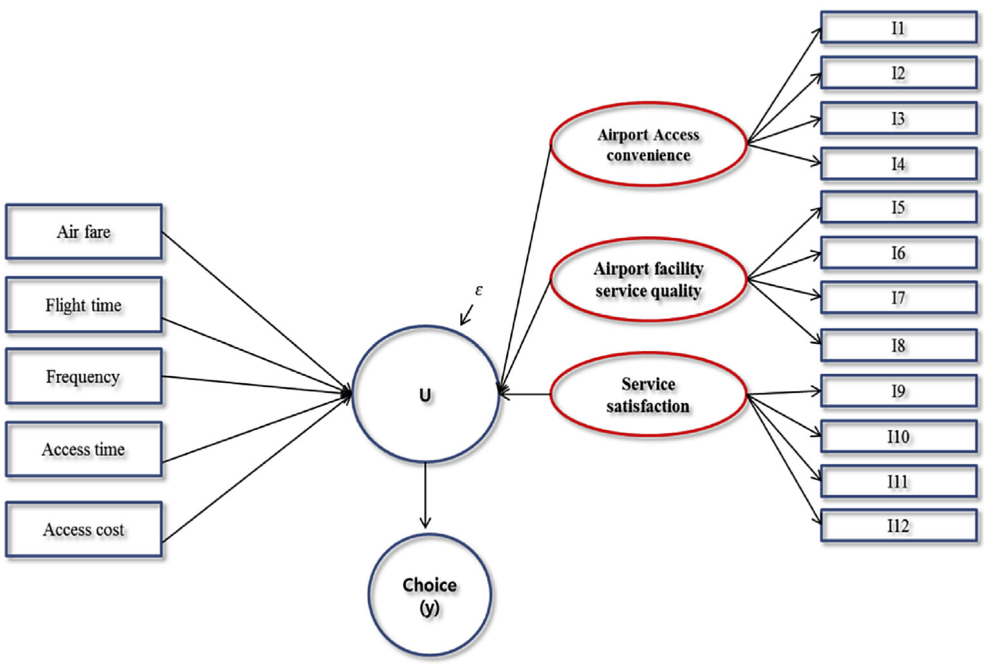

Fig. 5. Model framework.

Table 2
The experimental design.

Attributes		Levels		
Airline attributes	Air fare (US$)	1622	1909	1336
	Flight-time (hour)	20	14	17
	Frequency (weekly flights)	9	14	7
Airport attributes	Access cost (US$)	14.5	10	5.4
	Access time (minutes)	120	80	45

1100\ = 1$.

Table 3
The example of SP survey table.

Airport	ICN	GMP	CJJ
Airline	Foreign airline	Foreign airline	LCC
Air fare (US$)	1909	1336	1622
Flight-time (hour)	20	14	20
Frequency (weekly flights)	9	14	7
Access cost (US$)	120	80	45
Access time (minutes)	120	45	45
Choice	□	□	□

1100\ = 1$.

the MNL model. The NL with latent models shows the best fit to the data (*Peseudo*-R^2 = .187). The results indicate that incorporation of latent variables improved the Goodness-of-Fit of the choice model. This is because it can help not only to explain the random disturbance ε of the utility by explicitly considering passengers' perception in the choice model but also to reduce collinearity issues caused by approaching the latent variables as separates from attributes groups (Chen et al., 2004).

Since the *t*-values of five exploratory variables – fare, flight time, frequency, access time and access cost – and the airport access convenience latent variable estimated by NL are greater than the critical Wald-value, the analyst may reject the hypothesis that the parameter equals zero and conclude that the five exploratory variables and the airport access convenience which indicates emotional state are significantly affecting passenger's airport choice behavior (Table 9). However, the *t*-value of both airport facility service quality and service satisfaction are less than the critical Wald-value, so we cannot reject the hypothesis that the parameter equals zero. It means that airport facility service quality and service satisfaction are not statistically significant. Therefore, passengers are considering service quality and service satisfaction

Table 4
Latent variables and indicators.

Latent variables *L*	Indicators I
Airport access convenience (L_1)	I_1 Public transportation accessibility
	I_2 Traffic congestion nearby the airport
	I_3 Reasonable access fare
	I_4 Convenience of airport accessibility
Airport facility service quality (L_2)	I_5 Convenience of using airport amenities (duty-free shops, restaurants, etc.)
	I_6 Convenience of boarding and arrival procedures
	I_7 Available information on how to use airport facilities
	I_8 It is easy to use airport facilities
Service satisfaction (L_3)	I_9 Satisfaction with the given airport
	I_{10} Satisfaction with the trip from the given airport
	I_{11} Satisfactory service at the given airport
	I_{12} Satisfaction with overall service at the given airport

Table 5
Passenger profiles.

Alternatives/distribution	Sample number	Frequency %
Gender		
Male	219	58.6
Female	155	41.4
Age		
19–25	91	24.3
26–35	101	27.0
36–45	112	29.9
46–55	35	9.4
56 and over	35	9.4
Income		
Less than 20,000,000 (₩)	200	53.5
20,000,000~less than 30,000,000 (₩)	58	15.5
30,000,000~less than 40,000,000 (₩)	49	13.1
40,000,000~less than 50,000,000 (₩)	29	7.8
50,000,000~less than 60,000,000 (₩)	18	4.8
More than 60,000,000 (₩)	20	5.3
Journey purpose		
Business	53	14.2
Non-business	282	75.4
VFR	39	10.4
Total respondents	374	

of airport less significantly but emotional airport access convenient is significant factor when they choose their journey route. Therefore it is significant for the airport operators to reduce ground access time as well as improving the level of service of and airport access convenience (Tsamboulas and Nikoleris, 2007).

This paper calculated the direct-elasticities and cross-elasticities of fare, flight time, frequency, access cost, and access time based on a two-level NL model. The direct-elasticities are reported in Table 10. Taking the examples of the elasticity of airfare attribute on ICN, GMP and CJJ alternatives, direct effects are calculated respectively as ICN -1.411, GMP -1.298 and CJJ -1.231 which means that the fare elasticity of ICN alternative is relatively elastic. The reason ICN has the highest direct-elasticity of fare is because there is a larger variety of fare choices than other airports which makes passengers more sensitive to air fare. On the other hand, flight time elasticity for GMP alternative is relatively elastic because passengers using GMP, who are likely to be busy people located in the urban area, have a higher value of time. Table 10, also represents the cross-elasticity effects. Examining the cross-elasticity effects, the specified model suggests that a 1% increase in fare for the ICN alternative will result in a .75% increase in choice probability for the GMP alternative. A 1% increase in the flight time for the GMP alternative will increase demand for the ICN alternative by .75%. Also, a 1% increase in access time for the GMP alternative will result in a .09% increase in the choice probabilities for the ICN alternative. The results reveal that competition is more severe between ICN and GMP than that between GMP and CJJ.

Table 6
Preference heterogeneity.

Determinants of airport choice	Business traveler		Leisure traveler		Visit to friends and relations (VFR)	
Distance from home	1	1.9%	24	8.5%	7	17.9%
Distance from work	–	–	19	6.7%	–	–
Access fare from Home/work	–	–	3	1.1%	–	–
The existence of direct flights	1	1.9%	40	14.2%	–	–
Appropriate flight schedules	31	58.5%	20	7.1%	2	5.1%
Air fare	9	16.9%	155	54.9%	28	71.8%
Convenience parking and parking fee	9	17%	5	1.8%	1	2.6%
Duty-free shops	2	3.8%	16	5.7%	1	2.6%
X^2	152.04					
P-value	.000					

Table 7
The results of Goodness-of-Fit.

Goodness-of-fit measure	
Chi-square value (x^2)	590.381
Degrees of Freedom (DF)	57
P-value	.000
Goodness-of-Fit Index (GFI)	.901
Adjusted Goodness-of-Fit Index (AGFI)	.842
Normed Fit Index (NFI)	.814
Root Mean Square Residual (RMR)	.080
Root Mean Square Error of Approximation (RMSEA)	.079

Table 11, represents joint probability reflected in the scenarios with different air fares and flight times in accordance with the airline alternative along with different access times and access costs for airport alternative. The results show that the joint probability of the airport$_n$*airline$_2$(FSC) alternatives are higher than other airline alternatives even when fare is higher. Also, the joint probability of the airport$_n$*airline$_3$ (LCC) alternatives are higher than the airport$_n$*airline$_1$(Foreign airline) alternatives which means that the perception regarding LCCs is improving, especially in GMP even with South Korean passengers' strong preference towards its nationality airline.

7. Conclusion

The amount willing to pay (WTP) for reducing flight time and access time is estimated based on two-level NL and NL with latent models. The travelers in the market would be prepared to pay

Table 8
The results of Confirmatory Factor Analysis.

Variable			Factor loadings	S.E.	C.R	P.	Construct reliability	Variance extracted
Airport access convenience (L_1)	I_1	Public transportation accessibility	.605				.967	.882
	I_2	Traffic congestion nearby the airport	.786	.091	11.521	***		
	I_3	Cost of access to the airport	.589	.085	8.974	***		
	I_4	overall accessibility to the airport	.829	.095	10.748	***		
Airport facility service quality (L_2)	I_5	Convenience of using airport amenities (duty-free shops, restaurants, etc.)	.717				.960	.889
	I_6	Convenience of boarding and arrival procedures	.795	.068	15.016	***		
	I_7	Available information on how to use airport facilities	.700	.071	13.167	***		
	I_8	Overall convenience of using the airport	.788	.079	14.731	***		
Service satisfaction (L_3)	I_9	Satisfaction with the given airport	.860				.986	.948
	I_{10}	Satisfaction with the trip from the given airport	.825	.048	20.842	***		
	I_{11}	Satisfactory service at the given airport	.843	.052	18.471	***		
	I_{12}	Satisfaction with overall service at the given airport	.804	.053	16.937	***		

***P < .001, **P < .05, *P < .01.

Table 9
Estimation results.

Variable	Multinomial logit model		Two-level nested logit model	
	Without latent variables	With latent variables	Without latent variables	With latent variables
Constants				
$ASC_{Airport1*Airline1}$	.495	.518	−.491	−.411
	(.875)	(.916)	(−.485)	(−.512)
$ASC_{Airport1*Airline2}$	1.627***	1.649***	1.622**	1.051**
	(3.813)	(3.856)	(2.086)	(2.045)
$ASC_{Airport2*Airline3}$	3.674***	3.691***	.571***	.320***
	(6.888)	(6.908)	(5.245)	(5.120)
$ASC_{Airport2*Airline1}$	−.935**	−.924*	−.934***	−1.890***
	(−2.456)	(−2.428)	(−5.790)	(−4.990)
$ASC_{Airport2*Airline2}$	1.921***	1.926***	1.922***	1.565***
	(4.907)	(4.915)	(5.251)	(5.451)
$ASC_{Airport3*Airline3}$	1.415**	1.436**	1.417	.605
	(2.439)	(2.474)	(.799)	(.779)
$ASC_{Airport3*Airline1}$	−1.458***	−1.457***	−1.455***	−2.559***
	(−4.193)	(−4.188)	(−3.018)	(−2.688)
$ASC_{Airport3*Airline2}$	2.053**	2.094**	.313**	1.251***
	(2.033)	(2.070)	(2.475)	(3.011)
Airline attributes				
Fare	−.0575***	−.0577***	−.0752***	−.00957***
	(−7.073)	(−7.088)	(−5.943)	(−5.176)
Flight time	−.017	−.0121	−.0647**	−.0139*
	(−.071)	(−.051)	(−2.151)	(−1.904)
Frequency	.0761***	.0766***	.0682**	.0136**
	(3.508)	(3.527)	(2.889)	(2.153)
Airport attributes				
Access cost	−.087***	−.0866***	−.0169***	−.0116**
	(−3.419)	(−3.406)	(−3.952)	(−2.065)
Access time	−.017**	−.0168**	−.0039***	−.00395**
	(−2.133)	(−2.108)	(−3.601)	(−2.290)
Latent variables				
Airport access convenience	–	.148*	–	.111**
		(1.782)		(1.984)
Airport facility service quality	–	.353	–	.037
		(.554)		(.763)
Service satisfaction	–	.784	–	.045
		(.898)		(.700)
Inclusive value parameters				
Incheon International Airport	–	–	.281**	.276**
			(1.999)	(2.170)
Gimpo International Airport	–	–	.275**	.241**
			(3.108)	(2.323)
Cheongju International Airport	–	–	.252**	.207**
			(1.983)	(2.135)
Model fit statistics				
LL function	−989.69	−999.69	−1172.42	−1001.94
LL (constants only)	−1101.21	−1202.21	−1431.21	−1232.21
Peseudo-R^2	.101	.168	.181	.187
VOT (Value of time)				
Value of time ($/per hour)	–	–	46.9$	79.2$
Value of Access time ($/per hour)	10.7$	10.6$	12.6$	18.6$

****P* < .001, ***P* < .05, **P* < .01, 1100\ = 1$.

Table 10
The results of direct and cross-elasticities.

Airport		E fare	E flight time	E frequency	E access cost	E access time
Direct-elasticities						
ICN		−1.411	−1.127	.747	−.303	−.238
GMP		−1.298	−1.269	.742	−.322	−.149
CJJ		−1.231	−1.220	.658	−.210	−.236
Cross-elasticities						
ICN	GMP	.748	.594	−.402	.162	.128
	CJJ	.636	.513	−.330	.135	.105
GMP	ICN	.772	.752	−.442	.202	.087
	CJJ	.715	.703	−.405	.166	.084
CJJ	ICN	.514	.513	−.292	.089	.104
	GMP	.561	.554	−.285	.095	.103

Table 11
The probability results of policy implications.

	Fare ($)	Flight time(h)	Frequency	Access time(m)	Access cost ($)	Conditional probability	Marginal probability	Joint probabilities
ICN*$Airline_1$	162.3	20	14	120	14.5	.15	.40	.058
GMP*$Airline_1$	162.3	20	14	60	5.5	.66		.010
CJJ*$Airline_1$	162.3	20	14	60	5.5	.19		.015
ICN*$Airline_2$	190.9	14	14	120	14.5	.03	.39	.263
GMP*$Airline_2$	190.9	14	14	60	5.5	.65		.253
CJJ*$Airline_2$	190.9	14	14	60	5.5	.32		.125
ICN*$Airline_3$	133.6	17	14	120	14.5	.07	.22	.076
GMP*$Airline_3$	133.6	17	14	60	5.5	.58		.126
CJJ*$Airline_3$	133.6	17	14	60	5.5	.35		.076

$Airline_1$(Foreign airline), $airline_2$(FSC), $airline_3$(LCC), 1100\ = 1$.

46.9(US $) and 79.2$ respectively more to reduce 1 h of flight time and willing to pay 12.6(US $) and 18.6$ respectively more to reduce 1 h of access time. Airports in a multiple airport region may have to compete with other airports for departing passengers since choice of airport by passengers is done by comparing airport service offered by the airline and access mode (Pels et al., 2003). The results of WTP indicate that reducing flight time is more important for international long-haul travel than reducing access time. To reduce flight time, the strategy of airline route is significant. Therefore cooperating with airline company managers is essential cause to improve airport's competitive power.

The study estimated the direct, cross-elasticities and probability of policy implications. Due to the growth of LCCs in multi-airport regions, passengers have various options of airports to choose from to take advantage of lower fares and more convenient airline services. It is possible to forecast the latent demand by estimating the elasticities and the probability.

Furthermore, the MNL and two-level NL models with latent variables are estimated in this study. The results reveal that the models with latent variables are improving the Goodness-of-Fit of the model in comparison to the classical discrete choice models by explaining the random disturbance ε of the utility and by providing a framework for the use of psychometric data to explicitly model attitudes and perceptions and their influences on passengers' choice behaviors, ultimately facilitating more accurate choice predictions (Chen et al., 2004). The results of model analysis show that fare, flight time, frequency, access time, access cost and airport access convenience latent variables are significantly affecting passenger's airport choice behavior. Adopting unobserved perceptions and attitudes with latent variables more effectively capture psychological factors that affect passengers' choice behavior. It is critical for airport-airline planners or local authorities to consider passengers' unobserved perceptions to improve attractiveness of airports.

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