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Passenger Choice Behavior between Direct and Transit Flights—A Case Study on Passengers Using Hub Airports in the Northeast Asian Region

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Abstract: This study analyzes air passenger route choice behavior for long-haul inter-continental travel. It employs the SP (state preference) technique and logit modeling to investigate the impact of route development via neighboring countries in the region. With the Japanese government pursuing an increase in international routes at Haneda International Airport, and the Chinese government planning to construct Beijing Capital Second International Airport by 2019, the competition among airports to serve as hubs in Northeast Asia will increase significantly. Korean passengers will have a greater number of route choices when traveling to North America or Europe, utilizing not only direct flights from Incheon International Airport but also flights via Tokyo or Beijing area airports including Haneda International Airport, Narita International Airport, Beijing Capital International Airport and Beijing Capital Second International Airport. Accordingly, passengers will choose among the alternatives by considering fares and flight times. As such, it is essential for airports to offer flights with competitive prices for transit passengers to become successful competitive airports in the region. Therefore, it will become more important for market decision makers to strive toward more attractive ticket prices and better route network quality.

Key words: Passenger route choice behavior, SP technique, multinomial logit model, nested logit model, competitive airports in Northeast Asia.

1. Introduction

Globalization has caused national markets to overlap, creating common competition areas and eliminating national borders. The geographical location of airports in relation to origins and destinations also influences route networks. The number of route patterns and connections between two countries is influenced by not only historical and cultural ties but also relationships in trade and business [1].

Travelers may choose between airports for a given itinerary in a strong competitive air transportation market that spans multiple regions [2]. Recently, along with strong growth in the overall aviation market, the Asian aviation market has become very competitive. In 2015, the Asia and Pacific region accounted for 24.6% of the market share for international routes. In particular, airports in each Northeast Asian country have gradually exerted greater effort to increase competitiveness. In the same year (2015), Northeast Asian countries accounted for 61.5% of the total Asian market share, and three countries—South Korea, China and Japan—made up 94.9% of the Northeast Asian share.

After the global economic crisis of 2008, the number of international passengers in Northeast Asian airports consistently increased, as shown in Fig. 1. The Japanese government intends to expand the Haneda International airport' international role in the aviation field and thereby regain a competitive position

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as a key traffic hub for international air transport in Asia [3]. Meanwhile, in 2015, Beijing Capital International Airport ranked first in terms of the number of passengers (90 million) among Northeast Asian airports. The Chinese government is aiming to open Beijing Capital Second International Airport to achieve, maintain or enhance hub status by 2019.

Since 2001, Incheon International Airport (ICN) has served as the largest airport in South Korea and, as part of its overall strategy, has consistently endeavored to serve as an international hub in the Northeast Asian region. In 2015, ICN crossed the 49.3 million passenger mark, an 8.3% increase over 2014 when it recorded 45.5 million passengers, as shown in Fig. 2. The airport is aiming for 10 million transit passengers in 2017 and is seeking new opportunities [4].

Fig. 3 indicates the ratios between direct and transit passengers on all routes, North American routes and European routes at ICN in 2015. The ratio of indirect flight passengers was about 13% for all routes. On the other hand, the ratios of transit flights for the North American and European routes were over 33.5% and 47.9%, respectively. The ratios of transit airports of NRT (Narita International Airport) and PEK (Beijing Capital International Airport) for North American routes were 10.2% and 2.3% which indicated first and second ranking among Asian airports. They also ranked first and third on the European routes among Asian airports. These ratios were influenced by the ticket prices of those transit flights. The ticket prices offered by Delta Air Lines and China Eastern Airlines were between 14% and 30% cheaper than the direct flight prices operated by Korean Air or Asiana Airlines.

Korea government considers the airports including NRT (Narita International Airport), HND (Haneda International Airport), PEK (Beijing Capital International Airport) and Beijing Capital Second International Airport as competitive airport to ICN. When considering the efforts by the Japanese and Chinese governments to pursue more international routes, the open skies policy, increases in airline strategic

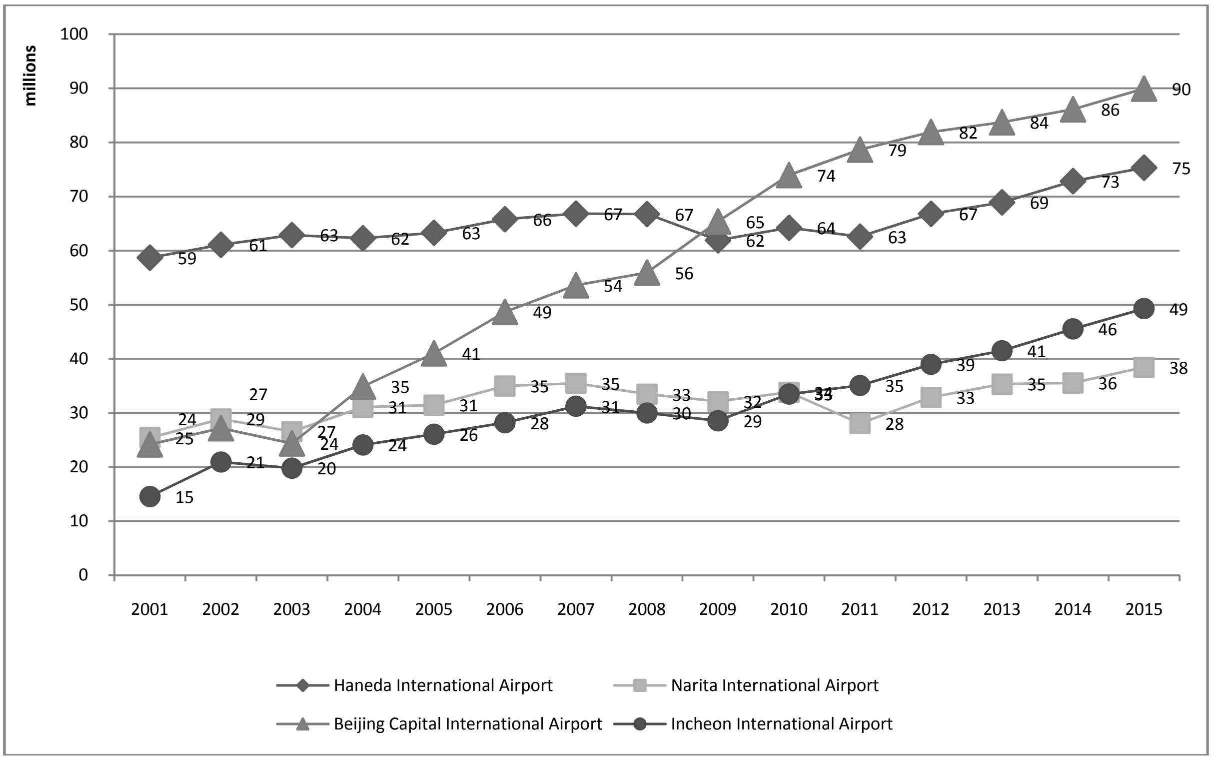

Fig. 1 Number of international passengers at selected hub airports.
Source: ACI (Airport Council International), 2015.

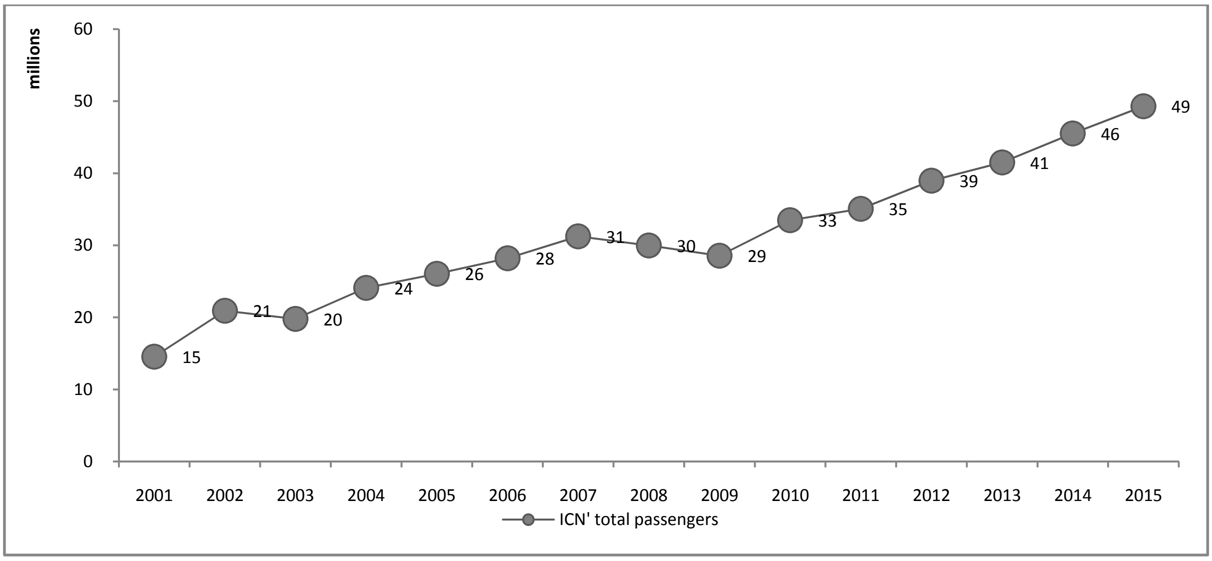

Fig. 2 The number of total passengers at ICN.
Source: KAC (Korea Airport Corporation), 2015.

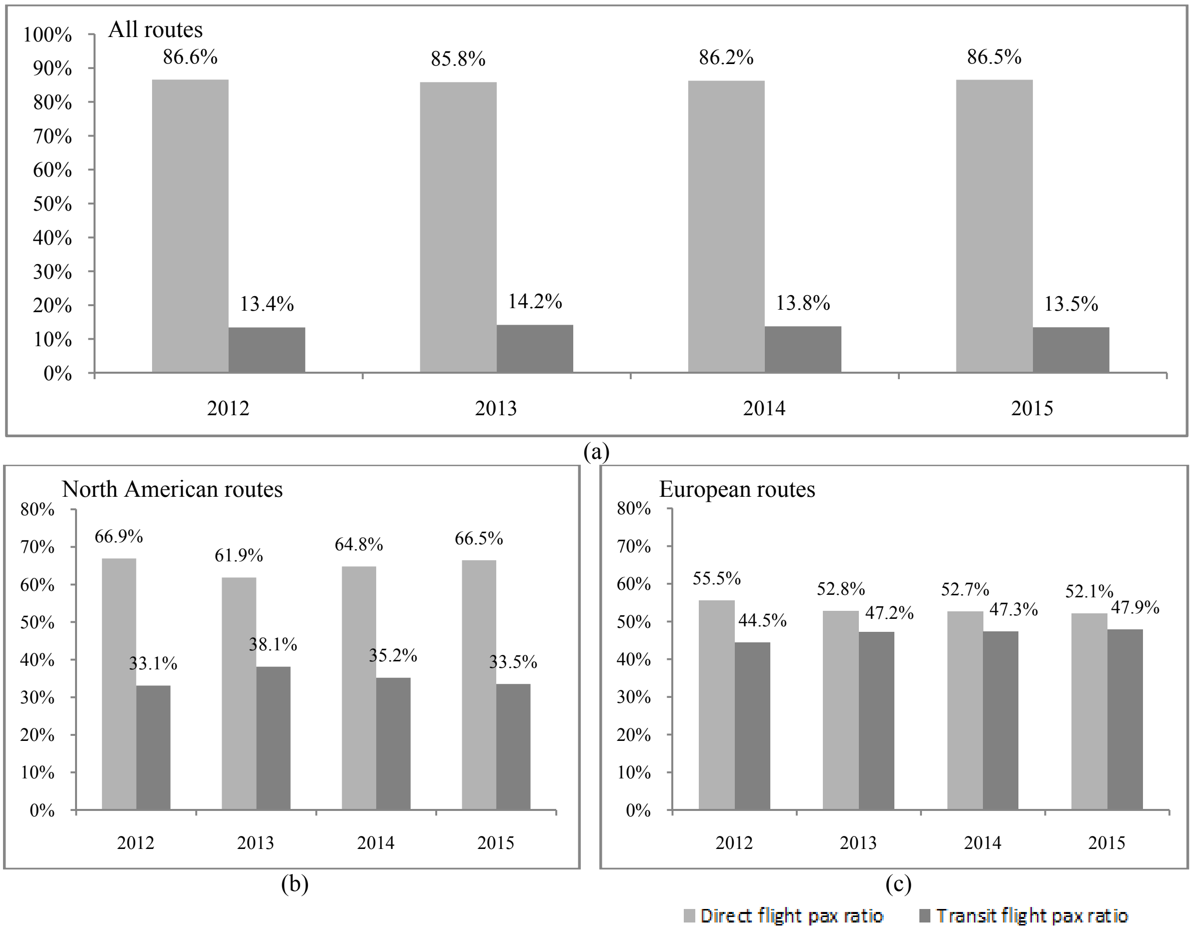

Fig. 3 Ratios between direct and transit passengers according to routes: (a) all routes; (b) North American routes; (c) European routes.
Source: OAG Traffic Analyser, 2015.

alliances and increases in the number of overall routes, it is clear that competition is on the rise. Accordingly, passengers will have a greater number of route choices when searching for long-haul inter-continental options.

2. Literature Review

Competition between airports looking to serve as hubs is expected to grow with the expansion of international routes. Airport operators are offering discounts on airport charges, encouraging airlines to select these airports as destinations or hub airports in line with the open skies policy [5]. However, airline operators need to understand how and why passengers are sensitive to routes when developing marketing strategies related to fares or flight frequency [6]. Air travel route models determine the factors that influence airline market leadership at the route level and support carrier decision-making. Route service attributes influence market share improvements [7].

A route choice model accounts for passenger benefits from increased frequency, passenger connecting costs and hub-and-spoke route structures that decrease the average cost of a direct route [8]. Passengers continuously search for their preferred travel routes, seeking to maximize their utility [9]. They choose routes depending on factors such as ticket price, flight time and frequency, but they also consider wait times at hubs when transferring between flights [10]. Airfare and flight times are both significantly important variables for route selection [6]. The high prices that some airlines are able to charge on specific routes may not be applicable to other carriers serving the same route [11]. Burghouwt et al. [10] indicated that the fares of non-stop or direct routes were generally higher than those of transit routes between two airports, and fares were generally lower when more competitors were operating the same route. Coldren et al. [7] studied the influence of various service attributes on travel route choice. Among level-of-service, connection quality, aircraft type and size, departure time, carrier presence and fare, the most important attribute was the provision of a higher level of service, which indicated nonstop and direct itineraries.

Many previous papers have studied passenger route choice behavior because developing a route choice model can provide carriers with an understanding of the relative importance of different service factors that enable routes to increase market share [7]. An accurate route choice model is a powerful tool for airlines and airport managers to plan their networks and make decisions at the strategy level [7].

These previous studies used variables such as airfare, air travel time, frequency and direct routes, and then measured their effects on passenger route choice behavior. However, there has been a lack of systematic examinations on passenger route choice behavior and its evolution over time in South Korea despite the rising competition for routes from airports throughout the Northeast Asian region. Accordingly, the present study analyzes passenger route choice behavior for trips to North America and Europe, utilizing not only direct flights but also transit flights. The SP (state preference) technique and logit modeling are employed to determine how passengers select their routes.

3. Model Framework and Experimental Design

This study explores the travel route choices of passengers by utilizing both multinomial logit (MNL) and nested logit (NL) models. The choice probability is P_{ni}, which is the share of people who choose alternative i within the population of people who face the same observed utility for each alternative as person n. $V_{nj} = x_{nj}\beta + k_j \forall j$, where x_{nj} is a vector of variables that relate to alternative j as faced by decisionmaker n, β are the coefficients of these variables, and k_j is a constant that is specific to alternative j [12].

The MNL probabilities are given as:

$$P_{ni} = \frac{\exp(V_{ni})}{\sum_j \exp(V_{nj})}$$

$$P_{ni} = \frac{1}{\sum_j \exp[-(V_{ni} - V_{nj})]}$$

However, researchers are often unable to capture all of the sources of correlation or the major cause of correlation of unobserved portions of utility, and accordingly, IIA will not hold [13]. The NL model is consistent with utility maximization. Let the set of alternatives i be partitioned into K non-overlapping subsets denoted B_1, B_2,…, B_k, called nests. The utility that person n obtains from alternative i in nest B_k is denoted as $U_{ni} = V_{ni} + \varepsilon_{ni}$ [14].

In this paper, airports based in the capital cities of South Korea's neighbors are used for the analysis. However, it should be noted that other airports such as Shanghai Pudong International Airport operate on larger passenger scales than the areas serviced by Tokyo and Beijing area. There are currently three hub airports in the Beijing and Tokyo areas that compete with Incheon International Airport (ICN)—Narita International Airport (NRT), Haneda International Airport (HND), and Beijing Capital International Airport (PEK). A fourth hub, Beijing Capital Second International Airport, will commence operations in 2019. It takes about 2 hours and 10 minutes to fly from ICN to Tokyo area including NRT and HND and about 2 hours to fly from ICN to Beijing area including PEK and Beijing Capital Second International Airport, as shown in Fig. 4.

Korean passengers will be able to choose from a greater number of routes when traveling to North America or Europe, utilizing not only direct flights from ICN but also transit flights via neighboring Northeast Asian hub airports in Tokyo and Beijing area that included Haneda International Airport, Narita International Airport, Beijing Capital International Airport and Beijing Capital Second International Airport. This paper analyzes passenger route choice behavior for the three route alternatives depending on the assumptions in Fig. 5.

The required data is gathered via the SP technique and then analyzed using not only an MNL model but also an NL model. SP methods are mainly used to research human decision making, marketing and transportation. SP choice experiments depend on the representation of a choice situation using an array of attributes. As such, it relies less on the accuracy and completeness of description of the good or service [15].

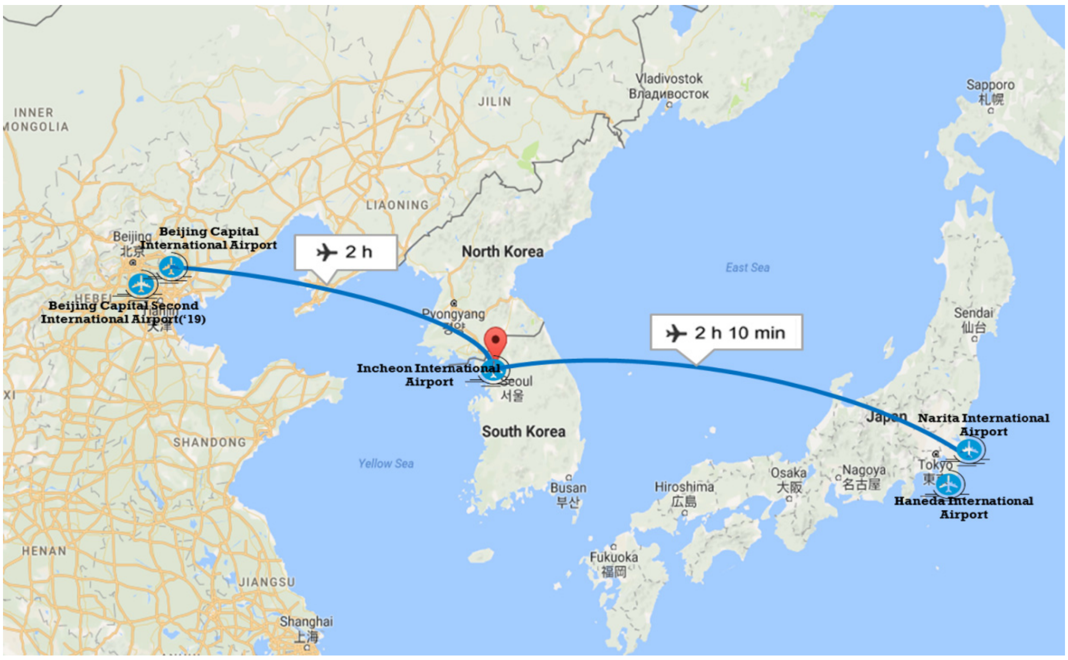

Fig. 4 Hub airports in Northeast Asia.

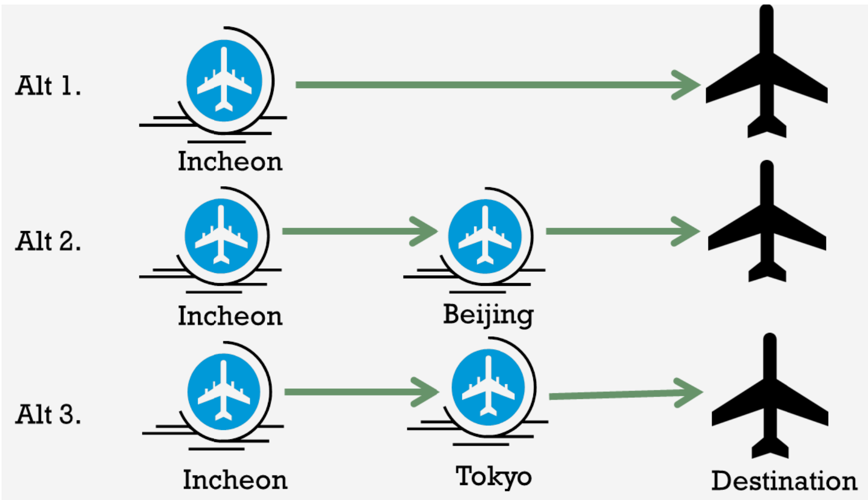

Fig. 5 The three route alternatives in this study.

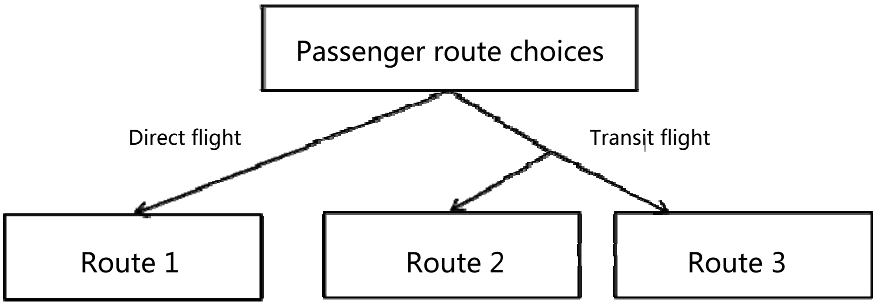

Fig. 6 Structure of passenger route choicesin NL model.

Following previous studies on the impact of variables for passenger route choice behavior, this study uses three of the same variables—airfare, air travel time and frequency—and one variable specific to this study—the added existence of direct flights. The terms airfare and flight time specifically refer to the ticket price and flight time from ICN to North America or Europe. Frequency indicates the number of flights per week, and the existence of direct flights indicates whether the flight is direct flight from ICN to the destination airport or whether the flight goes through airports in Tokyo or Beijing area. It should be noted that air fare and frequency are composed using the current levels of direct airlines average departing ICN as a base; i.e., 25% and 40% for lower level, respectively. The flight time attribute levels are considered in terms of indirect flights which take more than 3 hours or 6 hours.

The utility function of the model can be written as:

$$U = \text{Constant} + {}_{\alpha 1}Air\ fare + {}_{\alpha 2}Flight\ time + {}_{\alpha 3}Frequency + {}_{\alpha 3}Existence\ of\ direct\ flights$$

where,

Airfare: in KRW (Korean Won);

Flight time: difference between ICN departure time and final destination arrival time (hours);

Frequency: number of flights per week;

Existence of direct flights: existent or non-existent.

The alternatives are grouped by direct flight or transit flight criteria. The structure of the NL model is shown in Fig. 6.

Table 1 shows the SP attributes and their values. Respondents are able to select one of the options from the three alternatives. They consider airfare, flight time and frequency and whether direct flights are available at the same time.

4. Analysis Results

For the analysis, the main SP survey was conducted

Table 1 An example of SP attributes and attributevalues.

	Alt 1.	Alt 2.	Alt 3.
Airfare	1,300,000₩	975,000₩	780,000₩
Flight time	10 hours	13 hours	16 hours
Frequency	Weeks: 14/Days: 2	Weeks: 21/Days: 3	Weeks: 32/Days: 4
Direct (0)/Transit (1)	0	1	1

Table 2 Passenger profiles.

Alternatives/distribution	Sample number	Frequency (%)
Gender		
Male	360	59.3
Female	247	40.7
Age		
19-25	12	2.0
26-35	180	29.7
36-45	144	23.7
46-55	82	13.5
56 and over	189	31.1
Income		
Less than 20,000,000 (₩)*	111	18.3
20,000,000~less than 30,000,000(₩)*	73	12.0
30,000,000~less than 40,000,000(₩)*	218	35.9
40,000,000~less than 50,000,000(₩)*	102	16.8
50,000,000~less than 60,000,000(₩)*	67	11.0
More than 60,000,000 (₩)*	36	5.9
Purpose of travel		
Business	173	28.5
Non-business	434	71.5
Total	607	

* 1,095 Korean won (₩) is equivalent to US 1$ (May, 2015).

for four weeks in May, 2017. Interviews and a questionnaire were employed. A pilot study of 42 respondents was performed prior to the full administration of the survey. 607 respondents who intended to travel on long-haul inter-continental flights were used for the final analysis. 59.3% of them were male, and 40.7% were female. The profiles also indicate that 28.5% of the respondents were travelling for business, while the majority (71.5%) were travelling for other purposes. Their profiles are shown in Table 2.

Table 3 indicates the determinants of route choices. The results confirm that the top three business passengers' determinants, airfare, short flight times and appropriate flight schedules, while in terms of non-business passengers' determinants, airfare, appropriate flight schedules, short wait times and the existence of direct flights were ranked. The ratio of airfare of non-business passengers were 48.8% which was higher than business passengers' ratio of airfare considering. This indicates that non-business passengers choose tickets more carefully because non-business passengers rely on personal budgets when traveling.

Both MNL and NL models were estimated. Table 4 shows the parameters with the corresponding *t*-value, pseudo-R^2 and Chi-square value (x^2). The value of the likelihood ratio test was larger than the value of x^2 at

Table 3 Passenger route choice determinants.

Determinants of route choice	Business travelers		Non-business travelers		Total sample number	Frequency (%)
	Sample number	Frequency (%)	Sample number	Frequency (%)		
Airfare	68	39.3	212	48.8	321	52.9
Short flight times	55	31.8	19	4.4	56	9.2
Short wait times	16	9.2	54	12.4	54	8.9
Appropriate flight schedules	20	11.6	95	21.9	115	18.9
Existence of direct flights	14	8.1	54	12.4	61	10.0
Total	173	100	434	100	607	100
Mean($\bar{X}$)		2.1		2.4		
Variance(S^2)		1.6		2.4		
Standard deviation($\sqrt{S^2}$)		1.2		1.5		

Table 4 Logit model results.

	Multinomial logit model			Nested logit model
	Total passengers	*Business passengers*	*Non-business passengers*	
Constants				
$ASC_{\text{Via Beijing area}}$	-0.1350** (-10.659)	-0.1323** (-4.223)	-0.1342** (-6.714)	0.1464** (4.423)
$ASC_{\text{Via Tokyo area}}$	-0.1069** (-8.058)	-0.1055** (-3.214)	-0.1065** (-5.086)	0.1827** (5.431)
Variables				
Airfares	-0.0094** (-25.567)	-0.0094** (-10.394)	-0.0093** (-16.226)	-0.0106** (-24.375)
Flight times	-0.0002** (-7.998)	-0.0002** (-3.273)	-0.0002** (-5.085)	-0.0002** (-7.578)
Frequency	0.2697** (14.330)	0.2669** (5.830)	0.2698** (9.096)	0.3003** (14.463)
Existence of directflights	.00179** (11.369)	0.0177** (4.541)	0.179** (7.178)	0.0195** (11.419)
IV parameters				
Direct (Incheon)				0.8829** (37.467)
Indirect (via Beijing and Tokyo area airports)				0.6609** (30.215)
Model fit statistics				
$L(\beta)$: log likelihood function	-55,982.47	-9,186.00	-22,498.86	-55,888.40
$L(0)$: likelihood with zero coefficients	-72,289.78	-11883.68	-29,068.18	-81,317.94
Pseudo-R^2	0.23	0.22	0.22	0.32
Chi-square value (x^2)	.000**	.000**	.000**	.000**
Value of time ($/per hour)	15.0$	15.1$	14.6$	13.2$

**: $P < 0.01$, *: $P < 0.05$ for one-tailed test (t-values are shown in parentheses);

1,100 Korean won (₩) is equivalent to US 1$ (May 2017).

the 95% confidence level. The pseudo-R^2 values of 0.23 and 0.32 implied that the models were a good fit for the data and that the NL model provided a better fit than the MNL model. The NL model showed the good fit to the data (Peseudo-R^2 = 0.32). The results indicate that alternatives grouped by direct flight or transit flight criteria improved the goodness-of-fit of the choice model. Four variables—fare, flight time, frequency and existence of direct flights—were greater than the critical Wald-value, indicating that they significantly affected choice behavior. The results indicate that travelers compare fare, flight time, frequency and existence of direct flights when they choose flight routes.

To examine passenger willingness, the marginal rates of substitution between fare and time attributes were calculated. The results of the VOT (value of time) based on the MNL and NL are shown in Table 4. The VOT via MNL was $15.0/hour and via NL was $13.2/hour. Business passengers were willing to pay $15.1 to reduce one hour of flight time and the VOT of non-business passengers were $14.6. This confirms that business passengers are generally more willing to pay than non-business passengers to curtail travel time [16].

Direct- and cross-elasticity values were estimated to measure sensitivity, as shown in Tables 5 and 6. Because four variables—fare, flight time, frequency and existence of direct flights—affected choice behavior to a greater extent, they were used for the elasticity values. In addition, the elasticities of business passengers and non-business passengers were investigated. The results of the elasticity analysis indicated that passengers using transit flights were the most sensitive to fare than using direct flights. In addition, non-business passengers were more sensitive to the fare increasing. This indicated that the fare elasticity of the transit flights alternatives in non-business passenger is relatively elastic. In other words, passengers using transit flights are willing to change their routes if the ticket price is beyond their budget. In terms of flight time, business passengers using direct flights were sensitive to the flight time. This indicated that the flight time elasticity of the direct flights alternatives in business passenger is relatively elastic.

Tables 5 and 6 also represent the cross-elasticity effects. The model results suggested that a 1% increase in the flight time for the ICN direct flights alternative in business passengers will result in 0.40% increase in the choice probabilities for the via Beijing area airports alternative and in 0.45% increased for the via Tokyo area airports alternative. Also, 1% increase in the fare of the ICN direct flight alternative in non-business passengers will have a 0.17% increase for the via Beijing area airports alternative and a 0.13% increase for the via Tokyo area airports. The results of the cross-elasticity analysis suggested that in general, for attracting passengers, it is significant to strive for more attractive ticket prices and to develop various route through the airline strategic alliances.

Table 5 Direct-elasticity results.

Airport	Direct-elasticities							
	Business passengers				Non-business passengers			
	E fare	*E flight time*	*E frequency*	*E existence of direct flights*	*E fare*	*E flight time*	*E frequency*	*E existence of direct flights*
Alt 1.	-0.754	-1.046	0.290	0.115	-0.892	-0.345	0.284	0.105
Alt 2.	-0.798	-0.800	0.131	0.105	-1.052	-0.331	0.131	0.100
Alt 3.	-0.766	-0.872	0.039	0.100	-1.028	-0.338	0.039	0.101

Note: E for elasticity.

Table 6 Cross-elasticity results.

Airport		Cross-elasticities							
		Business passengers				Non-business passengers			
		E fare	*E flight time*	*E frequency*	*E existence of direct flights*	*E fare*	*E flight time*	*E frequency*	*E existence of direct flights*
Alt 1.	Alt 2.	0.180	0.040	-0.103	-0.037	0.177	0.022	-0.098	-0.033
	Alt 3.	0.137	0.045	-0.078	-0.029	0.134	0.020	-0.077	-0.030
Alt 2.	Alt 1.	0.182	0.030	-0.103	-0.057	0.179	0.023	-0.101	-0.057
	Alt 3.	0.177	0.021	-0.067	-0.081	0.177	0.021	-0.059	-0.081
Alt 3.	Alt 1.	0.061	0.022	-0.029	-0.071	0.059	0.020	-0.029	-0.071
	Alt 2.	0.043	0.030	0.020	-0.042	0.038	0.028	-0.202	-0.043

Table 7 Choice probabilities for each scenario.

Mode	Fare	Fight time	Frequency	Probability	Fare	Fight time	Frequency	Probability
Incheon	1,450,000	720	14	25.4%	1,450,000	720	14	27.4%
Via Beijing area	870,000	1,080	14	41.4%	870,000	900	21	45.4%
Via Tokyo area	1,100,000	900	14	33.2%	1,450,000	1,080	21	27.3%
Mode	Fare	Fight time	Frequency	Probability	Fare	Fight time	Frequency	Probability
Incheon	1,450,000	900	14	25.2%	1,450,000	720	14	25.2%
Via Beijing area	1,100,000	900	14	33.1%	1,100,000	900	21	33.1%
Via Tokyo area	870,000	900	14	41.7%	870,000	1,080	28	41.8%

*Unit of fare: Korea won, fight time: minutes.

Table 7 shows four probability examples chosen for each scenario. Berry et al. [17] and Erdem et al. [18] recognized that product-differentiated price sensitivity might vary widely, and Gallego and Wang [19] recognized the importance of allowing different price sensitivities in an MNL model. Nest coefficient restrictions in the unit interval too often lead to the rejection of the NL model [20]. Furthermore, the utility functions at higher levels of the NL model are connected to the lower levels. The probability of the NL is conditional upon the branch to which the alternative being chosen belongs. The present study sought the probability of each alternative without the effects of the branch scale parameter. Thus, the probability analysis was based on the MNL model.The results indicated that it was important for passengers to pay low prices, even when using transit flights. This suggested that it should be more probable that carriers would offer routes at lower ticket prices rather than sticking to national carrier routes, even when passengers were inclined to fly via Beijing area airports or Tokyo area airports. Accordingly, the passenger choice probabilities revealed that when considering marketing policies for airports and airlines, emphasis should be placed on maximizing route market share.

5. Discussion

This study was limited in terms of the survey destinations used in the research design. Only long-hall operations flying to Europe and North America were considered. Although hub airports in the Middle East, including Dubai, Doha and Abu Dhabi are competing strongly with ICN for routes to and from Europe, this paper only focused on passenger route choice behavior as it pertained to South Korea's neighbors. In addition, in terms of the survey sample used in the analysis, the estimation results might have differed if the final destination had been divided into business and non-business. These points should be considered for future studies.

6. Conclusion

With the Japanese government pursuing an increase in international routes at the two Tokyo area airports and the Chinese government planning to construct a new airport in the Beijing area, the competition among airports seeking to serve as hubs in Northeast Asia will increase significantly. Korean passengers will have a greater number of route choices when traveling to North America and Europe, utilizing not only direct flights from Incheon International Airport but also flights via Tokyo or Beijing area airports. Accordingly, passengers will choose among the alternatives by considering fares and flight times.

This confirmed that, as a means of improving airport route competitiveness, passenger route choice behavior modeling could help airport authority managers and airline operators develop more effective strategies [6]. MNL and NL models were estimated, and the results of route choice behavior model indicated that airfare, flight times and existence of direct flights significantly affected choice probabilities. The elasticity analyses revealed that passengers using transit flights were sensitive to airfare, which suggested that the passengers should be willing to change their route if the ticket prices increased beyond their budget. According to the choice probability scenario analysis, passengers tended to choose flights transferring through Beijing area airports or Tokyo area airports if those flights offered lower ticket prices. As such, it is essential for airports to offer flights with competitive prices for transit passengers to become successful competitive airports in the region. It was clear that airlines could alter their route market share via their marketing policies at the airport. Therefore, it is significant to strive for more attractive ticket prices and better route network quality.

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