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Estimation of User Value of Innovation in Airport Facilities

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Abstract

The aviation market in Asia is expected to show high annual growth rate and fierce competition is developing between neighboring airports. More than 94% of international tourists use flights to travel in and out of Korea and The Ministry of Land, Infrastructure and Transport (MOLIT) revealed the three-stage business expansion plan that is a new leap toward becoming the "Hub Airport of Northeast Asia". This study aims to measure the appropriate value for traffic time of the aviation sector using CVM-based questionnaire survey. The empirical results shows time values per one air passenger generated by this study are at a similar level with cases in the U.S.A. and at a higher level than with cases in previous studies in Korea. This is because the business purpose travel ratio among travel purpose has been continually getting lower since 1999.

Key Words: Preliminary Feasibility Study, Value of Time, CVM, Willingness to Pay

1. Introduction

The world has proceeded to the one economic block as technologies develop and the barriers separating each nation from the outside are reduced. In this situation, airplanes contribute in connecting the entire world. In terms of speed, they are

incomparably superior to other means of transportation. The global financial crisis in 2008 did not deteriorate to a severe global economic depression such as the Great Depression. The growth of the emerging market could have contributed to this recovery. Markets in Asia are leading the growth of the emerging market. The aviation market of every nation in Asia is expected to show an average annual growth rate of 6%, which is higher than other regions in the world given that the world average annual growth rate is 4.1%. Fierce competition is developing between neighboring airports in terms of expansion of airport infrastructure and other areas (Chang-soo Jung, 2013).

Korea is a peninsular country with seas on its three sides, and has a demilitarized zone on its north side. Thus, in a sense, Korea is characteristically similar to insular countries. Accordingly, more than 94% of international tourists use flights to travel in and out of Korea (Sung-Tae Yee, 2014). Korea has become the ninth country in the world that reached one trillion dollars in international trade. Therefore, The Korean economy today has a status different from that in the past and can independently impact the world economy. The geopolitical factors and economic growth of Korea must have an effect on the increase of the use of airplanes. The number of air passengers in 2014 reached a total number of 80 million, which is the highest record in Korea. The total amount of air cargo was 3.7 million tons, which is 5.6% higher than the previous year (Ministry of Land, Infrastructure and Transport, news release). At the 10th anniversary of Incheon International Airport, the Ministry of Land, Infrastructure and Transport (MOLIT) revealed the three-stage business expansion plan that is a new leap toward becoming the "Hub Airport of Northeast Asia" and can catapult the airport in becoming a leader in air power in the pan-Pacific zone by providing comfortable and safe air transportation service. In addition, the MOLIT is continually investing in the aviation sector. The MOLIT is planning to construct the Second Air Traffic Center by 2015 to provide uninterruptible air traffic service(ATS) even when disaster takes place (Ministry of Land, Infrastructure and Transport, Homepage).

The preliminary feasibility study should have been conducted according to Article 38 of the National Finance Act based on the investment of the aviation sector. However, for the time value of the aviation sector presented in the current guidance for preliminary feasibility study, the value which was applied to the Chungju Airport business of 1997 is used. Thus, the study on time value of the aviation sector is in process. The Korea Development Institute (KDI) performs a diverse parameter renewal study in which it carries out a study on passenger traffic time value of the airport sector in part. However, the KDI simply made use of previous data in its analysis. Thus, the significance of the results and their application may be contested.

Applying the contingent valuation model (CVM), which has recently been more frequently used, this study aims to measure the appropriate value for traffic time of the aviation sector, which is highly important in coming up with plans for improvement of facilities, and expansion and construction of terminals targeting improved convenience.

2. Literature Review

For the appropriate time value of aviation sector, the time value of each related subsection can be measured as suggested in the Fifth revision of "Transport Investment Appraisal Guideline" of the MOLIT and the "A Study on Standard Guidelines for Pre-feasibility Study on Airport" of KDI (2001). However, both of them presented not only the value based on the previous value but also different application methods, thus another rational research method is necessary to obtain the objective value of air service from the improvement of airport facilities.

The U.S. Federal Aviation Administration (FAA) (1998) introduces labor product approach and willingness-to-pay approach as methods to evaluate the time value of traveling by plane. While showing little variation depending on researchers, the labor product approach does not work well in non-business use. Although the willingness-to-pay approach can be applied to both business use and non-business use, it generates values that are considerably deviates depending on the researchers.

The Department for Transport (DfT) of the UK adopted the Stated Preference Techniques as the reference in measuring the range of environmental influence, which is included in the official cost–benefit analysis of expressway plan (Pearman, 1994). This Stated Preference Techniques includes CVM and conjoint analysis (CA). CVM is a method of directly asking about the preference and choice of a traveler through interviews or questionnaires, and is now hardly used because of problems occurring in the process of interviews (U.S. FAA, 1998). In Korea, however, the value estimation through CVM has been recommended as a research method in the fifth edition of the "General Guidelines for Preliminary Feasibility Studies" (Korea Development Institute, 2008) for atypical projects, such as research development, environment, and so on. With KDI's guideline as a basis, we apply CVM as the research method to estimate the passenger time value. However, of course, the most generalized method to measure value of travel time for a transportation passenger is to apply the marginal ratio of substitution method based on the modal split model. Alternative methods are limited in a case of domestic and foreign passengers, thus it could be difficult to use the marginal ratio of substitution method by based on the modal split model.

CVM has been known as a research method in measuring the potential value of non-commodity goods and services, which are difficult to quantify. Recent studies have made use of CVM in various fields (Sung-Min Park et al. 2012). Hee-Young Hurr al. (2014) analyzed the economic value of exploration of the moon by using CVM. 'General Guidelines for Preliminary Feasibility Studies on atypical business such as research development, environment, and etc.' (Korea Development Institute) has already recommended CVM-based value estimation as the research method. In addition, studies in the field of transportation have used CVM to ensure economic viability of the adoption of an intelligent transport system (ITS) or new transportation means and traffic safety procedure, among others (Kyung-Ah Lee et al., 2011).

Jung-Yoon Choi and Whon-Yu Jeong(2013) estimated variable message sign (VMS) traffic information value by utilizing CVM, and Hwan-Jin Lee and Yun-Pyo Oh(2012) applied CVM to estimate value of restoration of crosswalk and improvement of pedestrian overpass. Jung-Sil Lim et al. (2012) applied CVM to estimate user value of smart transfer information service at a complex transfer center.

Kyong-Ju Kim et al. (2010) measured the indirect benefit of road business by utilizing CVM to monetize the ripple effect which could be caused by road business, which has not been quantified and therefore has not been applied yet. Jung-Soo Park et al. (2009) utilized CVM to estimate benefit from construction of mountain train. Jun-Jeong Kim and Eui-Eun Lee (2004) estimated value according to types and kinds of expressway traffic information by constructing a logit model through CVM. Mi-Young Bin and Hyo-Bin Kim(2005) utilized CVM to estimate value of real-time bus arrival information. In addition, studies utilizing CVM are actively being conducted to ascertain economic viability of the adoption of ITS or new transportation means and traffic safety procedure, among others (Kyung-Ah Lee et al., 2011).

Particularly, 'Study on improvement of benefit estimation method of (preliminary) feasibility study of rail business' (The Korea Transport Institute, 2008), which was recently conducted, partially adopted CVM method. Therefore, if items to be evaluated are recognized by a respondent as an attribute variable which explains particular targets, choice model would be more useful; however, if the whole target is considered, CVM would be a more appropriate approach. That is, although choice model is efficient when estimating sensitivity of willingness to pay of consumers to changes in the levels of attribute variables, CVM can examine directly willingness to pay of the whole target of research. As regards choice value to research willingness to pay in potential consumption in the future, or non-use value, although such value does not exist and is added to endogenous economic value of existence itself, the entire rail transportation is recognized as one single target. Consequently, even though passenger value of travel time has non-commodity properties, it can be analyzed by marginal ratio of substitution method through modal split model. However, given the fact that aviation means lacks alternative means and the questionnaire and analysis techniques of CVM have considerably developed in recent years, CVM would be appropriate to estimate value of travel time of aviation passengers, as done in this study.

3. Methodology and outline of questionnaire survey

3.1 Method for generating willingness to pay and estimation of suggested cost

The questionnaire survey method on willingness to pay (WTP), which is adopted by CVM in general, has two types: open-ended (OE) questions and dichotomous choice (DC) question. As reported, if the estimated economic value by CVM is actually unfamiliar to the respondents, the dichotomous choice(DC) question could be adopted, with the premise that benefits can cause over-evaluation (Tae-Yun Kim and Sang-Bong Kim, 2004). In addition, double-bounded dichotomous choice (DBDC) question, where two questions are consecutively given, is preferable to a single-bounded DC (SBDC) question, where only one question is given (Sung-Min Park et al., 2012).

Kang-Soo Kim (2009) suggested that in a research employing DBDC CVM, range and number of suggested cost have no effect on deviation and efficiency of estimated WTP. Particularly, the larger the dispersion of WTP researched in advance is, the larger the deviations of the estimated WTP is, regardless of suggested methods, as well as the larger the dispersion of the least WTP is. However, he analyzed that the dispersion showing efficiency of estimated WTP is comparatively smaller than that of

the suggested method, where the optimum WTP is in a certain range. Thus, to increase efficiency and to measure an accurate estimated WTP, a research using the current WTP distribution on the basis of the preliminary study should be initially conducted, then based on it, the function and parameter of WTP could be estimated, the suggested cost by optimum plan could be measured, and the cost to the sample of the main research could be suggested (Kang-Soo Kim, 2009).

Thus, considering time and cost limitations, we analyze the distribution of the current WTP in this study through OE questions as part of a preliminary survey, then based on it, suggest an optimum cost by using the DBDC question in the main research.

By letting respondents directly enter values they want in the OE survey questionnaire, the burden of biased data could be reduced. However, in this case, the respondents could have difficulty judging and answering correctly. The first OE questionnaire survey was conducted on 15 July 2014 to reduce the limitations and to minimize deviation. If some outliers are found after the analysis of the results of the OE questionnaire survey, an additional OE questionnaire survey may be conducted. However, no outlier was found, thus the second (DC) question questionnaire survey was conducted for three days. Size of the sample was determined by considering random sampling. In case the confidence interval is 95 percent and error limit is 7 percent, more than 196 samples are necessary to represent the population (Kang-Soo Kim, 2009). Thus, this study, considering the use proportion of domestic and international lines, conducted the survey with 200 OE questionnaires and 1,100 DC questionnaires for four days.

3.2 Estimation of WTP by using Tobit model[1]

The probit model demonstrates the probability of choosing a dependent variable, whereas the tobit model estimates the expending cost to choose the dependent variable. The question of WTP could be answered with zero (0), which means no intention to expend. It is datum which has independent variable, but zero (0) dependent variable; which is different from response objectors. Here the tobit model (equation 1) for censored sample could be applied.

$$y_i^* = x_i\beta' + \upsilon_i \qquad (i = 1,2,\cdots,N)$$

$$\upsilon_i = \nu_i + \varepsilon_i \left(\nu_i \sim \text{iid } N(0,\sigma_\nu^2)\right) \left(\varepsilon_i \sim \text{iid } N(0,\sigma_\varepsilon^2)\right)$$

$$y_i = \begin{cases} y_i^*, \text{if } y_i^* > 0 \\ 0 \text{ otherwise} \end{cases}$$

When independent data are found, but dependent data are not observed, analysis using least-squares method could generate distorted results. Therefore, this

[1] Summarized from Hee-Yong Kang (2004) and Ji-Young Lee (2014).

case must be analyzed by the method of maximum-likelihood estimation, which is a nonlinear model. In addition, if the dependent variable of the logit and probit model is in a nominal scale, the method of maximum-likelihood estimation can be used, whereas tobit model is used when the dependent variable is a quantitative variable.

This study estimates WTP by using the DBDC-question CVM. Therefore, the dependent variable, which is censored sample, is a nonlinear model. It is analyzed using tobit model because it is quantitative variable.

3.3 Outline of questionnaire survey

Questionnaire survey was conducted to estimate the ratio of time values of non-business travel to business travel among aviation passenger time value. The method used to estimate the ratio of time values of non-business travel to business travel generally includes marginal ratio of substitution method and CVM. Although previous studies estimated the ratio by using the marginal ratio of substitution method, this study estimates the ratio of time values of non-business travel to business travel by using CVM reflecting the fact that domestic Jeju route and international routes do not have alternative transportation means.

The questionnaire survey was conducted with passengers of domestic and international airlines as target respondents. Interviewers facilitated one-on-one question-and-answer questionnaire surveys with the interviewees. Four interviewers did it for four days. For the domestic line, it was conducted at the domestic terminal of the Gimpo International Airport, and for the international line, it was conducted at the Incheon International Airport (See <Table 1>).

<Table 1> Outline of questionnaire survey

Survey	Contents
Target	Domestic and international line
Methodology	1 :1 question-and-answer questionnaire survey
interviewers	Four(two for domestic line, two for international line)
Interview period	July 15th and July 17th~19th 2014 (four days)
Interview time	7:00~9:00, 10:00~13:00, 14:00~16:00, 17:00~19:00
Interview place	Gimpo International Airport, Domestic Terminal(Domestic line), Incheon International Airport(International line)

4. Empirical Results

4.1 Social and economic characteristics of interviewees

A total of 1,300 OE and DC questionnaire survey sessions were conducted. Questionnaire items were answered by 1,262–1,266 respondents. <Table 2> shows the social and economic characteristics of interviewees. Regarding questions of experience of airport usage, 583 respondents (46%), which is the largest proportion, answered that they use airport once or less per year; 462 (37%) answered 2–5 times; 154 (12%) answered 6–10 times; and 63 (5%) answered more than 10 times.

Regarding demographic characteristics of the sample group, 772 respondents (61%) are males and 495 (39%) are females. In terms of distribution of ages, 479 persons (38%), which is the largest proportion, are in their thirties; 264 (21%) are in their twenties; 268 (21%) are in their forties; and 255 (20%) are over 50. Difference in usage ratio based on age is not so large. Regarding civil status, 730 respondents (58%) are married and 535 (42%) are single. Respondents who are married respondents outnumber those who are single by 16%. Regarding education, 630 respondents (50%), which is the largest proportion, are college graduates; 293 are high school graduates; 196 (16%) are two-year college graduates; and 147 have master's or doctoral degrees.

<Table 2> Social and economic characteristics of interviewees

Variable	value	frequency	ratio
Experience of airport usage	Once or less/year	583	46%
	2~5/year	462	37%
	6~10/year	154	12%
	More than 10/year	63	5%
	Total	1262	100%
Sex	Male	772	61%
	female	495	39%
	Total	1267	100%
Age	Twenties	264	21%
	Thirties	479	38%
	Forties	268	21%
	Over fifty	255	20%
	Total	1266	100%
Marital status	Single	535	42%
	Married	730	58%
	Total	1265	100%
Education	1.High school graduate	293	23%
	2.Community college graduate	196	16%
	3.Bachelor's degree	630	50%
	4.Master's degree	139	11%
	5.Doctoral degree	8	1%
	Total	1266	100%

The CVM questionnaire survey of this study aims to estimate the ratio of time value of non-business travel to business travel in order to estimate non-business travel among aviation passenger time value. To achieve this purpose, housekeepers, students, and other unemployed individuals are excluded from the research target to reduce the response error of CVM questionnaire survey and convenience of employing WTP. The respondents are evenly distributed in various occupational clusters, and 157

respondents (15%), which is the largest proportion, are belong to management, accounts, and office work (See <Table 3>).

<Table 3> Job characteristics of interviewees

	Variable	frequency	ratio
Job	1.administrative position	53	4%
	2. management, accounts, and office work	157	12%
	3. finance, insurance	67	5%
	4. education, science and social science research	45	4%
	5. law, police firefighting	28	2%
	6. public health, medical treatment	57	5%
	7. social welfare, religion	52	4%
	8. culture, art, design, and broadcasting	63	5%
	9. driving, transportation	37	3%
	10. sales	98	8%
	11. security, cleaning	32	3%
	12. beauty, lodge, tourism, entertainment, sports	39	3%
	13. food service	77	6%
	14.construction	63	5%
	15. machinery	46	4%
	16. material	21	2%
	17. chemistry	24	2%
	18. textile, apparel	56	4%
	19. electronics	35	3%
	20. information	45	4%
	21. food processing	23	2%
	22. sweeper, printing, lumber, furniture, crafts, and simple production	137	11%
	23. agriculture, forestry, and fishery	9	1%
	total	1264	100%

4.2 Estimation of Willingness-To-Pay (WTP)

A preliminary statistical analysis was initially conducted on the results of the questionnaire survey. Then, the econometrics model was applied to estimate WTP.

4.2.2 Preliminary statistical analysis

1) Stage I : OE questionnaire survey

Stage I OE questionnaire survey estimated the average time value of business, non-business, and leisure-type travels of domestic and international airlines. For domestic airlines, the results are as follows: business travel: 50,102 Korean Won(KRW), non-business travel: 21,304 KRW, and leisure-type travel: 35,551 KRW. For international

airlines, the results are as follows: business travel: 61,565 KRW, non-business travel: 28,037 KRW, and leisure-type travel: 27,750 (See <Table 4>).

<Table 4> First Stage OE questionnaire survey

(currency unit : Korean Won(KRW))				
		Business travel	Non-business travel	Leisure-type travel
Domestic line	mean	50,102	21,304	35,551
	S.D.	36,707	15,970	27,427
	Median	50,000	10,000	30,000
International line	Mean	61,565	28,037	27,750
	S.D.	54,543	15,684	15,969
	Median	50,000	25,000	25,000

2) Stage II : Double Bounded Dichotomous Choice Question (DBDC) questionnaire survey

On the basis of the average time value according to purposes of travel, which was estimated by stage I OE questionnaire survey, stage II questionnaire survey was conducted using DBDC question. Value of travel time was estimated according to travel purposes such as business, non-business, and leisure for domestic and international lines. For domestic airlines, average value of travel time was estimated as follows: business travel: 55,860 KRW, non-business travel 25,958 KRW, and leisure-type travel 19,789 KRW. For international airlines, the average value of travel time was the following: business travel: 69,909 KRW, non-business travel: 37,299 KRW, and leisure-type travel: 29,648 KRW(See <Table 5>).

<Table 5> Second Stage DBDC questionnaire survey

(currency unit: Korean Won(KRW))				
		Business travel	Non-business travel	Leisure-type travel
Domestic line	mean	55,860	25,958	19,789
	S.D.	30,321	53,351	15,074
	Median	50,000	16,000	26,000
International line	Mean	69,909	37,299	29,648
	S.D.	33,027	59,295	12,458
	Median	62,000	28,000	28,000

B. Estimation of WTP by using econometrics model (Tobit model)

Setting usage experience of airport, sex, age, marriage, education, and occupation as independent variables, and WTP as dependent variable, this study analyzed CVM value according for each purpose, business, non-business, or leisure, for both domestic and international lines by utilizing the Tobit model, which is an econometrics model. In applying the Tobit model, maximum value was set as the maximum suggested cost, and minimum value was set as zero (0). Pseudo R2 shows explanation ability results are as small as 0.0034 to 0.01, and significance probability of $\chi 2$ of every model is significant at the level of 1%, 5%, and 10%, excluding domestic business purpose. In each model, variables which have significant effect on WTP are age for domestic–business purpose; age and marriage for domestic–non-business purpose; education, occupation, and usage experience for domestic–leisure purpose; age, usage, and experience for international–business purpose; age and education for international–non-business purpose; and sex, age, education, and usage experience for international–leisure.

WTP to the suggested cost can be estimated by using the estimated figure of the value estimation model of respondents. That is, by substituting the coefficient value of the explanatory variable, which was estimated as significant, and the average value of the explanatory variables for the value estimation model, the WTP can be estimated. The WTP, which was estimated this way, is presented in <Table 6>.

<Table 6> WTP according to travel purposes for domestic and international lines

	Business travel	Non-business travel	Leisure-type travel
Domestic line	46,697	14,462	13,268
International line	65,281	28,222	28,311

4.3 Estimation of value of passenger travel time in the aviation sector

In general, value of travel time is divided into value of business travel time and non-business travel time. Although value of business travel time can be acquired by the wage ratio method, value of non-business travel time has not been monetized yet. Thus, value of non-business travel time can be indirectly calculated by using the ratio of value of business travel time and non-business travel time with the marginal ratio of substitution method or the CVM. If the weighted average is applied, by using the travel purpose ratio, to the value of business/non-business travel value which was calculated in the aforementioned way, the average value of travel time per one passenger who uses aviation transportation means can be estimated.

Through this process, the value of travel time has been calculated. We note that the analysis reflects the aviation characteristics as compared to those of previous studies in Korea (See <Table 8>).

<Table 7> Value of travel time compared with the existing guidelines

			Method	Value of Travel time(Korean Won(KRW)/person-time)	
				Business travel	Non-business travel
General Guidelines for Pre-feasibility Study on Airport		1999 base year	Marginal ratio of substitution method	12,000	11,400
		2013 estimate		18,074	17,170
Transport Investment Appraisal Guideline (5th Revision)	2009 base year	Domestic line	Marginal ratio of substitution method	19,509	19,509
		International line		27,328	27,328
	2013 estimate	Domestic line		21,626	21,626
		International line		30,294	30,294
FAA (2000 Base year)	Air Carrier		-	40.30 $	23.30 $
	General Aviation			45.00 $	31.50 $

5. Conclusion

This study conducted a CVM-based questionnaire survey and estimated the user value of improvement in aviation facilities.

As a result, the values of travel time, which were calculated using an econometrics model, the Tobit model, are as follows: domestic business: 46,697 KRW/person-time; domestic non-business: 14,462 KRW/person-time; domestic leisure: 30,268 KRW/person-time; international business: 65,281 KRW/person-time; international non-business: 28,222 KRW/person-time; and international leisure: 28,311 KRW/person-time.

Comparing the results of previous case studies with time value per one air passenger generated by this study, both are at a similar level with cases in the U.S.A. To compare the time value in the previous cases with that in domestic cases, the former was converted to the value in 2013 by using the consumer price index and was checked against General Guidelines for Preliminary Feasibility Studies. Consequently, the time value per one air passenger has been calculated as follows: domestic line is about 20,000 KRW higher, and international line is about 30,000 KRW higher. Furthermore, this study concludes that the current business purpose travel ratio is

considerably lower than the previous one, whereas the non-business time value ratio is higher than the previous one. Since 1999, the business purpose travel ratio among travel purpose ratio has been continually getting lower. Such relative ratio has been reduced because of an increase in leisure travel frequency as income level and leisure time are increased.

This study, through questionnaire survey, estimated value of travel time of each purpose, travel purpose ratio, and time value per person with respondents who are actual users of airplanes. In this respect, this study is different from previous studies and is able to reflect effectively the travel characteristics of airplane users.

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