ANALYSIS OF INTERNATIONAL AIR PASSENGER DEMAND IN THE PACIFIC-EAST ASIA REGION

Tetsuo YAI
Associate Professor
Department of Civil Engineering
Tokyo Institute of Technology
2-12-1 O-okayama, Meguro-ku,
Tokyo 152, JAPAN
Fax.No: +81-3-3726-2201

Kazuyuki TAKADA
Graduate Student
Department of Civil Engineering
Tokyo Institute of Technology
2-12-1 O-okayama, Meguro-ku,
Tokyo 152, JAPAN
Fax.No: +81-3-3726-2201

abstract : After reviewing recent changes in international airline network, we estimated nationality-based international passenger demand in the Pacific-East Asia by integrating several data sources and evaluated reliability of the estimates by considering relative error of each data. Airline choice behavior of international passengers was modeled to comprehend route choice activities. Market-segmentation was also accomplished using the models to consider the heterogeneity of passengers. Furthermore, the trip distribution was revised using a Bayesian technique. Finally, we calculated user benefit caused by airline service change to demonstrate further applicability of the models and data.

1. INTRODUCTION

The purpose of this study is primarily to estimate international passenger distribution in the Pacific-East Asia region. In truth, international air demand in this region has been drastically increasing in accordance with the economic growth in the region. Fig. 1 shows historical changes in international flights from major airports in East Asia, which were summarized by Official Airline Guide. The number of cities connected by international direct flights indicates recent network expansion on each airport and the frequency of international non-stop flights represents the improvement of the level of service at air routes. The figure shows that the service at each airport has improved rapidly, especially from 1987 to 1993, though the factors which led such increase differ in the geographical and cultural background of countries. Fig. 2 and 3 show the changes of the number of city served by direct flights for specified direction from 1971 to 1993. Fig. 2 shows flights for north America and Fig. 3 shows flights within East Asia. Fig. 4 and 5 show the changes in frequency of international flight. Fig. 4 is restricted to the direction for north America and Fig. 5 is for East Asia. There are directional differences among airports. For instance, the Narita Airport especially enlarged the number of city and frequency for north America. On the other hand, Hong Kong and Singapore located in the center of East Asia increased their flights and destination cities to other Asian countries.

A rapid change in the circumstance of international aviation in East Asia may required quantitative analysis to evaluate aviation policies such as airport investments and air transportation network improvement. Lately a lot of studies focused on air transportation networks conducted in the world. From the view point of demand analysis, Kanafani et. al.(1979) and Oberhausen et.al.(1982) focused on passenger demand by means of time-series analysis. Harvey(1987) analyzed air passenger behavior and proposed the hierarchical structure of passenger behavior. Morichi et.al.(1989) analyzed not only international passengers but also domestic passengers to evaluate air transport policies in Japan. In their study, three kinds of model such as trip production model, departure airport model and trip generation model were developed to present international passenger behavior. The last model was utilized to forecast induced demand using accessibility variable which varies according to level of service of each airport. They carried out one case study treating Fukuoka-Hong Kong city pair to evaluate an effect of flight frequency change and proposed increase international flight from/to local airports in Japan to decentralize the flight from the Narita airport. Furuichi et.al.(1994) developed integrated forecasting models for international air passenger demand using discrete choice models and air passenger survey data in Japan. The last two studies analyzed only Japanese travel behavior, therefore these works are not sufficient to evaluate international air transport policies and network design problem when we consider an air passenger demand in neighbor countries.

Now we have the necessity to consider region-wide air passenger movements including passenger who travel between other countries rather than domestic-based overseas passenger to analyze the international airport policies. However the absence of accurate data made it difficult to research on the global policies in this field. The statistics related to international passengers are published by International Civil Aviation Organization and the International Air Transport Association so far, which present total volume of data and no passenger's attribute data such as their nationality or trip purposes. Although the immigration statistics of each country are also available, the statistics may include the passengers who make a trip chaining behavior and may provide overestimated passenger demand between any two countries. As net origin and destination volume(OD) is obviously useful to analyze international aviation demand, we estimated the volume by citizenship using several existing data sources. This is because travel behaviors may differ among citizenship.

A research on Pacific air transportation market was examined by Hansen et.al.(1990). They mainly analyzed the impact of demand growth and the effect of high terminal cost at Narita Airport. The results of their simulation indicated that the increase of passenger demand made it possible to operate intercontinental direct flights not via Narita. Another Asian airport would be a major gateway because of high operation cost at Narita airport. On the other hand, Kuby(1993) showed that the flight schedule with stopover allowed an airline company to construct a more efficient network. He focused on only freight networks but his works is applicable to the passenger market. In our case studies, the possibility of increasing capacity at Narita Airport was examined to evaluate the effect of diversion from direct to indirect flights on international passengers.

International passenger's route choice behavior was analyzed in this study. Discrete choice models were employed to analyze airline choice activities. The model was used to estimate a link volume in section 4. . Meanwhile, market-segmentation derived from the estimated models showed importance of consideration of heterogeneity of international travel behavior. Furthermore, the calculation of user benefit according to the airline service changes was demonstrated under an artificial condition using the estimated OD and route choice models.

In section 2, the passenger distribution was estimated and accuracy of the estimates was statistically examined by considering relative error of each data. Airline choice behavior was analyzed and discrete choice model was estimated in section 3. In section 4 and 5, we experimented two kinds of demonstration studies, one is to revise the estimated OD using Baysian approach and another is to evaluate passenger benefit for international flight

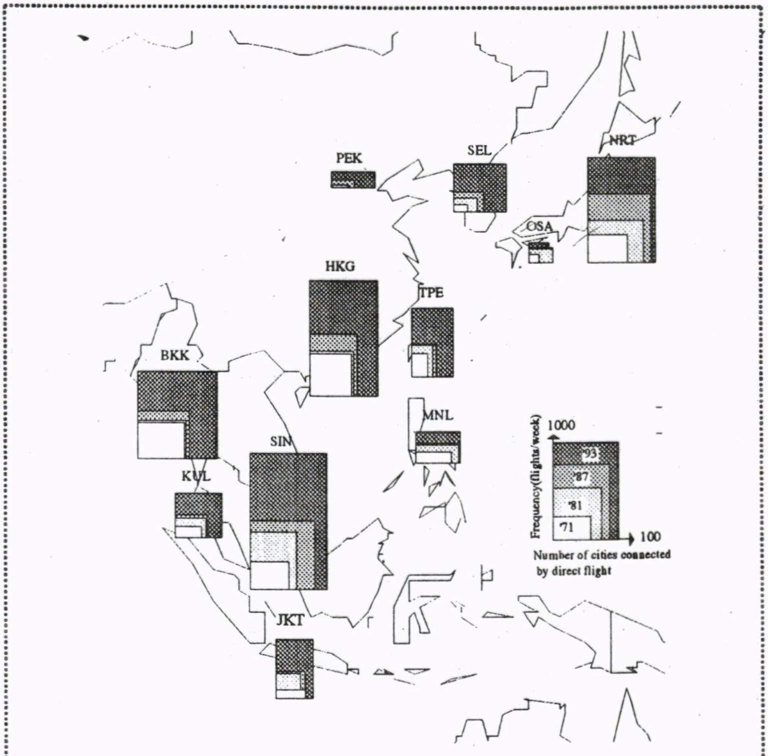

Figure1. Service Change on Network in East Asia

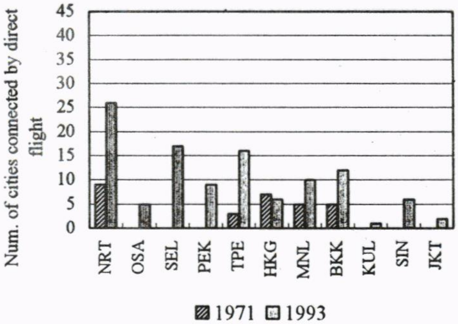

Figure2. Service Change in Num. of Cities (for U.S.)

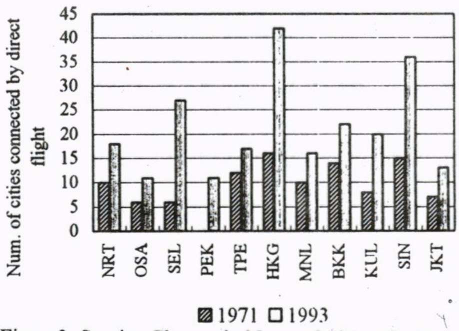

Figure3. Service Change in Num. of Cities (for East Asia)

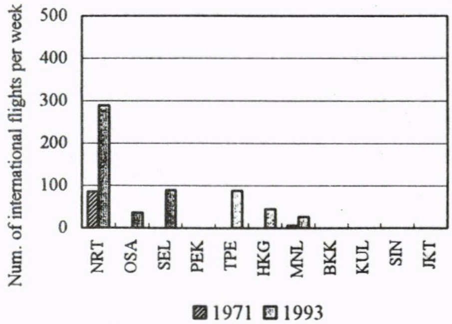

Figure4. Service Change in Frequency (for U.S.)

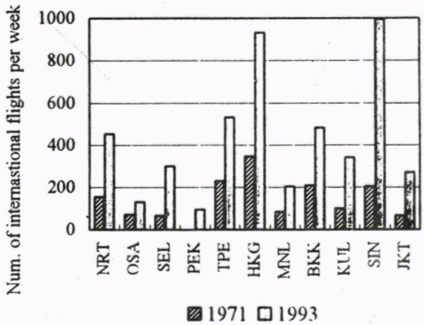

Figure5. Service Change in Frequency (for East Asia)

services.

2. ESTIMATION OF OD VOLUME

2.1 Summary and Data

Less data which present nationality-based air passenger demand among countries are provided in the East Asian region. OD data has been recently requested in accordance with growing of international passenger demand in this region. Ten Asian countries (Japan, South Korea, China, Taiwan, Hong Kong, Philippines, Thailand, Malaysia, Singapore, and Indonesia) and three U.S. zones (U.S.West, U.S.East and Hawaii) were considered. The U.S. passenger OD for East Asian countries and Asian passenger OD to the U.S. were estimated in this paper as shown in Fig. 6. We estimated a passenger volume between a departure country and a last destination country.

U.S. International Air Passenger Statistics published by the U.S. Department of Transportation(USDOT) presents the total volume of OD on coupons and it was used as a basic data set to estimate American passenger's OD. Summary and Analysis of International Passenger to the United States(USTTA), which is a title of data provided by the U.S. Travel and Tourism Administration of the U.S. Department of Commerce, present the total volume of passengers who traveled into the U.S. .

Travel behavior of foreign passengers visited Japan and transit passengers at airports in Japan was analyzed using International Passenger Survey data(IPS) conducted by the Japanese Ministry of Transport. Japanese overseas passenger movement was also analyzed using IPS data for Japanese passengers.

2.2 Estimation Process of OD Table

An estimation process of OD is described here.

2.2.1 American Passenger OD for East Asian Countries

STEP 1:
USDOT was divided into three region(U.S.East, U.S.West and Hawaii) by means of the location of airports.
STEP 2:
The number of passengers who visited Asian countries was aggregated for each U.S. region. The aggregated volume indicates the number of passengers who traveled between airports used by the first flight because USDOT counted passenger's destination country on coupons. Therefore, not only the passenger who traveled into the country directly but also the passenger who transferred at a airport which was the end of first flight was included in the total number of OD.
STEP 3:
The passengers related to airports in Japan were classified into two groups using IPS for foreign passengers. One is the group who directly visited Japan and another is the group who transferred at Japan to go to the final destination.
STEP 4:

The passengers who transferred at airports in Japan were classified by their destinations using IPS for transfer passengers. The volume of passengers who traveled via Japan were determined here.

STEP 5:

The passengers whose first flight was not a stopover flight at Japan were divided into two groups by assuming a ratio which indicated the number of passengers entered each country directly. The passengers who entered each Asian country except Japan and who transferred to go to another country were obtained up to this step.

STEP 6:

The share of destination after transferring was determined using the ratio of the number of U.S. passengers traveled into each country.

STEP 7:

By summing up former results, the movement of the U.S. passengers for their actual destination was obtained.

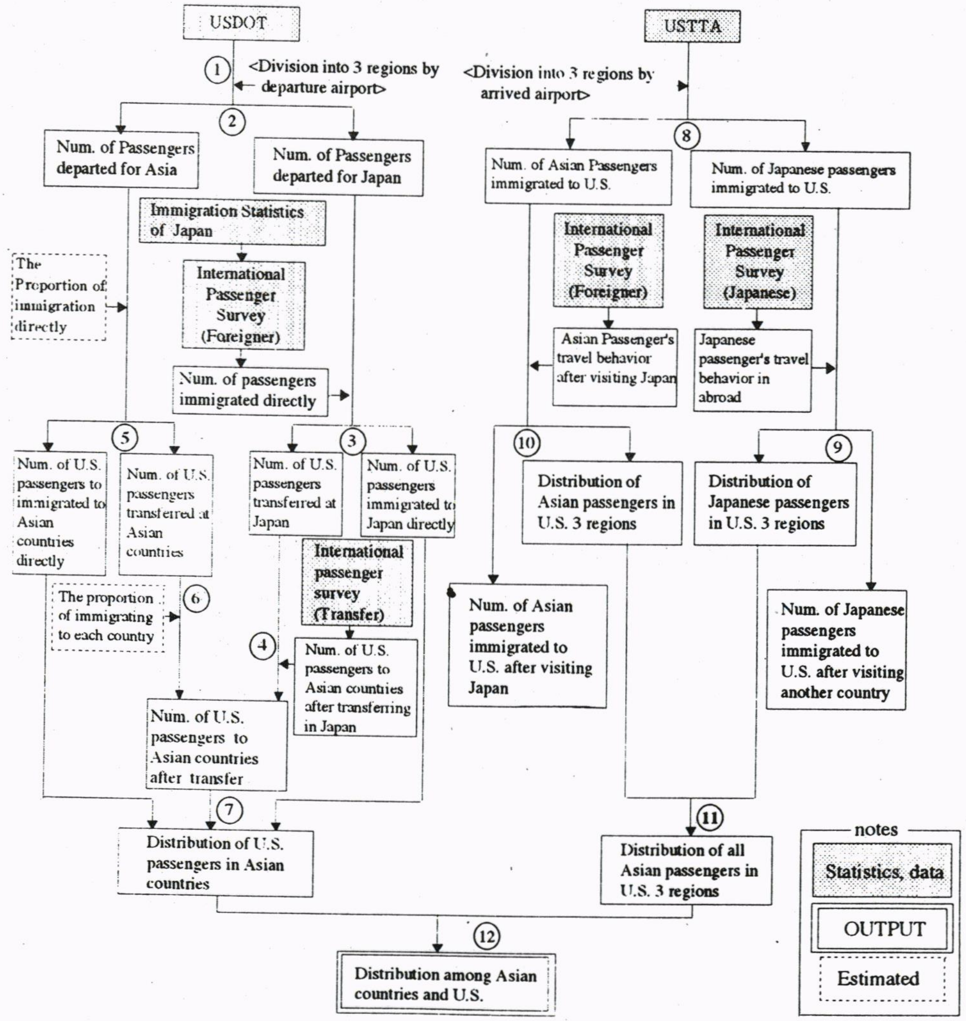

Figure6. OD Estimation Flow

2.2.2 Asian Passenger OD to the U.S.

STEP 8:
USTTA was divided into three regions(U.S.West, U.S.East and Hawaii) by means of the location of airports. Total number of passengers who traveled into each region were obtained here.
STEP 9:
The number of Japanese passengers who traveled in the U.S. after visiting other countries was obtained using the IPS for Japanese passengers. We assumed that a difference between the obtained volume and USTTA was the number of passengers who directly traveled into the U.S. .
STEP 10:
The number of Asian passengers who traveled in the U.S. after visiting Japan was obtained using the IPS for foreign passengers. We assumed that a difference between the obtained volume and USTTA was the number of passengers who directly traveled into the U.S. .
STEP 11:
By summing up these results, the distribution of Asian passengers including Japanese passengers for three U.S. regions was obtained.

2.3 Accuracy of Estimated OD

The estimated OD was not statistically evaluated yet. Although the reliability of estimated value depends on accuracy of using data, its accuracy is not known. Therefore, the relative error was assumed to be deterministic for each data as shown in Table1. Moreover, it was assumed that each data independently distributed as normal. These assumptions enable us to calculate the reliability of the estimated OD by the law of propagation error.

Table1. Assumed relative error

Statistics, Data	Relative Error(%)
International Air Passenger Survey for Japanese (MOT of Japan)	20
International Air Passenger Survey for Foreigner (MOT of Japan)	30
International Air Passenger Survey for Transfer passenger (MOT of Japan)	30
U.S. International Air Travel Statistics(USDOT)	10
Summary and Analysis of International Travel to the United States(USTTA)	20
Immigration Statistics	20
Assumed value such as proportion for transfer at the Asian airport	40

3. AIRLINE CHOICE

3.1 Airline Choice Model

In this section, airline choice behavior was analyzed and modeled to comprehend route choice activities of international passengers. Samples for modeling were restricted to the data collected at the Narita airport because the passengers who departed from local airports in Japan such as Sapporo, Sendai, Hiroshima had few airline alternatives to compare the level of service among airlines. IPS was used as fundamental data to analyze individual choice behavior. Furthermore, market price of international travel ticket was surveyed to travel agencies and flight schedule data were obtained from ABC international aviation timetable.

The alternatives for each passenger were determined by the process that an airline used by at least one passenger in samples was included in the choice set. The average number of alternatives are 4.6 for north America, 7.0 for Europe, 3.3 for Oceania and 6.3 for Asia.

The airline choice probabilities were obtained from the following Logit Model formulation.

$$P_{in} = \frac{\exp(V_i)}{\sum_{j \in J} \exp(V_j)} \qquad \cdots(1)$$

$$V_i = \sum_k \beta_k X_{ki} \qquad \cdots(2)$$

P_{in} : the choice probability of alternative i,

V_i : the utility of alternative i,

X_{ki} : k th variable of alternative i

β_k : parameters of k th variable(k=1..K)

The estimation results are shown in Table2. Sample segmentation were also executed by their trip purposes, destinations and the trip forms. Comparisons of estimated parameters among segments show that sightseeing passengers are highly sensitive to fare and business passengers are generally sensitive to frequency and travel time.

As we were not able to obtain the actual fare of ticket bought by each passenger, we utilized the economy class market price data collected from travel agencies in Japan. As the result, the difference in fare between business class and economy class was not considered in this research.

3.2 Market Segmentation

As described in the previous section, the preference for airline services such as flight frequency, travel time, and fare is different among travelers. Considering the heterogeneity among passengers is useful to understand the effects of transportation policies.

In this paper, we classified the international passengers using segmented models. The hypothesis that pre-segmentation of samples was statistically significant was examined by chi-square test.

$$\chi^2 = -2[L_b - (L_{a1} + L_{a2})] \qquad \cdots(3)$$

where L_b is a log-likelihood before segmentation and L_{a1} and L_{a2} are log-likelihood of sub-samples after segmentation. The results of test are shown in Fig. 7. Finally, all samples were classified into 5 segments. The notation in the figure corresponds to the model number in Table1. Passenger behavior may be well analyzed by considering heterogeneity of passenger.

Table2. Airline Choice Model

(below side : t value)

Explanatory variables	A	B	C	D	E*	F*	G*	H	I*	J*
Fare	-4.50E-06	-6.73E-06	-6.04E-09	-2.15E-06	1.55E-07	-2.22E-05	-2.54E-06	-7.45E-06	-1.25E-05	1.68E-05
(Yen)	-2.33	-2.94	-0.00160	-0.280	0.0348	-4.83	-0.895	-1.84	-1.00	1.31
Frequency	7.99E-01	6.78E-02	1.07E-01	8.17E-02	1.16E-01	9.93E-02	3.29E-02	8.57E-02	1.11E-01	-2.01E-02
(num. of flight per week)	17.5	12.5	11.9	4.87	10.8	12.8	3.83	8.55	5.24	-0.484
Travel time	-2.55E-01	-1.98E-01	-4.78E-01	-2.31E-01	-6.00E-01	-1.19E-02	-2.67E-01	-2.25E-01	-4.24E-02	-5.69E-01
(hours)	-8.62	-6.14	-5.73	-2.09	-5.21	-0.246	-5.84	-3.97	-0.311	-1.91
Dummy variable for	2.07E-01	1.92E-01	2.29E-01	-2.65E-01	3.63E-01	4.52E-01	3.36E-02	1.53E-01	3.00E-01	-1.48E+00
Japanese Airline(1 or 0)	3.55	2.78	2.02	-1.07	2.78	4.20	0.350	1.21	1.02	-2.99
Likelihood ratio	0.072	0.049	0.147	0.08	0.177	0.097	0.027	0.067	0.121	0.111
Num. of sample	1773	1209	539	114	422	545	664	406	74	40
Factors for segment (purpose, form, destination)		Leisure	Business	Business Group	Business Private	Leisure Asia	Leisure others	Leisure Private	Business Group Asia	Business Group others

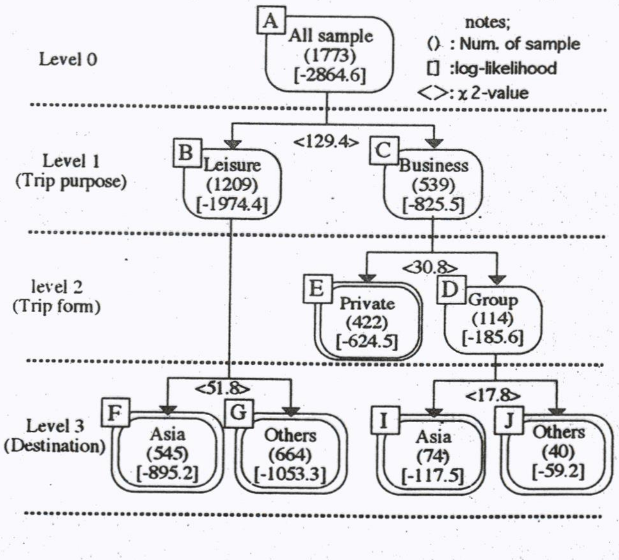

Figure7. Market Segmentation

4. REVISION OF OD VOLUME

4.1 Method

The purpose of this section is to examine the applicability of the estimated OD and models. The relation between the former and this section is shown in Fig. 8. We applied for the technique developed by Mahar(1983) using Baysian approach to revise the estimated OD.

Making use of the results of section 2, we already obtained the OD and their variances as accuracy. The passenger volume on each link can be calculated using the OD and route choice probability. In this case, direct flight routes connecting Asian countries and the U.S. were chosen for objective links. Now, we adopted Traffic by Flight Stage published by ICAO which presents the total volume of passenger flows as observations. We considered that the data have an error.
The relation was written as:

$$Q = PT + \varepsilon \quad \cdots(4)$$

where
Q : observation of link flow (k×1)
T : revised OD volume (n×1)
P : route choice probability in each OD (k×n)
ε : error of observation (k×1)
and is assumed that

$$\varepsilon \sim MVN[0, \Sigma] \quad \cdots(5)$$

and T is assumed to be distributed as

$$T \sim MVN[T_0, V_0] \quad \cdots(6)$$

then the distribution of Q is written

$$Q \sim MVN[PT, \Sigma] \quad \cdots(7)$$

According to the Baysian theorem, posterior distribution of T was derived from a proportional relation with prior distribution of T and posterior likelihood function:

$$P(T \mid Q) \propto f(Q \mid T) \cdot P(T) \quad \cdots(8)$$

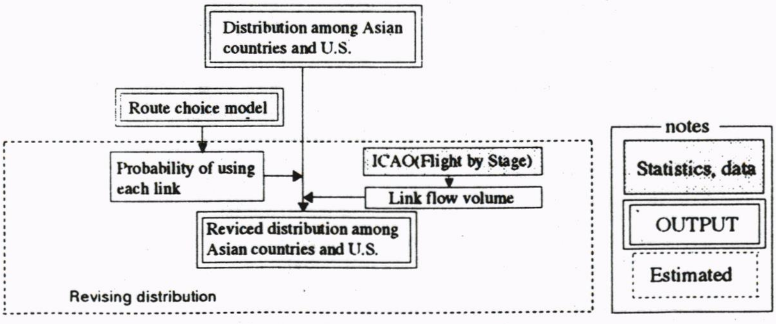

Figure8. Flow of Revicing OD

where

$P(T \mid Q)$: posterior distribution of T

$P(T)$: prior distribution of T

$f(Q \mid T)$: posterior likelihood function

To calculate the maximum point of posterior distribution of T is finally equivalent to minimizing the following equation.

$$\text{minimize} \quad (Q-PT)'\Sigma^{-1}(Q-PT)+(T-T_0)'V_0^{-1}(T-T_0) \qquad \cdots(9)$$

then, the revised OD can be obtained from equation (9). This is an useful procedure to integrate additional data sources into initially estimated volume.

4.2 Result

Fig. 9 shows the results of the revised OD. The relation between accuracy of link flow and the revised OD is illustrated there. The estimated OD varies according to the change of accuracy of additional data.

Fig. 10 and 11 show the results of comparisons between the revised OD and the immigration statistics of each country. Fig. 10 shows the distribution of Asian passengers to the U.S. and Fig. 11 shows the distribution of U.S. passengers to Asian countries.

There are somewhat large difference between the immigration statistics and the revised OD for the U.S. passengers in Fig. 10. The other way around, the OD for Asian passengers to the U.S. is close to the immigration statistics because the trip chaining behavior by Asian passengers in the U.S. are relatively fewer than those by the U.S. passengers in Asia. This indicates that the OD estimation method is applicable to overseas travel in the region.

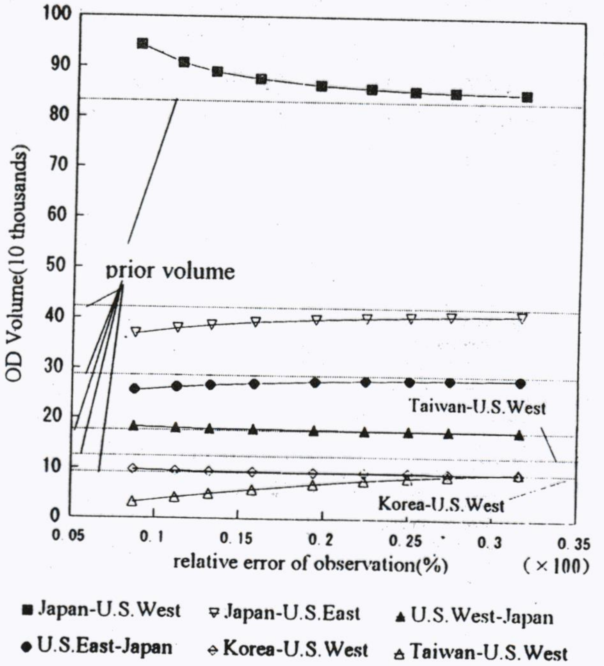

Figure9. Results of Reviced OD

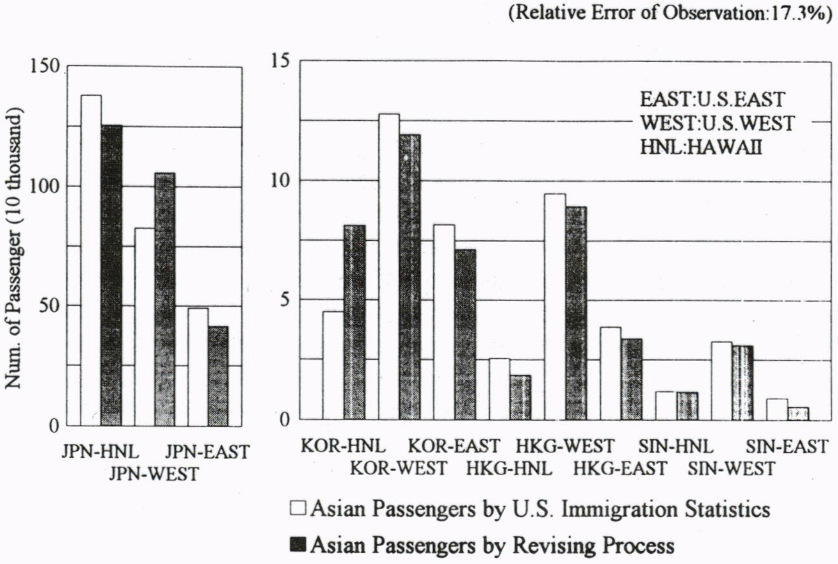

Figure10. Comparison revised OD with immigration statistics. (Asia Passengers to U.S)

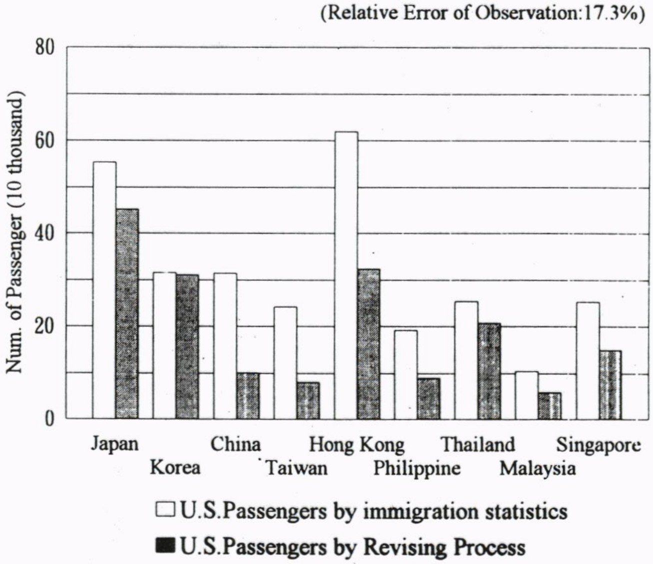

Figure11. Comparison revised OD with immigration statistics. (U.S passengers to Asia)

5. EVALUATION OF USER BENEFIT

5.1 Outline

In this section, we calculated user benefit which was affected by airline service change. The OD estimated in section 2 and route choice models estimated in section 3 were utilized under an artificial network condition. In section 3, we clarified that the airline choice behavior depends on the service such as frequency, fare, travel time. The present condition of airline choice using IPS(1993) was shown in Fig. 12 and 13. These figures show a share of each airlines in terms of company's nationality-base. Fig. 12 shows a share of airline used by foreign passengers who denatured from Japan and it was classified by passenger's nationality. Fig. 13 shows a share of airline used by Japanese passengers, which was classified by their destination. It is obvious that a passenger does not always use his country's airlines. As the result, an airline service change directly affects passenger's choice behavior. Here, flight frequency was introduced as a political variable to be simulated.

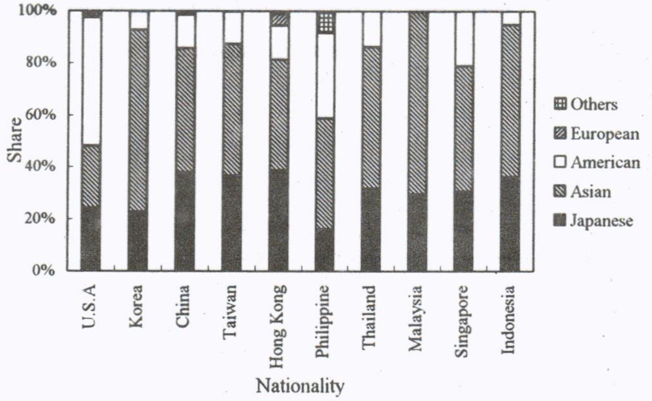

Figure 12. Share of Airline Used by Asian Passengers(Nationality-Base)

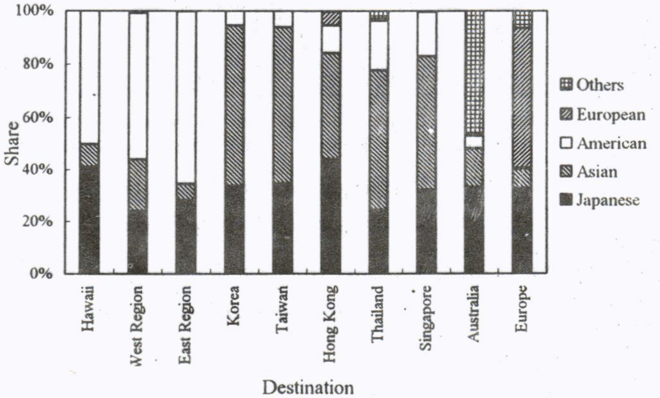

Figure 13. Share of Airline Used by Japanese Passengers(Destinationy-Base)

5.2 Process

Three city pairs : Seoul-Los Angeles, Taipei-Los Angeles and Hong Kong-Los Angeles were selected in order to evaluate user benefit. The method to divert a direct flight to a indirect flight(via Narita) was applied here. Table3 shows the level of service before/after diversion in each case. Three airline groups were considered according to their location of company base: Asia, U.S. and Japan, and the average services of airline group were employed. Fare data were assumed to be distance-proportional to fare data from Japan because of a lack of data except Japan.

For example, in the case of SEL-LAX, six types of passengers: Korean passengers between SEL-LAX and between SEL-NRT, U.S. passengers between LAX-SEL and between LAX-NRT and Japanese passengers between NRT-SEL and between NRT-LAX were affected by airline service change.

Fig. 14 shows the passenger volume of each origin and destination in all cases. Here the passenger volume represents the total number of demand between countries, that is to say, all Japanese were assumed to use Narita Airport to go abroad.

The utility function used in this calculation is,

$$V = -8.12 \times 10^{-6}(Fare) + 0.755(\ln(Freq)) - 0.0984(Time) + 0.171(Dummy)$$

Fare : air ticket price (yen),
Freq : frequency (flights/week),
Time : total travel time (hour),
Dummy : if airline is owned by Asian country 1, otherwise 0.

As the model is estimated using IPS which is restricted to Japanese passengers, we can not directly evaluate user benefit of foreign passengers. Therefore, time of value for each country should be modified. We revised time of value using Statistical Yearbook published by the United Nations and unified it by applying to exchange rate in terms of $.U.S. User benefit was calculated using proportional relation of time of value in each country. However in the case of Taiwan, the average of Korea and Hong Kong was employed due to a lack of data.

Table3. Change of Level of Service

		Time (hour)	Fare (Yen)	Frequency(flights/week) before	after
Case of Seoul SEL-LAX	D.US	12.1	92167	9	9
	D.AS	11.8	97180	21	20
	I.US	15.1	98322	14	14
	I.AS	14.2	104799	23	24
	I.JP	14.7	127753	7	7
Case of Taipei TPE-LAX	D.US	13.3	101902	3	3
	D.AS	12.8	93023	12	11
	I.US	17.0	106579	30	30
	I.AS	15.9	100569	17	18
	I.JP	15.3	145397	4	4
Case of Hong Kong HKG-LAX	D.US				
	D.AS	14.3	122417	7	6
	I.US	17.0	111103	28	28
	I.AS	15.8	119470	17	18
	I.JP	15.8	155120	7	7

cf. D.US:Direct flight of U.S. Airline
D.AS:Direct flight of Asian Airline
I.US:Indirect flight of U.S. Airline
I.AS:Indirect flight of Asian Airline
I.JP:Indirect flight of Japanese Airline

5.3 Results

Fig. 15 shows the results of calculated benefit per passenger. A flight service change causes passenger's user benefit change. For passenger whose direct flights decrease, his benefit also decreases. For the passenger whose flight begins/ends at Narita, his benefit increases. In the figure, the large benefit changes in the U.S. and Japanese passengers are shown because of higher time of value relatively to Asian passengers.

Fig. 16 shows the total user benefit obtained by multiplying the unit benefit by the estimated OD. In all cases, user benefit increases remarkably because the passenger volume from/to Japan are relatively larger than that unconcerned with Japan. At present the share of U.S. and Japanese passengers are higher than those of other Asian passengers. However, this situation may be changed in accordance with increasing passenger demand and rising time of value of Asian countries. Therefore, the research on the forecast of international passenger demand and analysis of travel behavior are both required for further planning practices in air transportation.

6. CONCLUSION

A lack of data has lately hindered progress in researches on international air transport. Especially, the absence of nationality-based OD might delay the research for evaluating the policies such as international airport construction and network design. We focused on the international air passenger OD and developed the method to estimate the OD in the Pacific-East Asia region. The OD between the U.S. and Asian countries was estimated by integrating several data sources. Accuracy of the estimated OD was also evaluated using the law of propagation error.

Route choice behavior of international passengers was modeled using discrete choice modeling method. As the results of comparing estimated parameters for each segment, it was shown that the preference for airline services differs among passengers. Market segmentation was also completed with the models and the necessity of considering heterogeneity of passengers was confirmed in order to analyze the international air transport market.

We experimented two primary studies for further research needs. First one is to revise the passenger distribution using a Bayesian updating technique and another is to evaluate the effect of airline service change in terms of user benefit.

We consider that our results may provide some contribution to the further research on international air transportation. However, our research was obviously induced by the insufficient data environment in this region and additional comprehensive surveys to comprehend international passenger behavior over Asian region are required to enlarge this field to be studied.

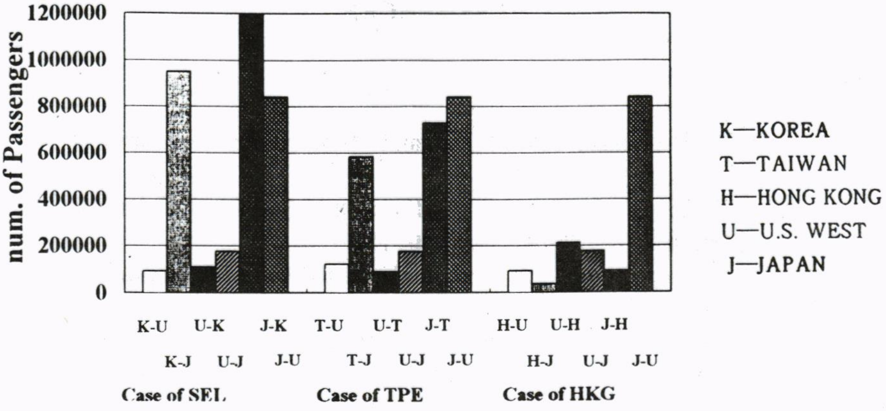

Figure14. Passenger Demand.

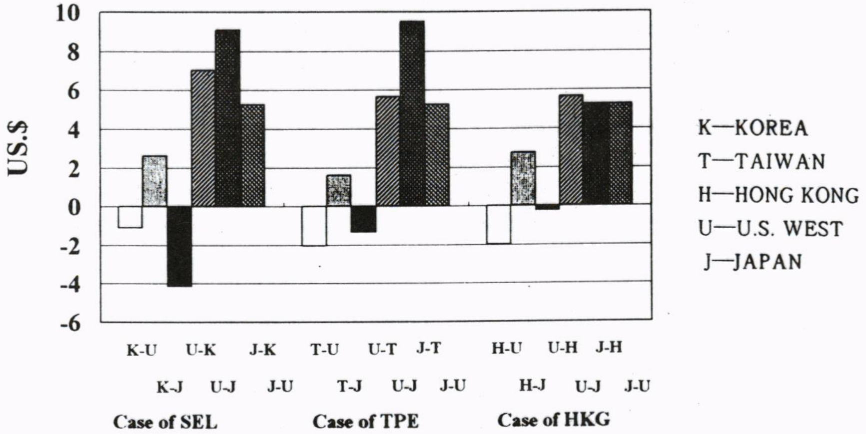

Figure15. Changes of user benefit per passenger.

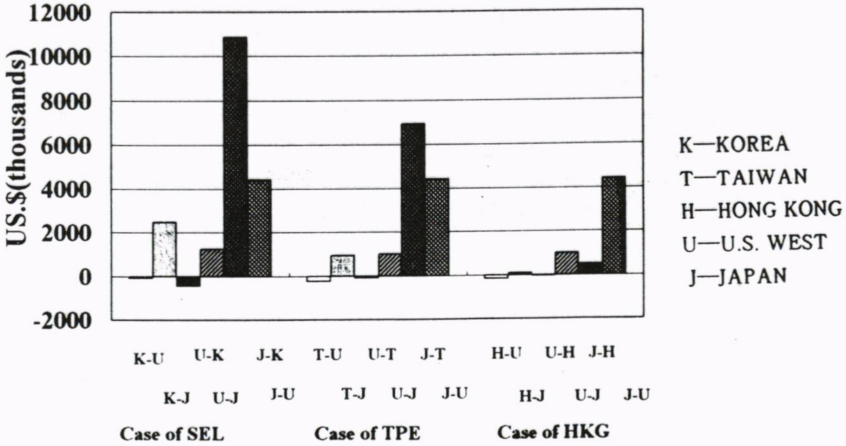

Figure16. Changes of total user benefit.

REFERENCES

a)Journal papers

A. Kanafani and R. Behbehani (1979) Demand Analysis for International Air Travel. **Transportation Research Record 732,** 5-14

Oberhausen P.J. and Koppelman F.S. (1982) Time-Series Analysis of Intercity Air Travel Volume. **Transportation Research Record 840,** 15-21

Harvey G.(1987): Airport Choice in A Multiple Airport Region, **Transportation Research A, Vol. 21A, No. 6,** 439-449

Furuichi M. and Koppelman F.S. (1994) An Analysis of Air Travelers' Airport and Destination Choice Behavior. **Transportation Research A, Vol. 28A, No. 3,** 187-195

M. Hansen and A. Kanafani (1990) Airline Hubbing and Airport Economics in the Pacific Market. **Transportation Research A, Vol. 24A, No. 3,** 217-229

Kuby, M.J. and Gray, R.G. (1993) The Hub Network Design Problem with Stopover and Feeders. **Transportation Research A, Vol. 27A, No.1,** 1-12

Maher M. (1983) Inferences on trip matrices from observations on link volumes Bayesian statistical approach. **Transportation Research B, Vol. 17, No.6,** 435-447

b)Papers presented to Conferences

S. Morichi, T. Yai and T. Hyodo (1989) Air Transport Policy Analysys for Future Network in Japan. **Selected Proceedings of the 5th World Conference on Transport Research**, Yokohama, Japan, Vol.1, 507-520

c)Other documents

OAG (1971,1993) **Official Airline Guides, World Wide Edition**

IATA:**World Air Transport Statistics**. International Air Transportation Association

USDOT (1991) **U.S. International Air Travel Statistics**. U.S. Department of Transportation

USTTA (1991) **Summary and Analysis of International Travel to the United States**. U.S. Department of Commerce, United States Travel and Tourism Administration

IPS (1991,1993) **International Passenger Survey**. Ministry of Transportation in Japan

ABC (1991) ABC, **World Airways Guide**. Reed Travel Group

ICAO (1991) **Flight by Traffic Stage**. International Civil Aviation Organization

UN (1989/1989) **Statistic Yearbook, Vol. 37,** United Nation

ED (1992) **Annual Report of Statistics on Legal Migrants**, Judical System and Research Department, Minister's Secretariat, Ministry of Justice