인천국제공항의 허브 경쟁력 강화를 위한 효율적 비행편 서비스망 구성방법에 관한 연구

A Study on the Flight Service Network for Incheon International Airport to be a Successful Hub Airport in Northeast Asia

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요 약

인천국제공항이 동북아 허브 공항으로서 성공하려면 동 공항을 중심으로 한 비행편 구성이 경쟁 공항보다 효율적이어야 한다. 본 논문은 항공여행자의 비행편 선택 행위를 분석하여 인천국제공항 허브화 성공을 위한 비행편 구성 계획에 이용하는 방법을 연구했다. 규제가 완화된 시장에서는 소비자의 선호 파악에 기초한 사업 계획이 유효하므로 비집계형 선택모델에서 산출할 수 있는 여행시간가치, 운항빈도와 여행시간의 대체율 등을 이용하여 비행편 구성 계획을 할 필요가 있을 것이다.

Abstract

Incheon International Airport(IIA) is planned to open in about two years. Korean government has an ambition to make IIA a major hub airport in Northeast Asia. The most essential and required condition for an airport to be a successful hub airport in a certain region is to have more efficient flight service network than the other airports in the same region. IIA should compete with Japanese airports to be a major hub in Northeast Asia because Japanese government also has a plan to expand greatly the airport capacity in Tokyo area and Kansai airport in Osaka. It is necessary for both IIA and Korean national air carriers to compose efficient flight service network considering hub competition with Japanese major airports. As the liberalization of international air transport industry would give more marketing freedom to airlines, they would plan the flight service network and flight schedule based on market analysis instead of governmental regulations. In the economically liberalized environment, it is very required to analyze air passengers' flight choice behaviour in order to induce other carriers and passengers through IIA's attractive flight service network. Disaggregate model is more appropriate than aggregate model to analyze consumers' behaviour. The information derived from disaggregate choice model of air passengers could be utilized in devising efficient flight network and schedule plan. Value of travel time or trade off ratio between flight frequency and travel time which could be estimated from discrete choice model could be utilized for scheduling an efficient flight plan for airlines and composing efficient flight service network for IIA.

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· 논문번호 : 98-2-8

· 접수일자 : 1998년 11월 28일

Ⅰ. Introduction

The aviation demand in Asian Pacific region has recorded larger growth rate than in other regions during last decade. In accordance with the rapid expansion of aviation demand in Northeast Asia, the construction of Incheon International Airport(IIA) was planned to meet the growing air transport demand of Korea and to play a role as a major hub airport in Northeast Asia. They should compose efficient hub-spoke flight network centered at IIA to make it a hub airport in the area. IIA is required to compete with other big airports in the same region to become a successful hub. Especially it is inevitable to compete with Japanese airports in Tokyo and Osaka because Japanese government also has a plan to add greatly airport capacity in those big cities and Tokyo is already known as a hub in Northeast Asia.

Through the expanding open-sky policy in international air transport industry led by USA, airlines are predicted to operate to meet market needs. The national barrier will become less important than consumers' preference in the market when an international airline or an airport plans a flight service network. Therefore, the study of air passengers' behaviour in the target market should be treated as an essential base for flight service planning.

The objective of this research is to study the way how to analyze the air passengers' flight choice behaviour and apply the findings of the analysis to air carrier's(or airport's) planning of flight service network. The area to study is air transport market in Northeast Asia region. To be more concrete, we will focus on hubbing competition of IIA with major airports in Japan. As they compete by flight service network, effective flight service network should be constructed through the scientific analysis of air passengers' flight choice behaviour. In this study, we will suggest a method to apply for planning flight service network so that IIA could win a competition with Japanese airports utilizing air passengers' choice model.

There are several previous researches to utilize passengers' flight choice models in air transport planning area. Kanafani and Ghobria utilized air passengers' route choice model for their research concerning hub pricing of airport[7]. Benchemam also utilized discrete choice model to study air passengers' airport choice behaviour in UK[4]. Alamdari and Black studied passengers' choice of airline with logit models[1].

Following this introduction, section 2 is to review the air transport market in Korea and Japan. Section 3 will discuss hubbing strategies in air transport industry. Section 4 will introduce the method of empirical research and section 5 will be dedicated to main discussion of this study and section 6 is the concluding remarks of the study.

Ⅱ. Air Transport Industry in Korea and Japan

This section will introduce the shape of air transport industry in Korea and Japan. However, this study does not introduce detailed information because it is not very necessary for the purpose of this study. The following sub-sections are to review it roughly, only mentioning the basic information related to this research.

2-1 The Policy for Air Transport Industry

The policy for domestic air transport in Korea has been somewhat led by government regulation. Now, there are two scheduled airlines operating as private corporation: Korean Airlines (KAL) and Asiana Airlines(AAR). Korean government which wants to introduce deregulation to all industry has changed regulatory form of air transport industry in order to make it greatly deregulated. It can be expected that domestic air transport is going to be operated without governmental regulation in near future. For international air transport, Korean government is seeking different policy case by case. As they accept the suggestion of "open sky" from USA, the international air transport between US and Korea is operated in economically liberalized environment. Airlines in this market can decide air fare, service route and service frequency without government intervention. However, the bilateral air service agreements with other countries except USA are more restrictive. They usually regulate service route and frequency.

Japanese policy for air transport industry is a little more restrictive than that of Korea. Japanese government would like to lead air transport industry to the direction where they intend to drive. For international air transport, Japanese government also takes more conservative attitude than Korea, since they feel Japanese airlines are not so competitive, caused mainly by high cost. They want to keep on regulating air fare even though the degree of regulation is going to be less severe. However, Japanese government is considering the expansion of the routes of multiple designation. In general, they also try to adopt themselves to new wave of international deregulation of the industry.

2-2 Capacities of Major Airlines and Airports in the Market

There are several big scheduled airlines in Korea and Japan. In the aspect of capacity, JAL ranked the first place beyond compare and ANA ranked the second place by a little more capacity than KAL which ranked the third place. AAR ranked the fourth and JAS ranked the fifth (refer to Table-1).

There are three major international airports in the market: New Tokyo International Airport in Narita Tokyo, Kansai International Airport in Osaka, and Kimpo International Airport in Seoul. New Tokyo International Airport has one runway and has a plan to add two more runways. Kansai International Airport is also operating one runway and has a plan to add two more runways. Kimpo International Airport has two runways. However, in January 2001, all of the international flights will move to new Incheon International Airport which will have one runway at the opening date and another one in six months. Eventually, In-

표 1. 한・일 주요 항공사의 공급 가용량

Table 1. Major airlines' capacity in Korea and Japan (1997).

Rank	Airline	Aircraft owned	RPM(millions)	World rank
1	JAL(Japan)	143	43,357.4	6
2	ANA(Japan)	137	26,629.4	14
3	KAL(Korea)	119	20,991.9	18
4	AAR(Korea)	45	8,026.5	39
5	JAS(Japan)	88	6,950.9	-

source: "Major Airlines Profiles", Aviation week & space technology, Jan. 1998 cheon International Airport will be operated with four runways when they finish final stage of construction.

The air passenger demand in Japan is concentrated in Tokyo area and Osaka area. New Tokyo International Airport and Kansai International Airport handled a major portion of international air passengers in Japan. In Korea, Kimpo International Airport handles almost all of the international air passengers. Table-2 shows the international traffic demand on these three airports.

표 2. 각 공항의 국제 여객 수요

Table 2. international passenger demand at each airport(1996).

City	Airport	International Passengers (thousands)
Tokyo	New Tokyo Airport	23,372
Seoul	Kimpo Airport	21,271
Osaka	Kansai Airport	8,578

source: 1. "Aviation shown by number(数字でみる航空)", Japanese Civil Aviation Bureau, 1997
2. "Aviation Statistics", Korea Aviation Development Association, 1997

Ⅲ. Hubbing Strategy in Air Transport Industry

3-1 Introduction - Justification of Hub-Spoke Network System

With the deregulation of air transport industry, airlines have altered their route structure to utilize their resources more efficiently and the hub and spoke flight network is proved to be effective. Hubbing occurs when airlines concentrate flights at a few airports which they use as collection-distribution centers for their passengers. Through hubbing, an airline could increase the number of connecting cities and flight frequencies with limited resources, which can be explained by Fig.1.

Fig. 1(a) is to serve five cities with complete connection, by direct service only. As shown at Fig. 1(a), ten ($_5C_2$ = 10) routes are required to supply complete connection with direct service for these five cities. Fig. 1(b) is utilizing hub-and-spoke system, and it can be seen that only four routes are required to connect five cities by way of the hub city "C". If the city "C" is a big city

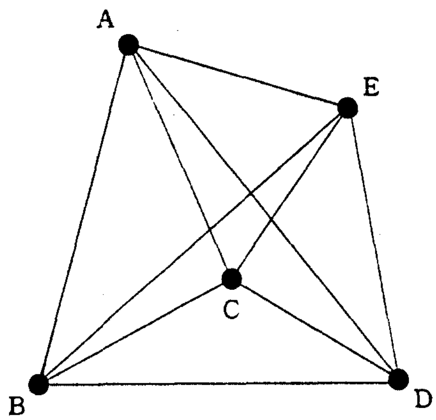

그림 1(a). 직통 비행편에 의한 노선망 구성

Fig. 1(a). Flight service network with direct connection.

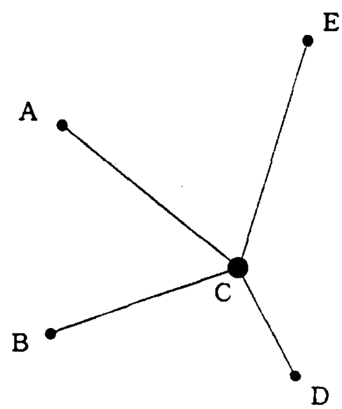

그림 1(b). 허브-스포크 노선망 구성

Fig. 1(b). Flight service network utilizing Hub-and-spoke system.

generating large traffic demand, the flight frequency between "C" and other cities could be greater than that of between small cities. Therefore, the passengers, for example, who want to travel between "A" and "D", have to transfer at "C", and this will enforce more travel time to passenger while the passenger can enjoy convenience by more flight frequency with hub-and-spoke flight service network. The air fare for connection flight usually cheaper than that of direct flight because airlines can reduce unit cost through high load factor. In many cases, since the route between hub city and a certain spoke city is for the purpose of transportation between hub and that spoke city, it may be considered as an additional revenue for the airline that earned from the passengers who travel between one spoke city and another spoke city by way of hub city. This will result in low air fare for the passengers who use connection flights. Therefore, the consequences for the passengers using hub-and-spoke system are the benefits from trading off longer journey times for more frequent flights, if necessary, and, on certain routes, the benefits from using cheaper flights.

Even though it is normally accepted that travellers consider flight frequency, travel time and fare in their decision making procedure of transport choice, it has been proved that high frequency is usually more attractive to passenger than short travel time. In a competitive market, frequency seems to be a key variable and the S-curve relationship between frequency and market share is often cited.

Since hub-and-spoke network systems are utilized in major continents in the world, multiple hub system serving between continents has been also developed(refer to Fig. 2).

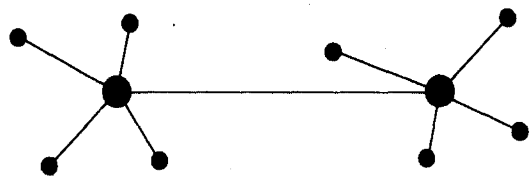

그림 2. 다핵 허브 시스템
Fig. 2. Multiple hub system.

3-2 Two Kinds of Hub

As Doganis and Dennis(1989) proposed, it is reasonable to classify hubbing function of airports by two main kinds of hub: hourglass hub and hinterland hub (refer to Fig. 3)[5]. As shown by Fig. 3(a), through an hourglass hub, flights operate from one region to points in the opposite direction. Through a hinterland hub, short haul flights feed connecting traffic to the longer trunk routes. An hourglass hub usually only caters for connections in two directions, outbound and return. However, a hinterland hub serves as a multi-directional distribution center for air travel to and from its surrounding catchment area.

Ⅳ. Research Method

4-1 Introduction

It is essential to study air passengers' behaviour for the planning of flight service network in the greatly deregulated air transport market. Disaggregate model is more appropriate than aggregate model in analyzing consumers' behaviour. This section will try to find the method how to apply the information derived from disaggregate choice models to flight service network planning.

By traditional economic assumption, commodities are finely divisible with a change in price having an effect on the quantity of the goods demanded.

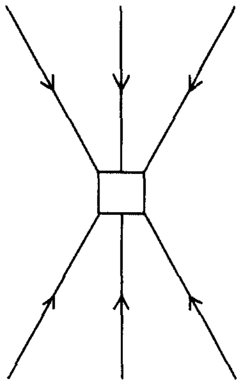

그림 3(a). 모래시계형 허브
Fig. 3(a). Hourglass hub.

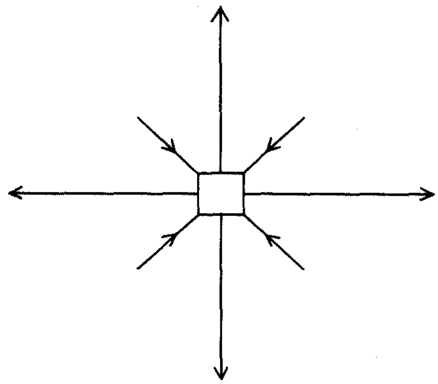

그림 3(b). 배후지형 허브
Fig. 3(b). Hinterland hub.

However, this assumption does not hold for some commodities, transport choice being one of them. For such commodities, a change in price may result in zero consumption or unaffected consumption. When commodities are not finely divisible, marginal adjustments of consumption are not feasible consequences. Thus the individual behaviour of consuming discrete commodities is better represented by an individual choice function.

4-2 Theory of Individual Choice Behaviour

It is assumed that the individual attempts to choose from the range of alternatives the option that maximizes overall utility, when the hypothesis of utility maximization is used as the decision rule of discrete choice. Individual k will select alternative i among a set of J alternatives if

$$U_{ik} > U_{jk} \quad (i \neq j,\ j = 1, 2, 3, \cdots\cdots, J) \quad (1)$$

However, in repeated choice experiments, individuals have been observed not to select the same alternatives in the same situation, and different decision makers have selected different alternatives in the same situation with the same alternatives. This led to the development of probabilistic choice theory which attempts to explain these behavioral inconsistencies[3]. This behavioral inconsistencies could be explained by random utility theory. In this random utility approach, the observed inconsistencies in choice behaviour are considered to be a result of observational deficiencies on the part of the analyst. The individual is assumed to select the alternative with the highest utility. However, the utilities are not known to the observer with certainty, and hence treated as random variables. Manski (1973) identified four sources of the randomness of the utilities,

- unobserved attributes
- unobserved taste variations
- measurement errors and imperfect information
- instrumental(or proxy) variables

With random utility approach, the utility of the ith alternative for the kth individual can be partitioned into two components,

$$U_{ik} = V_{ik} + E_{ik} \quad (2)$$

where V_{ik} represents the observable component, which also can be expressed as the systematic component or representative utility.

E_{ik} is the unobservable component or random component.

It is assumed that the systematic component is the part of utility contributed by attributes that can be observed by the analyst. For the random component, the sources of randomness are those stated in the above paragraph. Since, in consuming commodities, individuals attain utilities by consuming bundles of attributes which define level of service, a relationship between utility and level of service can be defined, so that the observable component of total utility in equation(2) can be expressed as follows if a linear-in-parameters is assumed.

$$V_{ik} = a_{0+a_1}X_1 + a_2X_2 + \cdots\cdots + a_nX_n \quad (3)$$

where, V_{ik} = *systematic component of utility of option* i for *individual* k

$a_0, \cdots\cdots, a_n$ = *coefficients*

$X_1, \cdots\cdots, X_n$ = *attributes of option* i

The coefficients ($a_o, a_1, \cdots\cdots, a_n$) are assumed to be the same for all members of the population in equation (3). If different socio-economic groups are believed to have entirely distinct coefficients, then it is possible to develop an entirely distinct model for each subgroup. This is termed as market segmentation. However, socio-economic characteristics are often included in the model using an appropriate specification. In such a case the utility function can be expressed as follows:

$$U_{ik} = U(Z_i, S_k) \quad (4)$$

where, Z_i = *a vector of attributes of alternative* i

S_k = *a vector of socio-economic characteristics of individual* k

4-3 Choice Model of Random Utility

This subsection will introduce the basic theory of the random utility model, as the random utility approach is more consistent with economic theory. By combining probabilistic choice theory and random utilty theory, the following equations are obtained:

$$P_{ik} = Prob.\,[\,U_{ik} > U_{jk} \;\; i \neq j, \; j = 1, 2, \cdots, J] \quad (5)$$

$$P_{ik} = Prob.\,[\,V_{ik} + E_{ik} > V_{jk} + E_{jk} \;\; i \neq j, j = 1, 2, \cdots, J] \quad (6)$$

$$P_{ik} = Prob.\,[E_{ik} - E_{jk} > V_{jk} - V_{ik} \;\; i \neq j, \quad j = 1, 2, \cdots, J] \quad (7)$$

where, P_{ik} *is the probability of selecting alternative* i for *individual* k *facing a set of* J *alternatives.*

It is important to stress that V_{ik} and V_{jk} are functions of service attributes and are assumed to be deterministic. The terms E_{ik} and E_{jk} may also be functions, but they are random from the observational perspective of the analyst. It is usually assumed that the means of the random variable E's are zero, and any non zero means of E's are 'absorbed" into the systematic component of the utility function, unless noted otherwise.

One of the most difficult arguments of random utility theory is defining a reasonable functional form for V. Ben-Akiva and Lerman proposed two criteria for selecting functional form: (1) the function to reflect how the various attributes in the alternative set influence utility (2) the function that has convenient computational properties that make it easy to estimate their unknown coefficients[3]. In most case, functions of linear-in-parameters are chosen. As for the functional form for the distribution of random component E, different assumptions regarding the distribution of E, lead to different choice models being developed. Although several models for the multinomial choice situation have been developed, multinomial logit (MNL) is the most widely used multinomial choice model.

4-4 Application of Stated Preference Techniques

Often it is not easy to calibrate an efficient discrete choice model with revealed preference data because there is not sufficient variation of all variables of interest, and there are also often strong correlation between variables or between variables and other invisible factors. Stated Preference(SP) techniques which allow the researcher to experiment, can offer a solution to these problems. With clearly defined attributes and attribute levels, SP experiments can give researchers the chance to have sufficient variation of variables of interest, and an orthogonal design which ensures that the attributes presented to respondents are varied independently from one another, avoids multi-collinearity between attributes.

4-4-1 Introduction to Stated Preference Techniques

SP methods which were originally developed in marketing research in the early 1970s have been applied in the empirical analysis of transport-related choice behaviour since 1979. Though these techniques were severely discredited at their beginning, by the end of the 1980s, they were perceived by many researchers to offer a real chance to solve the problem related to transport demand modelling.

Kroes and Sheldon (1988) described SP methods in transport research as a family of techniques which use individual respondents' statements about their preferences in a set of transport options to estimate utility functions[9]. The options are typical descriptions of transport situations or contexts constructed by the researcher. Generally, SP techniques can be defined as all the approaches which use people's statements of how they would respond to hypothetical situations.

4-4-2 Advantages of SP Techniques

Transport planners need to know the likely effect of any planning strategy they consider. However, the traditional methods using revealed preference data cannot provide good quality information on travel demand and travel behaviour mainly because there is insufficient variation in the variables of interest to produce statistically significant models, and further, such variables are often strongly correlated. Moreover, revealed preference methods cannot be used to evaluate demand under conditions which do not yet exist. SP techniques, however, allow the researcher to experiment the consumer behaviour under various conditions, offering an effective solution to such problems. The advantages of SP techniques over revealed preference (RP) methods are summarized as follows[11]:

(1) RP : Observations may not vary sufficiently for the construction of an accurate statistical

model and the variables may also be correlated making it difficult to estimate model parameters reflecting the proper trade-off ratios.

SP : SP techniques can ensure data of sufficient quality to construct a good statistical model because the researcher can control the choices offered to respondents.

(2) RP : The observed behaviour may reflect factors which are not of interest to the policy maker. In addition, the effects of the variables that are of interest may be "swamped" by these other factors. This is a particular problem with "secondary" qualitative variables.

SP : Due to the control available to the researcher, the effects of variables of interest can be isolated from the effects of other factors.

(3) RP : There is no information on how people will respond in situations where a policy is completely new.

SP : Where a policy is completely new, so that no RP data is available, stated preference techniques may represent the only practical basis for evaluation and forecasting.

(4) RP : To obtain adequate observations of behaviour, very large and therefore very expensive surveys may have to be carried out.

SP : Since each stated preference interview produces multiple observations per individual, efficient statistical models can be developed from much smaller sample sizes.

V. A method on IIA's Strategic Flight Service Network Planning to Win Hub Competition in Northeast Asia

This research reviewed air transport industry and introduced the hubbing strategies in the industry and discrete choice modeling. In this section, we will discuss how to utilize the information which could be derived from discrete choice model for IIA's strategic flight service network planning to make it successful hub airport in Northeast Asia.

5-1 Information derived from Discrete Choice Model to be Utilized for Flight Service Network Planning

This paper will research the method to utilize the information derived from the analysis of air passengers' flight choice behaviour for flight service network planning of IIA. Discrete choice model is useful to understand passengers' choice behaviour. Under the assumption that some utility functions concerning air passengers' flight choice have been calibrated, the methods to utilize the information derived from the models to IIA flight service network planning will be presented in this section.

Through the previous studies in the industry, it has been identified that flight frequency, air fare, and travel time are the major attributes to air passengers' flight choice behaviour[12]. If a discrete choice model is calibrated using these three attributes and equation (3) of this study, the results may be presented as follows:

$$V = a_0 + a_c \cdot \text{FARE} + a_t \cdot \text{TIME} + a_f \cdot \text{FREQUENCY} \tag{8}$$

Even though the magnitude of individual coefficient of equation (8) is important to estimate the weight of each variable considered in consummers' choice behaviour, this study would try to utilize relative importance of pair of variables, which can be estimated as the ratio of any two coefficients. The reasons to utilize relative importance of variables are as follows: (i) The passengers' flight choice or route choice is decided comparing each variable. That is to say, relative importance of variables becomes significant factor when he/she decides to choose an air trip anyway. (ii) Especially, the model coefficients estimated from SP data are not proved appropriate to be utilized as absolute value. Instead, the SP model is useful for seeing the relative importance which can be estimated by comparing the absolute value of coefficients[11].

There can be three ratios estimated by comparing any two variables with each other if a model is composed of three variables: air fare, travel time and flight frequency. The three ratios and their significance could be explained as follows, utilizing the quotation of the coefficients of equation (8):

(i) RATIO-1: a_t/a_c

where: a_t is the coefficient of travel time variable

a_c is the coefficient of travel cost(air fare) variable

(ii) RATIO-2: a_f/a_c

where: a_f is the coefficient of flight frequency variable

a_c is the coefficient of travel cost(air fare) variable

(iii) RATIO-3: a_f/a_t

where: a_f is the coefficient of flight frequency variable

a_t is the coefficient of travel time variable

RATIO-1 is the ratio between travel time value and travel cost value. This ratio is the most frequently utilized relative importance in transport studies, which is usually mentioned as value of travel time (VOT). The relative importance of flight frequency to air fare can be calculated by RATIO-2. RATIO-3 is the ratio between the coefficients of flight frequency variable and that of the journey time variable. This ratio is usually considered as a trade off between service frequency and travel time and can be utilized when they consider the choice between direct route system and hub-and-spoke system.

5-2 Methods to apply the Information derived to IIA's hubbing strategies

5-2-1 Application to Hinterland Hub Strategies

It is essential factor to have plenty of short-haul flights in catchment area in order to be successful hinterland hub. In addition, they should try to reduce transfer time required to change aircraft for the connection between short-haul and long-haul flights. IIA should try to increase the flight frequency considering the competition with Narita and Kansai Airports. Since the major airlines in Korea have much less capacity than Japanese major airlines to have enough flights to compete with, it is desirable for Korean airlines to utilize the alliance with Chinese airlines and Japanese regional airlines. With limited capacity, Korean airlines and IIA airport operator should try to supply more efficient flight service to make IIA a successful Northeastern Asia hub airport. In order to achieve such an object, this study suggests that the ratios of coefficients of discrete choice model can be utilized as follows.

They can utilize RATIO-1 to set air fare and to decide aircraft type to introduce. It is basic to introduce cheap and slow aircraft for the routes which reveals low VOT (value of RATIO-1) and to introduce expensive and higher speed aircraft for the routes which reveals high value of VOT. It is required to consider RATIO-2 in order to compromise the level of frequency and air fare. For the routes which have higher value of RATIO-2, they should try to increase flight frequency suffering low load factor. Low load factor may lead to high price inevitably if airlines seek to recover the operation cost. On the other hand, for the routes which have lower value of RATIO-2, it is effective to reduce flight frequency, which could result in higher load factor and lower air fare.

It is a normal practice that the routes which have large portion of business passengers would have higher value of RATIO-2 than the routes mainly composed of leisure passengers. If any routes are operated for mainly leisure passengers with small amount of demand, and if there is significant local traffic between cities near each other, then combining destinations on one or more spoke can be effective (refer to Fig. 4). In the case of which RATIO-1 is very small, this kind of routing strategy is desirable.

It would cost some expenses to improve operational standard to reduce connecting time on

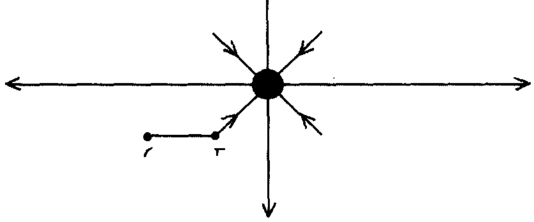

그림 4. 허브-결합 스포크 노선망

Fig. 4. Hub and combining spokes network(cities "P" and "Q" are combined spoke in the figure).

hub airport. The airline and airport operator should decide the level of cost to invest in order to reduce transfer time and they should set the level of air fare to recover the invested cost. It is useful to utilize RATIO-1 to optimize these two variables; travel time and travel cost. However, for the passengers originating from the cities where direct connections to long-distance major cities are impossible or inconvenient, it may be desirable to introduce low fare and high frequency service utilizing sixth freedom transportation to strength hubbing concept of IIA.

5-2-2 Application to Long-haul Flight Service Network Planning of IIA

We consider the long-haul flights as flights to serve inter-continents routes and there are relatively large demand between Korea and North America/Europe. However, the European routes are significantly regulated by bilateral air service agreements and the demand to Europe is far less than that of USA. For this reason, this study would discuss the flight network planning strategies on the routes to North America only as long-haul flights.

Because of the inferiority in the aspect of airline capacity as well as the magnitude of demand, Korean airlines should utilize effective flight schedule and efficient alliance with the major airlines in US. Fig. 5 shows the current flight service between Seoul and major cities in North America. IIA and Korean airlines could consider to change current network to new system as shown on Fig. 6.

The new system is the one which impose hubbing concept. The old one which has direct connection to many cities with low frequency may be suitable for the leisure traveller and for

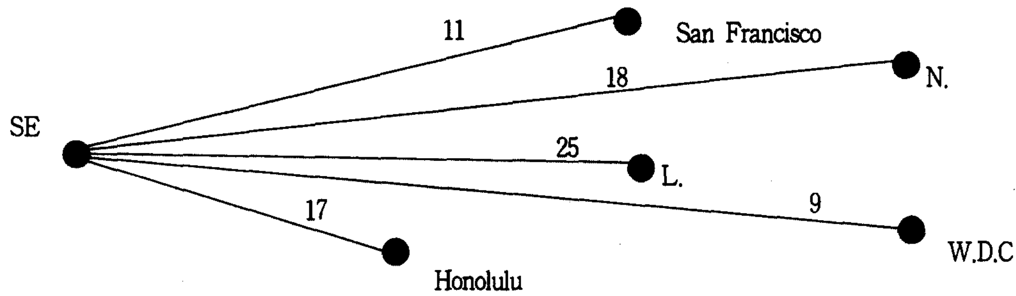

그림 5. 서울-북미 주요도시간 장거리 비행편 현황

Fig. 5. Long-haul flights between Seoul and major cities in North America.

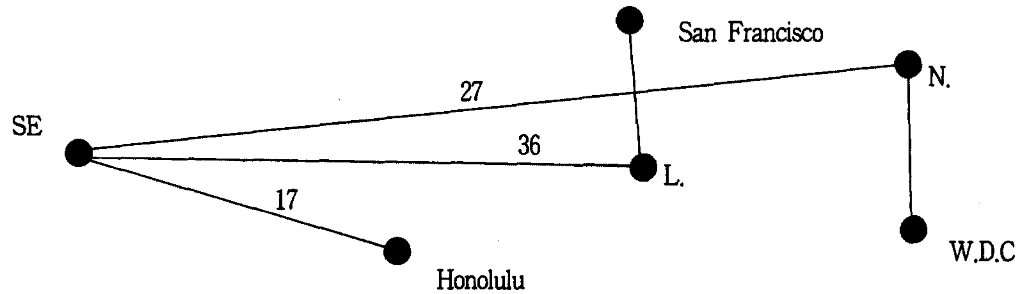

그림 6. 수정 장거리 비행편 구성의 예

Fig. 6 An example of revised long-haul flights.

cargo. However, such low frequency services do not offer the flexibility required by business community. The new system is to concentrate on high frequency services on the dense routes. For the other cities, connections are provided either by change of gauge equipment or allied partner airline's own local service. However, no one can calculate that the new system is better than old one for the airlines' or air passengers' welfare. It is necessary to estimate RATIOs defined in this study, and apply it for the decision making.

The discrete choice models should be calibrated for individual route separately. If the RATIOs estimated from discrete choice model of each route reveal that passengers of each route prefer evenly direct flight with scarce frequency of flight, which means high value of RATIO-1 and low value of RATIO-2, the old system is more appropriate than new one. However, if the RATIOs estimated from discrete choice model of each route are significantly different or they show that high frequency with longer travel time preferred, then it is justified to introduce new system.

To introduce new system, they estimate RATIOs from discrete models of each route, for example, route to Los Angeles, and route to San Francisco. They need to concentrate the flights on the route of the higher value of RATIO-1 which is selected as trunk route. The reason why they should utilize RATIO-1 is that RATIO-1 is the most seriously damaged one by intermediate stop. That is to say, the passengers who have higher VOT should be provided with direct service.

In addition, Korean airlines could utilize codesharing or other alliance techniques with American airlines to compose efficient flight network. Especially, the connection flight between foreign hub and spoke cities in USA should be operated by some of US airlines which allied with Korean airlines. Therefore, an airline which has scheduling power on foreign hub airport should be pointed as alliance partner. The transfer time between Trans-Pacific long-haul flights and short-haul flights connecting to some cities in US should be considered utilizing RATIO-1. This is because there is considerable competition with direct flights.

5-2-3 Application to Hourglass Hubbing Strategies

It is reasonable in the aspect of geographical position for IIA to take a role acting as an hourglass hub to connect the air passengers travelling between Southeast Asian Cities and Cities in the West Coast of USA. Actually, significant number of passengers travelling the cities of these regions are transferred at Kimpo

International Airport. This traffic could be hand- led as the sixth freedom air transport and low fare could be applied. Anyway, to set the air fare and flight frequency RATIOs should be utilized. To compete with direct flights between Southeast Asian Cities and West Coast Cities in USA, IIA should offer low fare and high frequency which can offset the negative effect caused by longer travel time. RATIO-1 would be effective is setting air fare and RATIO-3 would be effective in setting the level of flight frequency.

The results found through the discussions of section 5.2 could be summarized like table-3.

VI. Concluding Remark

With the trend towards liberalization in air transport industry, air passengers will have more options for their travel. In a more flexible planning environment, air transport system planners, airport operators and airline operators will need to know the consumer's preference. IIA which has an ambition to be a hub airport in Northeast Asia should study the consumer's behaviour and utilize the results for flight service network planning. Discrete choice models would be useful for analyzing air passengers' flight choice behaviour. Section 5 of this study introduced several ways to apply the information derived from air pas-

표 3. 인천국제공항의 효율적 비행편 서비스망 구성 전략 요약

Table 3. Summary of IIA's efficient services network strategies.

	Major factors of competition	Applied RATIOs
Hinterland Hubbing Strategies	· Plenty of short-haul flights · Minimum Connecting Time · Introducing efficient aircraft type	· RATIO-1 : to set air fare and aircraft type · RATIO-2 : to compromise the level of frequency and air fare
Long-haul flight Service network Strategies	· Integration of long-haul flights to concentrate on competitive routes	RATIO-1, RATIO-2: to select the routes which IIA concentrates on
Hourglass Hubbing Strategies	· Increasing 6th freedom transport · Low fare and high frequency service	· RATIO-1 : to set airfare · RATIO-3 : to set the level of service frequency

sengers for IIA's hubbing strategy.

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