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Intelligent airport gate assignment system

Lam Soi Hoi

1. Introduction

Aircraft-Gate Assignment Problem (AGAP) is a well-known NP-hard problem for optimization. In an airport, during daily airport operations the arrival and departure times of flights may vary compared to their original schedules. This may require reassignment of gates to capture the dynamics of flights and gate status to enhance the level of services provided to passengers. For busy airports with high number of arrivals/departures, the assignment decisions must be made within a short time to capture all the changes. To satisfy this requirement, a real-time intelligent airport gate assignment system is developed for this purpose for the management and assignment of gates at an airport for daily operations. The system is aimed at performing the gate assignment for every flight, taking into consideration of gate and flight dynamics, transfers, requirements of the airlines, aircraft types, airport operation rules, etc. A knowledge-based expert system forms the cores of the system and is connected to external databases for flight and passenger information. Real time changes on airport gates and flights can be made through a graphical user interface, with the capabilities of performing real-time updating of the results and information. Data obtained at Singapore's Changi Airport are used to examine the performance of the system. Results obtained from the scenario analysis have shown that the system provides an enhanced way to assign gates at an airport. In the development of the next stage, the intelligent airport gate assignment system will be integrated with an optimization model to provide an integrated solution for planning and assignment of gates at an airport.

Airports around the world are under constant pressure to expand their capacities to handle the increasing number of flights as the air traffic demand grows. The airspace will be more congested, and it will be increasingly difficult to site new airports or expand existing airports to cater for the growing demand for air travel. Therefore, efficient gate assignment is increasingly important because it would allow an airport to increase the capability of existing passenger terminal facilities and resources, as well as to cope dynamically and pro-actively with sudden changes which often take place in real-time operations.

Gate assignment is a complicated task involving the consideration of many factors. The assignment usually needs to be completed within a short timeframe, and under such constraint an overall optimized utilization of airport gates is difficult to achieve. In technical terms, the gate assignment problem is combinatorial in nature, NP-hard, and cannot be optimized easily within an acceptable timeframe. Past approaches have seen the use of simulation, mathematical programming and similar methods. Results have not been satisfactory due to the lack of responsiveness in coping with changes that could happen in real time, and the resultant abrupt modifications to the gate assignment plan.

Assigning aircraft to gates/stands is an important task in airport operations. Although these activities may take only a small part of the direct cost of airline operations compared to flight operations, sometimes they may have a major impact on maintaining flight schedules or even the flight networks. Normally, based on the flight schedules, the airport has an established assignment, which allocates aircraft to gates as well as specifies the apron time of aircraft at gates. Nevertheless, in daily operations, it is usually unavoidable for the airport scheduler to handle some unforeseen delays caused by various factors. Thus, the scheduler usually needs to reassign the aircraft to gates for a specific period in future based on the real-time dynamics and special requirements from aircraft/airlines. This has to be accomplished this in a short time period so as to capture the dynamics well. On the other hand, in order to enhance the productivity and service level, the real-time assignment is expected to be optimal in terms of minimizing passenger walking distance, baggage transferring distance and aircraft taxi distance, etc. In this sense the problem further becomes a very difficult combinatorial optimization problem. As a result, an efficient computer-based Decision Support System (DSS) would be very helpful for daily operations.

A knowledge-based approach is ideal for solving ill-defined problems through the use of heuristics reasoning. By using a knowledge-based system, the knowledge of experienced apron controllers in the airport, i.e. the heuristics, can be captured in the form of production rules. A recognize-action cycle that uses information held in the rules will search for the right actions through either backward or forward chaining of the rules, thus allowing the consideration of multiple objectives and constraints in the gate assignment problem. Such a system can also be used to obtain an optimised gate assignment due to unforeseen events such as bad weather, mechanical failure, late arrivals and so forth that would interrupt the original flight schedule.

Tosic (1992) gave a comprehensive review on modeling Aircraft-Gate Assignment Problem (AGAP), which is normally formulated as a Quadratic Assignment Problem and is a type of well-known difficult problem. Various researchers including Babic *et al* (1984), Bihr (1990), Mangoubi & Mathaisel (1985), Haghani & Chen (1998) have applied OR techniques to solve AGAP directly. These approaches have better assurance in terms of optimization, but need a lot of computation time in obtaining the solutions due to the complexity of the problem. In addition, these approaches also have the weakness in handling uncertain information and multiple performance criteria. Xu and Bailey (2001) reported solving a test-case problem using tabu search technique, which resulted in significantly short time in getting the solution. As a way to overcome the shortcomings of OR-based approaches, there were research conducted to apply knowledge-based approach to solve the problem, such as Brazile & Swigger (1988), Gosling (1990) and Srihari & Muthukrishnan (1991), etc. This type of approaches can capture well the operation features, handle uncertain information, meet needs of real-time decision support, etc., but have less assurance in terms of optimization.

This paper introduces a system, called InGates, for solving AGAP effectively combining the knowledge-based and OR techniques. A framework of such a system is designed based on the analysis of a real-time AGAP. Taking into account the complexity of the problem, the DSS consists of a knowledge-based module and an optimization module, as illustrated in Figure 1. The functions of the two core modules are:

Expert System: to determine the candidate gates for every aircraft. These gates are good to the aircraft considering the transferring passengers/baggage and transferring distance, operation rules as well as requirements from the Airlines, etc. This module aims to reduce the scale of the problem and is easier than to reason for a final optimal assignment. With this approach, available gates will be assigned to aircrafts through consideration of factors such as the compatibility of the gates and aircraft, passenger walking distances, baggage handling distances, conflicts between adjacent gates, as well as aircraft passenger capacity. These are rules implemented in the expert system.

The candidate gate list generated in the expert system module will be passed to the Mathematical Model and Algorithm to get an optimal assignment within the size limited by the Expert System module. This ensures that the solution will not be worse than any one concluded directly by the Expert System. The multi-objective function implemented in InGates includes a combination of minimum delays to arriving aircraft, maximum use of contact gates with aerobridge facilities, minimum passenger walking distances and baggage handling distances, and minimum changes to a pre-established assignment. In this paper, the emphasis will be placed on the expert system module.

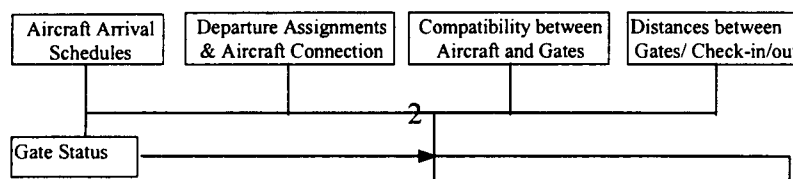


Fig.1. Flow chart of the system

2. Intelligent System Structure and Development

An object-oriented approach was used to model the important entities in the system. These include flights, aircrafts, and gates. Each entity contains attributes that are mapped into the attributes of relevant objects, which inherit characteristics and values from their parents, i.e., classes. The attributes are place-holders that contain values of specific characteristics associated with different objects. For example, for the gate object, one of the attributes is group number, which depicts particular operational characteristics of the gate and affects the types of aircraft compatible with the gate. The class-object structure provides an easy way to add/delete objects in the structure as well as sharing of common characteristics and values.

Based on the object-oriented structure, knowledge is represented using production rules, as shown below:

IF A (and B) THEN C

The IF-THEN rule structure of production rules effectively captures the essential cause-effect situations. These rules were developed based on the normal operation rules-of-thumb applied at the example airport used in this research. This information was obtained from interviews with apron managers and controllers, as well as documented domain knowledge obtained from company records and operational manuals.

Through the use of a graphical interface, the values and behaviors of objects can be modified at any time. Rules can be modified/inserted/deleted during run time. The users can monitor the gate assignment progress and override recommended gates by InGates, if desired. The followings are examples of how this can be done.

Stand Features

The system offers an interface, as shown in Figure 2, for users to set stand feature whenever they expect to. With this interface, users can set the operation time of the stand, limits for the

stand to hold various types of aircraft. Note that there are some aircraft types named as “NA”, those are pre-set places for users to add new aircraft types.

Gate Information

Gate Name: D51 Group Number: 2

Operation Time period: From 0 To 2400

This gate can NOT hold following types of aircraft:

F28 F50 F70 B737 A300

B757 B767 MD11 DC10 L1011

B747 Uknow Uknow Uknow Uknow

OK Cancel

Figure 2. The stand information window

Flight Features

In the flight information interface, as shown in Figure 3, users can set the flight features whenever they expect, such as arrival/departure time, arriving terminal, aircraft type, and expected stand type (remote or bridge), and current assignment for the flight (shown in the last line).

Flight Information

Flight: NW7

Arrival Time 37 Departure Time 143

Arriving at Terminal: Terminal 1

Type of Aircraft: B747

Type of Expected Gate -> Aerobridge Stand Remote Stand

Currently is assigned to Gate -- E73

OK Cancel

Figure 3. The flight information window

Rules

The rules are implemented to capture the knowledge retrieved from domain experts. Production rules with if-then structure were used. To cater for the easy customization of applications in different airports, the rules interface allows users to make changes to rules during run-time and avoids the needs of modifying the program. For instance, the rule *“Prohibit parking aircraft with sizes larger than A300 side by side among Gates C41, C43 and C45”* may be specific to an airport. Since the relationships among gates C41, C43 and C45 may be different from airport to airport, or, even there is no gate with such names, rules like this need to be revised or even deleted when applying the system for a new airport. Even for the same airport, sometimes there is a need to revise the rule when changes occur, such as changes of configuration, of requirements of airlines, ... etc. As shown in Figure 4, this can

be achieved by using a module that provides the users with an interactive interface to revise, enable/disable or add/delete rules on the run-time level.

Some rules are aimed at setting limits for stands/gates and flights, e.g. the rule “Do not park B737 and smaller aircraft at gates F75, F77 and F79”. This type of rules can be revised in a similar manner by setting stands/gates and flights’ information as presented previously. Rules can be turned on or off, or simply deleted from the knowledge base. The conditions of rules can be changed easily. As shown in Figure 4, the object attributes of aircraft and gate can be used in the left hand side (the IF portion) of the rules. The action of rules can be one of the followings: abidance, preference, avoidance and prohibition, to reflect the necessary requirements due to the real operations. In the example given in Figure 4, the rule indicates that if the aircraft type is B747, the gates C41, C43, C45, D51, D53 and D53 should be avoided in the allocation. While these represent specific gate names given at a particular airport, in this example, Changi Airport, similar rules can be adopted easily to the real situation at different airports.

Figure 4. Interface of Rules Editor

Other examples include “*Wherever possible assign aircraft arriving between 0100/0500 at Gate Groups 1 and 2*” as shown in Figure 5, and “*For aircraft with sizes larger than A300 and time interval of departure/arrival within 10 minutes, prohibit parking them side by side among Gates C41, C43 and C45*” as shown in Figure 6.

Real Time Aircraft Gate Assignment / Rules Editor CTS/NTU

RULE-2 Rule-2: Wherever applicable park aircraft arriving between 0100/0500

Enable
 Disable
 Delete

IF Dtime >< 0100,0500

AND

THEN Abidance Preference Avoidance Prohibition

Gate(s)
 GateGroup(s) 1 2
 Elight(s)
 Side by Side
 Same Gate

Assignment = TRUE FALSE

Fig.5. Edition results of Rule-2

Real Time Aircraft Gate Assignment / Rules Editor CTS/NTU

RULE-3 Rule-3: Prohibit parking aircraft with size >= A300 and Atimej-Dtimei <

Enable
 Disable
 Delete

IF Aircraft_Type >= A300

AND Atimej-Dtimei =< 10

THEN Abidance Preference Avoidance Prohibition

Gate(s) C41 C43 C45
 GateGroup(s)
 Elight(s)
 Side by Side
 Same Gate

Assignment = TRUE FALSE

Fig.6. Edition results of Rule-3

In some situation, the system variables are defined as V1, V2, ..., etc, and are included in the rules. These variables can be used effectively to help control the logical relationship between

rules. For example, as shown in Figure 7, users need only to key in the serial numbers of the system variables.

The screenshot shows a software window titled "Real Time Aircraft Gate Assignment / Rules Editor" with a menu bar containing "New", "Apply", and "Quit". The main area displays "RULE-8" with the rule text: "Rule-8: IF Gate_Name=C45 AND Aircraft_Type=B747 THEN V1=TR". Below the rule text are three radio buttons: "Enable" (selected), "Disable", and "Delete". The rule is structured as follows:

IF	Gate_Name	=	C45
AND	Aircraft_Type	=	B747
THEN	<input type="radio"/> Abidance <input type="radio"/> Preference <input type="radio"/> Avoidance <input type="radio"/> Prohibition		
	<input type="checkbox"/> Gate(s)	_____	
	<input type="checkbox"/> GateGroup(s)	_____	
	<input type="checkbox"/> Flight(s)	_____	
	<input type="checkbox"/> Side by Side		
	<input type="checkbox"/> Same Gate		
	<input type="radio"/> Assignment	V1	= <input checked="" type="checkbox"/> TRUE <input type="checkbox"/> FALSE

Figure 7. Assignment of system variable

3. Validation of System Performance

Thorough testing of model logic has been performed on test data as well as a data set collected in a typical day of operations at Singapore's Changi Airport, with two terminals and almost 100 gates. The data set consists of more than 200 flights in a 24 hour period. The testing performed on the data set has allowed the debugging and fine-tuning of the system. A comparison of the results from InGates and those obtained from manual assignment has shown that InGates is able to assign the gates in a manner similar to that of the human experts. The results illustrate that the objectives and the constraints stated above were satisfied. The computing time taken is just a few seconds on a mid-range PC.

The results of gate assignment are displayed in either an airport map, as shown in Figure 8, or a Gantt chart, as shown in Fig. 9. With the use of a Gantt chart, one can view the scheduled use and assignment of gates to different flights easily. The pictorial display of such assignment results is represented by an airport map, which provides the gate and flight information as well as the availability of gates and assignment results, at any time of the day, on the map through the clicking of appropriate buttons on the menu.

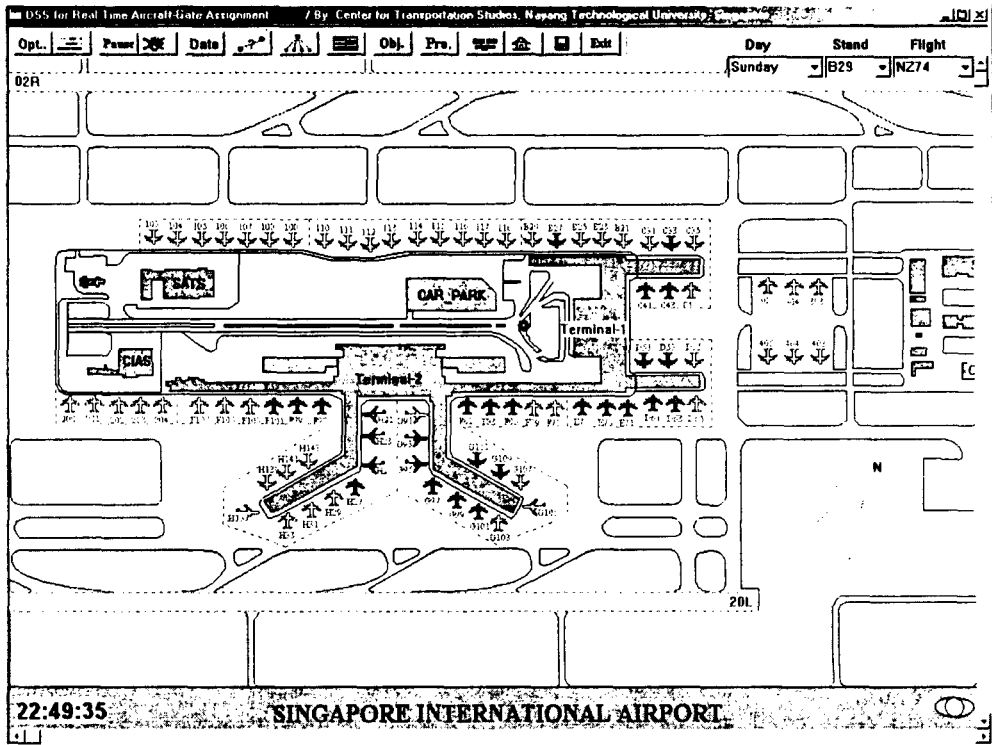


Figure 8. The airport base map showing the gates (aircrafts of flights allocated to gates are shown in red)

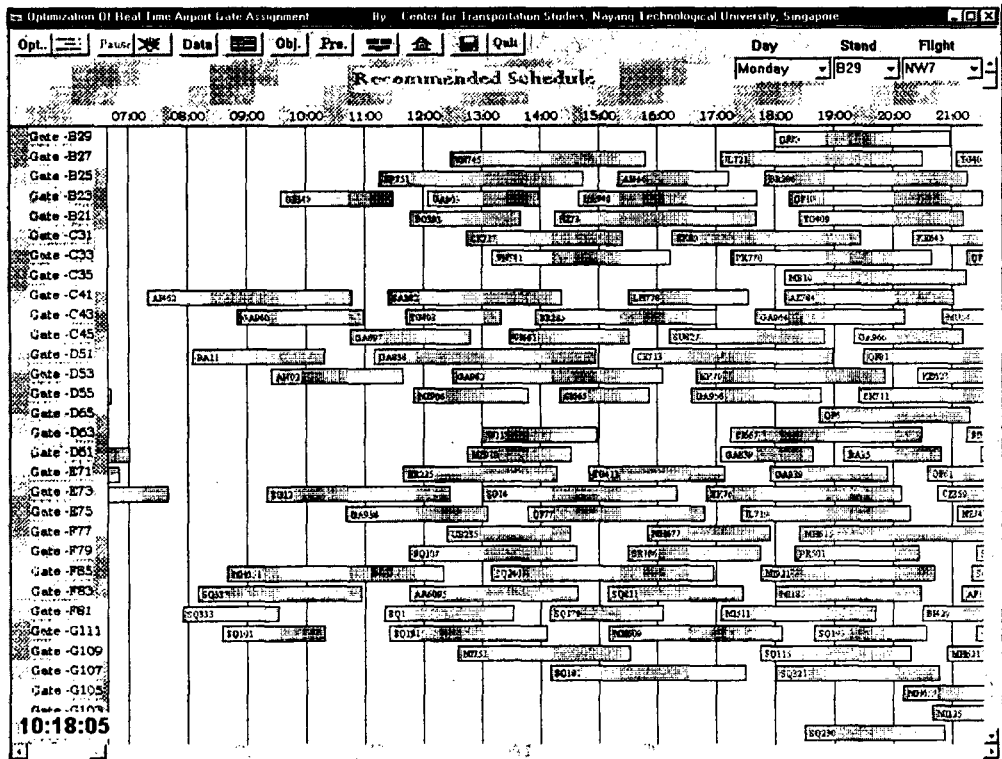


Figure 9. The Gantt chart showing the allocation results

4. Conclusions

In this paper, an intelligent system for airport gate assignment (InGates) was presented. The structure and special feature of the system were discussed, as well as applications to perform gate allocations to a set of data obtained from the Singapore's Changi Airport. The results show that InGates is able to allocate gates to aircrafts of flights in a reasonably large and busy airport within a short time. Together with systems and tools designed to allow for real-time adjustments to data and settings used by InGates, it has the capability to function as a real-time decision support system for airport gate assignment. The results obtained from the intelligent system module of InGates will be used as input to facilitate the search of an optimum solution for the airport gate assignment program as the next step of the development.

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A Study on the Effects of the Personality Compatibility to the job performance

ABSTRACT

This paper presents the results of studies on the effect of the personality compatibility to the job performance. As an empirical study, the relevant data is gathered by questionnaire survey whose samples are collected from aircraft cockpit crews of Korean Air and Asiana Airlines. For the personality type classification, this study utilizes the Enneagram Theory. This research claims that there are some personality types popular among Korean pilots, and that the desirable combination of personality in a cockpit crew team leads to better job performance, team satisfaction and minimization of human error. Consequently, this paper suggests that the personality compatibility should be considered when a cockpit crew team is organized. The results of this study may contribute to the improvement of the safety level concerned with flight operation.

Key Words: flight safety, Enneagram, personality compatibility, cockpit crew management

method of Presentation :

- (1) OHP (O)
- (2) Slide Projector ()
- (3) LCD Projector ()

A Study on the Effects of the Personality Compatibility to the job performance

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1. Introduction

The entire aviation industry is aware that flight crews are responsible, directly or indirectly, for about 80% of accidents worldwide. Therefore, the crew members' behavior related to cockpit operation is a matter of primary concern in the field of flight safety management. The concept of CRM(Cockpit Resource Management) has been developed and applied to flight crew training in order to minimize the probability of aircraft accident caused by human error. The CRM concept has emphasized leadership theory in most cases. However, it can be possible and desirable to substitute organization theory for leadership theory since the cockpit is composed of two or three people, which is so small that the effect of leadership is minimal. Moreover, with the situation in which unit members are well trained and the role is fairly shared, like in the aircraft cockpit, the leadership theory might have small room to be applied.

The point is the cooperation or co-work. The performance of co-work will be impacted somewhat by the personality of each member. The personality of any individual is hard to be changed and the easier way is to find harmonious combination of personality type. This research aims to study the harmony and compatibility of cockpit crews' personality type, in order to improve the job-performance and minimize human error in cockpit operation. According to the technical improvement, two-member-cockpit is widely introduced for many types of aircraft instead of three-member-cockpit. The conflict caused by the difference of personality and opinion is more usual between two people than among three people. Therefore, it is more required to get harmonious personality combination in modern cockpit environment.

The specific objectives of this research are to find out the effects of the personality compatibility; to test if personality harmony between cockpit crew members influences the level of human error, job performance and job satisfaction. It is required at first to define personalities(or characteristics) of individual and to categorize them for the research which has such objectives as stated above. This research as an empirical study will apply Enneagram Theory in defining and categorizing the personality type. Enneagram Theory which is adopted as a basic theory of this study will be introduced next section which is dedicated for research methodology. The area on which this study is based is Korea and the empirical data is gathered through a questionnaire survey. The samples for questionnaire survey are drawn from the Korean pilots who are working for Korean national flag carriers, such as Korean Air and Asiana Airlines.

2. Research Method

The leadership theory which is mainly adopted for current CRM program in the industry is not appropriate to be applied to the team work in aircraft cockpit as stated in the previous section. As a substitute for leadership theory, organizational behavior might be considered as a proper theory to apply to the job environment in aircraft cockpit. With the situation where two people should closely co-work like in the cockpit of the aircraft, the personality harmony might play an important role for the job performance. It is frequently noticed that the conflict caused by discordance of the personality causes problems and leads to the aircraft accidents. Even though the duty role of pilot and co-pilot is well described, they should complement each other and sometimes they should refer to each other for the decision making in unexpected situation. This may play very important role to prevent aircraft accident.

There are several theories related to personality in organizational behavior. However, this study mainly utilize Enneagram Theory, because it concentrates on the interaction of personality types and handles dynamic aspects of personalities more importantly, instead of static characteristics of personality, than other organizational theories. The authors consider those features of Enneagram's approaches appropriate for the study of cockpit crews' job performance. Following subsections briefly introduce the characteristics of Enneagram Theory.

2.1 General Characteristics of Enneagram Theory

This research as an empirical study does not discuss detailed matter about theoretical aspect of Enneagram. Only general characteristics of Enneagram will be introduced for the readers to understand the procedure of empirical analysis of this study and evaluate the results of the research.

Enneagram is a system of spiritual psychology, which is helpful to personal understanding. It has ancient origin, going back perhaps even 4,500 years, and many people in the East and West have contributed to the development of Enneagram theory. Enneagram argues that human behavior is motivated by addictions, so called, "Capital sin" from Christian antiquity. They categorize human personalities by nine types, which comes from the list of the seven capital sins - pride, greed, lust, anger, gluttony, envy and sloth - plus two more, fear and deceit, and these drives within the human personality. Each of these nine fixations of attention is so addictive that every person can have only one prime addiction at the root of his or her personality [5]. The nine types of personalities defined by Enneagram are summarized and explained as follow.

Summary of Characteristics of each personality type in Enneagram

Personality Type	Characteristics
1. The Achiever (prime addiction: Anger)	The Achiever focus their energy to improve the situation in which they find themselves. They strive to feel perfect.
2. The Helper (prime addiction: Pride)	The Helpers focus outward on the feelings and needs of others. They try to handle everyone's problems and difficulties.
3. The Succeeder (prime addiction: Deceit)	Their basic life issue is productivity. They repress their personal desire for a harmonious relationship and strive to feel successful. They fear failure, and the greatest failure for them is to lose the respect and approval of others.
4. The Individualist (prime addiction: Envy)	Individualists are emotional people. They strive to feel special and force their inherent strength of character into being impressed as a quiet but stubborn independence.
5. The Observer (prime addiction: Greed)	The Observers are factualist. Their goal is objectivity and they watch the world in a cool manner. They are logical and strive to feel full of knowledge.
6. The Guardian (prime addiction: Fear)	They are factual and social. Since they lack self-confidence, they depend on the stability and values of the relevant group. They strive to feel safe and secure by following the rules.
7. The Dreamer (prime addiction: Gluttony for anything that makes them feel good)	They are highly intuitive and often ahead of their time in the realm of ideas. They focus their thinking and calculating on planning ways to make their lives easier.
8. The Confronter (prime addiction: Lust)	The Confronters throw their stamina on the world and are energized in their self-appointed role as the fighter against injustice. They strive to feel strong and their basic life issue is control.
9. The Preservationist (prime addiction: Sloth or Laziness)	Preservationists repress their energy and power in order to maintain harmonious relationship between themselves and world. They try to avoid conflict and to feel peaceful.

2.2 Job Performance, job satisfaction and personality of flight crews in the cockpit

It is necessary to attend to personality and situational influences in order to understand of organizational behavior [6]. This research emphasizes the role of personality more than situational influences in organizational behavior as stated in previous section. Speaking in detail, it is tested and analyzed if job performance in aircraft cockpit is somehow effected by personality combination of flight crew members. That is to say, this research will test the assumption that job performance is somewhat influenced by job satisfaction, which is partly dependent on the personality type and personality harmony in organization.

2.2.1 Job performance of flight crews in the cockpit

The work in the aircraft cockpit has traditionally been performed by three member organization (team); a captain, a co-pilot and a flight engineer. The captain is responsible for all the matters related to flight operation in the cockpit, and has the power to make a final decision. The co-pilot has a responsibility for the air traffic control and for assisting the captain. The flight engineer is responsible for the aircraft engine and other aircraft technical aspect. However, there is a strong trend that flight engineer disappears in newly developed aircraft cockpit, since modern aircraft technology get rid of the necessity of flight engineer. So, it is desirable to consider two member's co-operation for the work in the aircraft cockpit. Two flight crew's function as group and group interaction, play a role in determining behavior and performance.

The job performance of flight crew team is evaluated by three factors; level of quality in performing the duty, level of human error, and quality of decision making. The level of quality for each crew member to perform the duty, is determined by skill, knowledge, experiences and attitude. The human error is the mistake occurred during the flight operation, which results in the deviation from the planned flight, or efficient work procedure, or the aircraft incident or accident. The decision making of the flight crews can be categorized by two types - *programmed decision making* and *non-programmed decision making*. The programmed decision making that is including normal procedure and emergency procedure, has prescribed contents, method and procedure. Non-programmed decision making is for contingent situation. It is necessary to have profound experience and knowledge to make appropriate decision in non-programmed decision making situation. In addition, the flight crew members must have the ability to perform best alternatives selected in non-programmed decision making situation.

2.2.2 Job satisfaction and personality of flight crew members in the cockpit

George(1992) insisted that job satisfaction or job attitude is somewhat determined by personality. She supported her insistence by several research results that show consistency in job satisfaction. This research also assumes that job satisfaction is influenced by personality[7]. Kim(1997) argued that there are several personality types which are appropriate to airline pilots. However, he insisted that personalities in the aircraft cockpit member should be well harmonized for the desirable work performance of flight operation of the crew members[8]. Next sections will discuss the issues concerned with relationship between job performance and job satisfaction, and personality compatibility of the cockpit crew members through analyzing empirical data.

3. Empirical Study

This section finds out the effects of the personality copatibility to the job performance and team satisfaction. The empirical data will be gathered through questionnaire survey. The samples for the questionnaire survey are selected among Korean pilots employed in Korean national carriers; Korean Air and Asiana Airlines. Followings are the hypothesis to be tested for this study;

- (i) Team satisfaction of flight crew members is influenced by the compatibility of their personalities;
- (ii) The perceived job performance of cockpit crew members is influenced by team satisfaction;
- (iii) The perceived human error of cockpit crew members is influenced by team satisfaction;

3.1 Empirical Data Collection Procedure

3.1.1 Required Information planned to obtain through the survey

At first, it is necessary to get the information to decide the personality type of the sample, according to Enneagram Theory. Because this study is mainly concerned with the personality compatibility, the information required to find out the preferred type and the disliked type for each personality type is also necessary. In addition, it is necessary to collect the information required to estimate the level of job performance and team satisfaction perceived by each sample(or each personality type) when he/she has worked with certain personality type of companion.

3.1.2 Questionnaire composition and response measurement scale

The survey is performed by two stages. At the first stage, the questions to decide the personality type of each sample are presented and the questions to get the information to find out the preferred type and the disliked type for each personality type are also presented. At the second stage, the questions are presented to gather the information to decide the level of job performance and team satisfaction perceived by each sample (or each personality type) when he/she has worked with certain personality type of companion. The survey questionnaire for the first stage of survey is composed of 100 questions that have been developed by Enneagram Theory. The authors translated English version of the questions to Korean since all the samples are Korean. The second stage of questionnaire is to ask the perceived level of job performance and job satisfaction when they work with a person of certain personality type as a flight crew team in the cockpit of the aircraft. All the questions are also presented in Korean.

The response measurement scale for the first stage questionnaire is as follows. The 100 questions presented to a sample is the description of the specific characteristics of each personality type defined by Enneagram Theory and at the end of each question, there are three boxes in which the letter 'M', 'L', 'H' is written. 'M' means the described characteristic of the personality is for himself/herself. 'L' means the described characteristic of personality is the one that he/she likes. 'H' means the described characteristic of personality is the one that he/she hates. The sample is requested to check the one of three boxes for each question. The response measurement scale for the second questionnaire is rating with five level semantic scales. The sample is asked to rate the strength of his/her team satisfaction, or job performance or level of human error, perceived according as he/she works with a person of each personality type defined by Enneagram as a flight crew team.

3.1.3 Field implementation of the Survey

The pilot survey was conducted with the student pilot of department of Flight Operation in Hankuk Aviation University in Korea. The objective of the pilot survey was to test the suitability of the questionnaire and through the pilot survey, the final questionnaires were defined. The first stage questionnaire for the main survey were distributed to all Korean pilots working for Korean Air and Asiana Airlines. Total 500 questionnaires were distributed and 249 questionnaires were collected, and collection rate was 49.8%. The second stage questionnaires were distributed to the 249 samples who answered the first one, and 117 questionnaires were collected with 47% of collection rate. The composition of the sample data that were utilized as input for the analysis is shown at

table-1.

<table-1> Sample Composition of Main Survey

Qualification	Korean Air	Asiana Airlines	Total
Captain	23	24	47
Co-pilot	32	22	54
Flight engineer	16		16
Total	71	46	117

3.2 Analysis

3.2.1 Operational Definition

Team satisfaction ; it means a relative satisfaction level that is perceived by each flight crew member, captain, co-pilot and flight engineer, when he/she performs flight operation in the aircraft cockpit. Therefore, it does not mean generally perceived preference level. This research assumes that it is mainly determined by personality resonance between flight crew team members. This is measured by the level of satisfaction perceived by each flight crew member during his/her work in an aircraft cockpit.

Job performance; this is related to the results of job performed by flight crew team. This is measured by the level of job performing skill, human error and the quality of decision making, which are perceived by the each sample.

3.2.2 Method to analyze the data collected

The personality type of each sample is determined by analyzing the answers for each questions of first stage questionnaire. In addition, we can summarize the 'preferred personality' and 'hated personality' to each personality type since first stage questionnaire collected the information concerned with it (refer to subsection 3.1.2).

We utilized the crosstab function of software SPSS and ANOVA(analysis of variance) to analyze the collected data.

3.2.3 Results of analysis

Charicteristics of Aircraft Cockpit Crew Personality

The frequency distributions by personality type of the samples are presented in table-2. The most popular personality type among the samples who answered to the first stage survey is the Achiever, followed by the Preservationist, the Guardian, the Helper, and the Individualist.

The distribution of preferred personality types and hated personality types stated by each one are summarized in table-3. According to table-3, the preferred type stated by each person of personality type can be explained as follows. The Achiever likes the Dreamer most, the Helper likes the Succeeder and the Dreamer most, the Succeeder likes the Dreamer most, the Individualist likes the Helper most, the Observer likes the Helper most, the Guardian likes the Dreamer most, the Dreamer likes the Helper most, the Confronter likes the Dreamer most, the Preservationist likes the Dreamer most. It can also be said that Dreamer and Helper are most frequently preferred as a team partner by the sample pilots.

<table-2> Frequency distributions of personality type

Personality type	Frequency(%), 1 st stage survey	Frequency(%), 2 nd stage survey
Achiever	59 (24)	27 (23)
Helper	31 (13)	15 (13)
Succeeder	13 (5)	13 (11)
Individualist	25 (10)	10 (9)
Observer	13 (5)	4 (3)
Guardian	31 (13)	21 (18)
Dreamer	21 (8)	8 (7)
Confronter	10 (4)	1 (1)
Preservationist	46 (18)	18 (15)
Total	249 (100)	117 (100)

The distribution of personality type hated in composing flight crew team for each person of personality type is also shown at table-3. Generally, the Korean airline pilots stated that they hate to work together in the cockpit with *Confronter*, *Guardian*, and *Succeeder*.

<table-3> Distribution of preferred personality and hated type

Personality type	Frequency	Distribution of preferred type (hated type)								
		Ach.	Hel.	Suc.	Ind.	Obs.	Gua.	Dre.	Con.	Pre.
Achiever	59	0 (0)	14 (1)	9 (8)	1 (4)	5 (3)	1 (19)	23 (7)	1 (9)	5 (8)
Helper	31	4 (0)	0 (0)	7 (4)	3 (5)	5 (4)	2 (7)	7 (2)	0 (7)	3 (2)

Succeeder	13	0 (0)	2 (1)	0 (0)	0 (2)	3 (2)	0 (3)	6 (0)	2 (1)	0 (4)
Individualist	25	2 (0)	8 (1)	3 (4)	0 (0)	1 (2)	3 (5)	7 (0)	0 (10)	1 (3)
Observer	13	0 (2)	5 (1)	3 (2)	0 (0)	0 (0)	1 (3)	1 (1)	2 (2)	1 (2)
Guardian	31	3 (1)	3 (0)	7 (6)	2 (6)	2 (4)	0 (0)	9 (2)	3 (11)	2 (1)
Dreamer	21	1 (0)	10 (0)	2 (1)	0 (3)	5 (4)	0 (7)	0 (0)	2 (3)	1 (3)
Confronter	10	2 (0)	2 (1)	2 (1)	0 (1)	1 (3)	0 (2)	3 (0)	0 (0)	0 (2)
Preservationist	46	7 (0)	7 (0)	8 (7)	2 (3)	8 (5)	1 (12)	13 (2)	0 (17)	0 (0)
Total	249	19 (3)	51 (5)	41 (33)	8 (24)	30 (27)	8 (58)	69 (14)	10 (60)	13 (25)

According to table-3, the hated type stated by each person of personality type can be explained as follows. The Achiever hates the Guardian most, the Helper hates the Confronter and the Guardian most, the Succeeder hates the Preservationist most, the Individualist hates the Confronter most, the Observer hates the Guardian most, the Guardian hates the Confronter most, the Dreamer hates the Guardian most, the Confronter hates the Observer most, the Preservationist hates the Confronter most.

Effects to the Level of team satisfaction perceived by each type for making team with each personality type

When a sample of a personality type is composed as flight crew team with each personality type, the stated level of team satisfaction perceived by the sample is analyzed and the results are shown at table-4. Since the sample size of the Confronter and the Observer is too small(refer to table-2), the appropriate data are omitted. It is noticeable that the stated team satisfaction reveals higher when the crew members are composed with identical personality types than composed with preferred one.

<table-4> Level of team satisfaction with personality type combination of flight crew

Interviewee	Ach.	Hel	Suc.	Ind.	Obs	Gua.	Dre.	Con.	Pre.
Partner
Achiever	4.26	2.60	3.32	2.90		2.71	2.50		2.44
Helper	3.78	4.07	4.00	3.90		3.57	4.13		3.72
Succeeder	2.63	2.47	3.46	2.70		2.38	2.50		2.50
Individualist	2.63	2.53	2.77	3.50		2.62	3.00		2.78
Observer	2.41	2.93	2.46	3.00		2.91	2.75		2.83
Guardian	3.26	3.00	3.15	3.30		4.10	3.50		3.44
Dreamer	2.85	3.07	3.15	3.30		3.43	4.13		3.44

Confronter	2.22	2.07	1.62	2.20		2.14	1.88		1.89
Preservationist	3.15	3.27	3.23	3.20		3.43	3.38		3.67

* The values in each cell are the mean value of the team satisfaction which is rated by five level semantic scale and converted to number ;
 very unsatisfied=1, unsatisfied=2, so,so=3, satisfied=4, very satisfied=5

** Since the sample size of the Confronter and the Observer is too small(refer to table-2), the appropriate data are omitted

Effects to the Level of job performance perceived by each type for making team with each personality type

When a sample of a certain personality type is composed as flight crew team with each personality type, the stated level of job performance perceived by the sample is analyzed and the results are shown at table-5. It is noticeable the stated job performance reveals higher when the crew members are composed with identical personality types than composed with preferred one. It is also revealed that the Helper is considered as the best partner to perform the job together successfully in the aircraft cockpit. The statistical test was conducted to see if there is a statistically significant difference in job performance perceived according to the personality type of the co-worker in the cockpit. The results are that the samples perceive statistically significant difference in the level of job performance with 5% of significance level, if a sample teamed with the Achiever, the Individualist, and the Guardian.

Table-6 is the results of correlation analysis between the level of team satisfaction and job performance perceived by each personality type. As it is shown in the table there is a positive correlation between those two values, and consequently we can argue that the samples perceive high level of job performance when they feel high level of team satisfaction.

<table-5> Level of job performance with personality type combination of flight crew

Interviewee	Ach.	Hel.	Suc.	Ind.	Obs	Gua.	Dre.	Con.	Pre.
Partner									
Achiever	4.11	3.33	3.31	3.20		3.05	3.38		3.11
Helper	3.36	4.00	4.08	4.00		3.71	4.13		3.61
Succeeder	2.93	2.93	3.77	3.00		2.57	3.00		3.06

Individualist	2.44	2.73	2.69	3.20		2.57	3.13		3.00
Observer	3.04	2.80	2.69	2.90		2.95	3.13		2.89
Guardian	3.41	3.07	3.31	3.30		4.14	3.25		3.44
Dreamer	2.89	3.53	3.46	3.20		3.24	4.13		3.28
Confronter	2.15	2.40	1.85	2.50		2.33	2.25		2.17
Preservationist	3.22	3.33	3.31	3.10		3.38	3.63		3.67

* The values in each cell are the mean value of the job performance which is rated by five level semantic scale and converted to number ;
 very unsatisfied=1, unsatisfied=2, so,so=3, satisfied=4, very satisfied=5

** Since the sample size of the Confronter and the Observer is too small(refer to table-2), the appropriate data are omitted

<table-6> Correlation between the level of team satisfaction and job performance

	Ach.	Hel.	Suc.	Ind.	Obs.	Gua.	Dre.	Con.	Pre.
Pearson correlation coefficient	0.70	0.39	0.64	0.49	0.67	0.65	0.55	0.43	0.63
Prob. > R	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

Effects to the Level of human error perceived by each type for making team with each personality type

When a sample of a certain personality type is composed as flight crew team with each personality type, the stated level of human error perceived by the sample is analyzed and the results are shown at table-7. It is revealed that the stated level of human error is lower when the crew is composed with identical personality types than composed with the other type. With this results, we may say that the higher team satisfaction lead to lower human error because the team composed with identical personality type showed higher team satisfaction. Table-8 is the results of correlation analysis between the level of team satisfaction and human error perceived by each personality type. As it is shown in the table, there is a negative correlation between those two values, and consequently we can argue that the samples perceive low level of human error when they feel high level of team satisfaction.

<table-7> Level of human error with personality type combination of flight crew

Interviewee	Ach.	Hel.	Suc.	Ind.	Obs.	Gua.	Dre.	Con.	Pre.
Partner									
Achiever	1.74	2.33	2.46	2.40		2.86	3.13		3.06
Helper	2.30	2.40	2.23	2.70		2.91	2.75		2.78
Succeeder	2.85	2.73	2.31	2.70		3.10	3.13		3.00
Individualist	3.41	3.27	3.08	2.90		3.38	3.00		2.72
Observer	2.78	2.93	2.85	2.90		3.05	3.38		2.78
Guardian	2.19	2.73	2.69	2.80		2.81	3.00		2.67
Dreamer	3.44	3.13	3.23	2.80		2.81	3.13		3.06
Confronter	3.82	3.67	3.54	3.10		3.62	3.00		3.33
Preservationist	2.63	2.93	3.01	3.30		2.62	2.88		2.67

* The values in each cell are the mean value of the stated human error which is rated by five level semantic scale and converted to number ;

very low=1, low=2, so,so=3, high=4, very high=5

** Since the sample size of the Confronter and the Observer is too small(refer to table-2), the appropriate data are omitted

<table-8> Correlation between the level of team satisfaction and human error

	Ach.	Hel.	Suc.	Ind.	Obs.	Gua.	Dre.	Con.	Pre.
Pearson correlation coefficient	-0.44	-0.21	-0.40	-0.27	-0.25	-0.04	-0.33	-0.04	-0.38
Prob. > R	0.0001	0.0204	0.0001	0.0037	0.0056	0.6928	0.0001	0.0003	0.0001

4. Conclusions

As an empirical research, this study has focused on the practical problems as follows; Are there significant effects to the team satisfaction by personality compatibility?; Are there any effects to the job performance by personality compatibility?; Is there any correlation between team satisfaction and job performance? For the practical results of the research, this study gathered data through the survey toward Korean pilots who are employed by Korean national air carriers, Korean Air and Asiana Airlines.

It was discovered that the level of perceived team satisfaction is significantly different according to personality type and combination of personality types within cockpit crew team. Personality compatibility have the significant effects to the team satisfaction. It is also revealed that there is a significant effects to the the level of perceived job

performance, human error and quality of decision making according to personality type and personality type combination in the cockpit crew team. In addition, it is also evident that there are some correlation between team satisfaction and job results. Conclusively, we claim that the personality preferred and personality compatibility should be considered in management of cockpit crew organization and the consideration of the personality type may improve the efficiency of the work in the aircraft cockpit and contribute to the improvement of the flight safety.

It was discovered that perceived job performance, human error and quality of decision making according to personality type and personality type combination in the cockpit crew team. In addition, it is also evident that there are some correlation between team satisfaction and job results. Conclusively, we claim that the personality preferred and personality compatibility should be considered in management of cockpit crew organization and the consideration of the personality type may improve the efficiency of the work in the aircraft cockpit and contribute to the improvement of the flight safety.

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ITS/CVO Application for Air Cargo Transportation in Korea

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Abstract: Recently, many counties issued CVO system, which are appropriate for their inherent transportation environment. It set out the architecture design not just transport system but also standard with ISO guide. The key factor is how much satisfied with international standard level. The standards development identifies potential standards areas, reviews existing standards efforts, describes a general process to assist standards development, and suggests beneficial actions to support and encourage CVO deployment. This study review CVO architecture method and looks at the design policy to meet ISO standard and also is intended for use as a guide to using the architecture standard in Korea. It is directed toward standards development organisations, product developers, service providers, and public agencies at all levels.

Key Words: CVO, ITS, Architecture, Standard, Logistics

1. Introduction

1.1 Background

As our roads become more congested, the costs to commercial carriers and government charge to meet the demands of the consumer have risen. The logistics cost are some 74.2 Trillion Won (\$ 62 billion) annually and represent approximately 16.5 percent of nation's gross domestic product in Korea. At the same time, commercial transportation industry face increasing pressure to ensure that they remain competitive and technologically efficient. The need to find solution that improve carrier safety and productivity, reduce congestion cost for carrier, and minimize carrier delays has become significant. Costs to the transport industry are continuing to rise while profit margins shrink. To solve the problem, government suggested some of strategies. Recently, the MOCT announced its master plan to invest a total of USD 3.5 billion in establishing an ITS system by the year 2010. The Ministry also announced its plan to invite Korean private firms to invest in this project. This is because, ultimately, the industries will benefit from the installation of ITS systems, which will contribute to lowering their transportation and distribution costs. The MOCT plans to implement and test the first phase of the ITS plan in the Seoul metro area by the year 2000. An electronic service of providing information on routes will start and be extended to other major Korean cities by

2005 in the second phase. Finally, they introduce "The national logistics plan 2001-2020" in early 2001. This plan includes establishing the national logistics system for transportation industries. Specially, the 21-century logistics vision shows "Cyber Logistics" which is focus on networking in this plan. The cyber logistics mainly base on CVO(Commercial Vehicle Operations) system. However CVO is not establishing as a national system, because of different interest group. For making the CVO system, it would be meet standardization with international standard level.

Many institute in Korea have introduced national logistics system architecture in transport industry. But these systems didn't developed as a national system. Similar CVO system is operating in private sector. In a studying sponsored by MOCT(Ministry of Construction and Transportation), small group of professionals begun to discuss ITS(Intelligent Transportation Systems) architecture in 1994. Studying continued in 1997 at KRIHS(Korea Research Institute for Human) for establishing the national ITS architecture. Following the 1997 study, KRHS was set up the national ITS architecture including CVO in 1999 with attendees from the academia, private sector, and government. Our studying was CVO architecture in 1999 study. But, Korea has problem that there are many similar CVO system without avoiding investing over again, before introducing ITS/CVO.

1.2 Purposes and Scope

The National Architecture is an important step in a larger process that is intended to promote national compatibility and interoperability across CVO deployments. To support this crucial transition between architecture and standards, this standards study reviews:

- Reviews standards efforts and their relationship with the architecture framework in existing logistics system.
- Describes the general process by which the National Architecture can inform and assist standards development.
- Establish CVO system and design the standard areas associated with the National ITS Architecture.
- Suggests actions to encourage timely and beneficial standardisation to support CVO deployment in Korea.

In the following chapter, we discuss the concept of Korea CVO system and earlier practical work in the subject. Chapter 2 describes the review of CVO architectures and standard technology in leading counties. The CVO architecture in Korea is described in chapter 3, followed by our result in chapter 4. We close by discussing a vision for CVO and suggest some of the barriers to implementation of the important new technology.

2. THE REVIEW OF CVO ARCHITECTURE

The CVO refers to the collection of information systems and communication networks that support logistics system. These include information system owned and operated by government, motor carriers, and other group related transportation. The CVO architecture is trying to create a new information system, but rather to create a way for existing and newly designed system to exchange information through the use of standards and available communication infrastructure. The CVO architecture is the part of ITS architecture. It includes standards for communications technologies such as EDI(Electronic Data Interchange) and DSRC(Dedicated Short Range Communication). These standard are being developed to promote interoperability and efficiency through the standard development organization.

There are many standards development organisations - Independent organisations that develop standards in the world. Each organisation is typically responsible to some specific community. Because ITS spans such a large number of agencies, producers, and technologies, there are a number of standards development organisations that of interest. The following section briefly review of CVO architecture considering standardization in leading countries.

2.1 CVO architecture in leading counties

In USA, the DOT plays a major role. DOT started a 33-month program to develop the System Architecture. USA has developed CVO system as a CVISN in some of group as ANSI (American National Standards Institute), SAE (Society of Automotive Engineers), and AASHTO (American Association of State Highway and Transportation Officials), etc. The TEA-21(Transportation Equity Act for the 21st Century), which controls the budget for domestic surface transportation, assigns subsidies for deployment project of ITS on condition of preparing system based on the National System Architecture.

Japan was decided that the five government bodies would compile the System Architecture for ITS in co-operation with VERTIS. The System Architecture for ITS will be revised occasionally in case the plan such as "comprehensive plan for ITS in Japan" is revised and conditions of ITS promotion changes, such as rapid progress in element technologies related to ITS. Japan is actively participated on ISO standard working group in ETC, AHS, TICS.

In Europe, the European Commission (EC) is in charge. The EC started T-TAP (Transport - Telematic Application Programme). One of activities is CONVERGE, method to examine System Architecture. They reformed the method examine in STAIN, and added a method of System Architecture.

In the case of Korea, MOCT has developed ITS Architecture in charge. It is a starting level in now. Also, The ITS was composed of 4 sections - ATMS, ATIS, APTS, and CVO in 1997. The System Architecture for Korean ITS adapted the USA method, which makes it easy to expand part the System Architecture.

2.1 CVO Standard Technology Area

The standard for CVO can be derived from the national architecture definition in several different ways. This section reviews the CVO standard area from the following 3 viewpoints.

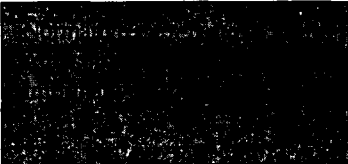

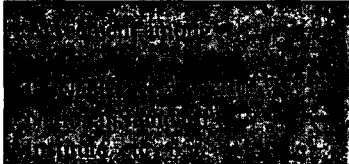
Level of prescriptiveness	Function	Development process
Standard Recommended practice Information report	Design standard Interface standard Framework standard Performance standard Testing method Terminology	De facto Regulatory Consensus
		

Figure 1. Viewpoint of standard area

The CVO is a reference framework that spans all of these standards activities and provides a means of detecting gaps, overlaps, and inconsistencies between the standards. Standards Requirements, based on the Logical and Physical Architecture, provide a requirements starting point for the standards activities and a tool for measuring their output. There are some standard areas by function.

- Dedicate Short Range Communications (DSRC)
- Digital Map Data Exchange and Location Referencing
- Information Service Provider Wireless Interfaces
- Inter-Center Data Exchange for Commercial Vehicle Operations
- Traffic Management Subsystems to Other Centers
- Emergency Management to Other Centers
- Information Service Provider to Other Centers
- Archived Data Management Interfaces
- Human Interfaces

Also, some of standard areas are shown on ISO technical activities. The working group 4, 5, 7, 15 in ISO/TC204 are in charge of standard area related CVO technologies similar with CEN/TC278.

3. CVO ARCHITECTURE IN KOREA

In constructing the System Architecture for CVO, it is necessary to clarify the overall system structure to build the system, while keeping their county and the principal in mind. When adapting the CVO Architecture, it is also necessary to following comparison:

Table 1. Comparison ITS Architecture

	U.S.A	JAPAN	Europe	ISO	KOREA
Involve year	1994	1998	1998	1997	1997
Character of ITS Architecture (Archi')	Top-down Strong recommend type Business unit focus	Integration current business type Service focus Object oriented approach	Pan-Europe master plan. Integration current business type	Standard Archi' Button-up Object oriented approach	Open/Recommend type Service /business unit focus
Structure	Logical Archi' Physical Archi'	Logical Archi' Physical Archi'	Function/Information Archi' Logical Archi' Physical Archi'	Reference Archi' Logical Archi' Physical Archi'	Logical Archi' Physical Archi'
User Service	6 Area 30 user service	9 Area 20 user service 56 specific ser' 172 sub service	6 Area 32 user service	8 Area 32 user service	7 Area 16 user service 62 specific ser'
Service unit	56 Market package	24 sub-system type	Planning	Developing Methodology	60 sub-system

3.1 Set up the Guideline on Applying the System Architecture

It is necessary to analysis a standard level of National Architecture among the various interested parties in order to achieve the future image of ITS. For establishing the Guideline of

system architecture, we choose following specific element of CVO architecture and set up the Guideline.

- Character of CVO User Services
- Structures of CVO User Services
- Constructing the Logical Architecture
- Constructing the physical Architecture
- Standardisation Area

3.2 Adapting the CVO standardization architectures in Korea

CVO Architecture as a part of ITS architecture follows basic frame of the National ITS configuration. Korea had designed first national ITS architecture except CVO part. This Study takes the project that performed second national ITS architecture with KRIHS to build Korean type CVO considering the ISO Standard Architecture. In order to adapt standardization architecture, it was necessary to follow these steps;

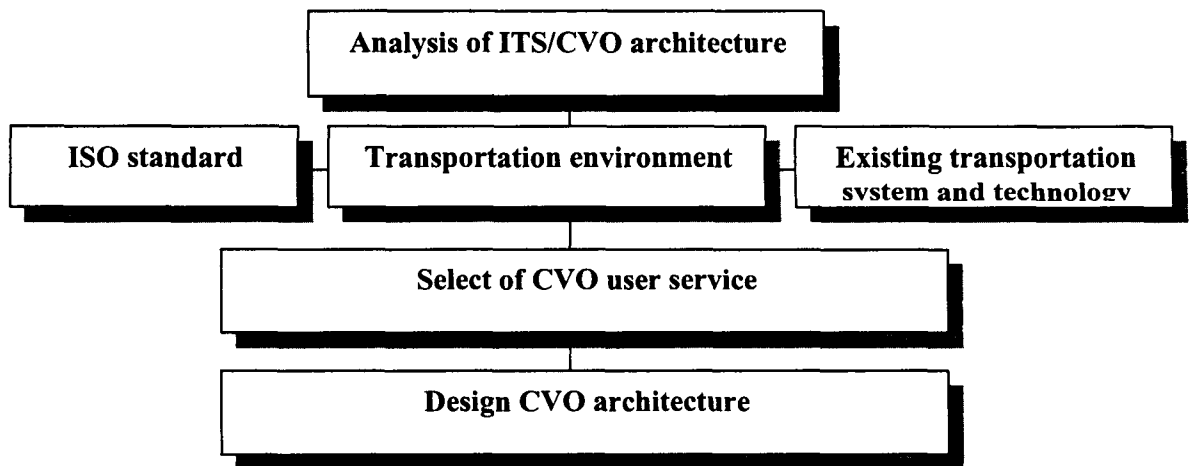


Figure 2. Architecture framework

3.2.1 Analysis of ITS/CVO architecture

The ITS elements support Commercial vehicle operations. These include information system, network, sensor system such as AVI/AEI, technologies such as DSRC equipment, and the components of the intelligent commercial vehicle. The national ITS/CVO architecture defines these CVO user services.

In order to determine CVO user service, we examined over the ITS leading countries. These countries selected user service item to fit the service item for their transportation environment and finished architecture task. The following table is the comparison of each country user service comparison;

Table 2. user service item comparison

User Service	
U.S.A	EUROPE

Commercial Vehicle Electronic Clearance Automated Roadside Safety Inspection Commercial Vehicle On-board Safety Monitoring Commercial Vehicle Administrative Processes Hazardous Material Incident Response Freight Mobility	Co-ordinated City Logistics Fleet and Resource Management Freight Management Hazardous Good Management Operational Planning Management
ISO Commercial Vehicle Pre-clearance Commercial Vehicle Administrative Processes Automated Roadside Safety Inspection Commercial Vehicle On-board Safety Monitoring Commercial Vehicle Fleet Management	JAPAN Commercial Vehicle Operation and Other Freight Information Operation Information in the other mode Automated Platooning

The result of above comparison and analysing sub-system classified these following user services.

- Freight and Transportation Mode

Fleet management, Transportation operation management, Freight management, Safety & road management

- Administration and Clearance

Freight administration

- Safety

Hazard good vehicle Management, Hazard good management, and Rescue system management

3.2.2 Review of ISO standard

ISO/TC204/WG1 are in charge of developing the Reference Architecture and based on this development logical and physical architecture. This method set up the Core Reference Architecture using the Object-oriented Analysis. To select the standard technology, we investigated present condition of Korea about ISO activities concentrating the working group in ISO.

Table 3. ISO standard and Response

W G	Standard Items	ISO Stage						Response strategy	Activities
		1	2	3	4	5	6		
1-1	Terminology						o	Adapting	Finished Adpt'
1-2	Reference Architecture					o		Adapting	Adpt' consider
1-3	Data Modelling		o					Participate	Not participate
1-4	Cross Mapping Object-oriented RA	o						Participate	Not participate
4-1	AVI/AEI Architecture						o	Adapting	Not participate
4-4	Intermodal AVI/AEI Reference Architecture		o					Participate	Not participate
4-5	Numbering and Data Structure		o					Participate	Not participate
4-6	System parameters		o					Participate	Not participate

4-7	Interface Specification		o				Participate	Not participate
5-1	Fee and Toll Collection					o	Adapting	Not participate
7-1	Commercial/Fleet management	o					Participate	Not participate
15.1	Dedicated Short Range Communication			o			Participate	Participate

Note: Adapting: Adapting the Standard in Korea

3.2.3 National transportation environment study

Coupled with the rapid growth of Korean industries over the last two decades, the nation is currently facing terrible traffic problems. Some of the key difficulties include: congestion on all major roads and highways, lack of railway capacity, delayed shipment in major ports. Due to this traffic congestion, the Korean industry currently pays almost 16 percent of total sales revenue in transportation costs. The major reasons cited by industry experts include: poor infra-structural development of transportation industries due to low social overhead investment, low efficiency in traffic control systems, and an abundance of private and commercial vehicles.

The following items are present condition in Korean transportation environment.

- The prime object of export transportation system, High international trading environment
- Serious problem of Urban traffic congestion and traffic regulation
- Increasing transportation cost in logistic cost
- High percentage of commercial vehicle companies rate
- Weak linkage between transport information system etc.

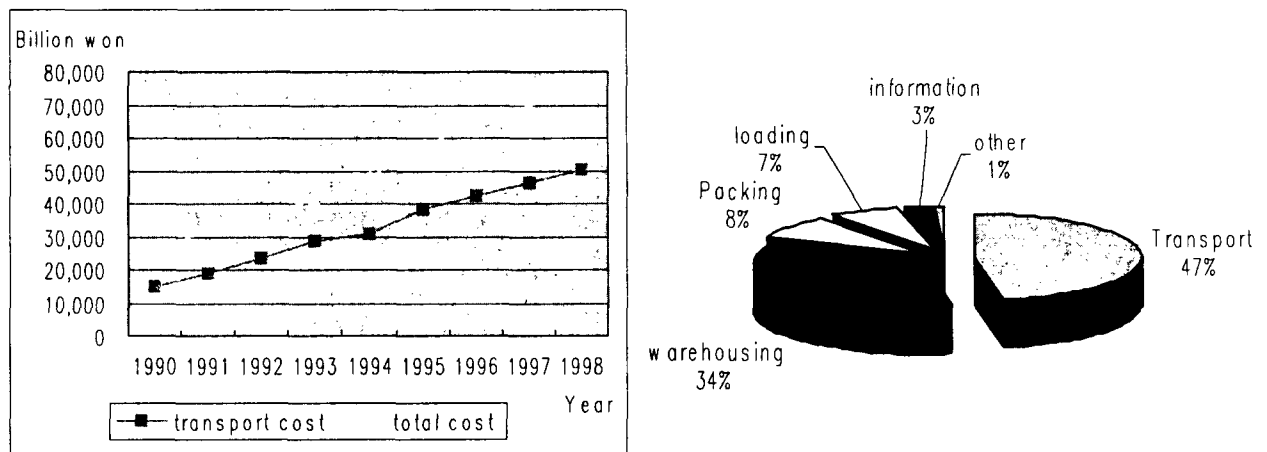


Figure 4. Logistics cost

3.2.4 Existing transportation systems and technology

Domestic Transportation system in Korea was developed in relation with logistics and new system supporting international trade was developed and currently in use. The following system, which is related CVO;

- National system: KL-net, KT-net, KROSIS, Port-MIS etc.
- Company system: HYDEX, Glovan, Dacom VAN, CONSYS, KIFOS, KT logis, etc

3.3.5 Selecting the CVO user service

Priority of establishing sub-system was set up, after service demand survey was made which was to standardise CVO planning system.

We have chosen CVO sub-system according to the service priority. Domestic transportation system specialities, status of domestic CVO system and technologies and priority of service demand survey were used to select logical architecture sub-system.

Table 4. Selecting the Service item

	Transport environment	Enabling System Service	Service demand	Leading county CVO Archi'	Level of Standard	Priority
Commercial Vehicle Operation Management	1	2	3	2	3	2
Commercial Vehicle Management	2	1	2	1	4	1
Commercial Vehicle Electronic Clearance	4	5	1	3	1	3
Commercial Vehicle Administration	5	4	4	4	5	4
Freight administration	3	3	5	6	6	5
Hazardous Material Management	6	6	6	5	2	6

4. The Result of Korea CVO

CVO architecture area is divided into the following 4 standard technologies and reflected in this architecture.

- Enabling Standard: Terminology, Architecture, Data Dictionary
- Message Set: Message set specification
- Communication Type: Wire-line, Wide Area Wireless, Wide Area Broadcast, Vehicle-to-Roadside, DSRC, Vehicle-to-Vehicle
- Other Technology: EDI, AVI/AEI technology, Container tag etc.

CVOMS(Commercial Vehicle Operation Management system)

CVOMS provide the capability for commercial driver, dispatcher, and intermodal operator to receive real-time route information and track vehicle and cargo locations using GPS. The communications capability of CVOMS subsystem support FMC, RTIC(Regional Traffic information Center)

CVMS(Commercial Vehicle Management system)

CVMS is used by the commercial vehicle operator to manage and optimise vehicle usage. It is for supporting the decision making to management.

FMS(Freight administration System)

FMS is used by the commercial vehicle operator to track cargo from source to destination using data links to intermodal freight shipper and depots. Also it provides the information to warehouse system for entry or exit freight.

CECS(Commercial Vehicle Electronic Clearance system)

CECS provides export/import information to trading organization. It sends trade data and credential information through the trading system.

CVAS(Commercial Vehicle Administration system)

CVAS is used by the vehicle operator to automatic the filing of credentials and vehicle use taxes. Commercial vehicle operator to manage document for registration uses CVAS on line.

HMMS(Hazardous Material Management)

HMMS provides technical resources, which supply information in the proper handling and routing of hazardous cargo and on emergency damage control procedures. Its purpose is to maintain maximum operational safety standards through rapid dissemination of information both internally and to the Emergency center.

Table 5. Subsystem definition

Subsystem			Managing Area	Service
		Coordinator		
CVOMS	MOCT Private	Carrier & Related group	Nation	Real-time tracking and locating
CVMS	MOCT Private	Carrier & Related group	Nation	Transport statistics Vehicle management
FMS	MOCT Private	Carrier & Related group	Nation	Freight statistics Freight Real-time tracking
CECS	Customs Service	MOCT MOCIE MOMAF	Region unit	On-line trade proceeding
CVAS	MOCT	NTS MOGAHA	Nation	On-line register, Tax, Clearance
HMMS	MOCT	Police 119 MOGAHA MOENV	Nation	Emergency procedure Routing, seceding

Note : MOCIE - Ministry of Commerce, Industry, and Energy

MOMAF - Ministry of Maritime Affairs and Fisheries

NTS - National Tax Service

MOGAHA -Ministry of Government Administration and Home Affairs

4.1 Design CVO architecture

CVO architecture was designed by ISO standard, which analysed above the study considering the expansion of linking with other systems. Also we chose USA architecture method that is well arranged. Korea had already finished ITS architecture in 1998, but CVO was not included in its work because of many operating logistics information system. Our researchers designed CVO architecture on the former national ITS architecture study under the MOCT support in 1999. Simultaneously, we performed CVO technologies standard develop project. The result of that study was product following logical & physical architecture, data dictionary & message set and communication & hardware standard.

CVO architecture procedure

1. Selecting the subsystem Logical Architecture
2. Physical Architecture
3. Functional Specification
4. Data flow definition
5. Data dictionary

The CVO data architecture consists of a structured definition of information used in national logistics system or ITS. It defines data entities and attributes. An entity is any person, place, thing, concept, or event about which the enterprise stores data. An attribute is a named characteristic of an entity.

The process architecture is a structured definition of all the processes necessary to carry out all the functions of CVO. It is defined as a hierarchy of processes and sub processes.

An application is a computer system or software package that performs some related set of functions. The applications architecture is not a design for applications, nor is it a detailed requirements specification for each application. It is a definition of the major functions to be performed and the top-level requirements to be met by each application, the interfaces to other applications, and the distribution of data among applications.

Note that with CVO, it is not possible to define application architecture in the same way as might be done for a large company or a single state. We cannot state definitively what applications each stakeholder will have. We can only create a generic "model" that each stakeholder will adapt to meet its needs.

- Logical Architecture

The logical architecture provides a description of what user does and the information it uses. The logical architecture contains two primary elements: the process architecture and the data architecture. The following figure (1) is shown logical architecture using the Structured analysis and top-level layer function.

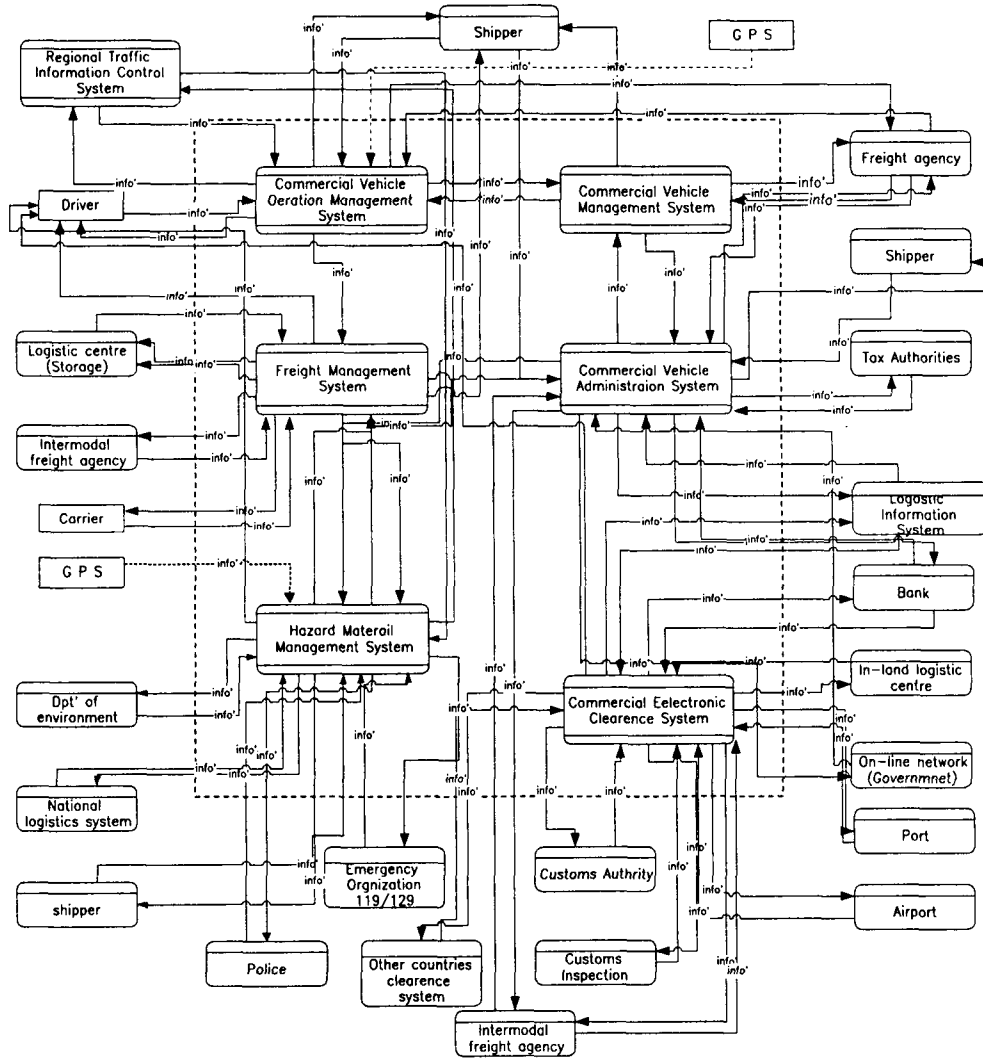


Figure 5. CVO Logical Architecture

- Physical Architecture

The following figure (2) is shown physical architecture dividing communication layer, transportation layer and institutional layer.

Centres: CVOMS, CVMS, FMS, CECS, CVAS, HMMS

Roadside: VMS, detecting beacon,

Vehicle: Tag

Traveller or Remote Access: RTS, TIS

Equipment Package: note CVO physical architecture

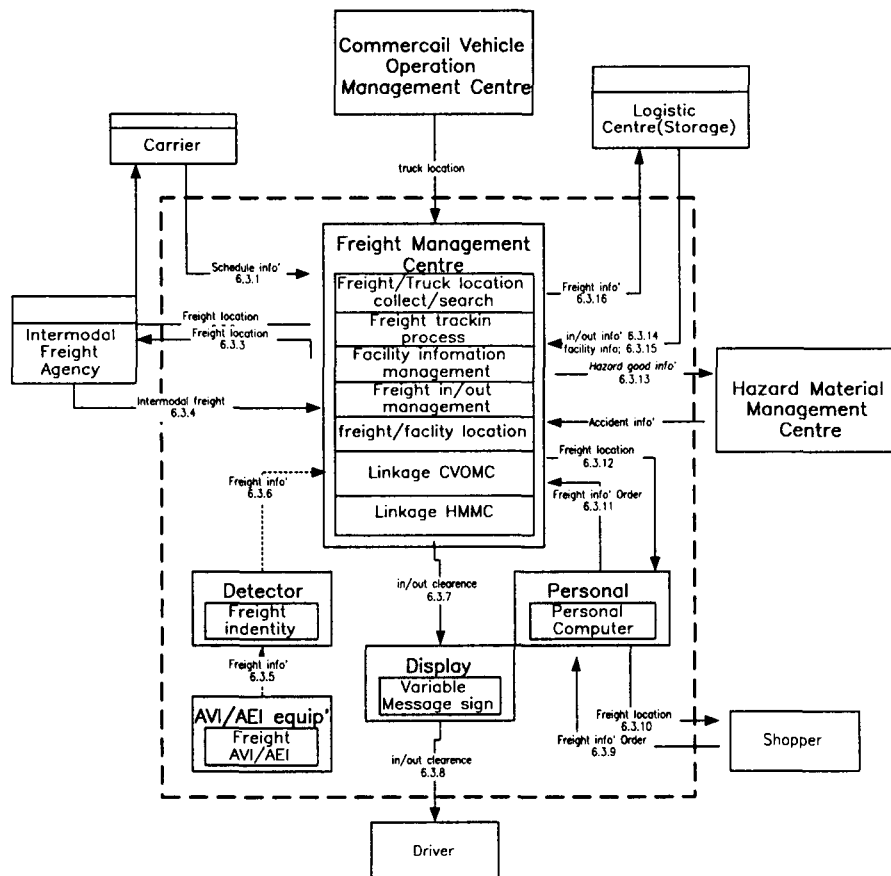


Figure 6. CVO Physical Architecture example - FMS

- Data Flow Table and Data Dictionary

Government and enforcement organizations, and entities that exchange information with these organizations should use this data dictionary. These entities include owners, lessees, and drivers of commercial motor vehicles, and other authorized parties. Our study was an establishment CVO architecture and CVO standard. According to this study. Another institute as KOTI made CVO Data dictionary.

A series of the tables containing commonly used data codes for commercial vehicle operation. The data dictionary identifiers correspond to the codes cited in the AVI/AEI Standard for Data Element and structure. Table 5 provides a sample data flow table and data dictionary with explanations for the information provided in the actual code tables.

ID : 6.5.1	Data flow table		
Name	Hazimat Vehicle Information		
Subsystem(Origin)	HMMS		
Data flow		Origin	Destination
	Subsystem	HMMS(System)	RTIS(System)
	Unit	HMMC(Center)	RTIC(Center)
	EP	Link RTIC	Link HMMC
Description	Link the RTIC for sending Hazimet information		
Specification	Hazimat information		
Usage	When transport Hazimat, send data to RTIC		
Source	HMMC		
Collection method	Creating transport information by carrier		
Frequency	When require		
Delivery method	Wire Communication		

Data Dictionary

Data Concept Identifier	40150
Descriptive Name	CVAD_HriHazard_Code
Descriptive Korean Name	-
Descriptive Name Context	CVO
Definition	Control function Hazard information
Formula	-
Source	ITS Logical Architecture – Volume III
Class Name	CVAD
Classification Scheme Name	ITS Data dictionary
Classification Scheme Version	V1.0
Data Concept Type	Data Element
Keywords	Hri
Keywords Korean	-
Related Data concept	Not Applicable
Relationship Type	Not Applicable
Remarks	-
Symbolic Name	-
Symbolic Name Context	-
ASN Name	cvas-HriHazard
Representation Layout	Not Applicable
Constraints	-
Value Domain	ASNI X3.4
Data Type	Not Applicable
Representation Class Term	Code
Valid Value Rule	Not Applicable
Data Concept Version	V0.01
Security Class	General
Registration Status	Unregistered
Date Registered	-
Last Change Date	20000228
Register Organization	MOCT
Register Phone No.	8225004057
Steward Organization Name	KRIHS
Steward Phone No.	823433800337
Submitter Organization Name	KOTI
Submitter Phone No.	823449103084
Relevant Group	-

Figure 6. Data flow Table and Data Dictionary

To ensure business requirements of the user community are met, MOCT would be directed main group through KRIHS, KOTI, and Hanyang University Transportation Laboratory with government agencies to provide user support, coordination, and oversight of on-going development and maintenance of the data directory. Therefore, if users want to submit data requirements not covered in this data dictionary document, these groups let its version 1.0 update timely.

4.2 Korean CVO perspectives

There are many system related CVO. The key factor of establishing CVO is linkage other system. We also find that modifying the existing system to new CVO architecture is better than new-built.

5. CONCLUSION

It was very hard to make general conclusion because measuring efficiency analysis of CVO standardisation is based on business oriented self-appraisal result, which came from limited survey. Although horizontal comparison was not made due to all different measurement was used.

Economic efficiency in adapting CVO architecture standard was very difficult showing the general conclusion because of limited survey result. However, we found good efficiency in which companies built CVO system by standard architectures in spite of different measurement with horizontal comparison. Therefore, future of CVO system architecture in Korea should consider new standard about ITS architecture and frequently participate ITS standard congress for obtaining the advanced technologies.

Our results indicate that CVO systems in Korea don't set up by itself for national ITS sector. we found the guideline on applying the system architecture in each standardisation leading country. Also we arranged constructing the architecture under the generic environment. Therefore we attained trend of CVO architecture standardisation and CVO policy of promotion of standardisation activities in each country. Flowing the this studies, we designed the Korean CVO Architecture included the relating CVO standard technologies.

ACKNOWLEDGMENT

This work was supported by Brain Korea 21 project.

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An Airport as a Logistics and Economic Hub:

The Case of Incheon International Airport

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Hankuk Aviation University

And

Han Mo Yang

Hankuk Aviation University

During 1990's, demand for airfreight transportation in Korea has been increased by higher than 9% annually. And since the demand in Asia-Pacific region also continues to grow steadily, it is forecasted to make up more than 50% of world demand by 2010. However Korea, which is located between China and Japan, may not be able to make the most of the opportunities which such a strategically advantageous position could provide, owing to lack of international competitiveness in the air freight industries.

Since passenger transportation has been at the core of aviation policies in Korea, airfreight transportation has not been given active supports and attention by the government. Instead unnecessary government regulations have further aggravated inefficiencies of Korean aviation industries which fell short of the global standards.

Now the opening of Incheon International Airport (IIA) provides excellent opportunities for aviation industries in Korea. And it is essential to develop effective mechanisms that can be used to revitalize aerospace-related and strategically important industries and also national economy through growth of IIA toward the logistics hub in Northeast Asia.

This research attempts to derive strategies to develop "The Winged City" (TWC) which covers IIA and its vicinity into the airfreight transportation hub, total logistics hub, distribution hub, and economic hub incrementally. Without successful development into such hubs, the goal of IIA to become a hub port cannot be reached.

The approach to identify potentiality of IIA as a logistics hub in Northeast Asia and develop options to improve its competitiveness consists of surveying literature, case studies for competitive analyses and benchmarking, and a Regional Cluster (RC) model.

The concept of RC is originated from Porter (1990) and it is based on the fact that certain key industries tend to form clusters in certain geographic areas (Enright 1994; 1995; Krugman 1991; Harrison 1992). RC is mostly formed due to natural resources and environments and developed as seller-buyer relationships and related industries become established. And development is accelerated as industry-specific know-how becomes accumulated, provider-buyer networks are established, and constructive competition is activated within the region. In order to maximize benefits for companies

within the region, efforts like infrastructure improvements, more active strategic alliances, tighter cooperation in market research, promotion, R&D and other marketing and management activities are necessary. Therefore policies and strategies to develop TWC and improve competitiveness of IIA as a logistics hub should be prepared to support formation and development of related RCs.

COMPETITIVE ADVANTAGES OF IIA AS A LOGISTICS HUB

Changes in International Logistics Environments

Changes in International Economic Environments and the Strategic Importance of Logistics

Multinational enterprises and many other companies in the world are expanding global sourcing of raw materials, parts, equipment, and finished goods and global manufacturing and marketing. Such a rapid trend of globalization has increased the international material exchange and trade and which in turn enhanced the strategic importance of international logistics.

In order to cope with such environmental changes and make the most of opportunities these changes could offer, Korea needs to grow into a global logistics hub with IIA and the new Pusan port for the foundation. And such a global logistics hub should be equipped with up-to-date facilities and management systems which are based on the technological advancement in areas including intermodal transportation, air and surface transportation, material handling, value-added logistics (VAL), and communication and information systems.

Economic Cooperation in Northeast Asia and the Strategic Importance of Air Freight Transportation

Northeast Asia, including South and North Korea, China, the Far Eastern part of Russia, and Japan, accounted for 24.3% of the world population and 13% of the world trade in 1996. GDP in the region has continued to grow by a lot higher rate than 6.8% which is world average between 1986 and 1995. Thus Northeast Asia is recognized as an economic bloc with the greatest growth potential.

Demand for airfreight transportation in the region also provides high growth estimation. Both demands in Korea and Asia as a whole are expected to grow faster than the whole world continuously.

TABLE 1
FORECASTS FOR AIRFREIGHT TRANSPORTATION DEMAND BY REGION

Region	2000		2001		2002		Annual Growth Rate
	%/world	Growth Rate(%)	%/world	Growth Rate(%)	%/world	Growth Rate(%)	
Asia	36.0	6.9	36.1	6.7	36.3	6.7	6.7
Korea	6.5	9.2	6.7	9.1	6.8	9.2	9.1
World	100.0	6.4	100.0	6.2	100.0	6.1	6.2

Source: IATA, Freight Forecast, 1998

There are various difficulties to overcome for economic cooperation in Northeast Asia to develop into economic integration. Those difficulties include uncertainties concerning normalization of

diplomatic and economic relations between South and North Korea, sociocultural differences, geographical constraints, and differences in political systems. Owing to such barriers, close economic cooperation between and among limited number of companies and countries in the limited geographical region is expected to precede full-scale integration like European Union (EU).

During the early stage of economic cooperation, transportation networks between and among key areas in the region are established. And as above-mentioned barriers become surmounted, tight economic cooperation in the region is expected to get into stride.

Since Korea already plays an important part in airfreight transportation services in Northeast Asia, airfreight bound for cities in the region commands a majority in airfreight from Korean airports.

TABLE 2
FORECASTS FOR AIRFREIGHT DEMAND FROM KOREAN AIRPORTS

Region	2000		2001		2002		Annual Growth Rate
	Demand(%)	Growth Rate(%)	Demand(%)	Growth Rate(%)	Demand(%)	Growth Rate(%)	
N America	31.2	11.0	32.5	10.0	31.9	10.0	10.0
NE Asia	36.2	7.1	35.5	7.2	34.8	7.0	7.1
Subtotal	67.4		68.0		66.7		
World	100.0	9.2	100.0	9.1	100.0	9.2	

Source: IATA, Freight Forecast, 1998

Concept of a Global Logistics Hub

With the advance of globalization in the business administration, the geographical scope of international logistics expands rapidly and the strategic importance of logistics continues to be enhanced. As the geographical scope expands, a logistics network framework undergoes changes from export- and import-oriented logistics networks through localized logistics networks to integrated networks utilizing global logistics hubs. Besides as the strategic importance of logistics enhances, a logistics management framework shifts from the in-house logistics management through outsourcing to strategic alliances.

Such changes increase a need for super regional hubs like Asian Hub whose function might include transshipment, VAL, customization, partial transformation, data processing and communication, international transaction support, exhibition, and international distribution.

Potential of IIA as a Logistics Hub

A hub airport plays a role as a central part of the hub and spoke network through providing facilities and services appropriate for hubbing. Assessment of IIA as a logistics hub in Northeast Asia is as follows:

1. IIA is located in the strategically advantageous position on intercontinental service routes. In

case of transpacific route, IIA is located at the geographical limit where a long-range transport aircraft like B747-400 loaded to capacity can make a non-stop flight from the East coast of US. And the same is true for Trans Siberian or Trans Chinese route bound for Europe. Although IIA is not located at the foremost front of both routes, it has a competitive edge due to its convenient location linking the intercontinental routes and major markets like China and Japan.

2. IIA is in the center of Northeast Asian economic bloc. Within a radius of 1,000 km (3.5 hours by air), there are 43 cities with the population of 1 million or more.
3. Airlines want to be based where home economy is strong, to give a good baseload of business. Thus it is essential for a hub port to have initial O/D (origin and destination) demand sufficient enough to develop basic routes and create additional demand hereafter. IIA possesses Seoul metropolitan area that accounts for 40% of GDP and 90% of international flight demand behind it.
4. A hub port must have a sufficient capacity and make continuous investments ahead of the current demand. IIA possesses the greatest capability for expansion among airports in the region. In case of IIA, the fully-developed airport space is over 10,000 acres and the ultimate target number of flights are 530 thousands per year, while those of Pudong airport in China are over 7,000 acres and 320 thousands.
5. In the long run, IIA is going to establish complete intermodal networks connecting in a seamless way from air to ground, railway, inland waterway and sea ferry. Especially sea-air intermodal transportation whose demand is increasing between Chinese coastal cities and Incheon is expected to be a substantial contribution to the success of IIA as a logistics hub.
6. The success of a hub port eventually depends on how well airlines perform. Since Korean flag carriers are expected to be ones who engage in the most active marketing and other business activities, the success of IIA as a hub port is closely related with competitiveness of Korean airline industries. Korean Air, one of two Korean flag carriers, was ranked third among airfreight transportation companies in the world and first among airlines. And the other airline, Asiana got into the business late but was ranked twelfth due to the rapid growth of the past few years (IATA 2000).
7. At IIA, airfreight terminals with advanced facilities and technologies are in operation. Those terminals can handle 1.7million tons per year now and will be capable of dealing with 7.5million tons on the completion of the final construction. On the other hand capacities of Kansai airport in Japan, Changi airport in Singapore, and Check Lap Kok airport in Hong Kong are 1.4million tons in 1997, 1.45million tons in 1999, and 3million tons in 1999, respectively. In 1999, Check Lap Kok airport handled 2million tons (2nd in the world), Narita airport in Japan dealt with 1.8million tons (4th), Kimpo airport in Korea took care of 1.7million tons (7th), followed by 10th ranked Changi airport (1.6million tons) and 21st ranked Kansai airport (.9million tons)(ACI 2000).
8. IIA and its vicinity (TWC) fairly well satisfy requirements to be developed into a global economic hub city with various supporting functions. Those functions may include

international business, tourism, VAL, manufacturing, distribution, and retailing. And such development is essential for TWC to grow into a global exchange hub of people, information, and freight.

9. Price is also a critical factor to select airports. Costs to use airport facilities at Kansai airport and Check Lap Kok airport are 3.76 times and 2.79 times greater than that at Kimpo airport. Although rate at IIA is 19% higher than that at Kimpo airport, IIA still enjoys the competitive edge in this category.

While IIA enjoys competitive advantages like the above-mentioned ones, competing airports are limited in their efforts to develop into a logistics hub owing to various weaknesses. Taking care of own O/D freight efficiently is top priority for Narita airport suffering capacity shortage problems. Kansai airport is also expected to face capacity shortage in around 2003 and the rates are also fairly high. Weaknesses of most Chinese airports include lack of open-door policies and relatively inefficient airlines of own nationality. Taiwanese airports also have problems including limits in capacity expansion, disadvantages regarding locations, and the limit of Taiwanese airlines' efforts to increase the number of flights owing to political and diplomatic difficulties with China.

Thus IIA is believed to possess sufficient potential to develop into the logistics hub in Northeast Asia.

Options to Improve Competitiveness of IIA as a Logistics Hub

Air Transportation Policy

Air transportation policies to support development of IIA into a logistics hub include:

1. Increases in routes and the frequency of flights through actively adopting Open Sky policy and other international agreements;
2. Protection for profitability of airlines through effectively responding to changes in air transportation policies of other countries;
3. Increases in opportunities for strategic alliances with advanced foreign airlines.

Since bilateral air transport agreements have limitations in freely increasing the frequency of flights and expanding routes, it is desirable to enter into the Open Sky Agreement more actively. Since such liberalization policies can eliminate limitations in operations of foreign airlines, promote constructive competitions, and in turn decrease level of freight rates, competitiveness as a logistics hub can be improved.

Besides, to support rapid handling and processing of the freight, it is also desirable to repeal approval regulations for transshipment freight; support business activities of freight forwarders; guarantee autonomy in deciding freight rates; and abolish various unnecessary regulations (Kim et al. 1998).

Airport Development

Increases in transshipment freight handled inside the airport facilities cannot be sufficient enough to maximize return on the huge investment for the construction and develop IIA into a global logistics hub. In order to survive in a fierce competition to become a hub port, IIA should be able to create sufficient O/D and transshipment freight through successfully positioning itself as a global trade center as well as a hub of international logistics.

Thus TWC needs mixed-use development to possess various functions including international business, information service, telecommunication, manufacturing, tourism, leisure, conference, and exhibition in addition to logistics-related functions. Development of sea-air intermodal transportation systems without delay is particularly important to attract freight from coastal cities in China and Japan and Hong Kong.

Airport Operation and Marketing

Management and marketing strategies to improve international competitiveness and customer satisfaction are as follows:

1. It is essential to minimize rates to use airport facilities and related logistics costs for customers. Although cost, marketing capability and quality used to be major sources for competitive advantages, nowadays time seems the most critical factor. Thus it is very important to support customers in their efforts to reduce costs and improve the level of customer service through making lead time or logistics cycle time shorter and more consistent. Such capabilities and various other incentives are needed to attract multinational mega carriers like Federal Express and UPS.
2. In order to secure and maintain the position of a hub port, accurate forecasting on capacity requirements and continuous early investments are important. And Kimpo airport maintains or is planning to possess facilities for pre-packaging, VAL services, cross docking, and various other logistics services. Therefore such facilities and freight handling facilities in IIA should be interfaced through intermodal transportation networks and real-time information systems.
3. It is essential to develop or join globally integrated cargo community systems (CCS) linking various regional CCS that support paperless processing between and among airlines, customhouses, customs agents, freight forwarders, consignors and consignees.
4. Effective marketing strategies for both airports and airlines hubbing at the airports are also important for customer satisfaction and profitability. Such marketing and service strategies can be established based on elaborate processes including assessment of needs and characteristics; segmentation of freight or customers, selection of target customer segments; identification of specific needs and requirements of target customers; and creation of customized VAL services. Electronic products such as semiconductors and cell phones become major export items carried by air and the portion of machine parts, high-grade consumer goods, and fresh agricultural and

marine products in imports by air continues to grow. Thus IIA needs to provide VAL services and freight terminal functions customized for such products.

5. Although the success of IIA as a hub port significantly depends on competitiveness and performance of Korean flag carriers, foreign airlines that can make up for the limitations of two Korean airlines must be attracted through effective international marketing strategies. And IIA should provide full supports to strategic alliances between Korean airlines and their foreign counterparts, that is crucial for development of complete hub and spoke networks.

Competitiveness Improvements for Korean flag carriers

For IIA to become a competitive hub port, Korean flag carriers that are expected to play a major part as leading airlines have to improve their competitiveness as soon as possible. Diversification of routes, customer management through sharing computer reservation systems and strategic alliances could be viable options for competitiveness improvements.

Code sharing between Korean and foreign airlines is an example of strategic alliances for freight transportation as well as for passenger transportation. For example, if Korean Air signs a joint operation agreement with Singapore Air through code sharing, Korean Air can penetrate Southeast Asian market indirectly. In order to support such alliances, the Korean government may need to select one or two countries for every major economic bloc and try to sign free flight agreements with them (Kim et al. 1998).

Although strategies for IIA as a logistics hub may include various options in extensive areas, this research places greater emphasis on mixed-use development strategies for TWC as a global economic hub. The next section discusses development strategies of Asian Hub that provides a basic framework of the logistics hub in Northeast Asia and Asian Business Center and Asian Logistics Center that are core projects of mixed-use development plans for TWC.

DEVELOPMENT STRATEGIES OF ASIAN HUB

Concepts and Objectives of Asian Hub

Concepts

In this research Asian Hub is proposed to consist of Asian Hub Center (AHC), Asian Logistics Center (ALC) and Asian Business Center (ABC). This research suggests that AHC take charge of management of Asian Hub and control of physical and information flow; ALC proposed to be developed within the Free Zone play a part as a logistics and manufacturing hub; and ABC be in charge of international distribution, marketing and business.

Critical Success Factors

Critical success factors for IIA and TWC to make incremental development into hubs for air

transportation, logistics, international trade, international business and finally international economic exchange are as follows:

1. Infrastructure and integrated logistics facilities of the global standards must be available.
2. Government policies and regulations including customs policies should be reformed for the highest degree of convenience and satisfaction of users.
3. Intensive competitive strategies and aggressive marketing strategies have to be adopted to run Asian Hub.
4. Asian Hub must develop extensive logistics and trade related databases and serve as a core of information networks in Northeast Asia.
5. Asian Hub needs to improve attractiveness of TWC by creating a tenant-friendly atmosphere where foreign enterprises are allowed to operate unrestricted.
6. Various producer services including finance and insurance and customer-oriented administrative services ought to be available.

Marketing Strategies

AHC is a marketing arm of Asian Hub and marketing strategies consist of product and service strategies, promotion strategies, distribution strategies and pricing strategies.

Product and service strategies include:

1. global one-stop services;
2. efficient matching mechanisms through developing extensive databases and securing a large number of participating enterprises and institutions;
3. value-added integrated logistics services;
4. international logistics and business services customized for requirements and characteristics of the specific economies, societies, cultures, industries, enterprises, markets and customers in Northeast Asia;
5. a cyber mall to support both business-to-business and business-to-customer transactions;
6. international logistics and business experts with an excellent command of foreign languages.

Examples of promotion strategies are international logistics exhibitions; internet marketing; extensive international marketing networks; close cooperation with international organizations; price discounts based on the sizes of a lot for rent and employment created; and various subsidies and incentives on customs and taxes. Distribution strategies include international marketing branches and support networks for global cooperation and customer services

Top priority of TWC should be to find multinational enterprises in the areas of logistics, distribution, and manufacturing which have intentions to participate and make the most of their reputation and credibility to attract other foreign and domestic enterprises. Examples of such global logistics companies are Ryder, Fritz, Schneider Dedicated, Penske Logistics, Danzas, Schenker, Sceta, NFC, etc. Domestic airfreight companies and forwarders may include East Asia Airexpress, Sunjin Shipping &

Air Cargo, Taehwa Aerosea Forwarders and Kec International. And the third party logistics (3PL) companies such as Tolos, SLS, CJ GLS, and Resko might be potential target customers.

Spillover Effects

Asian Hub can attract global logistics enterprises with advanced technologies and then support and promote benchmarking processes and strategic alliances between such companies and relatively less competitive Korean logistics companies. Such processes can enhance competitiveness of logistics industries in Korea. Korean logistics enterprises currently limited in their scope of business can grow into full-scale 3PL firms and play major parts in Asian Hub ultimately.

Through supporting strategic alliances and close cooperation between and among enterprises in the areas of logistics, manufacturing, distribution, trade, finance, insurance, information, and communication, Asian Hub can grow from a logistics hub into an international trade center. Then Asian Hub can ultimately develop into international business hub through the following mechanisms:

1. Above-mentioned development can allow logistics firms to secure stable customer bases for a long term.
2. An inflow of multinational corporations can promote revitalization of neighboring industrial parks and globalization of domestic firms.
3. Improvements in foreign direct investment (FDI) environments through enforcement of foreign investment promotion laws and assignment of the Free Zone, coupled with aforementioned mechanisms can produce synergism for Asian Hub.

Development Strategies of Asian Hub Center

The main objectives of Asian Hub Center (AHC) are:

1. supports for various global and local enterprises to make inroads into the Northeast (NE) Asian market;
2. promotion of Korea as an integrated distribution hub in Northeast Asia;
3. supports for global corporations to design and develop Pan-NE Asian logistics networks;
4. supports for small and medium-sized enterprises to actively participate in electronic commerce (EC).

Thus major services provided by AHC include:

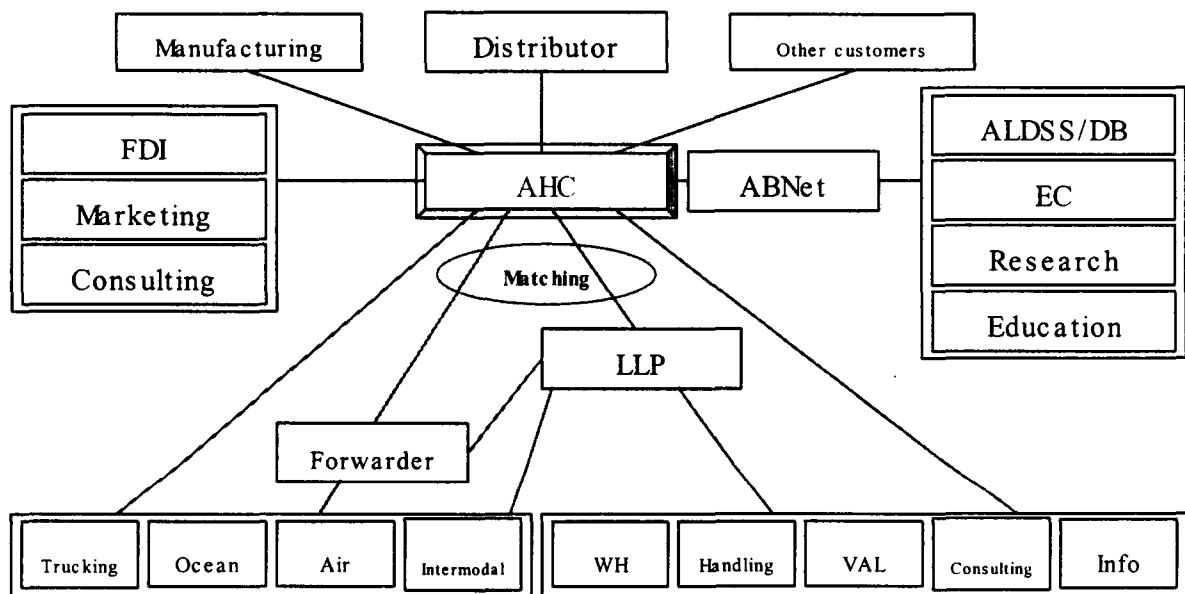
1. matching functions between and among logistics service users like manufacturers, distributors, and retailers and various logistics-related service providers which are AHC members and include transportation and intermodal transportation; warehousing, break and bulk, inspection, and inventory control; packaging, repackaging, labeling, and repair; reverse logistics; VAL,

customization, simple processing, and partial assembly; order processing, data processing, and communication; customs clearance agents, insurance agents, and forwarders; and container repair and management;

2. supports for strategic alliances between members of AHC and customers;
3. supports for development of consortium with a lead logistics service provider at the center to be able to provide one-stop shopping of various logistics-related services;
4. integrated logistics decision support systems that can recommend the best solutions based on analyses of various alternatives concerning logistics and distribution systems in NE Asia;
5. databases including extensive information on logistics, distribution, and international business, that are specific to NE Asia;
6. other services such as market research, consulting, training and education, and electronic commerce.

FIGURE 1

A FRAMEWORK OF AHC



DEVELOPMENT STRATEGIES OF THE WINGED CITY

Background and Objectives

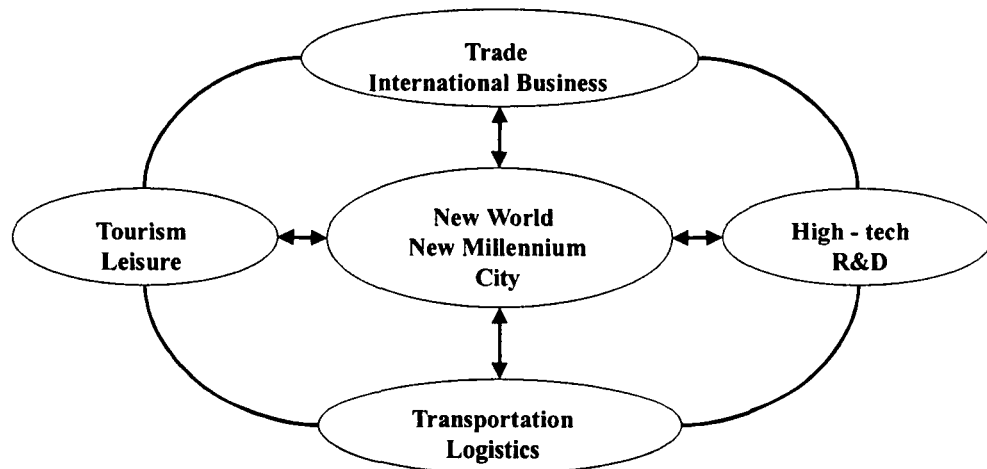
In order to grow into a hub port, airport development should be accompanied by mixed-use development in the vicinity of IIA through developing clusters of related industries and facilities. Thus construction of IIA should be based on comprehensive and systemized plans that consist of airport

development, city development, and industry development.

Visions of TWC include a transportation and logistics hub; regional headquarters of international business; the science park with business incubators for advanced aerospace industry and information & telecommunication industry, R&D centers, and education and training centers; and international tourism and entertainment centers of the global standards.

FIGURE 2

DEVELOPMENT VISION OF THE WINGED CITY



Interested concerns and government offices and institutions concerned expect various spillover effects. Therefore TWC should be developed in the direction of satisfying following expectations (Figure 3) as much as possible.

Environment Analysis

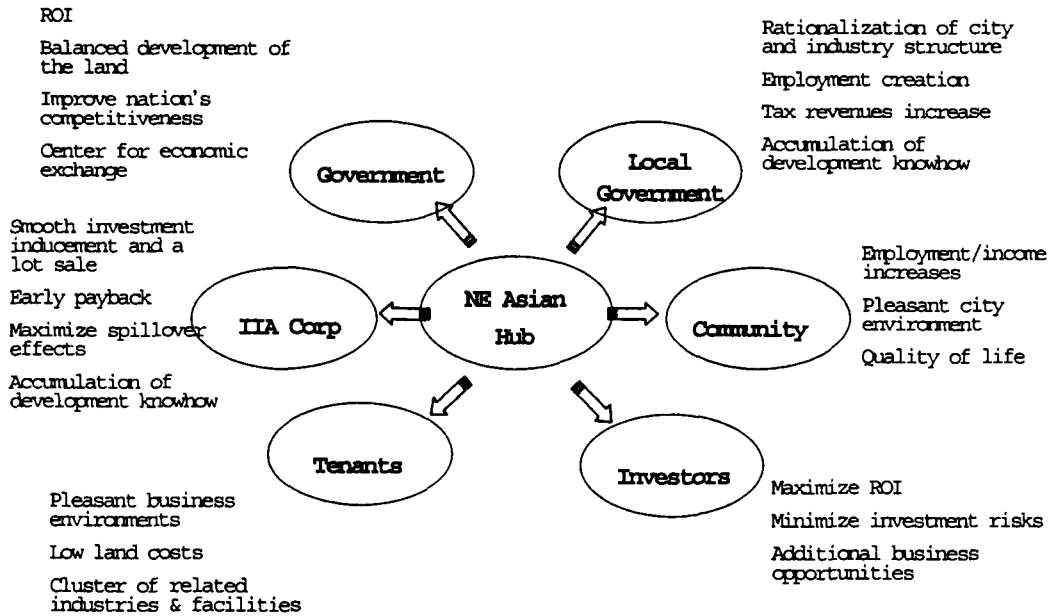
Socioeconomic Environments

Major environmental factors concerning TWC development include socioeconomic environments of Northeast Asia, the nation, and the community; the location, layout, and characteristics of TWC; size, characteristics, and other environmental factors of related industries; and analyses on trade areas including tourist markets.

As economic cooperation advances, TWC ultimately has to play a leading role in international business and economic exchanges through preoccupying a hub function in transportation and logistics networks. And in this age of information and telecommunication, development of TWC must be utilized as a springboard to foster frontier industries such as aerospace, IT and telecommunication, international business, and other service industries; improve competitiveness of existing industries; and revitalize the nation's economy.

FIGURE 3

SPILLOVER EFFECTS OF TWC DEVELOPMENT



Environment Analysis of Incheon

Incheon is located at the place of strategic importance where so-called BESETO (Beijing-Seoul-Tokyo) line and INTIDE (Incheon-Tianjin-Dalian) line are connected. Rapid growth of Chinese coastal cities like Dalian, Tianjin, Qingdao, and Lianyungang has consolidated the strategic importance of Incheon as a center for economic cooperation among cities around Yellow Sea.

To become a global logistics hub, Incheon has to make the most of strengths like the strategically advantageous position and convenient intermodal transportation systems and overcome weaknesses such as delays in the port and on the road owing to the insufficient infrastructure. "Logispolis" which consists of Airport, Seaport, Teleport, Business port, Ecoport, and Leisure port implies the development vision of the Incheon Metro City (IPS 1999).

Case Studies

Cases of the Mixed-use Development for Airports and their Vicinities

Airports studied include Kansai Airport and Rinku Town, Shanghai Pudong Airport, Changi Airport and its vicinity, new Kuala Lumpur Airport and its vicinity, Dallas Ft. Worth Airport and Las Colinas, New Denver Airport and Gateway, and Charles De Gaulle Airport and Roissy-Montparnasse. Most airports and their vicinities have functions such as international business, exhibition and conference, lodging, leisure, retailing, residential area, and industrial complex. And the industrial functions are mostly centered around aerospace and hi-tech industries.

The gross areas of land developed or to be developed in Shanghai Pudong Airport, Hong Kong Chek Lap Kok Airport, Kuala Lumpur Airport, Las Colinas, and Gateway are 75,000 acres, 240,000 acres, 20,250 acres, 11,000 acres, and 4,250 acres respectively.

In addition to Labuan International Finance Center, Malaysia developed Multimedia Super Corridor (MSC) with the specific purpose of attracting knowledge-based manufacturing operations from multinational enterprises in the multimedia industries to the production of films. The MSC extends south from the Kuala Lumpur City Center to the airport. This case shows international air linkages play a critical part for the MSC, highlighting the importance of global transportation networks as a complement to the MSC's virtual network (Bowen 2000).

Another example of utilizing airport for industrialization is the aerospace industry including airframe and aircraft engine component manufacture, repair, and assembly operations. Singapore, Malaysia and Thailand have adopted strategies attracting aerospace manufacturing and maintenance firms to serve the global market from their competitively positioned hubs (Bowen 2000). In Singapore, over 50 aerospace firms accounted for about 1% of Singapore's GDP (Low 1995).

Singapore, Malaysia, and Thailand have aspired to become an integrated international business hub through development of airport and urban megaprojects which have been built as new city spaces combining office, retail, hotel, conference center, and often residential land uses. Such new downtown complexes including Suntec City in Singapore, the Kuala Lumpur City Center in Malaysia, and the new Muang Thong Thani in Thailand were built along axes linking each city's traditional downtown core and its international airport (Olds 1995).

Singapore's vision to become a total business hub and Malaysia's efforts to attract the headquarters operations of multimedia corporations to the MSC, along with manufacturing facilities are premised on the easy access provided through the hub airport.

Holland International Distribution Council

Holland International Distribution Council (HIDC) is a private, non-profit organization with over 600 member companies or organizations. The members of HIDC provide a service relevant to companies analyzing or implementing Pan-European logistics and distribution solutions. The members of HIDC, individually or as a group, can provide answers to every possible question the potential customers will have on their road to Pan-Euro distribution networks.

Services provided by HIDC include:

1. matching foreign companies looking for logistics partners in Europe with many of its member organizations;
2. an extensive database on all the services provided by its members, markets, logistics, distribution, and international business;
3. a computer-based logistics decision support model, which helps foreign companies in the comparison of different supply chain structures for servicing the European Market.

Development Strategies of “The Winged City”

Asian Business Center

Main objectives of Asian Business Center (ABC) are as follow.

1. ABC, which is a core facility of IIA as a global trade center, promotes economic exchanges in Northeast Asia through efficient international business supports including exhibition of products from various countries.
2. ABC promotes international trade and creates new business activities through integration and systemization of Northeast Asian distribution networks.
3. ABC supports small and medium-sized distributors and retailers to open up new markets, identify customers' needs, and carry out merchandising and other marketing activities.

Major functions of ABC include international marketing supports, international information network services, consulting, exhibitions and conferences, lodging, and shopping. Specific functions of Aero Business Park, one of the key facilities at ABC, may include training supports utilizing flight simulators, software development, R & D, business supports, and information exchanges.

Critical success factors are as follows.

1. ABC should provide efficient supports for international marketing activities and business transaction deals.
2. Databases, which are comprehensive enough to include information such as trade, distribution, new technologies, new products, markets, customers, and competition, must be available. And information must be processed and analyzed to be ready for an immediate decision making. For such user-oriented and up-to-the-minute information to be continuously available, ABC needs decision support systems with extensive database management systems, efficient model base systems, and dialogue systems.
3. ABC needs to support small and medium-sized companies and foreign companies without sufficient information and experiences in the Northeast Asian markets. Specific supports offered include a trade analysis, marketing research, feasibility analysis, and development of various marketing and management strategies for market entrance, distribution channel design, and differentiation.
4. It is essential to secure and train experts who have various business experiences in Northeast Asian markets.

Asian Logistics Center

Asian Logistics Center (ALC) is a core facility of TWC that plans to develop into international business hub with manufacturing function, for the long run. ALC provides partial transformation and full-scale production functions as well as logistics functions including inspection, warehousing,

labeling, container marking, order processing, order picking, loading/unloading, reverse logistics, repair, repackaging, and various other VAL services.

ALC is recommended to be built inside the Free Zone, and key facilities will be various logistics facilities, processing and assembly facilities, factory outlets, exhibition halls, joint design and merchandising centers, marketing and logistics information systems, inspection and test facilities, and transaction and customs clearance support facilities.

Critical success factors are:

1. increases in the level of scope economy through integration of various logistics facilities and functions;
2. improvements in VAL services customized for specific needs and requirements of customers;
3. attraction of leading multinational corporations in logistics, distribution, and manufacturing;
4. a sufficient supply of highly skilled labor and labor-management cooperation;
5. service-oriented administrative supports.

ALC is believed to provide attractive core facilities and key functions for business enterprises adopting quick response strategies and strategic alliances. Below is a list of examples of such enterprises.

1. Dell Computer Corporation utilizes the vicinity of Penang airport in Malaysia as a production base and major airports in its Asian market as distribution and logistics hubs. The whole process including order processing, raw material sourcing, assembly, and delivery usually takes just 4 days in most of the Asian markets, thanks to quick response systems taking advantage of efficient air transportation networks and telecommunication systems.
2. Laura Ashley seems successful in achieving its rather ambitious goals of 2 day delivery anywhere in the world, 50% reduction of inventory, and 10-12% decrease of total distribution cost due to successful strategic alliances with Federal Express. With such alliances, extremely complex and costly logistics requirements of Laura Ashley are efficiently handled by Federal Express which has global air transportation networks, 3PL logistics division, and advanced monitoring and control systems.
3. Hewlett-Packard could cut back on total cost by 25% through adopting postponement strategies. Such strategies let distribution centers, located near markets and/or airports, take care of the final phase of assembly and product test in order to reduce risks concerning forecasting error and subsequent obsolete inventories.
4. Benetton successfully developed quick response systems which take less than a week to complete the whole process of order reception, production, packaging, shipment, and delivery, thanks to Benlog, a subsidiary and freight forwarder certified by IATA, and fully-automated logistics centers located near markets and/or airports.

CONCLUSION

The opening of Incheon International Airport provides excellent opportunities for aviation industries in Korea. And it is essential to develop effective mechanisms that can be used to revitalize aerospace-related and strategically important industries, and national economy through growth of IIA toward the logistics hub in Northeast Asia. Thus this research attempted to derive strategies to develop "The Winged City" into an airfreight hub, logistics hub, and economic hub incrementally.

Air transportation policies to support development of IIA into a logistics hub include: adopting Open Sky policy; effective responses to changes in air transportation policies of other countries; strategic alliances; creation of sufficient O/D and transshipment freight; minimization of rates and related logistics costs; accurate forecasting and continuous investments; real-time interface with Kimpo airport; aggressive marketing strategies; and improvements in competitiveness of Korean flag carriers.

Although strategies for IIA as a logistics hub may include various aforementioned options in extensive areas, this research placed greater emphasis on mixed-use development strategies for TWC as an economic hub. And development strategies of Asian Hub that provides a basic framework of the logistics hub in Northeast Asia and Asian Business Center and Asian Logistics Center that are core projects of mixed-use development plans of TWC were suggested.

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The Impact of Aviation Safety over the Consumer's Behavior

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ABSTRACT

The Impact of Aviation Safety over the Consumer's Behavior

The research purpose for The Impact of Aviation Safety over the Consumer's Behavior lies at the judgement that airline consumers' selection criteria has much changed after several serious aviation accidents as before when we used to overlook "aviation safety" variable through surveying to Korean aviation consumers and foreigners visit or travel Korea on various purposes. Therefore, for this research, practical analysis methods are employed after surveying to actual passengers who use Kimpo International Airport's international and domestic terminals. This study will be regarded significant in terms that empirical analysis was used to prove "Aviation Safety", a variable which had not been regarded as a airline choice factor within Korea air transport market so far, and has an effect on the aviation consumers' airline preference change and choice after recent frequent aviation accidents. Presenting this dissertation, I wish, it can be another opportunity for Korean two national flag airlines to reappraise and reinforce the significance of "aviation safety" and set forth immediate vigorous efforts to support the government's aviation safety improvement countermeasures. I hope the study to contribute and provide a variable idea and direction to improve aviation safety management of two Korean national flag carriers.

□. Introduction

1. Background and Purpose of the Study

Recently in Korea the air transport sector is facing rapidly changing world air transport market and the role of airlines become more important in international competition power to aviation safety. The Mokpo accident, however, by Asiana Airlines on July 1993 and Guam accident by Korean Air on August 1998 followed by serial accidents, Pohang accident on February 1999, Shanghai of China accident on April, and directly after Stansted airport accidents of England on December by Korean Air result in a situation that the discomfort factors are increasing when air consumers use air transport mode as well as lowered international credit level and some foreign airlines decided to stop codesharing flights with accident airlines. So it is time to improve airlines' image.

Therefore, focusing airlines making an effort to compete in world air transport market, it is studied the influence on domestic/international air consumers' air selection according to recent frequent air accidents' level of involvement on aviation safety. Also it is studied how "aviation safety", the variable recognized to not affect in selecting airline within Korean air transport market so far, much affected to air consumers purchase behavior in selecting airlines after accidents.

1. The Scope and Methodology

1) Scope of Study

The target group was established as domestic and foreign air consumer who uses Kimpo International Airport of Korea. Target group was classified in terms of great categories as Korean, American & European, Japanese, Chinese air consumers. In here domestic air consumers specify the respondent nationality is Korean and foreigners are English language speaking people from aviation advanced countries whose GNP score are higher than other countries and they can be classified U.S.A, England, Germany, France, Canada, Austrailias, and Japanese speaking Japanese and Chinese speaking Chinese, HongKong.

2) Methods of Study

This 1st survey was cited as restrictions that it is limited to Korean, had deficiency in systematic sampling. Processing some implementation, after one year, from may 25 to June 7 After one year, for 14 days, the 2nd survey was performed to compare and analyse the change in Korean air safety recognition and between domestic and foreign air consumers. As survey target group. to survey further, distinct from 1st survey, the questionnaires were prepared by each 180 pieces of Korean, Japanese, Chinese, English Language. And the survey was performed in arrival lounges, departure gates, check-in counters of Domestic, International 1st Terminal, International the 2nd Terminal of Kimpo Airport. The survey time has followed systematic sampling, selecting 1 among 5, by airlines time table which korean and foreigners most frequently depart and arrive.

Also domestic/foreign group travellers are excluded in this study, because the airline choices were on trevel agency's own preference, and the individual passengers are limited to whose air travelling experiences is more than one time in a year. To boarding passenger using domestic/international airlines of Kimpo International Airport including 173 Korean(96% were available from 180), 169 American and European(94%), 116 Japanese(61%), 128 Chinese(70%) were surveyed. The total number of collected by each countries was 720 and among them 120 questionnaire, the unfaithfully answered or personal information were omitted, thus had no standards for analysis, as well as Russian, Iran, African, Vietnamese, Pakistan, Indian, Carmeroon, Phillipine air user were excluded. Thus the certified questionnaires as final analysis target was 586, in the 2nd survey, to get more available questionnaire and faithful answers from foreigners, though it took long time for the survey. the researcher directly participated in implementing survey.

□ Hypothesis

The focus of this study's hypothesis lies in practical analysis on consciousness of domestic/international air consumers who use domestic airport on national carriers accident happened frequently more than two times in a

year. The hypothesis were established as below, after air accidents, air consumers' airline selection, behavioral change to air travel experience, consciousness difference on aviation safety by each countries, the importance of aviation safety by age.

[Hypothesis 1] After the frequent air accidents, more than 2 times within a year, domestic air consumer would prefer another transportation modes.

[Hypothesis 2] After recent air accidents happened more than 2 times within one year, the international air consumers show lower preference with the airlines had accidents.

[Hypothesis 3] After aviation accidents, the aviation safety has been much reflected in airline selection by aviation consumers.

[Hypothesis 4] air travel experience will have correlation with air consumers' attitude or behaviors to aviation safety.

[Hypothesis 5] The confidence on air travel safety would show lower level of effect to countries experienced frequent air accidents.

[Hypothesis 6] The air consumers from advanced countries are much conscious of safety emphasis considered in air travel.

[Hypothesis 7] The older the respondent, the higher do the emphasis on the confidence of air travel safety

□. Review for previous studies

As for the foreign literature, Mesachusetts Institute of Technology(MIT) in U.S.A, Professor Arnold Barnett from 1957-1976(20 years), 1977-1986(10 years) performed relationship between air consumers death risk and non-fatal safety accident. And Barnett, Abraham, and Schimmel[1979], Barnett and Higgins [1989] were announces. Recently in FAA Safety Report 1987-1996(10 years), the whole world's air consumer's fatal risk analysis by Arnold Barnett and Alexander Wang[1998].

Also there is study about the statistical difference on aviation safety by each airline group by Higgins (1987), GAO [1988], GRA [1988], Barnett-Higgins [1989], Oster et al. [1992], Stouffer [1992], FAA [1996], GAO [1996] In U.S.A or aviation advanced countries, the air accident rate are lower than undeveloped countries, particularly in U.S.A the accident rate of which airline operate jet aircraft are lower than commuter or regional airlines. In U.S.A established airline's accident rate are lower than newly entry airlines. FAA, GAO [1996]

As for on domestic literature, aviation safety, Choi[1995] told in "The Public Perception and Airline Safety : Case of Korea Airline Industry" that after the airlines competition system, air consumer's consciousness change for aviation safety and airlines have important duties to provide reasonable aviation safety information to air consumers and the problems are to be resolved from wrong consciousness. In "The impact of aviation safety on the consumer's choice of airline in the air transport market of korea" by Lee, KangSeok·Lee SeungChang(2000) there implemented a research about consumer's behavior before and after air accident to limited numbers of Korean.

□. Empirical Analysis for how aviation safety affect air consumer's behaviors

1. Technical statistics

After air accident, the adding value(30%) for aircraft safety in using domestic airlines, matters as well as air fare(30%). in using international airlines, the airfare(36%) and safety(31%) as important selection factors

<Table 1> Technical statistics for air service variables

Observed variables		Average	Standard Deviation
consideration importance for domestic flight selection(X2-1)*	air fare(X2-1-1)	30.24	22.90
	schedule(X2-1-2)	24.36	21.64
	safety(X2-1-3)	30.42	20.77
	service(X2-1-4)	15.54	12.47
consideration importance for International flights selection(X2-2)*	air fare(X2-2-1)	36.00	22.67
	schedule(X2-2-2)	18.04	14.70
	safety(X2-2-3)	31.32	21.63
	service(X2-2-4)	15.27	12.11
Aviation safety confidence(X3)**		76.26	19.17
New aircraft importance(X4-1)***		3.93	.85
Pilot performance importance(X4-2)***		4.62	.55
Airport facilities importance(X4-3)***		4.10	.80
Airline safety policy importance(X4-4)***		4.50	.69
Domestic air travel experience(X10-4-1)***		4.35	7.28
International air travel experience (X10-4-2)***		3.07	6.86

note) * total sum is 100 as standards ** 100 points full as standards. *** 5 points scale standards

2. Analysis for Reliability and Validity

1) Reliability and Correlationship Analysis

According to Nunnally(1978), Cronbach α , if usually above 0.7 in the fundamental study is admitted to be significant in terms of statistics. safety factor 0.7055, image factor 0.675, and convenience factor 0.827, they are relatively higher than economic factor 0.565, service factor 0.574.

Nextly, with the final selection variable which were excluded Cronbach α , we tested how exactly measured the concepts to try to measure. To certify the correct factors as established in advance, we used VARIMAX, A Rotation Method through principal component factor analysis

<Table 2>shows the result loaded factors after air service variable's rotating in the 1st survey on June 1999, <Table 3> shows the result loaded factors after air service variable's rotating in the 2nd survey on June 2000, after one year from the 1st survey.

To certify the correct factors as established in advance, we used initial Factor method as principal component analysis, selected eigenvalue more than 1.00 and decided 5 factor values, factor 1(safety), factor 2(image), factor 3(convenience), factor 4(economy), factor 5(service); which has 62.3% of explanation power, and judged considerably significant.

On the other hand, after analysing using VARIMAX, a kind of Rotation Method, the most big difference is lied in several factors are reconstructed compared to the 1st survey. Namely, in the 1st survey, it is analysed with image and services are distinguished, otherwise in the 2nd survey image and service are composed as same item. The air fare is composed with willingness to pay for service and it has positive appreciation for air consumers willing to pay air fare according to air service improvement.

<Table 2> Factor load after rotating (in the 1st survey)

	Factor1 (safety)	Factor2 (image)	Factor3 (convenience)	Factor4 (economy)	Factor (service)
X1- 5 Select safe airlines	.862	.002E-02	.432E-02	.4192E-02	.933E-02
X1- 6 Not prefer to accident airlines	.598	.182	.5681E-02	-.1921E-02	.7729E-02
X1- 4 Discomfort for accident	.494	.198	.7909E-02	.2855E-02	.278
X1- 8 Prefer good image	.348	.761	.5966E-02	.5248E-02	.246
X1- 7 Company morality	.319	.548	.173	-.162	.8229E-02
X1- 9 Image/service relationship	-.2732E-02	.527	.9366E-02	.177	.308
X1-14 Convenient telephone booking	.431E-02	.328	.797	.2503E-02	.185
X1-13 Convenient boarding process	.224	.201	.742	.3804E-02	.208
X1- 2 Selection for bonus system	.138	-.1505E-02	.1521E-02	.800	-.4971E-02
X1- 3 Selection for alliance card	-.3357E-02	-.1555E-02	-.4303E-02	.739	.2210E-02
X1-10 Difference crew service *	.276	.295	.128	.2537E-02	.632
X1-11 Service importance*	-.6547E-02	-.198	.3487E-03	.138	-.487
X1-12 Willing to pay for service	.5732E-02	.3943E-02	.9874E-02	-.5193E-02	.452

<Table 3> Factor load after rotating(in the 2nd survey)

	Factor1 (safety)	Factor2 (image)	Factor3 (convenience)	Factor4 (economy)	Factor (service)
X1- 5 Select safe airlines	.830	.160	.051	.098	.093
X1- 6 Not prefer to accident airlines	.750	-.049	.113	-.065	-.126
X1- 4 Discomfort for accident	.671	.251	.145	.097	.132
X1-11 Service importance*	-.081	.712	-.102	-.123	-.079
X1- 9 Image/service relationship	.072	.678	.213	.013	.203
X1-10 Difference crew service *	.302	.664	.135	.023	-.075
X1- 8 Prefer good image	.474	.564	.134	.157	-.123
X1- 7 Company morality	.380	.492	.109	.043	-.203
X1-14 Convenient telephone booking	.273	.145	.801	.171	-.160
X1-13 Convenient boarding process	.262	.197	.732	.196	-.213
X1-15 Convenient schedule *	-.213	.056	.687	-.253	.235
X1- 2 Selection for bonus system	-.012	0	.034	.881	0
X1- 3 Selection for alliance card	-.032	.113	.065	.876	.13
X1- 1 Low air fare *	.176	.145	.024	.167	.743
X1-12 Willing to pay for service	.276	.128	.127	.034	-.642

note) * means reconstructed items different from 1st survey. The bold are the groups of above 0.4 judged to be significant

3. Hypothesis Verification

1) Verification for [hypothesis 1]

"After the frequent air accidents, more than 2 times within a year, domestic air consumer would prefer another transportation modes". Though recent frequent happened air accident, there is more passengers who responded would change another airline than change another transportation mode, representing 42.1%, 41.6%, in the 1st and 2nd survey, and the respondent who would change transportation mode to 7.81%, 8.33%. This survey result show, different from other hypothesis, after air accidents, there is more air consumers who would move to another airlines than to another transportation mode in <Table 4>.

Above analysis was made through frequency of airline selection change in domestic route after air accidents, however <Table 4-1>shows Chi-Square test between the 1st survey and the 2nd survey's responses which would change airlines or transportation mode, the result was concluded it was not significant as shown <Table 4-1>. This is analysed that there is no difference between who respond would change domestic airline selection and would change transportation mode.

<Table 4> The rate of change to domestic airline selection

Classifications		1st Survey	2nd Survey	Total
change to another airline	frequency	81	80	161
	change rate(%)	42.19	41.67	83.85
	Row Pct	50.31	49.69	
	Col Pct	84.38	83.33	
change to another transportation mode	frequency	15	16	31
	change rate(%)	7.81	8.33	16.15
	Row Pct	48.39	51.61	
	Col Pct	15.63	16.67	
Total	change frequency	96	96	192
	change rate(%)	50	50	100

<Table 4-1> Chi-Square Test according to domestic airline selection direction

Test method	Chi-Square value	Degree of freedom	Prob
Chi-Square	0.038	1	0.845
Likelihood Ratio Chi-Square	0.038	1	0.844
Continuity Adj. Chi-Square	0.000	1	1.000
Mantel-Haenszel Chi-Square	0.038	1	0.845
Fisher's Exact Test(Left)			0.652
(Right)			0.500
(2-tail)			1.000
Phi Coefficient	0.014		
Contingency Coefficient	0.014		
Cramer's	0.014		

To the question why do not change the international airline selection after a series of air accident, the survey result for air consumers are in <Table 5>. In the first survey who didn't change international airlines were 78 among 140(55.7%), In the 2nd Survey, 116 among 171(60.2%).

In total survey including the 1st and 2nd. among air consumers who did not change the international airlines were 40.2%, 59.7% each. and there showed meaning difference between 1st and 2nd survey in terms of selection change rate. The reason why did not change the international airlines were convenient schedule(29.90%), mileage(26.80%), fare(13.92%), and good service(13.40%), otherwise in the first survey the priority was schedule(30%), mileage(25.7%), fare(17.1%), service(4.3%).

In the 2nd survey, schedule and mileage has no change compared to previous year, however, fare(14%), service(13.4%) variables showed great change. Therefore, in case of domestic air consumers, there is no great change between who replied would change airline selection and would use another transportation mode. It can be said that air consumers are will to pay air fare as far as the airlines' service is good. Thus the hypothesis 1 "After the frequent air accidents, more than 2 times within a year, domestic air consumer would prefer another transportation modes" " was rejected and there is significant to change selection to another airlines.

<Table 5> The reason why change international airlines

Classifications		1st Survey	2nd Survey	Total
mileage	frequency	22	30	52
	percentage of change (%)	11.34	15.46	26.80
	Row Pct	42.31	57.69	
	Col Pct	28.21	25.86	
convenient schedule	frequency	21	37	58
	percentage of change (%)	10.82	19.07	29.90
	Row Pct	36.21	63.79	
	Col Pct	26.92	31.90	
fare	frequency	12	15	27
	percentage of change (%)	6.19	7.73	13.92
	Row Pct	44.44	55.56	
	Col Pct	15.38	12.93	
good service	frequency	4	22	26
	percentage of change (%)	2.06	11.34	13.40
	Row Pct	15.38	84.62	
	Col Pct	5.13	18.97	
others	frequency	19	12	31
	percentage of change (%)	9.79	6.19	15.98
	Row Pct	61.29	38.71	
	Col Pct	24.36	10.34	
Total	not changed frequency	78	116	194
	selection rate(%)	40.21	59.79	100

<Table 5-1> Chi-Square Test for international airline selection change by cause

Test method	Chi-Square value	Degree of freedom	Prob
Chi-Square	13.079	4	0.011
Likelihood Ratio Chi-Square	0.038	4	0.008
Continuity Adj. Chi-Square	0.000	1	0.485
Mantel-Haenszel Chi-Square	0.038	1	
Fisher's Exact Test(Left)			
(Right)			
(2-tail)			

2) Verification for [hypothesis 2]

The hypothesis 2 "after recent aviation accidents happened more than 2 times within one year, the international air consumers show lower preference with the airlines had accidents. " has similar results with the 1st survey and the 2nd survey in those who respond he would change airlines in international air travel". At the 1st survey, as shown <Table 6>, the change rate of domestic airline selection is 45.5% which is lower than 15% by before accident. in the 2nd survey, the change rate was 45% which is appeared to be no big change. This means there is no larger than in domestic than international and there is more strong motivation to lead using previous airlines continuously.

<Table 6> Whether change international airline selection or not(In the 1st Survey)

Whether international airline selection or not (N=145)	Number of samples	rate
Changed	66	45.5%
Not changed	79	54.5%
Total	145	100%

<Table 6-1> Whether change international airline selection or not (In 2nd Survey)

Whether international airline selection or not(N=311)	Number of samples	rate
Changed	140	45.0%
Not changed	171	55.0%
Total	311	100.0%

There for, the hypothesis 2, "after recent aviation accidents happened more than 2 times within one year, the international air consumers show lower preference with the airlines had accidents." is accepted, though in 2nd survey, the domestic airline change rate is 59%, which is lower than in the 1st survey 58%. But the respondents' preference on airline selection about accident airlines as shown in the 1st survey 45.5%, in the 2nd survey 45%.

3) Verification for [hypothesis 3]

The hypothesis "After aviation accidents, the aviation safety has been much reflected in airline selection by aviation consumers." is a questionnaire(V) how recent frequent air accidents within 2 years was reflected as a aviation safety variables in selecting airlines. Shown in <Table 7>, the average has scored to 3.88 from 3.40 when setting standards at 5.00

<Table 7> The average reflection level of aviation safety variable to airline selection variables

Classification	Air safety reflection level before accidents	Air safety reflection level after accidents
Average	3.40	3.88

<Table 8> Analysis between the level of aviation safety reflection and airline selection change

		Accident		
		Before accident	After accident	
8a	Changed domestic airline selection (N= 92)	average value for reflection degree	3.5652	4.1413
		correlated value	0.424***	
		t-value of reflection degree before and after accident	-5.604***	
		accident point	average reflection degree before accident	average reflection degree after accident
8b	Unchanged domestic airline selection (N = 64)	average reflection value	3.1563	3.5625
		correlated value	0.497***	
		t-value of reflection degree before and after accident	-4.108***	
		accident point	average reflection degree before accident	average reflection degree after accident
8c	Changed international airline selection (N = 66)	average reflection degree value	3.6364	4.1818
		correlated value	0.433***	
		t-value of reflection degree before and after accident	-5.034***	
		accident point	average reflection degree before accident	average reflection degree after accident
8d	Unchanged international airline selection (N = 79)	average reflection value	3.1772	3.6329
		correlated value	0.425***	
		t-value of reflection degree before and after accident	-4.170***	
		accident point	average reflection degree before accident	average reflection degree after accident

1) t-value stands for average difference between the reflection level before/after accident and changing domestic/international airline selection

note) : *** 1% significant

<Table 9> Logistics regression analysis to effect on aviation safety

Variables	Domestics	International
Average safety-related factors	0.7382***	1.0254***
Degree of consideration safety-related factors in domestic/international airline selection	0.00975	0.0302**
Safety confidence	-0.00969	-0.0143
Aviation safety component	-1.0821***	-1.6794***
Degree of reflection after accident	0.6223**	0.7627**
-2Log(L)	33.815***	54.889***

note) N=146 ** 5% significant *** 1% significant

After analysing safety-related factors at the first survey, in domestic routes, the safety-related factors, namely aviation safety elements and the level of reflection after air accidents appeared to be significant effect to air consumers domestic purchase behaviors while in international routes, safety-related factors, namely, the level of consideration for safety in domestic/international routes, aviation safety elements and the level of reflection after accidents proved to be significant effect to air consumers international purchase behaviors.

As shown <Table 10>, the significant variables to air consumers' purchase behavior after air accidents are analyzed as safety, services, and airport facilities. On the other hands, <Table 10-1> shows, in case of international routes, the significant variable to air consumers' purchase behavior after air accidents is analyzed as safety,

<Table 10> significant Variables to purchase behaviors after air accident

Variables	Level of flexibility	Parameter estimate	Standard error	Wald chi-square	Prχ-square
INTERCEPT 1	1	-8.0641	1.6817	22.9951	0.0001
Safety	1	0.7330	0.2392	9.3866	0.0022
Airfare, Service	1	0.4051	0.1904	4.5286	0.0333
Airport Facilities	1	0.5421	0.2209	6.0252	0.0141
Criterion	Intercept only	Intercept & Covariates		chi-square for Covariates	
AIC	191.947	187.187			
SC	194.888	237.195			
-2 LOG L	189.947	153.187		36.759 with 16 DF(p=0.0023)	
Score		-		32.854with 16 DF(p=0.0077)	

note) purchase behavior=-8.0641+0.7330(safety)+0.4051(airfare:service)+0.5421(airport facilities)

<Table 10-1> significant Variables to purchase behaviors after air accident (international)

Variables	Level of flexibility	Parameter estimate	Standard error	Wald chi-square	Prχ-square
INTERCEPT 1	1	-5.4680	1.2311	19.8582	0.0001
Safety	1	0.5526	0.2255	6.0040	0.0143
Criterion	Intercept only	Intercept & Covariates		chi-square for Covariates	
AIC	186.467	176.779			
SC	189.372	223.263			
-2 LOG L	184.467	144.779		39.688 with 16 DF(p=0.0005)	
Score		-		32.643with 16 DF(p=0.0053)	

note) purchase behavior = -5.4680 + 0.5526(safety)

Namely, the hypothesis 3 "After aviation accidents, the aviation safety has been much reflected in airline selection by aviation consumers was accepted.

4) verification for [hypothesis 4]

The hypothesis "air travel experience" will have correlation with air consumers' attitude or behaviors to aviation safety", proved in the first survey that the number of domestic or int'l air travel have no special relations with aviation safety variables. In the Correlation Analysis with the first survey and the second survey, in domestic routes, they analyzed the number of air travel experience affected no significant effect to aviation safety or attitude. In case of international, however, the correlation analysis with the first survey and second survey of a year after, there seemed that the number of international air travel experience have no little significant correlation

to safety and it is interpreted it has no relations with the level of confidence to aviation safety.

But it also could be doubted in terms of the level of confidence air users of many experiences have tendency to have lower confidence in air travel safety than air users of little experience, which the former can consider various air fares, services and safety in contrast with that domestic air users have limited selections. In this study, they judged the more experiences have the air travellers, the lower confidence to air safety. Therefore <hypothesis 4> **air travel experience“ will have correlation with air consumers' attitude or behaviors to air safety”** was accepted international air transport.

<Table 11> The relationship between air travel experiences and other air safety variables

Classification	The number of domestic air travel experience	The number of international air travel experience
Aviation safety confidence	-.88	-.008
New aircraft	-.31	-.123
Pilot performance	-.99	.094
Airport facilities	.68	.154
Airline safety policy	-.011	.084
Degree of aviation safety reflection after accident	-.106	.091
Safety	-.055	-.025
Image	-.010	.085
Convenience	.38	.207*
Economical Efficiency	.009	.095
Service	.034	.167*

□) * 5% significant(2-tailed)

5) Verification for [hypothesis 5]

At the hypothesis that **“The confidence on air travel safety would show lower level of effect to countries experienced frequent air accidents”**, after reviewing the confidence on air travel safety by each group of countries, it showed at <Table 12> after accidents Japanese, America-Europe, Chinese people shaped a group, and the Korean people shaped another group of considerably low level of confidence in air travel safety after accidents, according to Duncan Grouping analysis from Among ANOVA test. This difference is analyzed that a series of air accident by Korea national flag carriers frequently happened in recent made Korean people distrust in aviation safety and this trend is partly because newspapers and mass communications raised the aviation safety issues and the consciousness that air travel is safe is relatively low than other target countries people.

<Table 12> The confidence on air travel safety

Duncan Grouping	Average	Number of Samples	Group of Countries
A	81.133	105	Japan
A			
A	80.232	166	America, Europe
A			
A	78.792	120	China
B	73.373	166	Korea

Therefore, <hypothesis 5> **The confidence on air travel safety would show lower level of effect to countries experienced frequent air accidents”** was accepted.

6) Verification for [hypothesis 6]

At the hypothesis that **“ The air consumers from advanced countries are much conscious of safety emphasis considered in air travel”**, there appeared Chinese group is distinct from the other similar group consist of Japanese, America and European, Korean group. The reason why Chinese group show difference than other groups is analysed it is because people does not much consideration on air fare from socialism system as well as from GNP effect and it naturally brought higher importance for aviation safety while air travellers from advanced countries has tendency to put less importance on aviation safety in air travel.

Therefore, the hypothesis 6, "The air consumers from advanced countries are much conscious of safety emphasis considered in air travel" was rejected.

<Table 13> Relative importance of safety in air travel

Duncan Grouping	Average	Number of Samples	Group of Countries
A	50.374	107	China
B	38.379	87	Japan
B	37.171	155	America-Europe
B	32.516	153	Korea

7) Verification for [hypothesis 7]

To verify hypothesis 7 "The older the respondent, the higher do the emphasis on the confidence of air travel safety", a SNK(Student Newman Keuls) through ANOVA test method is applied. Among <Table 14a, b, c, d, e>, <Table 14a>, the table analyzed by age for confidence for air travel safety, shows there is no difference by age between air travel safety confidence. Furthermore in <Table 14b>'s analysis by age for aircraft age among aviation safety elements, there shows no difference by age from who replied it is important to aviation safety variables

The air consumers who responded pilot performance is important among aviation safety variables show no differences by age at <Table 14c>. On the other hand <Table 14d> show some difference by age between who responded the airport facilities are important as aviation safety variables; the air consumers under 20 were distinct from other age groups, this can be judged they are not highly of air facilities. <Table 14e> show no difference by age between who responded the airline safety policies are important as aviation safety variables; Therefore <hypothesis 7> "The older the respondent, the higher do the emphasis on the confidence of air travel safety." was rejected, because there appeared some significant difference by age only for airport facilities, however not for any other variables.

<Table 14 a, b, c, d, e> Analysis to air travel safety by Age

Aviation safety confidence for air travel analysis by age ANOVA TEST						
[Table 14a]	Source	DF	Sum of Square	Mean Square	F value	pr\squareF
	Model	4	1575.0778079	393.7694520	0.96	0.4301
	Error	312	128076.94381	410.5029961	-	-
	Corrected sum	316	129652.01261	-	-	-
	Classification	R ² 0.012149	C.V. 27.11600	Root MSE 0.4736726	Mean 1.3455882	
Aircraft age among aviation safety importance by age ANOVA TEST						
<Table 14b>	Model	4	24.54893316	6.13723329	2.78	0.0404
	Error	322	6776.6804246	21.04559138	-	-
	Corrected sum	326	6801.2293578	-	-	-
	Classification	R ² 0.003609	C.V. 107.3053	Root MSE 4.58754738	Mean 4.27522936	
	Pilot performance among aviation safety importance by age ANOVA TEST					
<Table 14c>	Model	4	8.61790205	2.15447551	0.41	0.7987
	Error	323	1681.8577077	5.20698981	-	-
	Corrected sum	327	1690.4756097	-	-	-
	Classification	R ² 0.005098	C.V. 49.56673	Root MSE 2.28188295	Mean 4.60365854	
	Airport facility among aviation safety importance by age ANOVA TEST					
<Table 14d>	Model	4	4.78346956	1.19586739	1.56	0.1857
	Error	323	248.14031093	0.76823626	-	-
	Corrected sum	327	252.92378049	-	-	-
	Classification	R ² 0.018913	C.V. 21.82908	Root MSE 0.87649088	Mean 4.01524390	

Airline safety policy among aviation safety importance by age ANOVA TEST							
<Table 14e>	Model	4	2.11004514	0.52751128	0.87	0.4812	
	Error	323	195.49971096	0.60526226	-	-	
	Corrected sum	327	197.60975610	-	-	-	
	Classification	R ²		C.V.	Root MSE	Mean	
			0.010678	17.62289	0.77798603	4.41463415	

2. Conclusion

The result of this study can be summarized as below; firstly, it is fact that the air frequent air accidents by national flag carriers during recent 3 years affected greatly the level of perceptions of air consumers and it brought a big change in airline selection, quite different as before air accident which happen by chance. **[hypothese 1], <After the frequent air accidents, more than 2 times within a year, domestic air consumer would prefer another transportation modes>** was rejected, this shows the preference for another airlines moved than for another transporation modes.

According to survey result, the international air consumers require high involvement purchase than domestic air consumers and except for 'aviation safety' variable, such variables as airlines mileage, schedule, price(air fare), and service constantly worked as factors to strongly maintain air consumers in international air travel than domestic one.

Thirdly, after recent air accidents happened more than 2 times within one year, the aviation safety has been much reflected in airline selection by aviation consumers. Whether aviation consumers change airline selection in domestic / international according to the amount of "aviation safety" variable being aware of, there is significant difference between air consumers who has changed airline selection and who hasn't reflected level for selection after accident is higher than before accidents.

Fourthly, as "aviation safety" variable are not obviously demonstrated different consumers behavior pattern derived from air travel experience difference in Korea air transport market, "aviation safety" variable is so much regarded the object of enduring involvement as one of situational involvement. Therefore it is difficult to find out obvious consumers behaviors by each social layers.

It is expected the air travel frequencies has close and significant relations with aviation safety confidence because the consumers of many experiences show coherent consumers behavior in product selection than of little experience. In the 1st survey with the 2nd survey. In case of international air travel, however, air travel frequencies make an significant minus effect on safety. It is judged domestic airlines selection can be taken within only limited consideration otherwise international airline selection, various air fare, service and safety factors because the more experienced of air travel, the lower of confidence in aviation safety.

Fifthly, as for aircraft age, pilot's performance maneuver, and airlines safety policy are how much significantly affect to aviation safety; aircraft age has no relations with aviation safety otherwise pilot's performance maneuver and airlines safety policy has significantly relations. This means air consumers are conscious that aircraft age are not related to aviation safety

At the 1st survey, there is no difference in air consumers responses on the importance of aircraft age and airport facilities to aviation safety. Otherwise after 1 year there happened changes in air consumers consciousness in terms of responses on pilot's performance maneuver and airlines safety policy has significant relations with aviation safety. It also can be said that from the pilot's performance maneuver factor suggest human factors are important in aviation accident and airlines aviation safety policy affect air consumer's consciousness of aviation safety.

Sixthly, among the factors which considered in air travel, the relative importance of aviation safety are highly differed only in Chinese otherwise Japanese, North American and European, and Korean can be grouped as one. This can be analysed that the higher GNP and the more advanced countries, the lower of safety's relative importance.

Seventhly, the confidence of air travel safety, Japanese, North American and European, and Chinese are classified into one group otherwise Korean into another. Between Korean people, the level of air travel safety confidence are considerably low. This phenomena is due to the recent air accident more than 2 times within one

year and the problems on newspapers and mass communication, which gave distrust to Korean consciousness for aviation safety. Therefore as far as confidence in air travel safety, the confidence level of Korean are relatively low than other countries.

Eighthly, the reflection level of aviation safety as airline selection factor after aviation accident has most significant effect in North America, Europe and Japan; particularly in North America and Europe are shown to be highest level in term of aviation safety reflection otherwise in Japan the significance are relatively low than North America or Europe.

Ninthly, as for the domestic airline section change Japanese, North American and Korean can be classified into one group otherwise Chinese into another group. It can be said that Japanese, North American and Korean are to be significant to air accident in national airline selection and Chinese are not to change international airline selection irrespective of accident. Also, as for change of international airlines selection, Japanese North American and Korean can be classified into one group otherwise Chinese into another group. It can be said that Japanese, North American and Korean are to be significant to aviation accident international airline selection and Chinese are not to change international airline selection irrespective of accident.

Tenthly, as for the common sense increasement on aviation safety, its level difference between groups are large; the analytic data show its increasing trend of North-America and Europe is higher than those of China.

As a conclusion, this research has significance in the fact it analyse air consumer's preferential change by demonstrating "aviation safety" variable which has not been regarded as airlines selection factor in korean air transport market because airlines selection factor rose up after the recent air accident. Therefore this research result is expected to make some contribution to the effort for elevating aviation safety level and enhancing air transport competition power by preparing the government's fundamental policies to aviation safety and airlines systematic devices for aviation safety based on those policies.

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Topic Areas: A3. Transport Modes (Airport and Aviation)

The Integration of China and Taiwan Air Networks for Direct Air Cargo Services

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ABSTRACT

Two sides of Taiwan Strait speak the same language and share the same culture, however, the economic and social environments are quite different. China is a developing country with a vast of cheap labors and plenty of raw materials. Contrarily, Taiwan is a developed country with high-technology manufacturing economic base. Integrally, two sides perform mutually dependent but complementary activities on the global supply-chain manufacturing. As a result, the trade between two sides grew in double-digit annually in the 90's. Even though, there are no direct air links between two sides due to the political differences, the direct air links are inevitable. In this research, we researched and interviewed through a vast of governmental documents of China, Taiwan, Hong Kong and Macau, and air cargo carriers and airlines serving China-Taiwan air links. These materials enable us to tabulate the trade, estimate the air cargo and realize the major carriers and airports serving the China-Taiwan air link. Subsequently, we analyzed the current Chinese air route maps of her domestic airlines, and used the connectivity measurement to classify airports into national, regional and local classes. The classification allows us to determine the China hub-and-spoke air network and potential airports for future direct air connections. With the development of a mathematical model, we determined the top direct airfreight airports were Shanghai Xiamen and Changsha. The outcome does not coincide with direct passenger airports. The top three most proposed by researchers are Fuzhou, Xiamen and Shanghai.

Keywords: hub-and-spoke network, network design, Air cargo, Taiwan Strait

1 INTRODUCTION

Two sides of Taiwan Strait speak the same language and share the same culture, however, the economic and social environments are quite different. China is a developing country, having a vast of cheap labors and plenty of raw materials. Its economic base is primary agriculture and secondary low-technology manufacturing. Contrarily, Taiwan, a small island, is a developed country. The consequence of high labor wages together with the lack of raw materials, the high-technology manufacturing, especially in the electronic and computer industries constitutes its economic base. However, two different economic bases perform mutually dependent but complementary activities on the global supply-chain manufacturing. As a result, the trade between two sides grew in double-digit annually in the 90's.

No direct air links across the Taiwan Strait presents a great obstacle to the booming cross trade. Thus, more and more entrepreneurs advocate for direct air links in order to be more competitive on the global business environment. In addition, both sides are actively pursuing a separate member status of and are likely to join World Trade Organization (WTO) in a foreseeable future. The direct air links is seemly inevitable. Thus, the main purpose of this research is to design a methodology to determine the most cost-effective integrated airfreight network for China-Taiwan air link. The structure of this paper is as follows. In section 2, we tabulated the trade statistics between two sides to realize the value of direct airfreight link. In section 3, we analyzed the relationship between two sides of Taiwan Strait from the perspective of global supply-chain manufacturing. The mutual complementary roles point out the urgent necessary of direct airfreight link. In section 4, we interviewed government officials and airlines to understand the current airfreight routes of and airlines and airports serving China-Taiwan air cargo market. There are no official statistics on China-Taiwan air cargo market. Thus, in section 5, we

used other relevant statistics to estimate not only the aggregate air cargo total between two sides, but also airport-to-airport air cargo distribution. In section 6, we used the connectivity measurement as the index to determine the hub-and-spoke air network for China. The proper classification allows us to determine a set of candidate airports for future direct airfreight links. In section 7, we modeled the integration of China and Taiwan air network as a facility design problem with embedded least cost subproblem. Upon the determination of a set of candidate airports, the problem becomes the shortest path problem. We implemented the Dequeue implementation and coded in C. We studied various scenarios by selecting different sets of candidate airports. We also analyzed the cost and location implications of selection based on passenger and air cargo demands. Our conclusions were summarized in section 8.

2 TRADES

The China-Taiwan trade was increased in a steady pace in the 90's. The trade between two sides grew in a double-digit annually in the first half of 90's (Board of foreign trade, 2000). As the result, the trade has more than doubled in less than four years from \$8,054 in 1991 to \$16,511 million US dollars in 1994. Subsequently, due to the instability of cross strait relationship in the 1996 Taiwan presidential election and the 1998 Asia-Pacific economic and financial crisis, the growth was gradually tapping off in the second half of 90's. Despite the negative impacts, the trade in monetary still increased. As the result, in 1997, Taiwan is the 5th trade partner of China (National Bureau of Statistics of China, China, 1998); while China is the 4th trade partner of Taiwan. In 1998, 16.62% of China's total import was from Taiwan, the 5th trade partner, even though China only supplied less than 4% of Taiwan's total import (Mainland Affairs Council, 1999). Due to this trade imbalance, Taiwan has enjoyed more than \$14 million US dollars trade surplus. Needless to say, either side is an important international trading partner of the other.

Table 1: Trade between two sides of Taiwan Strait (in Million USD)

Year	Export to China			Import from China			Surplus
	Amount	Percentage	Growth rate	Amount	Percentage	Growth rate	
1991	6,928.3	9.09%	66.10%	1,125.9	1.79%	47.10%	5,802.4
1992	9,696.8	11.90%	39.96%	1,119.0	1.55%	-0.61%	8,577.8
1993	12,727.8	14.96%	31.26%	1,015.5	1.32%	-9.25%	11,712.3
1994	14,653.0	15.75%	15.13%	1,858.7	2.18%	83.03%	12,794.3
1995	17,898.2	16.03%	22.15%	3,091.3	2.99%	66.32%	14,806.9
1996	19,148.3	16.52%	6.98%	3,059.8	2.99%	-1.02%	16,088.5
1997	20,518.0	16.81%	7.15%	3,915.3	3.42%	27.96%	16,602.7
1998	18,380.0	16.62%	-10.42%	4,110.5	3.93%	4.99%	14,269.5
1999	21,221.3	17.50%	15.50%	4,526.3	4.10%	10.10%	16,695.0
2000	26,162.2	17.60%	23.30%	6,223.3	4.40%	37.49%	19,938.9

Sources: Board of Foreign Trade, Ministry of Economic Affairs, R.O.C., (2000.12), http://www.trade.gov.tw/prc&hk/bi_ch/mo_index.htm.

3 DISTINGUISHED ROLES ON THE SUPPLY-CHAIN MANAGEMENT

Either side imports quite different kinds of commodities from its counterpart. More than 72.7% of Taiwan's import from China in 1998 was agriculture and industrial materials. Electronic equipment and parts and consumer goods were a distance second and third with 16% and 11.3% of the total, respectively. On the other hand, Taiwan exported electronic and machinery, and textiles to China, each had 33.2% and 11.2% shares of the total import.

Table 2: Trade between the two sides of Taiwan Strait in 1998

Imports to Taiwan (in Million of USD)						
	Electronics & machinery	Raw materials	Metal	Chemicals	Others	Total
1999	1,905.9 (42.11%)	337.7 (7.46%)	508.4 (11.23%)	114.3 (2.53%)	1,660 (36.67)	4,526.3 (100%)
2000	2,853.5 (45.85%)	432 (6.94%)	783.2 (12.58%)	134 (2.15%)	2,020.6 (32.47%)	6,223.3 (100%)
Exports from Taiwan (in Million of USD)						
	Electronics & machinery	Plastics	Textile	Mental	Others	Total
1999	8,002.9 (37.71%)	2,500.5 (11.78%)	2,748 (12.95%)	1,691.1 (7.97%)	6,278.8 (29.59%)	21,221.3 (100%)
2000	10,498.5 (40.13%)	3,352.5 (12.81%)	2,914.7 (11.14%)	2,187.9 (8.36%)	7,208.6 (27.55%)	26,162.2 (100%)

Sources: Board of Foreign Trade, Ministry of Economic Affairs, ROC (2000.12);
http://www.trade.gov.tw/prc&hk/bi_ch/mo_index.htm

The statistics show two different economic bases perform mutually dependent but complementary activities. In a depth study, it reveals three fundamental mutual relationships between two sides from the supply chain manufacturing perspectives. First, China is the procurement market for Taiwan's products. The former provides the raw materials and/or labor-intensive less technical semi-products to Taiwan at where the semi and/or finished products are manufactured for overseas markets. Among them, U.S. and Japan are the two major consumption markets. Chemical and electronic products are the two most mentioned products. Second, China is Taiwan's out-dated machinery market. To modernize its manufacturing industries, the Chinese government levies no import taxes for machinery imported since 1998. Therefore, whenever the plants in Taiwan upgrade their machinery, the obsolete ones are shipped to China. This becomes one of the major export items from Taiwan. Third, Taiwan provides high-tech parts for Chinese domestic market. Taiwan has positioned itself as one of the world major electronic products providers, especially, the computer and periphery products. Therefore, Taiwan manufactures high technological electronic parts. They are shipped to China and integrated with other Chinese-made low-tech electronic parts for domestic consumption. Its market share is relatively small, but is becoming the trend for the future growth. Each side of the Taiwan Strait performs an independent but mutually complementary activity of the global supply-chain manufacturing.

4 MAJOR AIR CARRIERS AND AIRPORTS

Air and sea are the transportation modes serving the cross-strait trade. After for more than four decades, both sides finally agreed a direct maritime link in 1996, even though it limited to only a few seaports at each side. The agreement does not include direct air passenger or cargo links. All air cargo is still required to stopover at least one of the airports, called *transit* airports, in a third country or a special administrative region (such as Hong Kong or Macau) prior to entering the border of either side.

The air cargo industry consists of time-sensitive air express couriers and time-insensitive airlines. Express couriers are common carriers, providing door-to-door time guaranteed *express cargo* service to whomever pay for the published tariffs. They are also integrated carriers who integrate air transportation, pickup and delivery and customs declaration services in a package for shippers. Federal Express, UPS, DHL, are the top three air express delivery couriers. On the other hand, airlines provide air only transportation

service, are contract carriers, serving airport-to-airport *general cargo*. Shippers may reserve aircraft space directly with airlines or via forwarders. Otherwise, they will accept shipments only when there is available space on scheduled passenger or all cargo flights. Recently, some of airlines offer airport-to-airport time guaranteed delivery. In addition, if desire to provide the same integrated services as express couriers, airlines need to alliance with forwarders and customs brokers in both origin and destination countries. The alliances with freight real time tracking information system empowers the airlines to compete with time-sensitive air express couriers for the high growing time-sensitive air cargo market.

The hub-and-spoke network is the most commonly used line-haul network configuration for the air cargo industry (Chestler, 1985; Kuby and Gray, 1993). In each country, airfreight is picked up by widely scattered operations centers if hauled by time-sensitive express couriers; or by forwarders if hauled by airlines. They are transported to the major national airport of the country. Shipments are loaded unto aircraft for its primary hub for consolidation. In some cases, they make a very limited number of spilt, typically one for each Continent, if volume is heavy enough to build full loads. When receiving, air hubs consolidate inbound volume and build loads for each of their assigned satellite countries and each of other Continents. When economical to build a full load for countries of other Continents, they will do so to save an additional consolidation. When each country receives its delivery volume, express couriers will split the volume for each individual operations center for delivery. On the other hand, shippers will pick it up at airports, or airlines will forward it to forwarders for delivery. The hub-and-spoke structure may substantially reduce partial loads and therefore the overall operating cost.

Currently, Federal Express and UPS are the top express couriers, while China Airlines, Eva Airways, Cathy Pacific Airlines and Dragon Air are the top airlines serving China-Taiwan link. The Asia-pacific air hubs for Federal Express and UPS are located in Subic Bay in Philippine and Taipei in Taiwan, respectively. On the other hand, most airlines base their air hubs at their own countries. Therefore, Taipei is the Asia-Pacific air hub for both China and Eva, while Cathy Pacific and Dragon airlines designate Hong Kong as their air hub.

In 1998, the time-definite common couriers hauled less than 5% (525,165 tons) of Taiwan's combined import, export and transit volume. A large portion of air cargo was hauled by airlines. The top three, in order are China, Evergreen and Cathy Pacific. They hauled respectively 70%, 58% and 95% of the total tonnage of import, export and transit cargo (Taipei Air Cargo Terminal, 1999).

Table 3: Taiwan import, export, and transit air cargo by carrier (in Tonnage)

Imports by air carriers							
	1992	1993	1994	1995	1996	1997	1998
China	23.6%	25.2%	27.5%	30.0%	33.3%	33.6%	34.0%
Evergreen	4.3%	7.0%	12.5%	16.6%	20.2%	20.3%	23.7%
Cathy Pacific	14.3%	14.5%	12.7%	12.7%	11.9%	13.2%	12.6%
Total	188,321	207,953	#####	255,571	238,534	#####	#####
Exports by air carriers							
China	20.4%	22.4%	23.7%	24.0%	23.2%	22.3%	23.5%
Evergreen	3.0%	6.5%	11.1%	11.9%	12.9%	15.9%	20.1%
Cathy Pacific	11.9%	13.6%	15.4%	18.2%	18.7%	17.7%	15.2%
Total	295,010	295,072	#####	229,672	206,207	#####	#####
Transit cargo by air carriers							
Evergreen	2.1%	7.9%	24.0%	40.9%	44.3%	45.2%	55.6%
China	61.4%	61.4%	57.3%	43.2%	43.3%	45.9%	38.4%
Cathy Pacific	3.2%	2.8%	2.3%	1.8%	1.7%	2.1%	1.3%
Total	26,705	34,131	47,761	60,158	63,877	74,354	67,495

Source: Taipei Air Cargo Terminal, Civil Aeronautics Administration, Ministry of Transportation and Communications ROC, 1999

To serve the China-Taiwan link, Federal Express uses its Asia Pacific air hub in Subic Bay as the transit airport and is the only air cargo provider who may fly directly from the air hub to China and Taiwan. Other cargo carriers must stopover at least one transit airport. Hong Kong is the exclusive transit airport for UPS, China, Cathy Pacific and Dragon airlines, while both Hong Kong and Macau serve as the gateway for Eva Airways for China-Taiwan air cargo. Express couriers are integrated carriers who provide a complete door-to-door service for shippers. However, airlines will forward the shipments in the transit airports, to local forwarders who under the contract are responsible for customs declarations and contract airlines to transport them to their destinations.

Table 4: Weekly frequencies and aircraft fleets in Feb. 2001

	FedEx ¹	UPS ⁶ (1999.12)	China ²	Eva ³	Cathy Pacific ⁴	Dragon ⁵
HKG-TPE		767F(5)	747-400(29),737-800(2), MD-11(10),A300-600(36), 747F(6) ⁷	747-400(22) MD-11(1)	747-400(14), 777(17), A330(41),A340(17) 747F(6) ⁷	
TPE-HKG		767F(1)	747-400(29), 737-800(2), MD-11(10), A300-600(36), 747F(6) ⁷	747-400(22), MD-11(1)	747-400(15), 777(14), A330(44),A340(15) 747F(6) ⁷	
HKG-KHH			737-800(14),A300-600(14)			A330(21)
KHH-HKG			737-800(14),A300-600(14)			A330(21)
MFM-TPE				767-200(25)		
TPE-MFM				767-200(25)		
MFM-KHH				767-200(7)		
KHH-MFM				767-200(7)		
SFS-TPE	MD11(1)					
KHH/TPE-SFS	A310(1)					

Sources: ¹Lin, Cheng-Chang et al., (2001); ²China Airlines, <http://www.china-airlines.com>; ³Eva Airways, <http://www.evaair.com.tw/online/schedule.htm>; ⁴Cathy Pacific Airlines, <http://www.cathaypacific.com/ego/interactive/0.,16559,00.html>; ⁵DragonAir, <http://www.dragonair.com/chinese/flight/index.htm>; ⁶Civil Aeronautics Administration, Taiwan, <http://www.caa.gov.tw/account/1997/indexc.htm>; ⁷by communication.

Express couriers, Federal Express and UPS, flew all cargo freighters, while airlines utilized belly space of passenger scheduled flights for cargo carries. In Feb. of 2001, Federal Express scheduled two round-trip flights Beijing- Shanghai-Subic Bay and Subic Bay-Taipei, serving China-Taiwan air link. The inbound flight to Taipei was also stopped over Kaohsiung to unloading southern Taiwan packages.

In addition to an enormous number of passengers scheduled flights, both China and Cathy Pacific Airlines scheduled six weekly all cargo round-trips flights of freighter 747s between Hong Kong International and Taipei CKS international airports of the same month. In Hong Kong, China Airlines handled over (or received) the shipments to (from) local forwarders who filed customs declarations and arranged appropriate airlines and flight schedules for Mainland China-Hong Kong air feeds. There are several China domestic airlines available for selection. They are Air China, Eastern, Southern, Southwest, Northwest, North airlines and so on. On the other hand, upon completion of customs declaration, Cathy Pacific Airlines handled over exclusively to her partner, Dragon Air for China inland air feeds. Dragon Air flew out of Kaohsiung airports, uses belly space available on passengers scheduled flights for Taiwan-Hong Kong air link. At Hong Kong International airport, connections were made to an extensive passenger air network of Dragon Air serving majority of major cities in China. In addition, Dragon Air currently scheduled one, even though two additional are under planning, round-trip weekly all cargo freighter 747 between Hong Kong and Shanghai. For Eva Airways, they use the belly space of passenger flights between Hong Kong/Macau and Taipei CKS/Kaohsiung International airports for China-Taiwan air cargo. They act as the same as China Airlines by contracting local forwarders for customs declarations and connections to final destinations in Mainland China.

Table 5: Air links and frequencies between Mainland China and Hong Kong and Macau

Airports and Frequencies	
From HKG ¹	Beijing(58), Shanghai(106), Guangjoui(28), Chengdu(5), Kuenming(10), Xiaman(21), Shian(8), Wuhan(8), Haikou(9), Chungching(2), Hoju(14), Nanjing(17), Changsha(6), Shenyang(4), Fujou(28), Zhengzhou(2), Dalian(9), Shantou(14), Gueilin(13), Qingdao(9), Nanning(3), Wenzhou(3), Ningbo(7), Hefei(2), Nanchang(3), Sanya(9), Huangshan(2), Beihai(2), Tianjin(7), Jinan(3), Yantai(3), Zhanjiang(2), Shijiazhuang(2), Meixian(2)
To HKG ¹	Beijing(65), Shanghai(106), Guangjoui(28), Chengdu(5), Kuenming(10), Xiaman(21), Shian(8), Wuhan(8), Haikou(9), Chungching(2), Hoju(14), Nanjing(17), Changsha(6), Shenyang(4), Fujou(28), Zhengzhou(2), Dalian(9), Shantou(14), Gueilin(13), Qingdao(9), Nanning(3), Wenzhou(3), Ningbo(7), Hefei(2), Nanchang(3), Sanya(8), Huangshan(2), Beihai(2), Tianjin(7), Jinan(3), Yantai(3), Zhanjiang(2), Shijiazhuang(2), Meixian(2)
From MFM ²	Beijing(7), Shanghai(21), Kuenming(7), Xiaman(14), Shian(1), Chungching(3), Nanjing(2), Fujou(7), Gueilin(13), Wuisung(2)
To MFM ²	Beijing(7), Shanghai(21), Kuenming(7), Xiaman(14), Shian(1), Chungching(3), Nanjing(2), Fujou(7), Gueilin(13), Wuisung(2)

Sources: ¹Hong Kong International Airport http://www.hkairport.com/chi/flight_info/FlightInfoFrame.jsp; DragonAir, <http://www.dragonair.com/chinese/flight/index.htm>; Air China, <http://www.airchina.com.cn>; China Eastern, <http://www.ce-air.com>; China Southern, <http://www.cs-air.com>;

²Macau International Airport, <http://www.macau-airport.gov.mo/chinese/flight/flightfrm.html>;

5 THE ESTIMATION OF CHINA-TAIWAN AIR CARGO MARKET

Chinese and Taiwanese governments only tabulate and publish the trade statistics in monetary between China and Taiwan. No air cargo statistics are available. Hong Kong Special Administrative Region, however, collected and documented the transit freight via Hong Kong that originates from one and destines to the other side of Taiwan Strait. In a two-year span, 1996 and 1997, more than one-third of air cargo exported to Taiwan from

Hong Kong was originated from China. Even more astonishing, slightly less than two-third of import from Taiwan was destined to China. As the result, Taiwan exported four times of import to China.

Unfortunately, the similar statistics were not available for transit freight via Macau. The air cargo statistics tabulated by the Macau Special Administrative Region have the total import from and also export to China and Taiwan, as shown in Table 6. Moreover, the Administration published the proportions in monetary of her total export (import) trade was to (from) China and Taiwan, respectively. With these two pieces information, we estimated the air cargo to China (Taiwan) from Taiwan (China) was the average of the following two products. (1) Air cargo from Taiwan (China) to Macau times the proportion of total export trade that was destined to China (Taiwan); and (2) air cargo to China from Macau times the proportion of total import trade that was originated from Taiwan.

Table 6: The China-Taiwan air cargo via Hong Kong and Macau

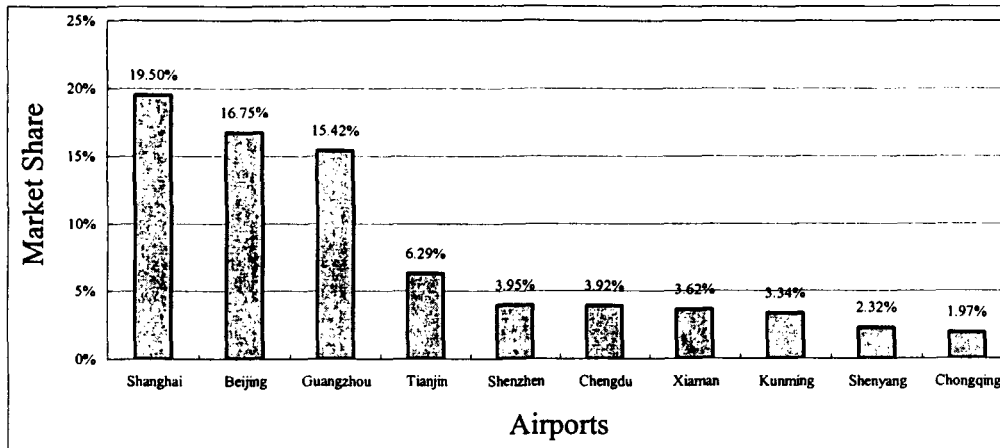
		Export to TWN	% transit to China	Import from TWN	% transit for China
Hong Kong ¹	1996	21,427	37% (7,928)	62,044	61.5% (38,157)
	1997	29,279	37.2% (10,892)	74,161	60.8% (45,090)
Macau ²	1996	120.16	23.97% (28.8)	498.01	8% (39.84)
	1997	338.66	28.56% (96.72)	1,049.88	6.49% (68.14)
	1998	421.55	32.65% (137.64)	1,809.26	6.77% (122.49)
	1999	324.44	35.64% (115.63)	1,292.1	9.2% (118.87)
		Export to China	% transit from TWN	Import from China	% transit to TWN
	1996	819.59	8.81% (72.2)	1,355.10	1.17% (15.85)
	1997	1,528.68	9.26% (141.56)	3,238.04	1.44% (46.63)
	1998	1,945.72	9.86% (191.85)	5,992.98	1.47% (88.1)
	1999	2,451.83	9.51% (233.17)	4,842.16	1.22% (59.07)

Sources: ¹Department of Statistics, Ministry of Transportation and Communications, ROC (1997);

²Department of Statistics and Census Services, Macau Special Administrative Region,
<http://www.dsec.gov.mo/html/chinese/index.html>;

As the result, the total tonnage of air cargo from Taiwan to China and from China to Taiwan were 10,958.47 and 10,958.47 tons in 1997, respectively. Upon the estimation of total tonnage on either direction of two sides of Taiwan Strait, we estimated airport-to-airport volume. We allocated each airport will receive the same share of its import (export) tonnage to the total of the country. Figure 1 shows the top ten air cargo airports in China in 1997. The top three in order are Shanghai, Beijing and Guangzhou.

Figure 1: The top ten air cargo airports in China



Source: Civil Aeronautics Administration of China (1997)

6 THE AIR FREIGHT NETWORK IN CHINA

Politically and economically, the Chinese government divides the nation into six regions, Northeast (NE), East central (EC), East (E), Southeast (SE), Southwest (SW) and Northwest (NW). There are in total of 67 airports in China. In this research, we classify them into national, regional and local airports based on their connectivity to other airports in the same region and also in other regions. A local airport is a gateway to local markets. A regional airport is a regional hub at where it can make connections to at least half of the other airports in the same region. When no such a candidate, we choose the one with the most connections as the regional hub. The NE, EC and NW regions all have a single regional airport. They are Shaya, Beijing and Wulumuqi, respectively. Each of the E and SW regions, however, has two regional airports. Shanghai and Wuhan are in the E while Chengdu and Kunming are in the SW. The SE region has the most number of regional airports including Guangzhou, Shenzhen, Xiamen, Haikou and Chongsha.

Table 7: National and regional airports in the Mainland China

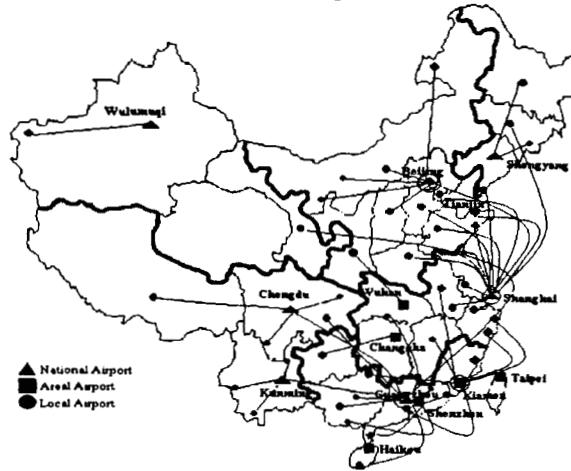
Region	Total in region (# of airports) ¹	Airports	Intra-regional connectivity (# of airports) ¹		Inter-regional Connectivity (# of regions) ¹		Class
Northeast	6	Shaya	3	60%	3	60%	National
East central	13	Beijing	11	92%	5	100%	National
East	14	Shanghai	7	54%	5	100%	National
		Wuhan	5	38%	4	60%	Regional
Southeast	18	Guangzhou	13	76%	5	100%	National
		Shenzhen	10	59%	3	60%	Regional
		Xiamen	8	47%	3	60%	Regional
		Haikou	7	41%	3	60%	Regional
		Changsha	6	35%	3	60%	Regional
Southwest	13	Chengdu	5	42%	4	80%	National
		Kunming	7	58%	3	60%	National
Northwest	3	Wulumuqi	2	100%	4	80%	National

Source: ¹Civil Aeronautics Administration of China (1997, 1998).

A national airport serves as a gateway to other regions for the respective region. Shaya, Beijing, Shanghai, Guangzhou and Wulumuqi are national airports to the NE, EC, E, SE and NW regions, respectively. In the SW region, Chengdu and Kunming, are both classified as national airports, serving identical number of regions. Local, regional and

national airports together form a hub-and-spoke air cargo network in China.

Figure 2: The hub-and-spoke network in Mainland China



There are several major airlines in China. They are Air China, Eastern, Southern, Southwest, Northwest and North airlines. Each has a non-duplicated respective service territory. Observing their route maps, their respective air hubs are Air China (Beijing), China Eastern (Shanghai), China Southern (Guangzhou), China Southwest (Chengdu), China Northwest (Shian) and China North (Shaya) airlines.

7 THE DIRECT LINKS

Recently, there are more and more voices for a direct air freight link. National and regional airports are naturally the candidate transit airports for future cross-strait direct links. The behavior of carriers is also to select and deliver airfreight on the least cost path. In this research, we made the following assumptions.

- (1) The non-stop flight time between any pair of cities in the combined territories of China and Taiwan is no more than 6 hours. Thus, we assume that carriers will make at most one-stop over a transit airport prior to the final destinations, unless no such paths exist.
- (2) There is an ample belly cargo space available on Chinese domestic and air links for airfreight. Thus, we assume the carriers will fully utilize the belly cargo aircraft space that is currently available.
- (3) In this research, we minimize the shipper expenses on the cross-strait air cargo demand.

7.1 Mathematical model

This problem is a facility location problem embedded with a minimum cost flow subproblem.

$$\text{Objective: } z = \min \sum_{ij} \sum_m P_{ij} x_{ij}^m \quad (1)$$

Subject to:

$$\sum_i x_{ij}^m - \sum_i x_{ji}^m = \begin{cases} Q^m; j = m_d; \\ -Q^m; j = m_o; \\ 0; otherwise; \end{cases} \quad \forall j \in N; m \in M; \quad (2)$$

$$\sum_m Q^m x_{ij}^m \leq \hat{V}_{ij} \quad \forall ij \in A; \quad (3)$$

$$\sum_i \sum_m x_{ij}^m \leq Bf_j \quad \forall j \in H; \quad (4)$$

$$x_{ij}^m \geq 0 \quad \forall ij \in A; m \in M; \quad (5)$$

$$f_j \in \{0,1\} \quad \forall j \in H; \quad (6)$$

with decision variables:

x_{ij}^m , the quantity of m^{th} OD pair flown on link ij ; and

$f_j = 1$, if airport j is chosen to be a transit hub for China-Taiwan air link; $f_j = 0$, otherwise.

and parameters:

P_{ij} , the freight tariff per ton on link ij .

The objective is to minimize the yearly air cargo transportation cost for China-Taiwan air link. Constraint (2) is the flow conservation. All the freight must depart from the origin airports and arrive at the destination airports. Any transit airport can not staging any freight, that is, the inbound must equal to the outbound volume. Constraint (4) is the bundling constraint, coupling freight routes with facility design variables, that is, only when an airport is designated as a transit airport, otherwise no freight can be fed to the facility. The current China air network can accommodate the China-Taiwan air cargo. Thus, in this research, B is a big number, implies that there is sufficient facility capacity to handle the possible assigned volume. The freight flows on links and facility design decision variables are non-negative real and binary that are stated in constraints (5) and (6), respectively. Note that, in the model, we do not explicitly consider the airport operational capacity. The direct link across the Taiwan Strait provides direct flight instead of current indirect flight via Hong Kong and Macau. Thus, the increase of direct flights will take no more than the capacity vacant by indirect flights via these two airports. Thus, we assume the net effect is very small and can be neglect.

7.2 Freight tariffs

The freight rates of international and domestic flights are quite different. In this research, we used international freight rate of Dragon Air, China and Cathy Pacific Airlines and Eva Airways to calibrate per kilometer and per ton international freight rate. On the other hand, we used the China domestic freight rate of Shanghai Airlines and Dragon Air to calibrate per kilometer and per ton domestic freight rate. The estimated international and domestic freight rates are NTD\$26.74 and NTD\$23.0 with R-square of 0.70 and 0.89, respectively. Both regressions were significant, thus, we applied them for our numerical testing.

7.3 Airport charges

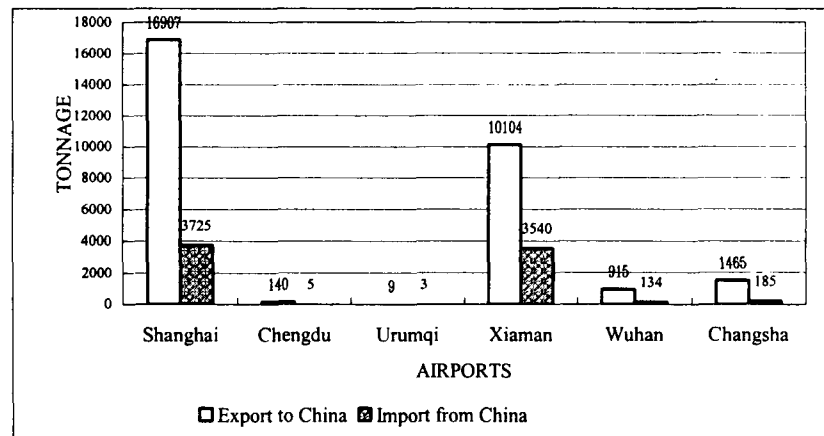
Chinese officials charge airlines various operational fees in using the airports under their jurisdiction. Fees include air navigation facility, landing and take-off, night operations and lighting, peak hour and aircraft parking. There is a peak-hour surcharge of USD\$100 per movement between 01:00 to 09:00 to Capital in Beijing, Hongqiao in Shanghai and Baiyun airport in Guangzhou. Besides that, all fees are standard (see Appendix) and applied to all the airports in China. Thus, in this research, we assume that the airlines will be expected to pay the same airport operating cost to all the airports.

7.4 Computational results

In this numerical testing, we conducted three scenarios testing. The first scenario, *12 cargo hubs*, designates all 12 national and regional airports as transit airports. The second scenario, *top 3 cargo hubs*, designating only the top three air cargo airports determined in the first scenario, as transit airports. The third scenario, *top 3 passenger hubs*, designating only the top three passenger airports proposed in research as transit airports. The three most proposed passengers airports are in order, Fuzhou, Xiamen and Shanghai (Lin et al., 1999; Lin and Liu, 1999; Wong, et al., 1996).

The facility design problem has an embedded least cost subprogram. Whenever a set of transit airports is determined exogenously, the problem becomes a least cost problem. In this research, we code the Dequeue implementation, a label-correcting typed algorithm to solve the shortest path problem. The program was coded in C and tested on a Pentium-III with a CPU speed of 500 MHz PC under Linux OS. As the result, the top two transit airports are Shanghai and Xiaman. The top two serve 59.77% and 66.30% of Taiwan to China and China to Taiwan air cargo, respectively. The distance three is Changsha with only 3.24% and 1.69% respective market share.

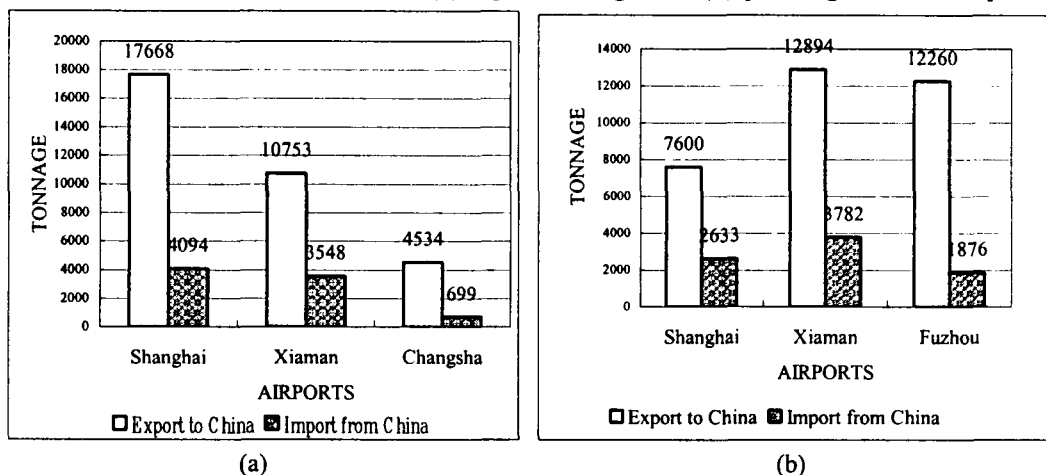
Figure 3: The market share of 12 candidate transit airports



The top three transit airports based on airfreight demand are quite different from the ones based on passenger demand. The top three passenger transit airports are Fuzhou, Xiamen and Shanghai. To realize the cost implication of two different selection criteria, we performed two separate tests. First, observe that Fuzhou is classified as a local airport due to its connectivity. The reason for chosen it as a passenger transit airport is that there is a high local demand by Taiwanese. Note also that Fuzhou and Xiamen are not only very close by airports, but also in the same providence. The inclusion of Fuzhou, some of transit freight via Shanghai has rerouted to Fuzhou and Xiamen, especially for the east

coastal cities. Moreover, Fuzhou and Xiamen split the air cargo originally handled by Changsha.

Figure 4: The market share of (a) top 3 air cargo and (b) passenger transit airports



The redirection of airfreight does a cost penalty associated with it. Limiting only to three top air cargo airports, the shippers pay additional NTD\$20 million annually. Moreover, in order to accommodate passenger demand, they will be charged additional NTD\$2 million annually. The selection of transit airports have definitely different cost implications to either group, passengers or shippers.

Table 8 : Direct linkage between two sides of cross strait

		Non-stop		One-stop		Two-stop		Total cost (NTD\$)	Tonnage (Tons)
		Cities	Vol. Ratio	Cities	Vol. Ratio	Cities	Vol. Ratio		
Taiwan→ China	12 cargo hubs	7	34.64%	35	63.99%	25	1.37%	1,495,851,648	45,194.74
	Top 3 cargo hubs	3	26.68%	38	76.08%	26	1.66%	1,505,014,822 (+0.61%)	
	Top 3 PAX hubs	3	25.33%	36	74.67%	28	1.68%	1,506,439,791 (+0.70%)	
China→ Taiwan	12 cargo hubs	7	30.72%	35	66.10%	25	3.18%	350,925,312	10,958.47
	Top 3 cargo hubs	3	22.40%	38	76.11%	26	1.49%	359,247,055 (+2.37%)	
	Top 3 PAX hubs	3	22.71%	36	76.65%	28	1.64%	359,774,173 (+2.52%)	

8 CONCLUSIONS

Taiwan and China perform mutually dependent activities on the global supply-chain manufacturing. Politically and economically, the direct air links between two sides are inevitable. In this research, we designed a methodology to determine the most cost-effective integrated airfreight network for China-Taiwan air link. Shanghai and Xiaman are the top two airfreight transit airports. They serve in total 59.77% and 66.30% of Taiwan to China and China to Taiwan air cargo, respectively. The distance three is Changsha with only 3.24% and 1.69% respective market share. However, the direct airfreight network is quite different from the passenger network. The most mentioned passenger transit airports are Fuzhou, Xiamen and Shanghai. The results show at least two interesting future researches. One is to analyze the fully integrated passenger and

airfreight network for China-Taiwan air link. The trade off between shippers and passengers may critical influence the decisions on the transit airports selection. Secondly, in this research, we do not include Hong Kong and Macau International Airports. In our analysis, the functions of both airports were replaced by Xiamen airport. However, future study is necessary to integrate both airports in the integrated China-Taiwan air network. In addition, a study to realize the potential impacts of direct airfreight link between two sides of Taiwan Strait on current transit airports of Hong Kong and Macau is an interesting extension of this research.

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APPENDIX

Yearly, the General Administration of Civil Aviation of China publishes airport charges of all the airports in China. They are classified under several categories as follows.

1. Landing and take-off charges

The maximum take-off weight is specified in the certificate of airworthiness.

Maximum take-off weight(tonne)	Charges(U. S. dollar per tonne or part thereof)
Up to 50	558
51—100	558 + 9×(T-50)
101—200	1008 + 10×(T-100)
Over 200	2008 + 12×(T-200)

Note: T represents the maximum take-off weight specified in the certificate of airworthiness rounded up to the higher tonne.

2. Night operations surcharge

An additional 25% of landing and take-off charges will be assessed for aircraft operating between 15:00 to 22:00(UTC).

3. Peak hours surcharge

An additional charge of 100 U.S. dollars per movement between 01:00 to 09:00 (UTC) at Beijing/Capital, Shanghai/Hongqiao, Guangzhou/Baiyun airport.

4. Lighting charges

A 10% of landing and take-off charges will be assessed for aircraft using night landing facility.

5. Parking charges

First two hours free. 15% of the landing and take-off charges will be assessed per 24-hour period or part thereof in excess of two hours.

6. Air Navigation Facility Charges

The total distance is the distance flown within the airspace of China expressed in kilometers and the maximum take-off weight is indicated in the certificate of airworthiness expressed in tonne. The total kilometers of each flight shall be determined in accordance with the actual kilometers of air routes in the Radio Navigation Chart (RNC) published by the General Administration of Civil Aviation of China. For all the flights flown over the airspace of China, a charge of USD\$1 per kilometer will be levied.

Maximum take-off weight (tonne)	Charges (U. S. dollar per kilometer)
Up to 50	0.40
51—100	0.45
101—200	0.50
Over 200	Charged as the formula: $R = T \times D / 100 \times \sqrt{\frac{MTOW}{50}}$

Note: R -- Total charge; D -- Total distance flown expressed in KM; T -- Unit rate: USD\$ 30.62;
MTOW -- Maximum take-off weight expressed in tonne.

QUALITY PERCEPTION AND CARRIER CHOICE IN CIVIL AVIATION

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ABSTRACT

The recent emergence of low cost carriers has drawn considerable attention in civil aviation. Many travelers nowadays choose 'no frill' flights at a low fare, which suggests that carriers have in the past allocated too much of their resources to quality. In this paper, we turn our attention to the quality of civil aviation service. We define quality as all factors other than price, that influence consumers' choices for carriers. We develop a framework where carrier choice is determined by generalized travel costs and the quality image of carriers. The latter may be either experienced or perceived quality of a carrier. The valuation of travel costs and quality image is influenced by person and trip characteristics, as well as by past experiences.

We use our framework to survey four types of approaches to quality in civil aviation. First of all, we analyze travel demand studies, both relating to demand volumes and carrier or airport choice. A second type consists of studies focussed on a single quality indicator. Next, we examine the results of carrier performance evaluation, while the fourth type consists of market research studies. We find that travel demand studies are mainly concerned with generalized costs. Performance evaluations are more likely to yield a complete image of carrier quality.

Key words: Civil aviation, Quality, Product differentiation

1. INTRODUCTION

Understanding and recognizing quality in civil aviation is important for four reasons. First of all, carrier quality influences demand, thereby also influencing carrier market share and the modal split of intercity travel. A second reason why we may be interested in the quality of carriers, is that we are interested in the outcomes of a specific aspect of quality, for instance air transport safety. Apart from the reasons mentioned before, we may also be interested in carrier performance in a broad sense. This information may be valuable to regulators, or to the companies itself, since knowing their relative position enables them to enhance their quality. For the companies, information on quality and the perception of quality is also vital in their marketing strategy, which is the fourth reason why it is important to understand quality in civil aviation.

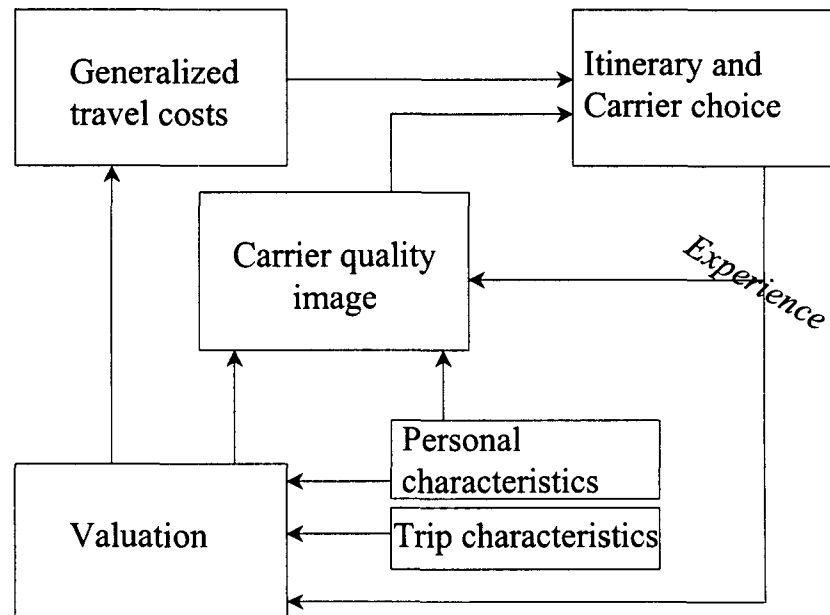
Parallel to these four reasons, we distinguish between four types of publications where to find information on carrier quality: travel demand analysis publications, one issue studies, carrier performance evaluations and market research publications. After a short introduction of our analytical framework in section 2, our paper follows these types, dedicating a section to each of the types of publications mentioned above. In section 7, we give an overview of the results and state some concluding remarks.

2. HOW CAN WE DEFINE CARRIER QUALITY?

Before we are able to assess carrier quality, we need to define the subject thoroughly. Let us do this by considering a traveler, who has already made part of his travel decisions. He knows he is going to travel from A to B, he knows his departure date and he knows he will travel by plane. Now he is on the brink of choosing an airline. Suppose our traveler is determined to make the choice himself, ruling out a decision by his travel agent. What we would like to know is what factors, apart from the ticket fare, influence this travelers choice for an airline.

First of all, we have to realize that a traveler chooses between itineraries. Each trip alternative that takes the passenger from A to B is judged on its own characteristics as well as on the characteristics of the carrier operating the flights. Figure 1 depicts a stylized version of the process of itinerary and carrier choice.

Figure 1 *The process of itinerary and carrier choice*



We define two important factors for carrier choice: generalized travel costs and carrier quality image. Generalized travel costs, consisting of the out of pocket expenses and the monetary value of travel time, are mainly attached to the choice of the itinerary. Apart from this, we define the carrier quality image, resembling what the traveler thinks of a carrier. It consists of the weighted sum of all choice variables other than generalized travel costs. The carrier quality image may relate to very different aspects of the flight, such as food quality, seating space, crew attitude and so on.

One important difference between carrier quality image and generalized travel costs is that the latter mainly consists of easily measurable components. One can obtain a fairly accurate image of fare, in-flight time, waiting time and transfer time, simply by consulting a travel agent or an internet reservation system. With the carrier quality image, this is less obvious. Although some quality aspects, such as delays and accidents, are publicly available figures and easy to interpret, other factors are either measurable but unknown to the public (e.g. seating space), or not objectively measurable (e.g. crew attitude, food quality).

Both generalized travel cost factors as quality image factors have to be valued in order to be compared. Each traveler implicitly values travel time against fare, chance of delay against travel time and so on. The valuation of quality aspects depends on both personal and trip characteristics. Obviously, a business traveler values travel time higher than someone on a holiday trip, and tall people are likely to value seating space higher than small people.

Apart from valuing aspects in a different way, personal characteristics may also influence the carrier quality image. As we saw earlier, carrier quality image is not objectively measurable. Taste variations, for instance, may go beyond valuation. If a certain carrier serves spicy food, this may be a positive aspect to some travelers and a negative aspect to others. This is not a valuation matter, since valuation only tells us how (un)important a good meal is to a traveler. The same goes for factors that may seem to be objectively measurable. The quality factor 'number of crew members speaking the traveler's native language' is totally different to an American as it is to a German citizen.

A final factor in carrier choice is experience. If a traveler has never traveled on a certain carrier before, the carrier quality image is built up out of published figures, advertising and hearsay. After flying with that carrier, the image may be changed because of the experience. Furthermore the valuation of trip aspects may change through experience. If a traveler never switched planes on a layover flight, it is fairly impossible for this traveler to value a non-stop versus a layover flight. In general, with growing experience, the accuracy of valuation gets higher.

3. TRAVEL DEMAND ANALYSIS

There are several types of travel demand studies. Some analyze demand volumes on city pairs, some analyze the factors behind mode choice, carrier choice, route choice or even airport choice in multiple airport regions. One may aspect that *travel time* plays an important role in travel demand analysis. However, it is hardly used in aviation travel demand analysis, probably because there are too little differences between carriers on given routes, so travel time is conveniently approximated by distance. The only recent

aviation demand study where in-flight travel time plays a role, is the one by Fridström and Thune-Larsen (1989). Bhat (1995) finds significant effects for both in-vehicle and out-of-vehicle travel time in a modal choice study, where travel time differences are expected to be larger.

Although travel time is rarely used as an indicator, travel demand analysis is dominated by factors that are closely related to travel time. Almost any empirical study takes schedule convenience into account. Chances of departing or arriving at a desired time are positively related to flight frequencies. Therefore, frequencies are often used as a proxy for schedule convenience. (Ghobrial, 1993, Kanafani and Ghobrial, 1985, Bath, 1995, Proussaloglou and Koppelman, 1995, Suzuki 2000a). Talley and Schwarz-Miller (1988) use number of departures, incorporating both frequency and number of destinations. The higher the number of departures of a carrier, the higher the chance that an itinerary of that carrier is taken into account by the traveler that makes the choice. Therefore, we like to think of frequency as an indirect measure for generalized travel costs.

Apart from in flight time, a trip from A to B consumes time on airports, as well as getting to and from airports. Airport quality may therefore play a role in carrier choice. Harvey (1987) finds that airport access time influences route choice in a multiple airport region. Unless all carriers serve all destinations from all the airports in the region, airport access time may influence carrier choice. Apart from getting at the airport, getting on and of the plane is time consuming. Swait and Bernardino (2000) and Suzuki (2000b) mention check in waiting time and luggage reclaim waiting time as carrier quality factors.

Both Ghobrial (1993) and Kanafani and Ghobrial (1985) mention aircraft size, measured by the number of seats, as a quality factor, though neither make very clear why they do so. Kanafani and Ghobrial (1985) use three size classes, where the largest plains are those with more than 50 seats. One can imagine that in this size range, size matters to comfort, and possibly also to flying speed. Ghobrial (1993) uses number of seats however on a sample with mainly intercontinental traffic, suggesting the use of planes well over 50 seats. This hampers a direct interpretation of the reason for using the number of seats as a quality indicator. It is however clear that the number of seats refers to an itinerary rather than to an entire carrier. Therefore, we label this indicator as an aspect of generalized travel costs.

Harvey (1987) finds that connecting flights are poor alternatives for direct flights but finds no difference between nonstop and multi-stop flights without a layover. This suggests that the change of plane aspect of non-direct flights weighs heavier than the extra travel time involved and the possible discomfort of an extra landing and take off.¹ The main differences between a mere stop and a layover is that the latter involves the discomfort of having to find your way at a strange airport and risks like losing luggage and missing connecting flights. However, since the layover is connected to the itinerary rather than the carrier, we like to think of layovers as a (negative) feature of a trip alternative. For this reason, we label layovers as an aspect of generalized travel costs.

The negative valuation of change of planes mentioned above suggests that the number of direct flights is positively valued. Prousaloglou and Koppelman (1995) define a positive valued characteristic labeled carrier market presence as the carrier's share of flights originating in a (geographic) market, reflecting both the number of links in a network as frequency. Much like frequency and the number of departures mentioned earlier, this market presence indicator relates to a chance that a carrier has of having one or more favorable alternatives in a traveler's choice set. Another way of measuring this type of quality is through network size, as Röller and Sickles (2000) do. They define the network size as the number of route kilometers, the total length of all routes of a carrier.

Röller and Sickles (2000) also mention load factor as a quality measure. Load factor can be seen as the inverse of the capacity offered per passenger and has the obvious advantage of avoiding multicollinearity problems in empirical studies. Higher capacity reduces the chance of being bumped because of an overbooked flight. Since load factors are generally measured at the carrier level rather than at the level of individual flights, we label it a carrier quality image aspect.

Suzuki (2000a) relates on-time performance to the loss aversion property and finds that an airline can lose passengers through delays, but the on-time performance statistic of an airline is not an important choice variable for passengers willing to switch. Several other authors, like Prousaloglou and Koppelman (1995), Abrahams (1983) and Suzuki (2000b)

¹ Kanafani and Ghobrial (1985) also find a strong route choice effect for non-direct flights. They distinguish between online stops and connecting service in a linear fashion only however, thereby assuming that the disutility from a change of planes is twice that of an online stop. Ghobrial (1993) also finds a negative effect of intermediate stops. It is however not clear whether online stops or changes of planes are meant here.

also use on time performance as a measure for service quality. The relation to the loss aversion property suggests that this measure is more likely to fit into the carrier quality image (CQI) category than in that of generalized travel costs. Furthermore, the loss aversion aspect indicates that this part of the carrier quality image is largely experience based, as our framework suggests.

Swait and Bernardino (2000) mention quite a few aspects of carrier quality, such as seat characteristics, crew attitude, food choice, in-flight entertainment and the number of crew members speaking the traveler's native language. Many of these quality aspects may differ from flight to flight, especially if we take taste variations into account, as Swait and Bernardino do. Having said this, we also note that the level of quality offered with respect to the indicators mentioned here is determined at the carrier level. If we look at it from the perspective of the traveler, as our framework suggests, we see that the traveler is unaware of the actual seating space at individual flights, whereas he might have the knowledge or perception that carrier A generally offers more space than carrier X. The same goes for the other indicators mentioned here. Therefore, we label them carrier quality image aspects.

The main subject of the article by Swait and Bernardino (2000) is taste variation. They find that, on three routes from different origins, there are some taste differences regarding food, in-flight entertainment and the design of the frequent flyer program. However, taste variations for crew attitude and seat comfort could not be found, suggesting that these quality factors are experienced in the same manner.

Suzuki (2000b) is the only travel demand study where the quality of the food and beverage service is explicitly mentioned as an airline attribute, although it is used together with other attributes to form a service quality variable. The other quality factors Suzuki uses to determine this variable are on time performance, fast check in and boarding and efficient baggage handling.

4. ONE ISSUE STUDIES

Berry (1990) and Berry, Carnal and Spiller (1996) define airport presence of an airline at an airport as the number of top 50 cities served by that airline from that airport.

Aggregating this line of reason, we can state that the number of links in a carrier's network is positively related to the quality of that carrier, which is quite similar to the definition of carrier market presence in Proussaloglou and Koppelman (1995), mentioned earlier. Again we relate this factor to generalized travel costs

Borenstein and Zimmerman (1988) analyze the effect of airplane accidents on carrier demand. They find a negative effect, as was to be expected. However, they also conclude that most of the effect is gone after two months. Rose (1992) explains this short period by the relatively small serial correlation of accidents with the same carrier. This implies that accidents in the past do not predict accidents with the same carrier in the (near) future, so an airline's safety record hardly informs travelers on accident probability. To label a plane accident a type of (dis)quality as mentioned in section 2 would be a severe understatement by definition: an airplane accident represents the ultimate lack of quality in aviation. Nevertheless, our best guess would be that the carrier quality image aspect may be the most appropriate.

5. CARRIER PERFORMANCE EVALUATION

Headly and Bowen (1997) construct a general measure for carrier quality by determining the weighted average of 19 quality indicators, among which factors mentioned earlier, like on time performance, load factor, number of accidents and frequent flyer awards. Another factor in Headly and Bowen (1997) is the average age of the carrier's fleet. Each of these factors clearly relate to the carrier quality image. Headly and Bowen also mention the number of aircraft in the fleet, which is probably an indirect way to measure the size of the network, combined with frequency. Like other size-related factors mentioned earlier, this represents a generalized travel cost aspect.

Several of the factors mentioned by Headly and Bowen (1997) refer to the number of complaints on a certain subject, such as flight problems, overbooking, mishandled baggage, customer service, refunds, ticketing and boarding, advertising and credit. These are all CQI-indicators and the mere fact that they are all measured in terms of complaints indicate that experience is involved. This is an elegant way to solve measurement problems, although this number may be biased because high expectations yield a higher number of

complaints. High numbers of complaints merely point at quality below expectations rather than at low quality per se. As a matter of fact, a carrier with an extremely luxurious carrier quality image may receive more complaints than a no frill carrier, operating at the lowest acceptable quality level.

Headly and Bowen (1997) also use two financial measures for the overall carrier quality: financial stability and average seat-mile cost. The former may be related to the security of refunds on cancellations and is therefore a carrier quality image indicator. The latter probably relates to fare, so it can not be labeled a quality factor as we defined it for the purpose of this study. On the other hand, both factors might as well relate directly to the carrier quality image. A financially healthy airline may contribute to a positive carrier quality image, whereas the image of a 'cheap' carrier may do the opposite.

In its reports on civil aviation, the U.S. General Accounting Office uses four measures to assess the overall quality of air services, the number of departures, the number of seats, the number of destinations served by nonstop and one-stop flights and the relative number of jet departures.² As we have seen earlier, the number of departures is a measure for scheduling convenience and therefore relates to generalized travel costs, which is also true for the number of nonstop and one-stop flights. The number of seats seems to be yet another indicator for network size and thus relates to generalized travel costs (via frequency). The relative number of jet departures relates to travel time, although there may also be some difference in comfort between jets and turboprops.

Carrier performance surveys are also conducted by consultancy companies. IATA affiliate AIR presents the Global Airline Performance Survey (GAP), and the Survey of Flights in Europe (SoFiE), whereas J.D. Power and Associates conducts the Annual Airline Customer Satisfaction Study (AACSS) in cooperation with Frequent Flyer Magazine. Although these studies vary in purpose, they have in common that they use a broad range of quality factors, often subdivided into groups of questions. All the surveys mentioned above extend their interest beyond the in-flight quality to the quality of check-in and sometimes even reservations.

6. MARKET RESEARCH

Market research studies are an instrument for carriers to find out which types of quality are important to consumers and therefore important to the carrier itself. Furthermore, market research provides the carrier with information on its relative position with respect to quality, although this is not likely to be reported in publicly available studies. Dennett *et al.* (2000) find that shorter check in times are positively related to overall satisfaction in a stated preference survey among customers of a chartered airline. In the same study, they find no relation between food quality, obviously a cqi-indicator, and overall satisfaction .

Westwood *et al.* (2000) also mention in-flight food as a minor factor in airline choice. Other factors of interest in this study are personal space, on-board or airport hygiene facilities, airport lounge facilities, information on the destination, crew attitude and safety. All of these factors clearly relate to the carrier quality image. The study by Westwood *et al.* (2000) is focussed especially on the needs of traveling business women. Therefore, they draw a relation between quality aspects and trip (purpose) as well as person (gender) characteristics.

Hu and Bruning (1984) use twelve quality factors in their stated preference survey to measure the difference between major carriers and commuter airlines. Of those factors, only one, desirable schedule, relates directly to travel time. On time arrival relates to carrier quality image because, as we argued before, delays are experienced mainly as negative quality. Furthermore, the factor profitable airline is mentioned. As we have seen before, this may relate to the security of refunds in case of cancellations, or to a more direct image aspect. Several other of the quality factors relate to the carrier quality image aspect of safety such as the safety record of the airline and security consciousness of the staff. The reliability of service seems to point to on-time performance, which is also a carrier quality image aspect, as are courteous and knowledgeable staff, clean and quiet equipment and roomy planes.

Toh and Hu (1988) focus on frequent flier members, and name scheduling convenience, on time performance service by attendants, meals and of course frequent flier programs as factors affecting carrier choice. Each of these factors were mentioned earlier in this paper.

² see, for example, GAO, 1999, page 9.

Furthermore, they name recommendations made by either corporate travel managers or a travel agent as factors, although not too many respondents in their survey label these factors as important. Despite the relatively low reported importance, these recommendations clearly contribute to a carriers quality image.

7. OVERVIEW

From the survey several quality indicators seem to be more important than others, as table 1 suggests. Flight frequency is used often as an indicator for quality, indicating chances of arriving at a preferred time. Judged by the number of references, on-time performance is also an important indicator for carrier quality. Both of these indicators are mentioned especially in travel demand studies, which form the main body of our survey anyway.

Several quality measurers are related directly or indirectly to the size of the carrier, like the number of departures, network size, market presence, number of aircraft and number of seats. Like frequency, these measures relate to the chance for the carrier of having a favorable itinerary in the traveler's choice set.

The safety record of carriers is also mentioned regularly in our survey. This is partly because several one-issue studies relate directly to carrier safety, but also other types of studies mention this factor. Obviously, safety is considered important, although the results of the studies mentioned suggest that it is not extremely so.

Other factors that are mentioned in four to six papers include measures of seat characteristics, crew characteristics, food and frequent flier programs. Furthermore, several quality factors are mentioned only once or twice, indicating that there are many different ways to look at quality.

Only a couple of studies take personal or trip characteristics into account. If they do so, it is often focussed on a specific group, like business women (Westwood *et al.* (2000) or frequent flier members (Toh and Hu, 1988). More general classifications, which were to be expected especially in travel demand analysis, were not found. Experience is taken into account only in relation to the loss aversion property (Suzuki, 2000) or complaints (Headly and Bowen, 1997).

Generally speaking we find that travel demand studies are mainly concerned with generalized costs, whereas market research tends to focus at indicators related to the carrier quality image. Furthermore, we find performance evaluations to be more likely to yield a complete image of carrier quality.

Table 1: *Quality indicators in civil aviation research*

	generalized travel costs	carrier quality image	personal char	trip char	experience
travel time	Bath (1995), Fridström and Thune-Larsen (1989)				
flight frequency	Bath (1995), Ghobrial, (1993), Hu and Bruning (1984), Kanafani and Ghobrial (1985), Proussaloglou and Koppelman (1995), Suzuki (2000a), Toh and Hu (1988)		Toh and Hu (1988)		
number of departures	GAO (1999), Talley and Schwarz-Miller (1988)				
airport access time	Harvey (1987)				
check in/luggage reclaim	Dennet <i>et al.</i> (2000), Suzuki (2000b), Swait and Bernardino (2000)				
waiting time	Ghobrial, (1993), Kanafani and Ghobrial (1985)				
aircraft size	Röller and Sickles (2000)				
load factor	GAO (1999), Harvey (1987)				
direct versus layover	Berry (1990), Berry, Carnal and Spiller (1996), Proussaloglou and Koppelman (1995)				
market presence	Röller and Sickles (2000)				
network size					
on-time performance		Abrahams (1983), Headly and Bowen (1997), Hu and Bruning (1984), Proussaloglou and Koppelman (1995), Suzuki (2000a, 2000b), Toh and Hu (1988)	Toh and Hu (1988)		Suzuki (2000a)
seat characteristics		Hu and Bruning (1984), Swait and Bernardino (2000), Westwood <i>et al.</i> (2000)	Westwood <i>et al.</i> (2000)	Westwood <i>et al.</i> (2000)	
crew characteristics		Headly and Bowen (1997), Hu and Bruning (1984), Swait and Bernardino (2000), Toh and Hu (1988), Westwood <i>et al.</i> (2000)	Toh and Hu (1988), Westwood <i>et al.</i> (2000)	Westwood <i>et al.</i> (2000)	Headly and Bowen (1997)
food characteristics		Dennet <i>et al.</i> (2000), Suzuki (2000b), Swait and Bernardino (2000), Toh and Hu (1988), Westwood <i>et al.</i> (2000)	Swait and Bernardino (2000), Toh and Hu (1988), Westwood <i>et al.</i> (2000)	Westwood <i>et al.</i> (2000)	
in-flight amenities		Swait and Bernardino (2000)	Swait and Bernardino (2000)		
baggage handling		Headly and Bowen (1997), Suzuki (2000b)			Headly and Bowen (1997)

Table 1: *Quality indicators in civil aviation research (continued)*

	generalized travel costs	carrier quality image	personal char	trip char	experience
frequent flier program / awards		Headly and Bowen (1997), Swait and Bernardino (2000), Toh and Hu (1988)	Swait and Bernardino (1988), Toh and Hu (2000)		
accidents / safety		Borenstein and Zimmerman (1988), Headly and Bowen (1997), Hu and Bruning (1984), Rose (1992), Westwood <i>et al.</i> (2000)	Westwood <i>et al.</i> (2000)	Westwood <i>et al.</i> (2000)	
average age of the fleet		Headly and Bowen (1997)			
number of aircraft overbooking	Headly and Bowen (1997)	Headly and Bowen (1997)			Headly and Bowen (1997)
financial characteristics		Headly and Bowen (1997), Hu and Bruning (1984)			Headly and Bowen (1997)
number of seats	GAO (1999)				
number of jet aircraft	GAO (1999)				
clean and quiet planes		Hu and Bruning (1984)			
recommendations		Toh and Hu (1988)			
destination information		Westwood <i>et al.</i> (2000)	Westwood <i>et al.</i> (2000)	Westwood <i>et al.</i> (2000)	
hygiene facilities		Westwood <i>et al.</i> (2000)	Westwood <i>et al.</i> (2000)	Westwood <i>et al.</i> (2000)	
lounge facilities		Westwood <i>et al.</i> (2000)	Westwood <i>et al.</i> (2000)	Westwood <i>et al.</i> (2000)	

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Future Trends in Business Travel Decision Making

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Future trends in business travel decision making

Abstract

1. INTRODUCTION

The business travel market has seen a marked change throughout the 1990s. The introduction of competitive pressures in the marketplace due to the liberalisation of many markets has lead airlines to attempt to increase market share and network coverage, while trying to reduce their costs. At the same time companies have been increasingly recognising the importance of travel expenditure to their businesses and making efforts to reduce this cost element within their businesses. These two major pressures has meant that the business travel market is in change and this paper reports the finding of a study to identify future trends in business travel decision making within the UK.

The business travel market remains vital to the airline industry. Within the EU, business travel accounts for 48% of all air travel passenger trips (CAA, 1996). One of the main problems for airlines in not the volume of business travel which has remained consistently high, but the fall in the fares that that business travellers and their companies are prepared to pay. The IATA Corporate Air Travel Survey shows that a large proportion of business travellers are no longer buying business class tickets, and many are purchasing highly discounted economy tickets (IATA, 1999). This downgrading activity has lead in part to the dramatic 32% fall in real yields reported for the ten years between 1988 and 1998 by the International Civil Aviation Organisation (ICAO, 1999).

The liberalisation of the air transport in the EU has lead to the development of a more highly competitive market. The UK CAA (CAA, 1998) has noted fairly modest increases in competitive activity across all routes, however, the most dense routes have experienced quite dramatic increases in competition. The most obvious evidence of the introduction of competitive pressures in the market has been the introduction and rapid development of low cost airlines such as Ryanair, EasyJet, Go and Buzz. These airlines have reported significant proportions of their passengers travelling for business purposes. Go have indicated that about 30% of their passengers are business travellers while EasyJet report over 50% of passengers on some routes are travelling for business prposes (Mason, *et al*, 2000).

Earlier research showed that travellers that work for small and medium sized companies are more likely to choose a low cost airline service than those that work for very large companies (Mason, 2000). The research investigates the reasons for differences in behaviour, and evaluates whether companies that seek to reduce travel expenditure will use low cost airline services more or will continue with similar purchase behaviour.

In more highly competitive markets traditional airlines have sought means in which to defend their position in the market, grow in new markets, and reduce their costs. During the 1990s the industry has seen a dramatic rise in the number of alliances. In 2000 there were 579 alliance agreements in place, according to the annual Airline Business Alliance Survey (Airline Business, 2000). This had risen from 280 agreements in 1994, when the survey was first conducted. Five major alliances (Star, Oneworld, Qualiflyer, Sky Team and Wings) now account for some 60% of all air travel (Airline Business, 2000). While a large body of literature has developed over a short period of time investigating the benefits and to a lesser extent the costs of strategic airline alliances from a supply side perspective (see for example Journal of Air Transport Management, 1997), relatively little work has been undertaken looking at the demand side. This research aims to go some way to rectify this imbalance by investigating the influence of strategic alliances on business travellers and travel managers purchase decisions.

While the airline industry has been changing, the companies that demand business travel have also been taking greater control of their expenditure on travel. In many companies travel expenditure is the second largest controllable cost item behind labour (Collis, 2001). Consequently, the role of travel manager in many companies has changed from a general administrative role, responsible for booking travel to one of managing this highly significant element of expenditure. The 1990's has seen the development of organisations for travel managers (such as the National Business Travel Association in the US and the Institute of Travel Management in the UK). These organisations have developed training programmes to increase the skills level of travel managers in their member companies. The research will assess the effect of corporate travel policies and increasing professionalism in corporate purchasing.

Distribution costs can account for some 20% of airlines' total expenditure and ranks as the second largest cost item after labour (IATA, 1999). The principal distribution channel for airlines is via travel agents. Commission costs account for about 10% of costs, while ticketing costs the airlines 2 – 3%, fees to computer reservations systems (2%) and credit card fees (2 – 3%) take up the rest of the costs. Consequently airlines have been seeking methods to lower the cost of distributing their products, which has included cutting commission payments and trying to seek a more direct relationship with their customers. The development of internet technology is a potential source of structural change in the distribution channel and needs to be assessed.

The research, therefore, addresses the relationships between travellers, travel managers, airlines and business travel agents. These relationships have been changing as; airlines seek to reduce their distribution costs, and therefore seek to increase their direct contact with travellers and companies; corporates seek single global travel agency deals; and the growth of internet based information and booking systems that allow the company to exercise greater control over its travelling executives.

Beyond the distribution channel information technology such as video-conferencing, e-commerce and internet communication is becoming increasingly commonplace in the work

place. The research investigates whether this technology is viewed by travellers and travel managers as providing an effective substitute to business travel.

2. RESEARCH OBJECTIVES

The introduction has highlighted a number of areas of change in the business travel market. The development of airline alliances, and the expansion of the low cost airlines have affected the supply side of industry. The demand side of the industry has seen the development of an increasingly professional attitude towards the management of travel expenditure. The supply chain is also in a period of change as airlines seek to reduce their distribution costs, leading travel agents to reassess their roles, while internet technology provides many new distribution possibilities.

This research seeks to identify and evaluate the effects of these pressures on the business travel market in the future. The influence of the following areas on the decision making process are addressed: -

- Corporate travel policies & increasing professionalism in corporate purchasing
- The development of global strategic airline alliances
- The emergence of low cost airlines on short haul markets
- The development of internet based booking tools and travel agency IT.
- Substitution of air travel by other forms of communication

3. METHODOLOGY

Literature has generally reported surveys of individual air travellers (Nako, 1992, Mason and Gray, 1995). However the effect of corporate involvement in the purchase decision has been highlighted (Mason, 1999), and therefore the effect of corporate decision making should be considered in evaluating buyer behaviour. Where the views of both individual traveller and corporate travel managers have been considered together (Stephenson & Bender, 1996), surveys have not been performed on travellers and travel managers from the same firms. It has not been possible, therefore, to compare and validate the results of both sets of surveys. For this study corporate travel managers and travellers of the same organisations are surveyed. The Institute of Travel Management, the major corporate travel management association in the UK, provided an email list of companies that are major purchasers of air travel. Matched questionnaires were developed that were designed to investigate differences in opinions between travel managers and the travellers that work for their companies. The purpose of survey was profiled in the Institute's monthly magazine and follow up emails were sent six weeks after the first electronic posting, along with a reminder in the magazine. The travel managers of twenty companies responded to the survey that was sent electronically. All the companies had more than 1000 employees and together they spent some £95 million on air travel in 1999. This represents about 1% of the total outbound UK business travel market (estimated at £8.72 billion by Mintel, 2000). The large company sector of the market is estimated at 46% of the entire market (CATS, 1999) and so the survey represents some 2.4%

of this market. Forty-four traveller surveys were returned from 16 of the companies that had completed the travel manager survey. Higher responses for both the travel manager and traveller surveys would have been beneficial, however, the results are viewed as being representative of the large company sector of the business travel market in the UK.

4. RESULTS

4.1 Company and traveller demography

The companies in the survey were all multinational organisations. The average corporate size was 37,000 employees. The organisations were generally European based and the average size of the local organisation (either UK or European depending on the structure of the company) was 18,600 employees. The companies spent £95 million on air travel in 1999. The average number of short haul trips taken in 1999 was over 9,000, and the average number of long haul flights (longer than three hours) was 2,260.

Most of the travel managers (80%) indicated that the amount of spend on air travel was greater than three years ago. Only 15% of the companies spent less in 1999 than three years earlier with the remaining 5% spending about the same. This growth looks set to continue with half of the respondents indicating that the company is likely to spend in excess of 10% more on travel (per annum) in the next five years. A further 30% thought the company would spend between 5% and 10% more per year. It would seem that travel for these companies is a large and growing cost to their business. The management of this cost is therefore important and the survey indicates that it is not left to junior staff with the average age of the travel managers in the survey being 45. The group was evenly split between the genders with 55% being female.

The travellers surveyed were mainly male (86%) with an average age of 44 with a standard deviation of 8 years. They were employed in various management roles. Nearly a fifth of the sample (18%) were company directors, with 43% in senior management positions, and a further 30% in middle management roles. The remaining 9% were employed in other roles. The travellers make, on average, 17 short haul trips and 6 long haul trips a year. Nearly half of the travellers (45%) said number of trips was greater than three year earlier while 21% had travelled less in 1999 than 1996.

4.2 Corporate travel policies and booking behaviour

All the companies surveyed had travel policies of some kind. This is not surprising as the sampling frame was of companies that are members of the Institute of Travel Management, with an obvious interest in managing corporate travel.

Of the companies surveyed 80% only used one travel agent with the remainder using two agents. Use of only one travel agent allows the company to manage its spend more easily

than using a number of agents as all expenditure can be consolidated and tracked through one account. The travel managers indicated that, on average, 92% of their air travel expenditure is placed with their main travel agent.

The main booking channel used by nearly 85% of travellers and their travel managers was by phone calls to the agent. A further 10% used email to send booking requests. It would seem that the most respondents still preferred to talk to an agent than to merely send an email. The interactive nature of booking over the phone, perhaps provides bookers with a reassurance that the booking request has been properly understood and that the booking has been processed. This is particularly important for complex itineraries.

The average amount of air travel on the corporate's biggest airline supplier is 54%. However, the standard deviation of 25% indicates marked differences in behaviour in spend between the corporates. These differences can be partially explained by types of routes flown, and the amount of travel on the most commonly used routes. The strategies adopted by the travel managers will also affect this proportion. The average proportion of total expenditure made on routes covered by route deals was 32%, however, the wide standard deviation of this variable also indicated clear differences in travel behaviour between the companies surveyed. When asked whether the proportion of flights placed with their biggest supplier would change within a five year time frame, 44% thought that the company would use this airline proportionately more in the future. Just over a quarter thought that the proportion would remain the same, while the rest of the sample thought the amount of business placed with their main supplier would fall. Consolidating travel with a major supplier allows the corporate to negotiate the best volume discount possible, and for some companies in the sample this strategy would seem to be adopted. However, the potential for changing the amount of business with any one supplier needs to be evaluated carefully to ensure that the best total cost situation for the corporate is achieved.

Nearly two thirds of the companies in the survey (65%) pay a management fee to their agents to take bookings, provide management information and perform other services. This agency basis has become the standard approach for most large firms in the last five years. In this system the full amount of commission paid by the airline is passed directly to the corporate client. A management fee is then charged to the corporate for managing the client's travel requirement with a profit element included. The amount of reward given to the agent may be based on some pre-determined service levels to suit the client. The rest of the companies have a rebate arrangement with their travel agent. Rebates may be offered by airlines to agents that can ensure high volume. Rebates may reward agents of specific corporate clients 4% discount on fares retrospectively if pre-determined volumes from the named corporate are met. The rebate paid to the agent is usually passed directly back to the corporate. The system provides airlines with a fairly assured amount of traffic and the corporate gains a discount.

As airlines seek to reduce their distribution costs the amount of commission paid to the agent has been reduced. Agents that have rebate arrangements with corporates will be less able to pass a commission rebate onto these clients. Indeed, in the UK British Airways has radically altered the method by which it remunerates travel agents. In April 2001 the airline ceased paying commission on a percentage basis to travel agents. Instead the airline introduced set payments for each sector booked by an agent. The level of payment depended on the length

of the sector and the class of travel. While short haul domestic payments have remained similar, if not slightly better than under the previous regime, agents have lost substantial payments when booking long haul first, or business class tickets. The development of management fees has provided a method by which agents can seek to charge corporate clients for added value services they provide. American Express has taken this remuneration method further by passing back to clients all commissions and payments received from airline and charges the client a fee for each transaction performed (American Express, 2001). This effectively changes the agency role from acting on behalf of the airline to acting for the corporate. This shift in agency allegiance will allow the corporate to be sure that the agent will be seeking the fares that minimises its spend rather than on suggesting itineraries that would maximise the agent's commission.

While in the majority of cases (52%) it is the traveller that selects his/her flights, nearly half of flights are chosen by either the traveller's secretary (25%) or by the travel department (23%). The purchase decision within the business travel market is clearly not made by the consumer - the traveller - in a large number of cases, and the airline marketer must recognise the decision stakeholders and their influence when constructing marketing strategies. Corporate influence in the purchase decision has been noted in earlier studies, but in this research the proportion of travellers that do not make the purchase selection is 12% higher than an earlier study (Mason, 1999) where the samples were drawn from a wider range of companies. In this sample, the companies are all large with more than a thousand employees. It would seem that travellers in larger companies are more likely to leave the travel selection to others in their organisation. With less involvement in the decision making process, it becomes more important to focus marketing attention to other players in the process. With airlines reducing their ability to (financially) influence agents to win business, and the increased role that secretaries and travel managers have in the purchase decision, it is important for airlines to develop direct links with these people. While the airlines have increasingly well developed loyalty programmes for their consumers, it is also important to develop customer relationship marketing programmes for these purchase stakeholders.

Once the flight is selected the traveller takes even less involvement in the purchase. Only 15% of travellers book their flights while secretaries (45%) and travel departments (40%) process the bulk of the flights.

Of the firms in the survey, 65% negotiate deals directly with airlines. Here the firms have sufficiently large purchasing power to negotiate deals better than those offered via the travel agency market. Travel agencies, however, can provide benchmarking data to a corporate so that it can ensure that the deals it has negotiated are as good as possible, depending on the company's air travel expenditure.

Table 1: Travel manager and Traveller attitudes to travel policies

	Travel Manager	Traveller
Type of Travel policy (%)		
Policies to be followed where possible	15.8	44.2
Airline and class level guidance	10.5	14.0
Airline and class level rules to be followed where possible	15.8	23.3
Airline and class level rules to be strictly followed	42.1	16.3
Other types	15.8	2.3
CTP wrt to Airline Choice		
Written policy	52.6	32.6
Unwritten policy	15.8	41.9
No policy	31.6	25.6
CTPs wrt to class of travel		
Written policy	89.5	69.8
Unwritten policy	5.3	25.6
No policy	5.3	4.7

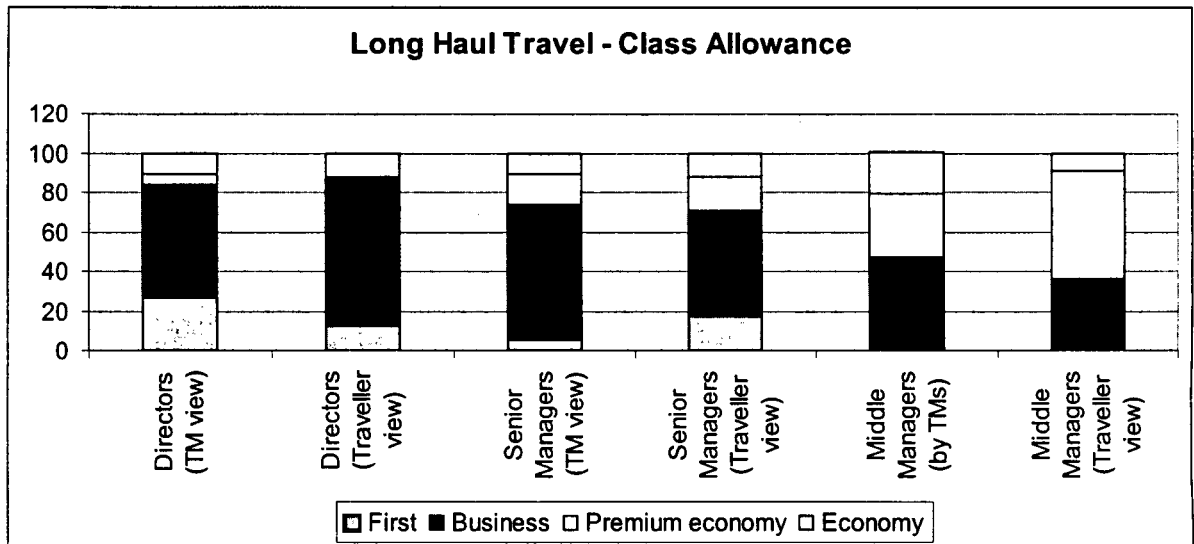
Table 1 shows the differences in views between travel managers and their travellers when considering aspects of the corporate travel policy. It would seem that travellers view travel policies as being much more flexible than their travel managers may have intended. 42% of travel managers described their policies as “airline and class level rules to be strictly followed”. Only 16% of the travellers agreed with their travel managers whereas 44% described their policies as “policies to be followed where possible”.

These differences in understanding about the travel policy are also shown when each group was asked to explain the policy with respect to airline choice and class of travel. The choice of airline and class of travel is very important to the traveller and prescriptions in these areas will affect the traveller’s comfort in-flight and his/her ability to accumulate frequent flier awards on a favoured airline scheme. Conversely, the travel manager will be able to save the company money if he/she makes the choice of airline and class of ticket for the traveller by focusing the spend where the company has the best deals.

The class of travel is more heavily regulated than the choice of airline. This is not surprising as differences between ticket classes will be much more significant than between airlines in the same ticket class. Nearly 90% of travel managers indicated that their company had written policies with respect to class of travel whereas only 53% had written restrictions about airline choice. The lower proportion of travellers that described the policies as written indicates that they either are not aware of the policies, are not sent the policies, or have forgotten them. It is possible that these travellers make so many trips that they know the rules and are unaware that they are written down somewhere in the organisation as they do not need to refer to them.

The hierarchical differences in the class of ticket travellers are allowed for long haul travel and for short haul travel are shown below in figures 1 and 2 respectively. The views the travel managers and travellers are shown.

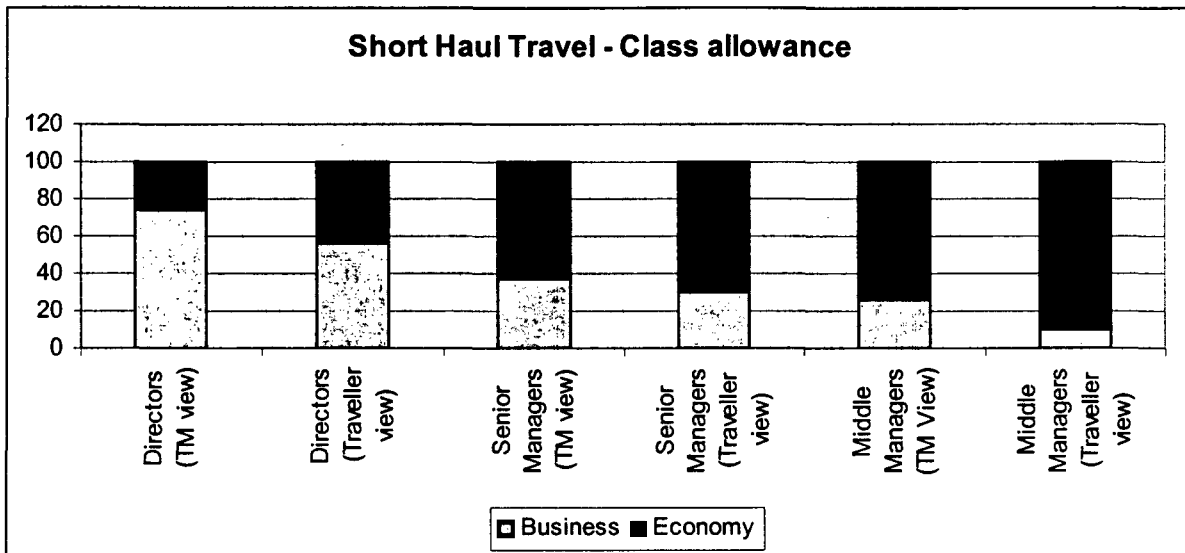
Figure 1: Fare class differences between traveller hierarchical levels for long haul travel



For long haul travel, over 80% of directors are allowed either first or business class tickets. This proportion is lower for senior managers and lower still for middle managers. While the hierarchical difference is not great between director and senior manager level, there is a marked difference for middle managers. The development of premium economy class travel on long haul seems to be well targeted at this sector of the market as a large proportion of this group is allowed this slightly better than economy service.

There are only two classes available for short haul European travel. Again there seems to be a hierarchical bias towards those in the most senior positions, with the vast majority of middle managers having to travel in economy while over 70% of directors are allowed to fly in business class.

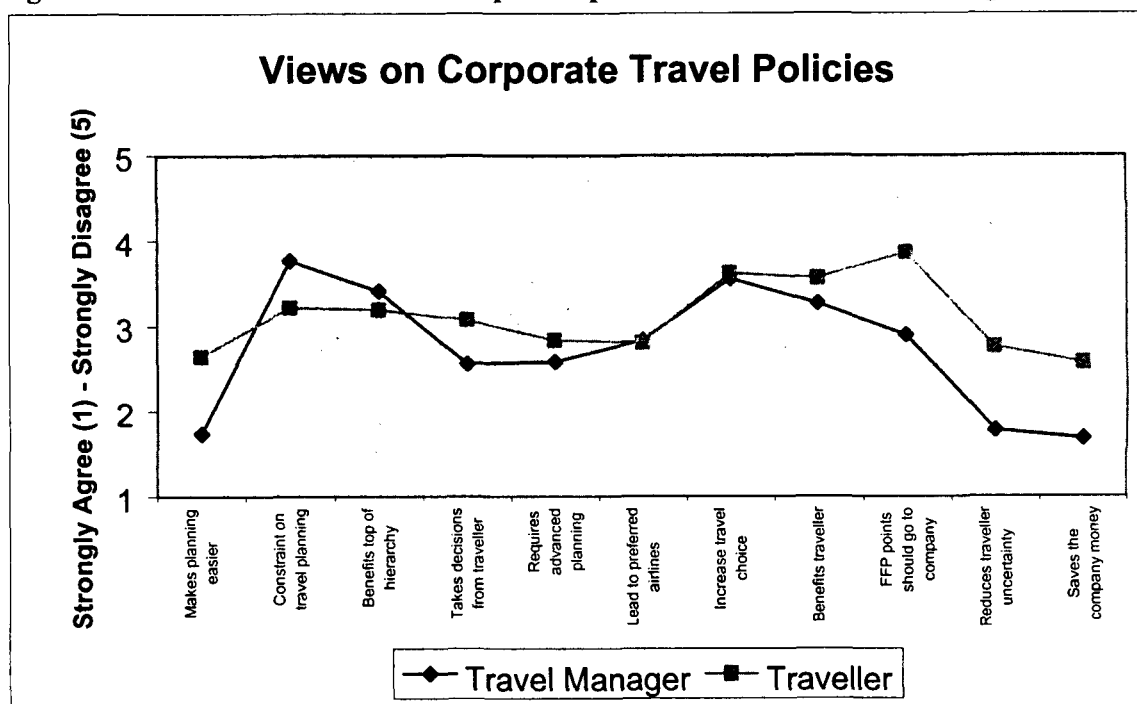
Figure 2: Fare class differences between traveller hierarchical levels for short haul travel



The two groups seem to be in general agreement with the allowances granted to different corporate level, but there seems to be a general belief by the traveller group that they are more restricted than the travel managers say they are. Perhaps the travellers see that policies are becoming stricter. This is confirmed by the travel managers, 63% of who indicated that the travel policy would become more stringent in the next five years, with a quarter of the group saying that their policies would be greatly more stringent. The hierarchical differences look set to be diminished as the vast majority of the travel managers (84%) indicated that the changes that will be introduced to make policies stricter would be applied to all travellers irrespective of status.

The two groups were asked to indicate their level of agreement with a number of statements about corporate travel policies. A Likert five point scale was used for this element of the questionnaire. The differences in attitudes between the two groups can be seen in Figure 3. Strong agreement with the statement was given a score of one and a score of five was attached to a strongly disagree answer.

Figure 3: Attitude toward travel corporate policies between travel managers & travellers



The general profile of the two groups is similar. The largest differences in opinion were on the following statements: -

- Corporate travel policies (CTPs) makes the whole process of travel planning more easy
- Frequent flier points should be awarded to the company
- CTPs reduce traveller uncertainty
- CTPs save the company money

While the travel managers thought that the CTPs made travel planning easier, the travellers were clearly less convinced on the ability of the travel policies to do this. It is logical that travellers and travel managers should disagree about who should benefit from FFP rewards, but is perhaps surprising that the difference was not more marked. While travel managers view the CTP in reducing traveller uncertainty the travellers disagree, and here there is a case to build internal communications to highlight the corporate and individual benefits of having a policy. The travel managers disagreed with the opinion that CTPs put a constraint on travel planning, while the travellers were neutral in their opinion. It is perhaps surprising that the travellers did not see CTPs as placing a constraint on their travelling behaviour. Both travellers and travel managers agree that travel policies reduce travel choice, while travel managers agree much more strongly with the statement that CTPs saves the company money than the travellers. Again, there is an opportunity for travel managers to communicate the benefits of the CTP to those that have to work within it.

The travel managers were asked what processes they use to ensure traveller compliance with the travel policy. There seemed to be two approaches applied. The first allows the traveller to book the flights they request. Management information systems are used later to identify those travellers who have fallen outside the policy's prescriptions. The manager relies on the agent to report the transgressors and then the travel manager can take the action deemed appropriate. An extreme, but effective, method is to refuse to reimburse all costs incurred by travellers who have booked outside the policy. Other travel managers indicated that a quiet word to the traveller would be the method used to get the traveller to stay within the policy in future. The second approach applied by travel managers to ensure traveller compliance was the prevention of travellers from booking outside the policy. Some managers funnelled bookings through their office and thus could refuse to book travel outside the policy. In other cases the manager would rely on the agent either refusing to book outside the policy without appropriate signed approval, or to provide pre-trip alerts of non-compliant travel. Some travel managers saw the internet, and on-line booking systems as a means by which the company, with its agent, could construct an electronic barrier to non-compliance.

4.3 The effect of airline alliances

For many companies a large proportion of travel is on a small number of routes, and on these routes the companies may have deals with individual airlines. However, the ability for an airline group to provide global coverage for all of a company's air travel requirements can be beneficial for both parties. The company is able to negotiate better discounts on their most travelled routes by ensuring a higher proportion of their travel is on the preferred airline group's services worldwide. The airline group ensures increased volume throughout its network and is able to build yield on the less travelled services.

The development of global airline alliances has enabled the alliance groupings to compete to provide global coverage for a company. Consolidating spend with an alliance group to negotiate higher discounts is perceived as beneficial by about half the travel managers (47%). A further 37% of the respondents thought that alliance development has a neutral effect on the company's air travel expenditure. Although none of the companies surveyed had a global deal currently, a quarter had been approached by one or more global alliance to try to negotiate a global deal. A further 15% of the companies had approached alliance groups to discuss the possibility of a global deal. While this development to the relationship between airlines and corporates is in its infancy, 75% of the travel managers surveyed believed that their companies would sign a global deal with an alliance group within the next five years.

Alliances groupings indicate that the traveller will reap many benefits from alliance developments. These include "seamless" travel across the group's network; better customer services at airports as the airlines group together their ticketing, check-in, and customer service desks; and a wider route network on which travellers can collect FFP points and spend loyalty rewards. More than half of the travel managers surveyed (55%) believed that the travellers benefit from airline alliances as the alliances begin to deliver the improvements in service. Only 5% of those surveyed thought alliances would have a detrimental effect on travellers, but a large proportion (39%) of the sample thought that alliances would have little effect on their traveller. In comparison, one in five of the travellers surveyed thought that

alliance developments would be detrimental to their travel experiences. Differences in the quality of on-board service between code-sharing and alliance partners can lead to traveller confusion and dissatisfaction. The alliances groups will need to work hard to provide a “seamless” level of service throughout an alliances’ network to minimise such business traveller attitudes.

Certainly traditional scheduled carriers will need to demonstrate a greater level of value for money in their products as eight out of ten travellers and nine out of ten travel managers believe that traditional airlines do not offer value for money.

4.4 Effect of low cost airlines

One of the key reasons why travellers question the value of traditional airlines’ service is the development of low cost airlines. Currently only a small number of flights bought by the companies surveyed are taken with low cost airlines. Earlier research (Mason, 2000) showed that travellers working for smaller companies are more likely to use a low cost airline for making a business trip. Travel expenditure may be more tightly restricted in a small company compared with a larger one, also a small company will not be in a position to negotiate volume discounts with traditional airlines as the amount of business they generate will not be sufficient.

Table 2: Attitudes towards low cost airlines

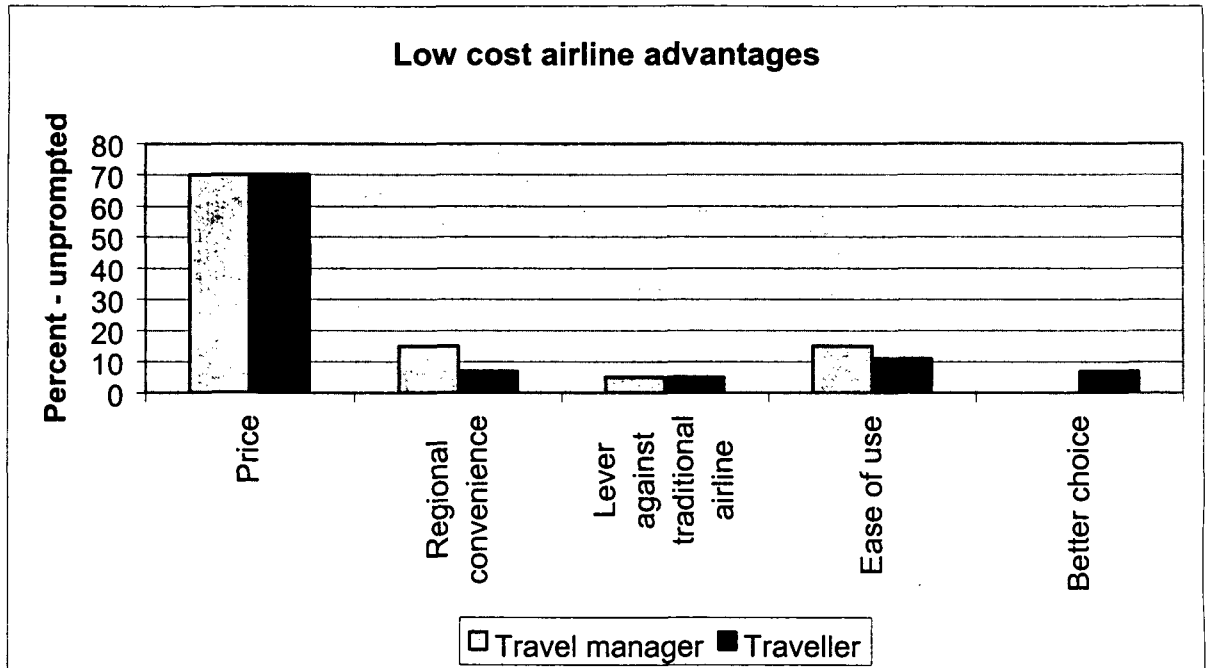
	Travel managers	Travellers
Traditional airlines do not offer value for money	88.9	81.4
Low cost airlines do offer value for money	84.2	73.7
Attitude towards using low cost airlines for business		
Positive	65.0	31.7
Neutral	10.0	36.6
Negative	0.0	29.3
No opinion	25.0	2.4
Attitude toward low cost airlines		
Positive	65.0	31.7
Neutral	10.0	36.6
Negative	0.0	29.3
No opinion	25.0	2.4
Proportion of short haul travel on low cost airlines in five years	24.2	29.3

Travellers working for small companies will probably more involved in the purchase decision and consequently be more likely to be aware of the cost of tickets, and seek cheap prices. In

contrast, travellers working for larger companies are more likely to work within the prescriptions of a travel policy, and as we have seen in this set of results are likely to be less involved in the purchase and to seek cheap flights. Where a large company has a complex set of deals with various airlines, a traveller is likely to be discouraged from making his/her own travel decisions, as they are likely to be sub-optimal from the company's perspective, and a waste of a significant amount of his/her time. Travel managers will have focused on deals with traditional airlines that can be monitored and enforced through booking procedures that relies on the travel agent to flag travel plans that fall outside the travel policy. As travel agents are loathed to book low cost airlines, as they receive no or very low commission, it is not surprising that only 4% of the flights booked by the companies surveyed were with these budget airlines. However, 60% of travel managers said that their company encourages the use of low cost airline were appropriate, indicating that the proportion of short haul travel placed with low cost airlines for these large companies is set to rise. Indeed travel managers thought the proportion of short haul trips made on low cost airlines would rise to 22% in five years time. Travellers thought this proportion would be even higher at 29%. If this penetration in the large company market is to be achieved, low cost airlines will need to show a satisfactory level of service, while providing sufficient cost savings to recompense for poorer deals with the traditional airlines that will be achieved by switching significant volumes of traffic.

The majority of travel managers and travellers thought these airlines offer good value for money. While both groups surveyed thought that these airlines offered good value for money, and this is reflected in the travel managers' opinions towards the airline sector with 65% of managers indicating a positive attitude towards these budget airlines, a significant proportion of travellers (29%) held negative opinions about the services offered. Figures 4 and 5 show the main advantages and disadvantages of low cost airline services indicated by the respondents.

Figure 4: Advantages of low cost airlines usage

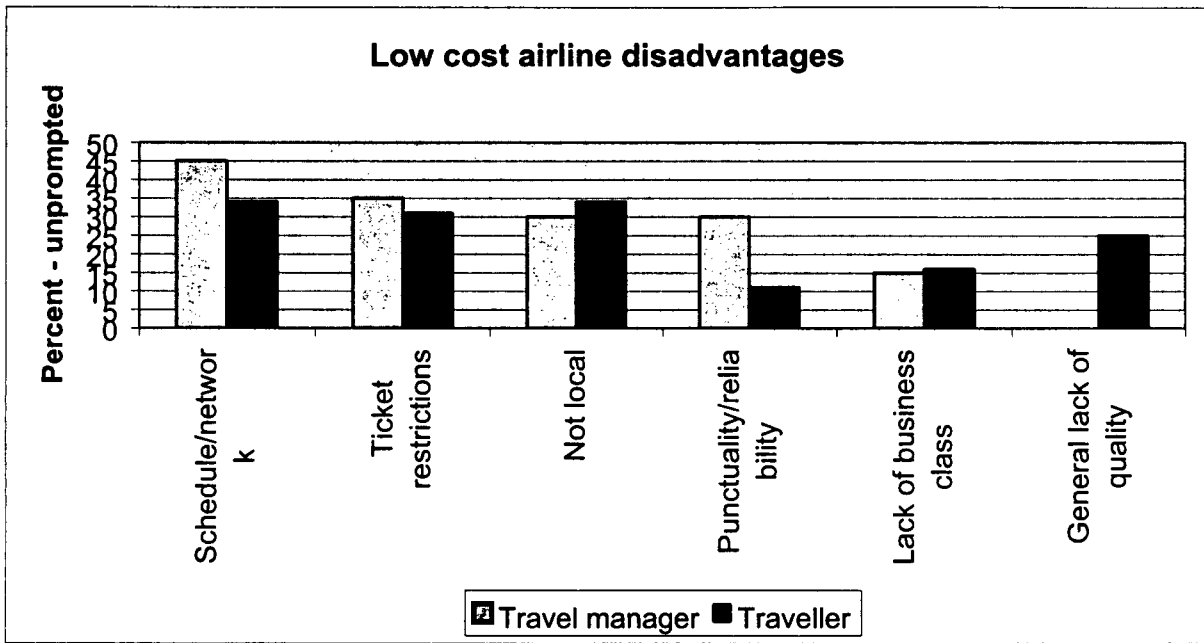


Respondents were asked to suggest up to three advantages and three disadvantages of these airlines. Price is clearly seen, by both travellers and travel managers, as the main advantage of low cost airlines, with the ease of use being suggested by 15% of travel managers as an advantage.

In comparison, both travel managers and travellers highlighted a number of disadvantages of using low cost airlines. The schedule was identified as being the main disadvantage, and then the ticket restrictions generally applied to low cost airline tickets. A number of travellers noted a general lack of quality on these airlines, while travel managers were more concerned about punctuality and reliability.

For the low cost airlines to develop in this segment of the market it will require a clear shift in travel managers' strategies to consolidate travel in one alliance group's services. To persuade the travel managers to switch, the low cost carriers will need to provide consistent, reliable, high frequency services on a widened route network, and also alter the non-flexible ticketing regime. While some low cost airline have introduced flexible "business" fare types, and increased frequency on some routes to levels expected by frequent fliers, none yet have the wide route network, high frequency and flexible ticketing necessary.

Figure 5: Disadvantages of low cost airline usage



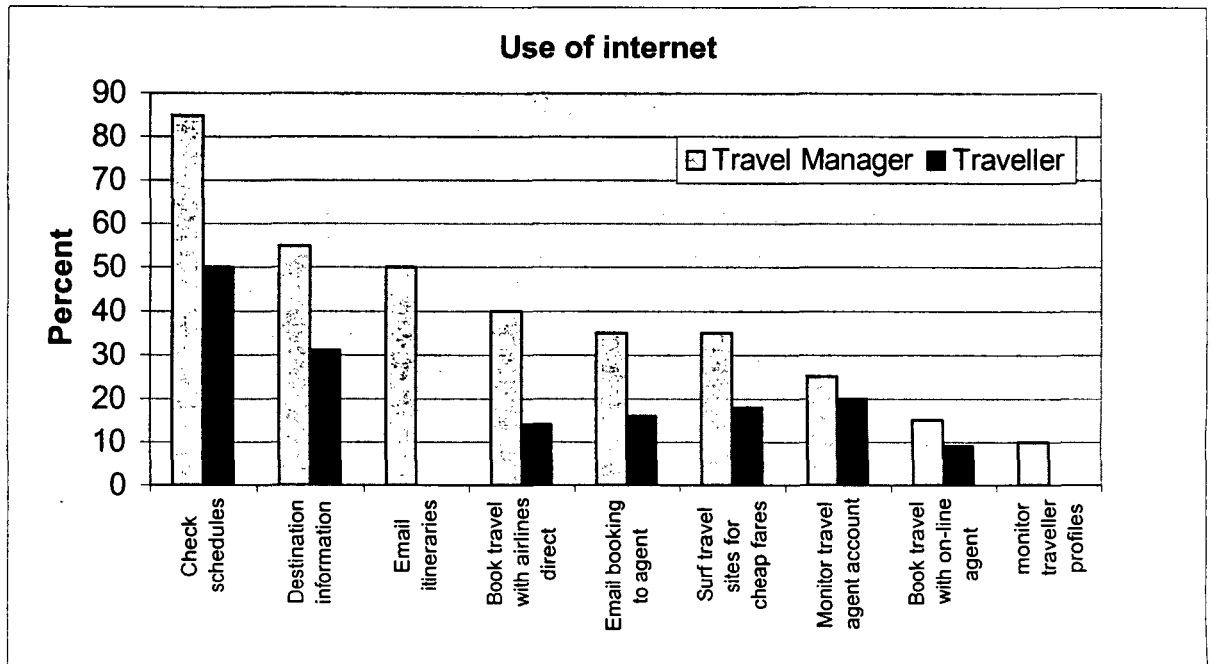
4.5 Effect of changing distribution patterns and booking tools

Internet technology has begun to change the way in which airlines can distribute their products. A company can either book online via travel agency booking sites, an internet based booking agent, with the airline direct, or via various portals provided by airline groups (Orbitz), CRSs (Travelocity), or consolidators (priceline.com). With such a wide range of booking options it is perhaps surprising that online booking is not a common activity for the travel managers or travellers in the survey with less than 5% of the flights booked online. This general reticence is not due to lack of internet infrastructure. 95% of travel managers and 91% of travellers in the survey currently have access to the internet. Of the companies surveyed, 15% have an extranet account with their agent, and allowed travellers to book online. However, 72% of travel managers discouraged travellers from booking online. This is partly as nearly half (47%) of the managers believe that traveller online booking hinders their role to minimise travel spend, also makes it harder to monitor and control the spend. One in four travel manager thought, however, that travellers using this channel helps them in their role, mainly by reducing administrative burdens. The general feeling was that online booking was set to grow. The travel managers believed that, on average, 42% of travel would be booked online by their travellers within a five years time span. Travellers thought this amount would be even higher at 62%.

With the development of so many potential channels open to the corporate, should the corporate try to direct all bookings via a single port? This may be possible in some companies, particularly, if booking lead times are long, and changes in itinerary are rare, but for most companies, such rigid administration may be onerous. The use of traveller held corporate credit cards for all travel expenses is one method in which a travel manager can monitor and control the company's spend, while allowing the use of many different booking channels. The fairly rigid approach of the travel managers in the study to limit their travellers

access to internet booking, may be overcome if real time booking approval systems, using a credit card are available.

Figure 6: Travel manager and traveller use of the internet



4.6 Substitution of air travel by other forms of communication

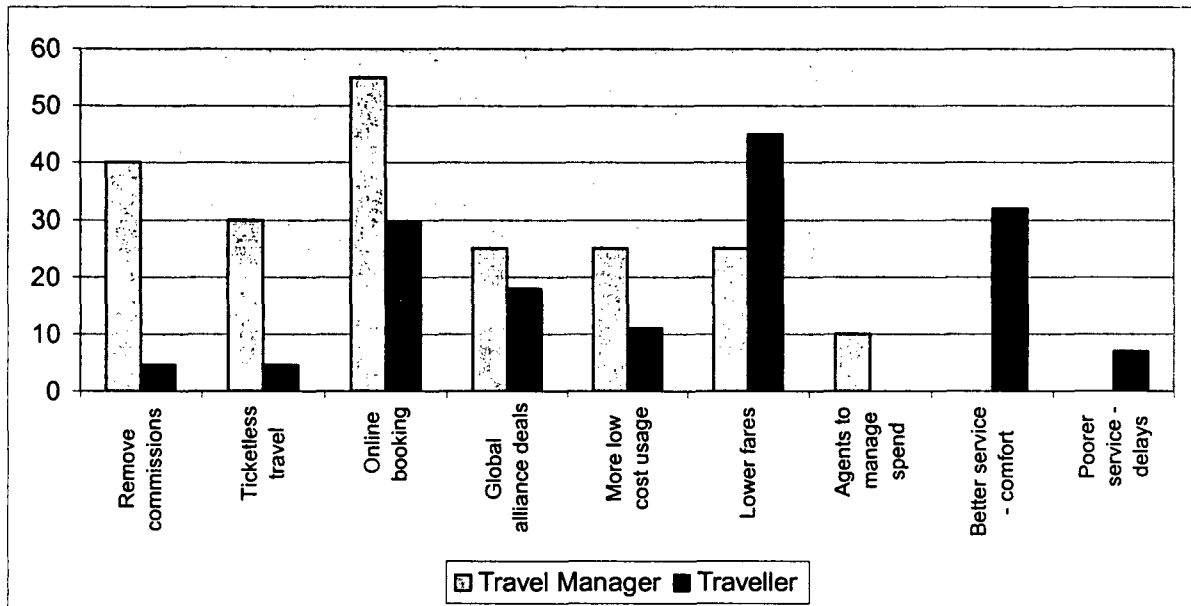
The final area considered in the survey was the effect of the development of the video conferencing and the internet on the demand for business derived air travel. The vast majority (over 70%) of both travellers and travel managers believed these technologies have not had any substantial effect on the number of trips taken. While these forms of communication currently have little effect on the demand for air travel, both groups of respondents believed that within a five year time frame, that technologies will have improved sufficiently to allow for some substitution, depending on the time of work being performed. 22% indicated that internal meetings and some meetings with well established business partners might be conducted over some improved information technology solution, but the total proportion of such substitution would be small. However, the general feeling was that there is no substitute to meeting people face to face.

Indeed 66% of travel managers thought that the company would increase its volume of business travel in the next five years. A large group (36%) believed that their company would increase the number of trips consumed by more than 15% from its currently level.

4.7 Future changes

Figure 7 shows the unprompted responses to the question “What do you see are the three main changes likely to happen in the business travel market in the next five years?”.

Figure 7: Future changes in the business travel market



The travel managers highlighted changes in the airline, agent, corporate relationship, as commissions are removed, and online booking, and ticketless travel becomes much more widespread. A quarter of the group viewed alliances as having an increasingly important role to play in the market if global network coverage can be achieved. A significant number of travel managers also highlighted the growing use of low cost carriers for short haul travel, with fares falling as competition increases. 10% of respondents indicated that travel agents will become managers of a company’s travel spend, as travel managers outsource the management and administration of this purchasing function. A logical extension of the consultancy role that agents are increasingly looking to pursue as the airline, agent, corporate relationship alters.

Travellers have a slightly different perspective on the business travel market in the next five years. The continued growth in competition between airlines is seen as providing lower fares, improved levels service, and better comfort. The other main change for travellers is the increase in online booking.

5. CONCLUSION

This research aimed to provide further insights into the decision making processes and buying behaviour of business travellers and the companies for which they work, and sought to identify future trends in the market. The focus of the paper was on larger companies and comparison has been drawn with the trends in business travellers that work for small and medium sized companies.

There are two principal reasons for differences in the use low cost airlines by large and small companies. Firstly large companies have a third of all travel on routes on which are signed route specific deals with traditional airlines to and this is likely to keep the majority of their business with these larger carriers. As airline alliances grow to enable carriers to offer global coverage of travel needs, large companies are likely to stay with one alliance grouping and negotiate global deals.

Secondly travel agents have been the traditional channel through which companies book travel. For small companies the development of internet has provided a method through which prices can be compared. Without the volume of business to enable the company to negotiate route deals small companies are increasingly using the internet to select flights and thereby the travel agent has lost the ability to influence the decision towards the larger traditional airlines. In contrast large companies have used specialist business travel agents for booking travel, and also hotel accommodation and car rentals. Corporate infrastructure and monitoring and management systems are well developed for quick and efficient travel booking. This infrastructure is sufficiently well developed for the companies to continue using the travel agency channel for future booking. As the low cost airlines generally do not sell through agents this market is effectively closed to these carriers.

The companies surveyed have not yet embraced new booking technologies, with the majority of flights booked by phone. However, travel managers believe that online booking will become at least as popular as phone booking in the next few years. For this change to happen, not only does the technology need to develop further, but also travel managers will need to release travellers and secretaries to book online, as currently this practice is discouraged.

The introduction of transaction fees by agents is changing the relationship between the airline, traveller and agent, with the agent working on behalf of the traveller not the airline. This change may lead to the outsourcing of the management of travel expenses to travel agents with the travel manager role changing into one of contract management. To do this the agent, agents or airline principal must demonstrate the ability to enact the chosen travel policy effectively.

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COOPERATION AMONG GERMAN AIRPORTS IN EUROPE

1. The Market environment of airports in Europe

The nature of the air transport industry and airports has changed dramatically over the last decade, and this change has been particularly noticeable within the European Union. The liberalisation of air services has created significant challenges for the airport sector, traditionally a much more heavily regulated sector.

- Liberalisation changed the European aviation market
- Liberalisation also dramatically changes airports
- Rapidly growing aviation market (5-7 percent)
- Shortage of airport capacity on account of lacking infrastructure or limitations
- Strong market concentration through Airline alliances
- Intensified competition among Hub-Airports and in overlapping catchment areas
- Current worldwide trend of airport privatisation

For decades Governments have controlled the development of air services from particular airports through bilateral agreements. The management of airports has also been dominated by national or local Government. However, with the implementation of the full liberalisation of air services across the European Union, arising from the Third Package, the role of airports has been transformed.

2. Effects of the market environment on the airports – Competition of airports

Airports are endeavoured to change from a pure infrastructure supplier to modern service enterprises.

- Higher pressure on the price level
- Increasing capital investment needs
- Raised compulsion for optimisation of service
- Strong focuses onto the field of Non-Aviation
- Search for locations to earn money away from own airport

In this case, the airports have to offer a wide spectrum of different services on high quality level. On account of this new role of the airports a great number of competitive and cooperation relationships arise. Airports are forced to find new ways to protect their own economic success and also their customer's interests. The different forms

of cooperations among airports which were agreed to in recent years could solve this problem.

3. Cooperation and ownership stakes among airports

For some years airports announced cooperations or partnerships among each other. The number of airports who have partnership shares in other airports, or own other airports, increased also. In this case, airports mainly indicate the targets for cooperation as cost reduction, increase in productivity, service and competitive capacities of the partners by exchange of experience and know-how-transfer. Purchase, technique, electronic data processing, ground handling, airport personnel and safety are mainly designated as cooperation fields.

Airports have different cooperation possibilities. They can unite both case by case and permanently project oriented cooperation. The cooperation can apply purchase communities or a joint offer for take-over of airports. Some forms of cooperation among airports will be represented at the following.

3.1 „Open“ or “free-and-easy” Cooperation: Cooperation in the Secondary Market and Competition on Primary Market

Cooperation of the airports occur in the most different sections of the airport business. However, a cooperation is also possible in a single field, as for example the marketing cooperation of the airports Frankfurt and Berlin. Different German airports arranged a free-and-easy-cooperation in some more area of operations, like the cooperation among the south-german airports (“South-Alliance”): Munich, Dresden, Leipzig, Nuremberg and Stuttgart. In this case, it was stressed that a practical cooperation is only striven by mutual investments by protection of independence and without interlacing or fusion of the cooperation partners.

3.2 Ownership Cooperation among Airports or partnership shares in other Airports

In the case of cooperation with ownership stakes, one airport acquires business interests of another airport and takes influence on the business policy and the development of the other one. In Germany airport ownership cooperations can be divided in two ways: ownership stake among a large airport and a small "satellite

airport" (Frankfurt-Hahn, Dusseldorf-Gladbach, Munich-Augsburg) or a large airport and a distantly located airport (Frankfurt-Saarbruecken and Frankfurt-Hanover).

3.3 Cooperation through holding structure and/or within airport systems

The cooperation form of the holding company supports a homogeneous and comprehensive strategic appearance of the partners. The concept of an airport holding company is especially widespread among the European airport systems.

3.3.1 Examples for holding company structure in Germany

The airports of Berlin Schoenefeld, Tegel and Tempelhof are part of the dominating BERLIN BRANDENBURG AIRPORT HOLDING LTD. (BBF). For the members, this holding company takes care of the following tasks: accountancy, controlling, marketing, public relations and environmental control as well as the project control for the Single-Airport Berlin-Brandenburg-International (BBI) and the preparation of the privatisation of the BBF. A few months ago the airports Leipzig-Halle and Dresden became the MIDDLE-GERMAN-AIRPORT-HOLDING.

3.3.2 Example for holding company structure: AIRPORT GERMANY LIMITED COMPANY

The beginning of cooperations among German airports was required by the Airport Frankfurt within the initiative "AIRPORT GERMANY LIMITED COMPANY" some years ago. This initiative was mainly debated because of the possible sale of the public interests of the German airports. On the one hand the "AIRPORT GERMANY LIMITED COMPANY" should hold the parts of almost all German airports and on the other hand the Airport Frankfurt should be simultaneously supported through this constellation as an international hub. The arguments for this initiative were the bottleneck problems of the German airports and the concentration on a few German airports. The resistance of the country governments (Bundeslaender) and the German airports to the concept of AIRPORT GERMANY LIMITED COMPANY was too hard, because they feared that the regional site interest and the air transport policy of all German airports would then be determined by the airport Frankfurt and/or the Hessian congress (Landtag). So the concept failed completely. However, the discussion about the GERMAN AIRPORT LIMITED COMPANY started an increased cooperation process of the German airports. Among other things, there was formed

an alliance of the North German Airports (Hamburg, Bremen and Hanover) and an alliance of the South German Airports (Munich, Stuttgart, Nuremberg, Leipzig/Halle and Dresden). In the case of these “free-and-easy-cooperations”, the airports work together in some areas (training and further education, common purchase, procurement of common software and general exchange of experience), but they remain competitors at the market.

3.4 Cooperation in airport networks and/or “enterprise compound”

This is a further form of the cooperation with ownership stakes by a Non-Airport-enterprise - An example for this are the activities of the 100 percent subsidiary of the building combine HOCHTIEF LIMITED COMPANY, the HOCHTIEF AirPort Ltd. This enterprise invests in airports, develops and operates them like the airport Athens-Spata. The project of the new international Athens Airport was constructed by a consortium as BOT-Model. Since 1997 the HOCHTIEF AirPort Company tenders in cooperation with the Irish airport management company AerRIANTA INTERNATIONAL for privatisation of airports. In this case, they received the acceptances of a bid for minority stakes at the two privatisation in part of airports in Germany, Duesseldorf and Hamburg.

The airport network of the HOCHTIEF AirPort, that is the investment to commerce airports, exists in present 39,9 percent at the ATHENS INTERNATIONAL AIRPORT S.A. and together with AerRIANTA 50 percent at the Airport Duesseldorf and 36 percent (with an option of further 13 percent in the next years) at the Airport Hamburg. Furthermore this airport compound have also indirect the investment on the Airport Moenchengladbach with 70 percent, because its included in the Airport Duesseldorf stake.

For HOCHTIEF AirPort Company is - after the integration of the airports into their airport network - one of the aims the creation of additional profit potentials from compound effects (“Economies of scope”) for the member airports. On account of the view into the processes, the organization and the cost structures of “their” different airports the stake owner can perform optimal Benchmarking. Efficiency gaps of the airports can be filled systematically by the continuous comparison of the processes and the means.

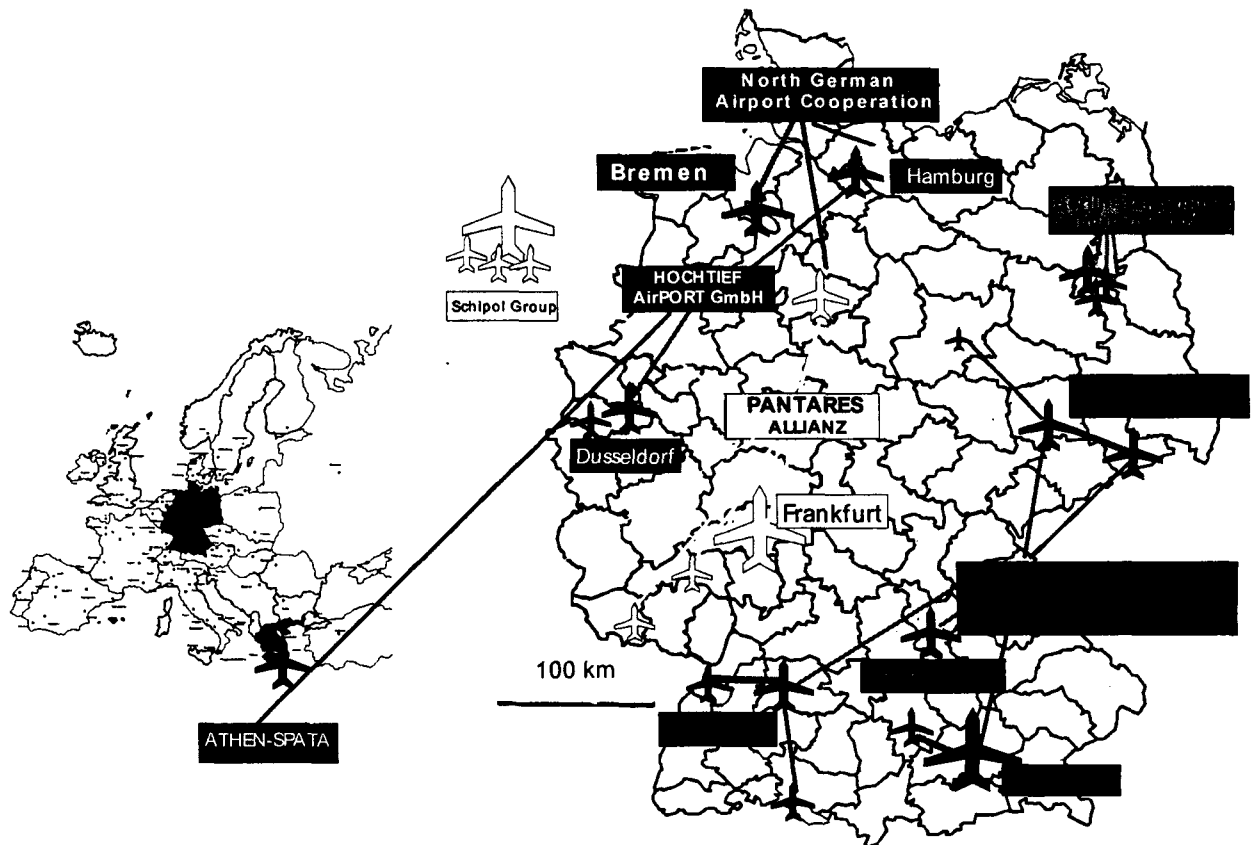


Illustration: Cooperations among German airports

3.5 PANTARES ALLIANZ – Cooperation between the airports Frankfurt and Amsterdam

The limited growth possibilities in the home markets (not in the end on account of capacity and expansion problems) force the large airport operator companies via partnerships up to cooperations and stake ownerships in the global field. Example is the cooperation between the Schiphol group (Airport Amsterdam) and the formerly hard competitor Airport Frankfurt. In November 2000 this first alliance between two international hub airports was announced officially under the market appearance of the common subsidiary PANTARES.

FRAPORT and Schiphol Group are developing cooperation in six key business areas: passengers and retailing, aviation ground handling and cargo, real estate development, facility management, information and communications technology, and international activities. In the near future, FAG and Schiphol Group will be developing business activities in other fields such as joint purchasing, terminal development, and

E-business. In the age of E-business and logistics, distribution systems will gain in importance. FAG and Schiphol Group plan to participate in this growth market at their respective home airports and around the world. Both airport companies believe that close cooperation is crucial for maintaining a leading role in the global air transport industry. Airport Frankfurt/Main AG and Schiphol Group are planning to work closely together in other fields on an international scale, with a focus on European opportunities. Together, the two companies will also explore possibilities in other parts of the world. With support of Schiphol Group, FRAPORT recently made a strategic investment in Brisbane Airport Corporation Ltd. (BACL), the company that manages Australia's third busiest passenger airport. FRAPORT now holds about one percent of BACL's stock, with plans to increase this share in the future. Schiphol Australia holds almost 16 percent of BACL. Brisbane is the first overseas airport where both companies will be able to work together as partners. In South East Asia, FAG and Schiphol Group are interested in the airport privatisation program that is expected to get underway in Indonesia and Thailand.

With a few big players in worldwide airport development and operation, cross-ownership and horizontal cooperation will be a hot issue during the next years of airport privatisation.

4. Possible advantages of a airport cooperations

- Costs reduction/synergies
- Complementary know-how
- Advantages of competition
- Offer of services and products on different markets.
- Risk spread with investment projects
- Perhaps an antidote against airline alliances
- shift of air traffic ?

5. Subject of "shift of air traffic"

The capacity enlargement is limited through the problems at the expansion of the airport infrastructure so that often politics spoke about the "shift of air traffic" of certain national and international flights among cooperating Airports to solve this capacity problem. In this case, the politicians speak of the shift of aviation in the case of cooperation of airports in the first place. On the one hand, the international air traffic is in this case addressed, that should be shifted by superloaded airports onto

neighboring ones with free capacities and on the other hand, the regional aviation should be transferred to the surrounding regional airports in order to create capacities on the large airports for international aviation. Furthermore short frequent haul routes shall be won for the rail too, what presupposes an appropriate accessibility of the airports to the land transport network. Both in scientific studies and in practice these shifts are no substitute for the expansion of capacities in order to be able to overcome the rate of increase in aviation.

5.1 The legal factors are not given

Example: Region of Milan with the airport system of three airports

- Linate: International airport, superloaded, expansion is not possible, 8 kilometers (5 miles) away from the city center
- Bergamo: Regional airport, 50 kilometers/30 miles away from the city center
- Malpensa: Enlarged to the new international airport, without limitations, 50 kilometers/30 miles away from the city center

- Italian government wanted to force foreign carriers to fly from MALPENSA
- LINATE should become the domestic airport for the Italian airline ALITALIA
- Protests of the Airlines in the case of the EU: Italy must take back regulation

5.2 Airlines must be convinced with different ways of acting by the airport management:

- financial concessions
- special infrastructure factors
- own market questioning and market analyses
- developed plans for possible offers

But: A discrimination is never to be excluded and of course legal objections

In the case of cooperation between airports with regional satellite airfields, the experiences also showed up to now that no releases at the large airports could be achieved even with clear price and capacity advantages. Even in conurbations which have very small distances between the two cooperation partners there was no air traffic shift possible. Shift efforts show a certain success on an individual basis at the most with a big effort in creativity. It must be mentioned that experiments to control traffic streams were not crowned with success up to now. Neither private travellers nor Airlines should be made to do something, that they do not want.

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The following table gives a survey of cooperation and ownership stakes among the German airports:

Airports	since	Cooperation, ownership stakes, etc.	Targets (according to press announcements and publications)	cooperation fields
Berliner Flg.: Schoenefeld, Tegel, Tempelhof	Dec. 1991	Airport-Holding: Berlin Brandenburg Flughafen Holding GmbH (BBF)	Preparation of the privatisation, project control of the expansion of Schoenefeld to the single airport Berlin Brandenburg International	Legal department, controlling, marketing, public relations, environmental control
Dusseldorf, Moenchengladbach	01/01/1994	Ownership stake in Moenchengladbach with 70%		
Dusseldorf, Cologne/Bonn	Spring 1994	Cooperation declaration between the companions (state, commune and the two cities)	Synergy effects and cost savings; improvement in the competitive capacity of the airports compared to national and international airports; joint planning to the appropriate expansion of the airports	Exchange of experience and perception of common tasks
Munich, Dresden, Leipzig-Halle	June 1996	Cooperation	Cooperation on technical and economical field, Transfer of the EU-guidelines for liberalisation of the ground services	joint procurement of vehicles and tools, cooperation with electronical data processing, in financing and during organisation of the operational field
Frankfurt, Saarbruecken	09/20/1996	Ownership stake in Saarbruecken with 51%	Improvement in the operational and economic framework; Transformation of the airport Saarbruecken in a profitable enterprise	
Munich, Stuttgart	Sept. 1996	Cooperation	Synergy effect and saving potentials	Joint procurement, technique, EDP, ground services, marketing, personal
Frankfurt, Cologne /Bonn	12/23/1996	Cooperation considerations	Improvement in services around start- and landing; use of the short distance between the airports.; Concentration on other customers segments (e.g.: Charter to Cologne)	
Frankfurt, Hahn	01/01/1998	Cooperation and ownership stake in Hahn with 74,9%	Acquisition of additional aviation and new enterprises locations; prevent migration of airfreight and passengers to other European airports; using synergy effects; market complement for Frankfurt (Niche provider in the low price segment), additional skimming off potentials	Cooperation in material and device purchase, education and consulting as well as accountancy; At short notice help in the staff field through FAG
Frankfurt, Hanover	07/14/1998	Ownership stake in Hanover with 15%		
Munich, Stuttgart, Dresden, Leipzig-Halle, Nuremberg	08/26/1998	Cooperation, "South-Alliance", legal and economical independence of the airports is maintained	Synergy effect and saving potentials, Know-how-transfer and Benchmarking, cost savings, increases in productivity, exchange of experience. Service and competitive capacities of the airports in European aviation should be increased Savings are striven by cooperation at million height.	Procurement, technique (definition of homogeneous standards), EDP, ground service, marketing, personnel (use of mutual training potentials during the employee education)
Stuttgart, Friedrichshafen, Karlsruhe/Baden-Baden	07/14/1999	Close cooperation between the state airports	Cost reduction, using synergy effects in the cooperation field, Stabilization of the location Baden-Wuerttemberg	Purchase, technique, EDP, ground service, personnel, safety

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Leipzig/Halle, Magdeburg	12/07/1999	Cooperation descendants	Increase in productivity, cost reduction, exchange of experience, common workshops of managers and specialists	Common purchase, formation of device and repair part pools up to complete integrated networks (e.g.: EDP), use common marketing possibilities, personnel evolution
Munich, Augsburg	Spring 2000	Cooperation and ownership stake in Augsburg with 50%	Support of Augsburg with the enlargement of the master plan and building of a narrower network of regional and commerce airports in Bavaria	4 Mio. EURO (4 Mio US Dollar) financial contribution of Airport Munich for expansion of Airport Augsburg
Stuttgart, Karlsruhe/ Baden-Baden bzw. Baden-Airport	Dec. 2000	Ownership stake in Karlsruhe with 7 %	The cooperation of the two airports should be intensified by Ownership stake further. Also the synergy effects should be used more strongly. From transportation point of view, investment is regarded as vital since the airport Stuttgart is not to be enlarged. Stuttgart Airport wants to invest into the Baden-Airport and into the trade park.	As fields for cooperation were confirmed the purchase, the personnel evolution, the marketing, EDP projects and the evolution planning.
Leipzig/Halle, Dresden	12/06/2000	Cooperation and foundation of the Holding MITTELDEUTSCHE FLUGHAFEN AG	Under the common name MITTELDEUTSCHE FLUGHAFEN AG, the two German airports want to position themselves on the European market. A comprehensive structuring programme should become the preconditions for the future organisational and strategic new direction.	Central point of the new strategy is combining of the previous and of the new business field units of both airports.
Bremen, Hamburg, Hanover	07/24/2000	Cooperation of the north-german airports in the field of ground handling services by the common take-over of all parts of the handling enterprise AHS (Aviation Handling Services GmbH)	Evolution of tailor-made services for the customers. Realisation of these services, where the customer airlines operates (at least a Europe-wide expansion). Improvement of the competitive position in the business fields of ground handling	Ground traffic service through the AHS in the business fields: Services for airlines, check-in, representation of airlines at the airports, processing of aviation related logistics
Frankfurt, Amsterdam	11/02/2000	Cooperation and common firm foundation of the PANTARES ALLIANZ	Connection between management and capital strengths for better chances of success with privatisation of Airports; Investigation of the common enterprise fields for synergy effects FRAPORT and Schiphol Group developed cooperation in six key business areas.	Key business areas: passengers and retailing, aviation ground handling and cargo, real estate development, facility management, information and communications technology, and international activities; also: E-Business; personal; marketing; controlling; environmental topics, etc.
Aeroporti di Roma (ADR), Frankfurt, Amsterdam	02/02/2001	Cooperation connection of the ADR (operator of the airports in Rome) with the PANTARES ALLIANZ (FRAPORT and Schiphol group)	New subsidiaries should lead to a more efficient operation of the airports. The triple-cooperation expects that the SEA, operator of the two Milan airports (Malpensa and Linate) will follow too.	Teams are concerned with ground handling, retailing, E-Commerce and information technology.

Source: ADV - Arbeitsgemeinschaft Deutscher Verkehrsflughäfen - information according to press announcements of the last 10 years.

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**Inbound and Outbound Air Passenger Traffic Forecasting
between the United States and Selected Asian Countries**

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Abstract

The air passenger traffic volume has increased between the United States and Asian countries for the last 15 years. This article discusses and analyzes international air passenger traffic between the United States and selected Asian countries (Japan, S. Korea, Taiwan, China, and Hong Kong). A pooling technique is used to forecast air passenger traffic for short- and medium-terms. Major explanatory variables include income per capita, airfare, trade volume, and exchange rate. Effects of income and Asian financial crisis on the air passenger traffic volume are evaluated.

I. Introduction

Air passenger traffic between the United States and the selected Asian countries grew by 367 % from 1980 to 1999; air passenger traffic between the United States and the rest of the world grew by 236% during the period (Table 1). There are several economic and non-economic factors contributing the increased air passenger traffic between the United States and selected Asian countries (Japan, S. Korea, Taiwan, China, and Hong Kong). Some of these factors are increases in trade activities between the United States and the countries through bilateral and multilateral trade agreements and increases in income in the Asian countries.

The percentage of air passengers between the selected Asian countries and the United States to the number of air passengers between the rest of world and the United States was highest (20.6 %) in 1995. Even though the number of passengers to and/or from the Asian countries has decreased during past few years, the percentage is about 15% and very significant for the U.S. air transportation industry. According to a report from the US Department of Transportation (US DOT 2000), Japan, S. Korea, Taiwan, and Hong Kong are among the top 25 foreign countries for air passenger traffic.

During the last two decades, rapid growth of GDP in the selected Asian countries stimulated the air passenger traffic. In the period from 1986 to 1999, the annual GDP growth rates were 8.6% for China, 5.9% for southeast Asia (Hong Kong and Taiwan are located in this region), and 2.8% for northeast Asia (S. Korea and Japan are located in this region). These growth rates were much higher than the world average of 2.5% per year. The high growth rate of income has increased the resources of high and middle income classes for air travel and changed the air travel from an essential for commerce and government to a leisure.

It seems likely that passenger traffic will grow at a rate between 5% and 7% into the foreseeable future, about 9% annually in the Asian-Pacific region and a slower growth in the more mature U.S. and European markets (Button, 1999). Air transportation agencies, such as International Air Transport Association and the Air Transport Action Group, shared the optimism for the Asian air transportation market. Rising per capita incomes in Asian countries and increasing international trade keep sustaining annual air travel growth rates in excess of 10% in the Asia Pacific region. However, some emerging events and problems, such as the handover of Hong Kong to China in 1997, Asian financial crisis, sluggish Japanese economy, and smog from the forest fires in Indonesia, temporarily prevented the growth in the demand for air travel from the countries.

The handover of Hong Kong to China adversely affected the Hong Kong travel market. Under Chinese rule, air travel growth rate between Hong Kong and the United States began to decline rapidly in 1996 (Table 2). The 1997-98 Asian financial crisis led to a dramatic depreciation in their currencies against the U.S. dollar and reduced income, coupled with negative economic growth rate. The financial upheaval affected Korea, Indonesia, Malaysia, Philippines, and Thailand, through shocks in exchange rates, incomes, and interest rates.

While the value of Asian currencies stabilized in 1998, the Asian economies continued to contract through the end of the year. After 2 years of setbacks, some countries started to recover in 1999. The financial crisis spread to Japan, Taiwan, China, and Hong Kong, resulting in a slowdown in domestic consumption and the growth of trade. China, of which economy grew more than 10 percent a year, started to experience a slowdown in its economy in 1998. The economic conditions in the Asian countries caused decreased demand for air passenger traffic (Table 2).

Air passenger traffic demand forecasting is important for airport planning, design, and operations. Forecasts of passenger volumes can be translated to space requirements for the terminal buildings, while forecasts of aircraft movements are translated to the airport facilities (Karlaftis, 1996). Underestimating and overestimating demands can lead to congestion, delay, lack of storage facilities, underutilization, and difficulties in managing airline industries. Therefore, errors in the forecasting process can cause significant problems to revenue of airports and airlines.

This study discusses and analyzes air passenger traffic and airfare between the United States and the selected Asian countries. Special attention is given to inbound and outbound air passenger forecasting. This paper examines factors affecting air passenger traffic volume to analyze pricing behavior of airlines and to forecast air passenger traffic volume, especially for short- and medium-terms.

Estimations of air passenger traffic and airfare and the forecast of air passenger traffic between the United States and selected Asian countries will contribute to a better understanding of characteristics of air passenger traffic as well as supporting facilities needed in the near future.

In this study, the causal model approach identifying functional relationships among variables is used. The pooling technique based on the covariance technique is used to estimate the air passengers and the industry's pricing behavior. The study indicates that air passenger traffic volume will more than double during the next 10 years between the United States and the Asian countries. The increased traffic volume is due mainly to increased per capita GDP in the Asian countries and increased trade activities between the United States and the Asian countries.

II. Model Development and Estimation Procedure

A variety of forecasting techniques are available. Forecasting methods can be categorized into two techniques, quantitative and qualitative. Accuracy is the most important characteristic of a forecast, while ease of use of the forecasting technique, cost of producing the forecasts, and period of time with which the forecasts can be produced are also important factors. The quantitative method gives more accurate forecasts than judgement forecasts such as those based on the opinions of the involved individuals and/or corporate executives. Quantitative methods are divided into two subcategories: causal (econometric) model and time series approach.

For air passenger traffic demand forecasting, the causal model approach (Cigliano, 1980; Cline *et al*, 1998; Jorge-Calderón, 1997; Karlaftis *et al*, 1996; Moshirian, 1993) is used to identify functional relationships between dependent and independent variables. The model may depend on some predictor variables such as airfare, GDP, exchange rate, and trade volume. A major advantage of causal models over time-series models is explaining economic and business phenomena and increasing our understanding of relationships between and among variables. The time series approach (Karlaftis *et al*, 1996; Kawad and Prevedouros, 1995; Nam and Schaefer, 1995) relates current values of a variable only to its past values and makes use of the information in the past values of a variable for forecasting its future value. The use of time series models for forecasting may be attractive when the objective is a short-term forecast.

In general, to forecast the international air travel demand, two main groups of variables, geo-economic factors and service-related factors, are used. Geo-economic factors, which fall outside the control of airlines, are determined by the economic activities (Cigliano, 1980; Cline *et al*, 1998; Jorge-Calderón, 1997; Karlaftis *et al*, 1996; Kawad and Prevedouros, 1995; Moshirian, 1993) and geographical characteristics (Jorge-Calderón, 1997) of a country, such as income, population, and distance/travel time. Service-related factors (Jorge-Calderón, 1997; Kawad and Prevedouros, 1995; Moshirian, 1993) such as airfare, the frequency of departures, intra- and inter-modal competition, the load factor, and aircraft size are determined by both the quality and money price components of the transportation service provided by airlines.

Empirical models developed for this study are air passenger traffic demand and airfare equations. These two models are developed for air passenger transportation services between the United States and selected Asian countries.

Air Passenger Traffic Demand Equation

The specification of this model is based on demand theory. Demand for a commodity, in general, is a function of price of the commodity, prices of competing or complementary commodities, and personal income (Henderson and Quandt) as follows;

$$D = f(P, P_c, y),$$

where

D = demand for a commodity;
P = the price of the commodity;
P_c = prices of competing or complementary goods; and
y = per capita income.

Following this demand theory, demand for air passenger traffic is specified as a function of average prices of air services given to the passengers by an air carrier, prices of air services by competing airlines, per capita GDP in both the United States and the Asian countries, trade volume between the United States and the Asian countries, and the jth currency value per the U.S. dollar as

$$D(\text{us-j}) = f(P(\text{us-j}), \text{PGDP}(\text{us}), \text{PGDP}(j), \text{TV}(\text{us-j}), \text{ER}(\text{us},j)),$$

where

D(us-j) = the total number of air passengers between the United States and country j;
P(us-j) = average airfare between the United States and country j;
PGDP(us) = per capita GDP in the United States;
PGDP(j) = per capita GDP in country j;
TV(us-j) = total trade volume between the United States and country j; and
ER(us,j) = the value of the j th country's currency against the U.S. dollar.

Since the dependent variable represents total number of passengers between two countries, we include per capita GDPs in both countries, implying that air travel is influenced by income levels in both countries. It is hypothesized that these GDP variables are positively related to demand for air passenger services. In general, increased personal income tends to stimulate both leisure and business travels and consequently increase demand for air transportation service. Another important variable is trade volume, representing business activities between two countries. Increased business activities may require more business travel between two countries. Thus, it is expected that trade volume between two countries is positively related to demand for air passenger service. Exchange rate between two countries may influence leisure travelers in the jth country more than those originated in the United States. As expected in a demand model for normal goods, airfare has a inverse relationship with the number of passengers.

Airfare Equation

The ratio of the fixed cost to the total cost in the airline industry is much higher than in rail and trucking industries. Thus, each airline competes with one another to capture its market share in air transportation markets. Several different airfares exist in the industry to penetrate various market segments, such as business and leisure travelers, by exercising price discrimination between these market segments. In general, business travelers are less sensitive to airfare than leisure travelers. Airlines, therefore, charge a higher price to business travelers who travel during weekdays and charge a lower price to leisure travelers who sleep at destinations on Saturday. Based on this observations, an airline's pricing behavior is generally determined on the basis of competition with other airlines. Actually, airfares have been declining at an annual rate 1 % and most of this decline has been in leisure airfares (Boeing, 2000). Thus, airfare is a function of volume of passengers between the United States and country j, and competition among air carriers as

$$P(\text{US-j}) = f(V(\text{US-j}), \text{HI}(\text{US-j})),$$

where

$P(\text{US-j})$ = average airfare between the United States and country j ;
 $V(\text{us-j})$ = number of passengers between the United States and country j ; and
 HI = the Herfindahl-Hirschman index.

The Herfindahl-Hirschman index¹ indicates the levels of concentration in the air passenger transportation market. It is hypothesized that airfare is negatively related to the number of passengers and positively related to the H-H index. Table 3 summarizes these key differences in competitive structure. Under an assumption that airfare is seasonal, seasonal dummy variables representing quarters of a year are added to the equation.

Estimation Procedure

Both passenger demand and airfare equations are estimated using a pooling technique. Two different techniques are generally used with panel data. Those are covariance technique and error component technique (Green). The covariance technique assumes that cross section and time effects are fixed and uses dummy variables to incorporate time and cross sectional effects, while the error component technique assumes the cross sectional and time effects are random. This study uses the covariance technique mainly because this technique allows us to evaluate price discrimination between different routes and over time.

Data used for this study are quarterly time series data from the first quarter of 1988 to the second quarter of 2000 for the United States and the selected five countries. Nominal variables are transformed into real prices with using price indexes and the airfare index. The sources of data used for this study is summarized in Table 4.

III. Results and Forecasting

Air Passenger Traffic and Airfare Estimations

Air passenger traffic demand and airfare equations are estimated by using quarterly data from the first quarter in 1988 to the second quarter in 2000 for the passenger equation and from the first quarter in 1994 to the second quarter in 2000 for the airfare equation. Table 5 shows estimated coefficients of both models. R^2 s are 0.95 for the air passenger traffic demand model and 0.91 for the airfare model, indicating that the estimated models are acceptable.

In the air passenger demand model, the airfare variable is significantly different from zero at the 10 percent significant level, indicating that air passenger traffic increases with reductions in airfare. Per capita GDP is also significantly different from zero at the 5 percent level, indicating that people in Asian countries travel more when their income increases. U.S. per capita GDP is not involved in this estimation mainly because the variable is not significant and causes multicollinearity. This implies that U.S. passengers are not generally sensitive to airfare. The exchange rate variable is not significant mainly because of offsetting effects of exchange rates to passengers in the United States and those in Asian countries. As the U.S. dollar appreciates, there is an increase in demand for air traffic in the U.S. because foreign travel becomes cheaper. However, the reverse situation holds for passengers in Asian countries. Trade volume represents business activities between the United States and the Asian countries. The variable is significantly different from zero at the 5 percent significant level, indicating that more people travel as business activities between two countries increase.

We tested a hypothesis that the Asian financial crisis reduced the air passenger traffic between the United States and the selected countries. It is well known that international air passenger traffic sharply plunged in those countries affected by the financial crisis. The financial crisis dummy variable has a negative sign but it is not

¹The Herfindahl-Hirschman index is the sum of squares of the market shares of the firms in the industry: $H = s_1^2 + s_2^2 + s_3^2 + \dots + s_n^2$. The index is a useful indicator of concentration: the larger the Herfindahl-Hirschman index, the fewer the number of firms dominating the industry.

significantly different from zero, indicating that there is no strong statistical evidence for decreasing air passenger traffic between the United States and the selected Asian countries during the financial crisis period, from the third quarter in 1997 to the last quarter in 1998.

Coefficients and t-statistics for quarter dummy variables indicate that there is a strong seasonality. The third quarter (July-September) has highest air passenger traffic during the year, while the lowest traffic volume is in the fourth quarter (October-December). Dummy variables for countries imply that the US-Japan route has highest air passenger traffic among the selected Asian countries. The dummy variable for the US- S. Korea route is positive, but is not significantly different from zero at the 5 percent significant level. Dummy variables for years indicate that air passengers increased each year compared to those in 1988.

The airfare model is estimated with quarterly data from the first quarter in 1994 to the second quarter in 2000. It is hypothesized that airfare is significantly related to the competition among air carriers competing for traffic volume in a specific route. H-H index is used to measure the extent of competition. We found that H-H index is positive and significantly different from zero at 5 percent significant level. The number of air passenger variable is statistically different from zero at the 10 percent significant level, indicating that airfares tend to be lowered when number passengers or load factors increase.

We included real crude oil price, one of major costs in the air transportation industry, in the preliminary analysis. The variable was dropped from the equation because it had the wrong sign and was not statistically significant. This implies that airfare is largely determined by service characteristics and the market structure rather than cost factors, indicating that competition lowers airfare.

The financial crisis dummy variable is significantly different from zero at the 10 percent significant level, indicating that the airfare during the financial crisis period was not decreased. Quarter dummy variables show some seasonality for airfare but the evidence is not strong. Country dummy variables indicate that the airfare for U.S.-Japan route is higher than U.S.-S. Korea and U.S.-Taiwan routes, but lower than U.S.-China and U.S.-Hong Kong routes. Dummy variables for years indicate that airfare has decreased each year compared to those in 1994.

Table 6 summarizes the estimated elasticities of demand and price with respect to key elements of the air passenger traffic and airfare. All elasticities in passenger and airfare models are smaller than one, indicating that air passenger traffic and airfare are not highly sensitive to changes in independent variables.

For the passenger demand model, the estimated airfare (price) elasticity is - 0.41, indicating that a 10 percent increase in airfare, all else held constant, would lead to a 4.1 percent decrease in air passenger traffic. The estimated income and exchange rate elasticities are 0.28 and 0.0087, respectively. The trade volume variable is more sensitive. The estimated trade volume elasticity is 0.95, indicating that a 10 percent increase in trade volume, all else held constant, would lead to a 9.5 percent increase in air passenger traffic. Growing international trade is an important reason playing a part in stimulating air passenger traffic growth.

In the airfare model, the estimated passenger (demand) elasticity is -0.051, indicating that a 10 percent increase in air passenger traffic, all else held constant, would lead to a 0.51 percent decrease in airfare. The estimated H-H index (competition) elasticity is 0.245, indicating that a 10 percent increase in H-H index, all else held constant, would lead to a 2.45 percent increase in airfare. Thus, airfare is relatively more responsive to competition rather than traffic volume.

Air Passenger Traffic Demand Forecasting

The passenger model depends on predictor variables such as per capita income, airfare, exchange rate, and trade volume which are themselves not available at the moment of prediction. Thus, these variables must be estimated carefully, and the accuracy of the forecast will then depend upon the precision of these estimates of variables. A major advantage of the causal model is that the components of the forecast show why changes are

taking place. Thus, various estimate combinations of independent variables estimated can be taken into account to find the impacts on the dependent variable and to evaluate changes in determining forces. To forecast the air travel level between the United States and the selected Asian countries, it is assumed that the independent variables decrease, increase, or remain constant with reasonable assumptions (Table 7).

In the air transport demand forecast, details about individual markets and fluctuations in medium-term traffic levels are more important than the long-term growth trend because medium-term forecasts are particularly important in many managerial decisions, such as the ordering of new aircraft (Button 1999). The estimated passenger model is used to forecast air passenger traffic demand between the United States and the Asian countries in short- and medium-terms, from 2000 to 2010.

Table 8 and Figure 1 show the short- and medium-term air passenger traffic demand forecasts for these routes. The short-term air passenger traffic demand forecasts for these routes implies that the total number of air passengers will increase from 19.8 million in 1999 to 34.1 million in 2005, with an overall growth rate of more than 72 % and an average annual growth rate of 9.5 %. The medium-term air passenger traffic demand forecasts for these routes indicate that the total number of air passengers will increase from 19.8 million in 1999 to 51.3 million in 2010, with an overall growth rate of more than 159 % and an average annual growth rate of 9 %.

According to *Current Market Outlook 2000* by Boeing, the annual traffic growth rate between North America and Asia-Pacific regions is 5 % for the period of 2000-2019. Our forecasts are higher than Boeing's forecasts mainly because they are focused on the 5 Asian countries which dominate economic growth in the region. China is predicted to have the high growth rate, followed by S. Korea. Japan will have the highest share of air travel demand among these countries for the forecasting period.

IV. Conclusions and Implications

This study reveals that air passenger traffic demand is determined by airfare, GDP in the Asian countries, and trade volume between the United States and the Asian countries. This study also indicates that air passenger demand increased annually for the last decade. Air passenger traffic demand is highly seasonal, highest in the third quarter and lowest in the fourth quarter.

Airfare is largely determined by traffic volume and competition among air carriers, but airfare is more sensitive to competition than the number of passengers. Airfare is seasonal to some degree. The country dummy variables indicates that airfare in the US-S. Korea route is lower than in other routes, while it is highest in the US-China route. This study also indicates that airfare has declined for the forecasting period.

The number of passengers between the United States and the Asian countries is predicted to increase 160 percent from 19.8 million in 1999 to 51.3 million in 2010. The fastest growth market is the US-China route, followed by the US-S. Korea route. However, the US-Japan route will maintain the largest share of air passenger traffic during the forecasting period.

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Table 1 Total Number of Air Passengers From/To ROW and Selected Asian Countries and Percentage of Air Passengers From/To Selected Asian Countries (Thousands)

Year	Total Air Passengers From/To ROW	Total Air Passenger From/To Selected Asian Countries	Percentage
1975	24699	2691	10.9
1980	39518	4229	10.7
1985	46643	6314	13.5
1990	70460	11876	16.9
1995	89936	18528	20.6
1996	113335	20081	17.7
1997	120476	20281	16.8
1998	125368	19080	15.2
1999	132916	19768	14.9
2000(as of June)	68429	10065	14.7

Sources: US Department of Transportation

Table 2 Annual Air Passengers and Growth Rate from/to the United States (Thousand People)

Year	Japan		Korea		Taiwan		China		HongKong		Total	
1994	11060		2415		1636		150		956		16217	
1995	12622	14%	2744	14%	1861	14%	153	2%	1145	20%	18527	14%
1996	13614	8%	3063	12%	1959	5%	242	58%	1201	5%	20081	8%
1997	14186	4%	2836	-7%	1753	-10%	305	26%	1199	0%	20280	1%
1998	13244	-7%	2127	-25%	1957	12%	511	68%	1238	3%	19079	-6%
1999	13628	3%	2284	7%	2059	5%	570	12%	1223	-1%	19767	4%

Source: Calculated from T-100f International Market Data

Table 3 Annual H-H Index

Year	China	Hong Kong	Japan	Korea	Taiwan
1994	4622	3297	2037	3027	2776
1995	4457	3124	2059	3334	2937
1996	3482	3550	2100	3454	3071
1997	3076	3446	2071	3278	3019
1998	2371	3455	2084	4111	3231
1999	2384	3855	1981	4814	3320
2000	2304	3792	1788	4503	3300

Source: Calculated from T-100f International Market Data

Table 4 Sources of Data

Variable		Source
Passenger		T-100f International Market Data: Bureau of Transportation Statistics, U.S. Department of Transportation
Airfare		Data Bank1B: Bureau of Transportation Statistics, U.S. Department of Transportation
Per Capita GDP: calculated from GDP and Population	GDP	International Financial Statistics: International Monetary Fund Official Web Sites of each Country
	Population	International Financial Statistics: International Monetary Fund Government Official Web Sites of Selected Countries Population Division, United Nations
Real Exchange Rate		Economic Research Service: USDA
Trade Volume (in US \$)		Foreign Trade Statistics: U.S. Censes Bureau
Herfindahl-Hirschman Index		Calculated from T-100f International Market Data
Price Index		International Financial Statistics: International Monetary Fund Official Web Sites of Selected Countries
Airfare Index		U.S. Import and Export Price Indexes: United States Department of Labor

Table 5 Estimation of Equations

Passenger Model ($R^2 = 0.95$)			Airfare Model ($R^2 = 0.91$)		
Variable	Coefficient	t Ratio	Variable	Coefficient	t Ratio
Intercept	35369	0.20	Intercept	643.78	6.47
Airfare	-427.78	-1.65	Passenger	-3.73E-05	-1.22
Per Capita GDP	79.35	2.95	H-H Index	0.05	6.79
Exchange Rate	34.04	0.14			
Trade Volume	5.62E-05	10.29			
Dummy for FC	-14113	-0.19	Dummy for FC	25.06	1.46
Dummy for Q1	22542	0.59	Dummy for Q1	12.29	0.99
Dummy for Q2	30346	0.77	Dummy for Q2	-21.94	-1.73
Dummy for Q3	164483	4.28	Dummy for Q3	6.32	0.46
Dummy for Korea	13670	0.07	Dummy for Korea	-173.17	-2.13
Dummy for Taiwan	-274162	-5.89	Dummy for Taiwan	-128.84	-1.49
Dummy for China	-327934	-2.83	Dummy for China	127.34	1.30
Dummy for Hong Kong	-180309	-2.09	Dummy for Hong Kong	58.16	0.63
Dummy for 1989	104299	1.56			
Dummy for 1990	209568	3.05			
Dummy for 1991	180108	2.46			
Dummy for 1992	212923	2.96			
Dummy for 1993	208356	2.99			
Dummy for 1994	136019	1.98			
Dummy for 1995	126452	1.78	Dummy for 1995	-43.36	-2.73
Dummy for 1996	209063	2.88	Dummy for 1996	-70.91	-4.28
Dummy for 1997	222423	2.84	Dummy for 1997	-41.53	-2.19
Dummy for 1998	207127	2.01	Dummy for 1998	-96.71	-4.07
Dummy for 1999	153703	2.03	Dummy for 1999	-100.95	-5.89
Dummy for 2000	83311	0.92	Dummy for 2000	-115.55	-5.56

Table 6 Elasticity Estimation

Passenger Model		Airfare Model	
Airfare	-0.41 (-1.65)	Passenger	-0.051 (-1.22)
Per Capita GDP	0.28 (2.95)	H-H Index	0.245 (6.79)
Exchange Rate	0.0087 (0.14)		
Trade Volume	0.95 (10.29)		

t-statistics are in parentheses.

Table 7 Estimates of Independent Variables for Forecasting

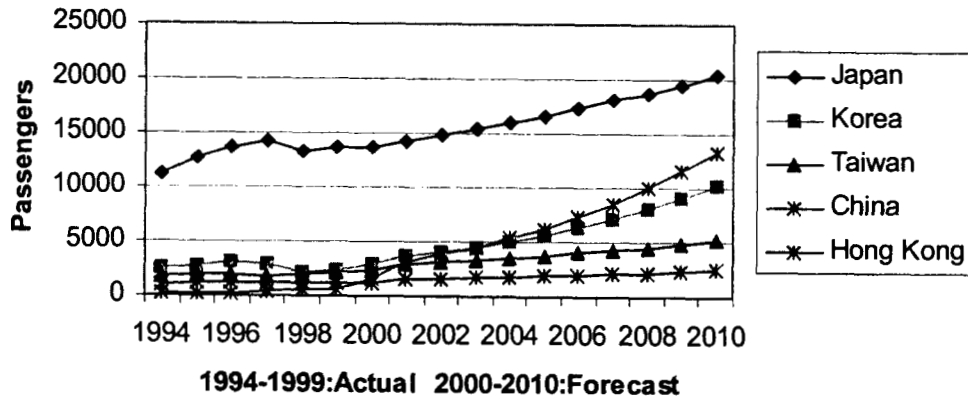
Independent Variable		Estimated Annual Growth Rate	Source
Airfare		all countries: - 1%	Current Market Outlook 2000, Boeing
Per Capita GDP: calculated from GDP and population	GDP	Japan and Korea: 2.31% Taiwan and Hong Kong: 4.73 % China: 6.28%	Current Market Outlook 2000, Boeing
	Population	China: 1.2% Korea and Taiwan: 1.1 % Japan and Hong Kong: 0.9%	Population Division, United Nations
Exchange Rate		each country: fixed with recent 2 year average	
Trade Volume		each country: fixed with recent 2 year growth rate	
Year Trend (Dummy for Year)		all countries: fixed with recent 3 year average	

Table 8 Passenger Forecasting (Thousand People)

Year	Japan	Korea	Taiwan	China	Hong Kong	Total		
Actual	1994	11060	2415	1636	150	956	16217	
	1995	12622	2745	1861	154	1146	18528	
	1996	13614	3064	1959	243	1201	20081	
	1997	14186	2837	1754	305	1200	20281	
	1998	13245	2127	1958	511	1239	19080	
	1999	13629	2285	2060	571	1224	19768	
	Forecast	2000	13713	2905	2254	1608	1212	21692
		2001	14199	3629	2810	3112	1492	25242
		2002	14766	4041	3015	3750	1565	27138
2003		15360	4509	3229	4478	1666	29242	
2004		15978	5038	3455	5305	1761	31537	
2005		16623	5639	3692	6246	1863	34063	
2006		17298	6329	3953	7320	1966	36865	
2007		18003	7110	4226	8541	2072	39950	
2008		18737	7996	4512	9932	2181	43358	
2009		19503	9002	4813	11517	2293	47128	
2010		20304	10145	5130	13322	2408	51310	

Note: Numbers may not add to totals shown owing to rounding.

**Figure 1. Air Passenger Demand Forecast
(Thousand People)**



Session area:

3B

Authors:

Yonghwa Park & Byung Jong Kim

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An Evaluation of Alternative Facilities for Airport Redevelopment using Fuzzy Linguistic Approach

Abstract:

Over the last few years, the major airports in Asia have been operating at or close to their capacity. As a result, Korea, Japan, China, Hong Kong, Thailand, Malaysia, and Indonesia took the decision to expedite the development of new airports. According to these new development airports, some of exist airports have been completely closed to convert other functions and purposes and the others operated as a domestic airport. In the latter case, some of idle facilities are needed the redevelopment plans.

This paper presents an evaluation of the alternative options for redevelopment of airport idle facilities in case of Seoul Gimpo International Airport. The methodology proposed in this paper can provide a practical and applicable evaluation of airport redevelopment plan. In particular, it can convert the perceptual views of differential interesting groups, airport experts, passengers and airport peripheral community to the selection of alternative facilities.

The direct interviewing method was conducted and taken related information in order to obtain the differential groups' view. To evaluate and select the best option of the airport redevelopment, it has adopted a fuzzy linguistic approach and is based on airport experts, passengers, and peripheral community's points of view.

Keywords: airport redevelopment, fuzzy linguistic approach, airport idle facility

**An Evaluation of Alternative Facilities for Airport Redevelopment Using
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1. INTRODUCTION

Over the last decade, demand for high quality air transport service in the Asia-Pacific region has grown at a dramatic rate. In response, many Asian countries have undertaken air transport infrastructure expansion projects to accommodate the increased demand. Since the late 1980s nearly every major airport in the region has been operating near full capacity. As such, major regional airports were forced to eke out every available inch of capacity out of congested existing airports until new facilities would become available. Finally, the countries of Korea, Japan, China, Hong Kong, Malaysia, and Thailand decided to embark on new airport development projects. Several airports have resulted from these efforts. Kansai International Airport, which opened in Japan September 1994; the international gateway at Sepang in Malaysia, which serves Kuala Lumpur and opened in June 1998; and the new Hong Kong International Airport at Chek Lap Kok, which opened for service in July 1998. Moreover, China opened the new Pudong International Airport, serving Shanghai, in October 1999. Each of these airports was launched with passenger handling capacities ranging from 25 to 35 million persons per year, as the first phase of construction.

In Korea, the air transport industry took a major leap forward in the late 1980s with the liberalization of overseas travel and deregulation of the air transport market (Park 1997:295). In the Seoul metropolitan area alone, air traffic increased by an average of over 10 percent a year from 1988 and 1997. By the end of the 1980s, the Korean government decided to build a new offshore airport in Youngjong island, 55 kilometers west of Seoul, in order to relieve the overload at Gimpo International Airport (GMP) which had resulted in congestion and delays during peak hours. The first phase of the construction project was completed in March 2001, and resulted in facilities capable of handling 27 million passengers and 1.7 million tons of cargo per year. The estimated cost of phase one was approximately US\$5 billion. The following phases of construction will continued through the year 2020.

The Republic of Korea's main international gateway airport has been converted from Gimpo to Incheon International Airport (ICN). Before the ICN opened on March 29, 2001, Gimpo International had been Korea's gateway for two decades. Currently, Gimpo Airport handles only domestic flights, while its idle facilities are either involved in or will be used for other purposes, such as a passenger and cargo terminal connecting ICN, the site of various commercial facilities, a theme park, and outdoor road net. It is important that the idle facilities of GMP are redeveloped in a careful and systematic manner so as to achieve the objectives of Korea Airport Authority as the airport operator and satisfy the needs of various types of user in- and outside of airport.

This paper presents an evaluation of the various redevelopment options for the idle airport facilities at GMP. The methodology proposed in this paper can be used to provide a practical and applicable evaluation of an airport re-development plan. In particular, it can incorporate the views of various interest groups in deriving the most workable alternative. The researchers used the direct interviewing method in gathering needed data. In evaluating and selecting the best option for redevelopment of GMP, the study adopted a fuzzy linguistic approach based on the views of airport specialists, passengers, and residents of the neighboring areas.

2. PROPOSED METHODOLOGY

2.1 Background

Since the fuzzy theory was developed by Zadeh (1965), it has been used as a mathematical tool for dealing with systems of organized complexity. While the diversity of successful applications has been expanding rapidly, the theory of fuzzy sets in particular, and the mathematics of uncertainty and information in general, have been widely acknowledged as valid and useful extensions of classical mathematics (Klir et al. 1988:4). Fuzzy set theory is a methodology that provides useful tools for particular systems and phenomena in real situations, which can often be highly uncertain or vague, through the use of mathematical definitions. Therefore, fuzzy set theory provides not only a strict mathematical framework for vague conceptual phenomena, but a modeling language for situations in which fuzzy relations and criteria occur (Park 1994:99).

According to the first publication of fuzzy set theory by Zadeh (1965:339), “the notion of a fuzzy set provides a convenient point of departure for the construction of a conceptual framework which parallels in many respects the framework used in the case of ordinary sets, but is more general than the latter and potentially, may prove to have a much wider scope of applicability, particularly in the fields of pattern classification and information processing. Essentially, such a framework provides a natural way of dealing with problems in which the source of ‘imprecision’ is the absence of sharply defined criteria of class membership rather than the presence of random variables.” In other words, ‘imprecision’ means here a sense of vagueness rather than the lack of knowledge about the value of a parameter as in tolerance analysis (Zimmermann 1991:6). Imprecision can arise from a variety of sources (Dutta 1985): incomplete knowledge, inexact language, ambiguous definitions, inherent stochastic characteristics, measurement problems and so on.

Fuzzy set theory has attempted to deal with the decision processing that involves subjective judgement. Subjective judgement of an evaluation has typically faced the problem of building a mathematical framework, because it cannot deal effectively with the decision maker’s feeling of ambiguity, uncertainty and vagueness. Fuzzy sets make it possible to analyze these problems through a method of multi-valued logic. Since fuzzy linguistic models permit the translation of verbal expressions into numerical ones, thereby dealing quantitatively with imprecision in the expression of the importance of each objective for re-developing and adopting functions involved in implementing Gimpo International Airport. Use of the fuzzy linguistic approach resolves the dilemma of the quantitative forecasts required by scoring models discussed above since the adaptability of each enabling function or facility in meeting re-development objectives is assessed in terms of natural language.

2.2 Fuzzy Approach

A linguistic variable is defined as a variable, the values of which are words, phrases, or sentences in a given language where such a language can either be natural or artificial (Schmucker 1983). Zadeh (1973:3) presented in a nutshell the motivation for fuzzy logic and approximate reasoning when he stated, “...in retreating from precision in the face of overpowering complexity, it is natural to explore the use of what might be called linguistic

variables, that is, variables whose values are not numbers but words or sentences in a natural or artificial language and the motivation for the use of words or sentences rather than numbers is that linguistic characterizations are, in general, less specific than numerical ones”.

In applying a fuzzy linguistic variable approach to the assessment of functional suitability of the GMP re-development, we define two fuzzy linguistic variables:

X = “importance”, and
 Y = “adaptability”.

The use of these two linguistic variables allows the analyst to specify the $X = important$ associated with each of a set of re-developing objectives, and the other variable $Y = adaptability$ of each function or facility to accommodate the objectives of the airport operational organization, the Korea Airport Authority. For example, the “outlet store” function is *above average* in its ability to increase airport profits, which is a *very important* goal in accomplishing the re-development objectives. The term “above average” is a value of fuzzy variable adaptability (Y), and the term “very important” is a value of the fuzzy linguistic variable importance (X).

The primary values of the two fuzzy linguistic variables X and Y are defined on the universe of discourse $\{0, 1\}$. They are shown in Table 1 and 2, and are plotted in Figure 1.

Table 1. Compatibility Functions for the Fuzzy Linguistic Variable $X = important$

Variable Value (x)	Universe of Discourse										
	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
<i>Critical</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.15	0.80	1.00
<i>Important</i>	0.00	0.10	0.25	0.75	0.90	1.00	0.90	0.75	0.25	0.10	0.00
<i>Unimportant</i>	1.00	0.80	0.40	0.20	0.05	0.00	0.00	0.00	0.00	0.00	0.00

Table 2. Compatibility Functions for the Fuzzy Linguistic Variable $Y = adaptability$

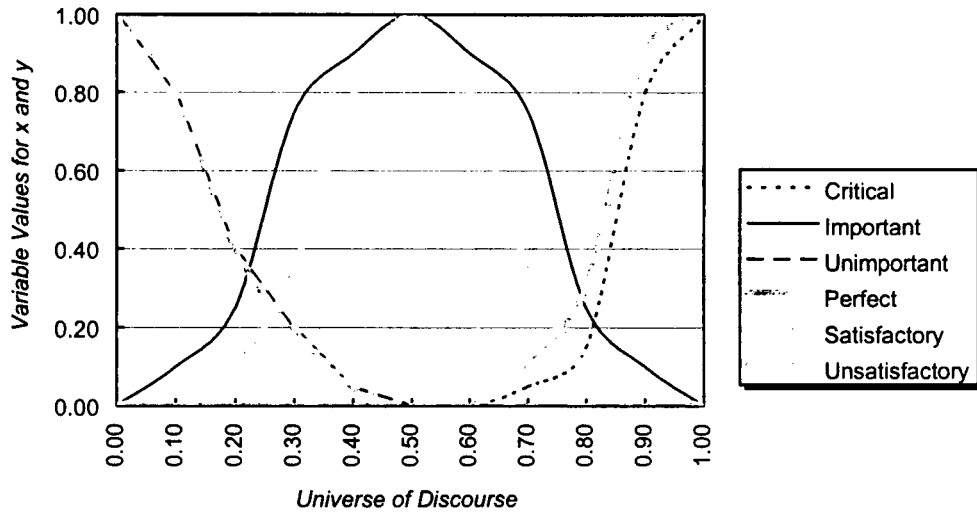
Variable Value (y)	Universe of Discourse										
	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
<i>Perfect</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.30	0.90	1.00
<i>Satisfactory</i>	0.00	0.05	0.10	0.35	0.80	1.00	0.80	0.35	0.10	0.05	0.00
<i>Unsatisfactory</i>	1.00	0.80	0.40	0.20	0.05	0.00	0.00	0.00	0.00	0.00	0.00

Suppose $M(x)$ is defined as a semantic rule for associating a meaning with each variable name, and is a fuzzy subset on the universe of discourse for linguistic variable X :

$$M(x) = \{important\} = \{x, \mu_{M(x)}(u_x) \mid u_x \in U_x\} \quad (1)$$

where, $\mu_{M(x)}(u_x)$ is the compatibility function of u_x in $M(x)$.

Figure 1. Values of the Linguistic Variable X and Y



The primary values displayed in these tables were selected arbitrarily, as were the values defining the universes of discourse, and are not intended to be a rigorous specification of the appropriate primary values for every analysis (Wilhelm *et al.* 1991:194). The general terms of importance and adaptability are still imprecise and can be further modified using a linguistic hedge or a modifier. The concept of linguistic hedges or modifiers is very significant and meaningful for using linguistic variable in fuzzy logic in order to extend the range of assessment and classification. A hedge acts as modifier to determine the meaning of the arbitrary term set using natural language statements such as *indeed*, *more or less*, *above*, *below*, and so on. The new variable values can be derived by the primary values using linguistic hedges, connectives such as “and” and “or,” and operators.

Suppose $Q(x)$ and $Q(y)$ are defined as a semantic rule for the new variable values in hedging primary variables X and Y . We assume that the primary values of $X = \text{important}$ and $Y = \text{adaptability}$ variable, and new variable values are as follows:

$$\begin{aligned} Q(x) &= \{\text{important}\} = \{x, \mu_{Q(x)}(u_x) \mid u_x \in U_x\}, \text{ and} \\ Q(y) &= \{\text{adaptability}\} = \{y, \mu_{Q(y)}(u_y) \mid u_y \in U_y\} \end{aligned} \quad (2)$$

where, $\mu_{Q(x)}(u_x)$ and $\mu_{Q(y)}(u_y)$ are the compatibility or membership functions of u_x in $Q(x)$ and of u_y in $Q(y)$. Hence, new linguistic variable values are defined in Table 3 and 4.

Table 3. Compatibility Functions for Hedges on Values of $X = \textit{important}$

Variable Value (x)	Universe of Discourse											
	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	
Very Important (VI)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.92	1.00	
More Important (MI)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.39	0.89	1.00	
Important (IM)	0.00	0.01	0.06	0.56	0.81	1.00	0.81	0.56	0.06	0.01	0.00	
Less Important (LI)	0.00	0.32	0.50	0.87	0.95	1.00	0.95	0.87	0.50	0.32	0.00	
Not Important (NI)	1.00	0.90	0.75	0.25	0.10	0.00	0.00	0.00	0.00	0.00	0.00	

Table 4. Compatibility Functions for Hedges on Values of $Y = \textit{adaptability}$

Variable Value (y)	Universe of Discourse											
	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	
Perfect (PE)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.18	0.98	1.00	
More Satisfactory (MS)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.55	0.95	1.00	
Satisfactory (SA)	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.65	0.90	0.95	1.00	
Less Satisfactory (LS)	1.00	0.95	0.90	0.65	0.20	0.00	0.00	0.00	0.00	0.00	0.00	
Unsatisfactory (US)	1.00	0.64	0.16	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

In order to analyze the fuzzy relation of the two selected variables $X = \textit{importance}$ and $Y = \textit{adaptability}$, the related methodologies can be considered in using the heuristic algorithm. The basic linguistic equation by Sanchez (1976) is applied for analysis as shown below:

$$x_i = q_{ij} \circ y_j \quad (3)$$

where, x_i is value of importance of an objective i ,

y_j is value of adaptability of a function or facility j ,

q_{ij} is a fuzzy relation of objective i and facility j , and

\circ is a composition operator which is defined such that the compatibility function of $q_{ij} \circ y_j$ is determined from:

$$\mu_{Q(q \circ y)}(u_x, u_y) = \text{Max}_{u_y} [\text{Min} \{ \mu_{Q(x)}(u_x, u_y), \mu_{Q(y)}(u_y) \}], \text{ for each } u_x. \quad (4)$$

In the proposed methodology, the linguistic assessments of x_i and y_j are assumed to be provided by the decision maker. Thus, Sanchez's procedure is used for finding the fuzzy relation, q_{ij} , in the equation, as presented in the equation below:

$$q_{ij} = x_i^{-1} \otimes y_j, \quad (5)$$

where, x_i^{-1} is the transpose of the variable value x_i , and \otimes is a compositional operator defined such that the membership function of $x_i^{-1} \otimes y_j$ which is determined from:

$$\mu_{Q(x^{-1} \otimes y)} = \text{Min} [\mu_{Q(x)}^{-1}(u_x) \circ \mu_{Q(y)}(u_y)], \quad (6)$$

where, \circ is a compositional operator defined such that the elements of its compatibility function are determined as follows:

$$[\mu_{Q(x)}^{-1}(u_x) \circ \mu_{Q(y)}(u_y)] = \begin{cases} 1 & \text{if } \mu_{Q(x)}^{-1}(u_x) \leq \mu_{Q(y)}(u_y), \\ \mu_{Q(y)}(u_y) & \text{if } \mu_{Q(x)}^{-1}(u_x) > \mu_{Q(y)}(u_y). \end{cases} \quad (7)$$

Another useful concept is the intersection of fuzzy relations. This intersection is defined as a fuzzy relation $R_j = \bigcap_i q_{ij}$ having a compatibility function given by Kaufmann (1975):

$$\mu_R(u_x, u_y) = \text{Min}_{x,y} [\mu_{Q(r)}(u_x, u_y)]. \quad (8)$$

Finally, the adaptability of each re-developing facility, $\mu_{R_j(y_{\max})}(u_y)$, can be described by a fuzzy relation as the rule of compositional inference. In order to determine the preference of each facility, it is necessary to calculate the fuzzy relation as:

$$\mu_{Q_j(y_{\max})}(u_y) = \text{Max}_y \left[\text{Min} [\mu_{Q(x)}^{-1}(u_x) \circ \mu_{Q(y)}(u_y)] \right]. \quad (9)$$

3. APPLICATION OF PROPOSED METHODOLOGY

3.1 Airport Selection

This section describes the practical application of the proposed methodology in order to assess the suitable functions or facilities for an airport being redeveloped. A case study of Seoul Gimpo International Airport (GMP) has been selected for application of the fuzzy linguistic approach. GMP is situated to the northwest of the capital city of Seoul. Before the opening of the new Incheon International Airport (ICN) on March 29, 2001, GMP was the air gateway of Korea. Since the ICN opened, Gimpo has been serving only domestic flights. Its substantial reserves of idle facilities have been converted for other uses.

3.2 Re-development Objectives

The objective of developing alternative uses for GMP idle facilities is to generate additional revenues and enhance connection with ICN. It is assumed that maximizing profits is the first and foremost concern of the airport operational organization, the Korea Airport Authority, since the authority continues to subsidize regional air transport functions for flights into and out of GMP. One advantage of the GMP is that it has a good image that has been developed over three decades, and it is well recognized by the public and potential customers. Moreover, the GMP is highly accessible via various transportation modes: private cars, buses, subway, and even air. Moreover, it is anticipated that such accessibility will be enhanced further since the airport will be included on the route of a planned express rail to ICN, as well as an additional subway connecting to the center of Seoul.

GMP still handles domestic flights, so that the primary role of GMP is definitely provision of air services. Also, most ground access modes bypass Gimpo to the Incheon International Airport. The connectivity between the two airports is fairly important. Thus, based on all the abovementioned factors, the objectives of GMP redevelopment can be defined as follows:

- *Profitability*: To generate additional profits. Once GMP was converted to a domestic-only airport, it lost many opportunities to generate profits.
- *Spatiality*: To contribute to more balanced development of the metropolitan area, since the area to the northwest of Seoul has been developed poorly relative to other areas.
- *Connectivity*: To ensure that ICN and GMP function well together, handling international and domestic air transport, respectively.
- *Sociality*: To improve the lives of the areas surrounding GMP, in the form of regional community development, job creation, and so on.
- *Publicity*: To promote the role of air transport as a public good.

Therefore, the objectives for assessing the linguistic variable X are defined as below:

$$O = \{o_i\} \quad i = 1, 2, \dots, I, \quad I = 5,$$

where, o_1 : profitability,
 o_2 : spatiality,
 o_3 : connectivity,
 o_4 : sociality, and
 o_5 : publicity.

3.3 Selection of Alternatives

In the proposed approach, the linguistic assessment of the variables $X = importance$ and $Y = adaptability$ is provided by a variety of sources: airport and regional development experts, air passengers, and residents of the airport vicinity. The surveys were carried out through the interviewing of passengers and airport vicinity residents and by mail-back questionnaires to experts in April and June of 2000. There were 872 useful respondents, consisting of 71 experts, 392 air passengers, and 409 airport vicinity residents. From the survey results, the degree of importance of re-developing objectives was evaluated as well as the alternative facilities or functions were selected. Respondents were provided over 40 alternatives, and they can be grouped into 14 similar functions as follows:

$$F = \{f_j\} \quad j = 1, 2, 3, \dots, J, \quad J = 14,$$

where, f_1 : city passenger terminal,
 f_2 : reserved facility for the future international services,
 f_3 : general aviation facility,
 f_4 : express bus terminal,
 f_5 : exhibition and convention center,
 f_6 : shopping mall and outlet stores,
 f_7 : theaters,
 f_8 : business offices,
 f_9 : game lands,
 f_{10} : wedding hall,

- f_{11} : foods and restaurant complex,
- f_{12} : cultural and art center,
- f_{13} : leisure complex, and
- f_{14} : sports complex.

3.4 Example

Through interviews of airport vicinity residents and air passengers, and through mail-back surveys of experts, the relative degree of importance of each re-development objective was calculated. Next, the importance of each objective was evaluated using values of the linguistic variable $X = importance$, as shown in Table 5. The value set of the assessment for objectives is shown in Table 3. According to the survey results, the most important objective to be achieved through redevelopment of GMP was profitability; the next most important objectives were sociality, spatiality, connectivity and, finally publicity.

Table 5. Linguistic Assessment of the Importance of each Objective

Objectives	Points of View (%)			Share Rate (%)	Assessment
	Experts	Passengers	Residents		
Profitability	29.6	26.8	42.9	33.1	Very Important $Q_1(x)$
Connectivity	8.5	9.7	17.6	11.9	Less Important $Q_4(x)$
Sociality	23.9	42.1	26.7	30.9	More Important $Q_2(x)$
Spatiality	35.2	17.3	8.6	20.4	Important $Q_3(x)$
Publicity	2.8	4.1	4.2	3.7	Not Important $Q_5(x)$
Total	100	100	100	100	-

The assessment for each alternative is represented in Table 6, and the set of the alternative functions or facilities are determined by use of the linguistic variable $Y = adaptability$. The criteria of linguistic modified variables Y are defined such as:

- $Q_1(y) = \{\text{perfect}\} = B1,$
- $Q_2(y) = \{\text{more satisfactory}\} = B2,$
- $Q_3(y) = \{\text{satisfactory}\} = B3,$
- $Q_4(y) = \{\text{less satisfactory}\} = B4,$ and
- $Q_5(y) = \{\text{unsatisfactory}\} = B5.$

The membership set of the assessment for each alternative function or facility is shown in Table 4. The universe of discourse set is $[0, 1] = \{0.0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0\}.$

Table 6. Linguistic Assessment of the Adaptability of each Alternative Function

Objectives	f_1	f_2	f_3	f_4	f_5	f_6	f_7	f_8	f_9	f_{10}	f_{11}	f_{12}	f_{13}	f_{14}
Profitability $Q_1(x)$	B5	B5	B4	B4	B4	B1	B2	B2	B1	B2	B1	B4	B2	B2
Connectivity $Q_4(x)$	B1	B3	B4	B2	B4	B4	B4	B4	B4	B4	B4	B4	B5	B4
Sociality $Q_2(x)$	B2	B2	B1	B2	B2	B1	B1	B2	B2	B2	B1	B1	B1	B1
Spatiality $Q_3(x)$	B4	B4	B4	B2	B2	B2	B1	B3	B3	B2	B3	B1	B2	B2
Publicity $Q_5(x)$	B1	B1	B1	B1	B3	B5	B4	B4	B5	B4	B4	B2	B1	B3

For each alternative facility and objective, the linguistic assessment, q_{ij} , in equation (5) uses the compatibility functions of the fuzzy linguistic variable X and Y . For example, let us assess the adaptability of shopping mall and outlet stores (f_6) using the profitability objective, with profitability assessed as being very important, $Q_1(x)$, and f_6 evaluated as perfect, $Q_1(y)$. This relationship is represented by the fuzzy relation q_{16} , shown below:

$$q_{16} = x_1^{-1} \otimes y_6 = Q_1^{-1}(x) \otimes Q_1(y)$$

$$= \begin{bmatrix} 0.000 \\ 0.000 \\ 0.000 \\ 0.000 \\ 0.000 \\ 0.000 \\ 0.000 \\ 0.010 \\ 0.020 \\ 0.920 \\ 1.000 \end{bmatrix} \otimes [0.000 \ 0.000 \ 0.000 \ 0.000 \ 0.000 \ 0.000 \ 0.000 \ 0.000 \ 0.010 \ 0.18 \ 0.980 \ 1.000]$$

$$= \begin{bmatrix} 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 \\ 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 \\ 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 \\ 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 \\ 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 \\ 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 \\ 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 \\ 0.000 & 0.000 & 0.000 & 0.000 & 0.000 & 0.000 & 0.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 \\ 0.000 & 0.000 & 0.000 & 0.000 & 0.000 & 0.000 & 0.000 & 0.010 & 0.180 & 1.000 & 1.000 & 1.000 \\ 0.000 & 0.000 & 0.000 & 0.000 & 0.000 & 0.000 & 0.000 & 0.010 & 0.180 & 1.000 & 1.000 & 1.000 \\ 0.000 & 0.000 & 0.000 & 0.000 & 0.000 & 0.000 & 0.000 & 0.010 & 0.180 & 1.000 & 1.000 & 1.000 \end{bmatrix}$$

The next step is formed across each of the 14 alternative facilities under consideration for each of the give objectives using the intersection of fuzzy relations in equation (8). Using the fuzzy relation as the rule of compositional inference, equation (9), the highest level of adaptability of each alternative facility can be calculated as follows:

$$\begin{aligned}
\mu_{Q_1(\max)}(U_y) &= \{0.00 \ 0.01 \ 0.05 \ 0.36 \ 0.16 \ 0.00 \ 0.00 \ 0.07 \ 0.21 \ 0.85 \ 1.00\} \\
\mu_{Q_2(\max)}(U_y) &= \{0.00 \ 0.02 \ 0.05 \ 0.36 \ 0.76 \ 1.00 \ 0.76 \ 0.30 \ 0.21 \ 0.85 \ 1.00\} \\
\mu_{Q_3(\max)}(U_y) &= \{0.00 \ 0.30 \ 0.45 \ 0.57 \ 0.19 \ 0.00 \ 0.00 \ 0.01 \ 0.09 \ 0.87 \ 1.00\} \\
\mu_{Q_4(\max)}(U_y) &= \{0.00 \ 0.00 \ 0.00 \ 0.00 \ 0.00 \ 0.00 \ 0.00 \ 0.28 \ 0.28 \ 0.85 \ 1.00\} \\
\mu_{Q_5(\max)}(U_y) &= \{0.00 \ 0.30 \ 0.45 \ 0.57 \ 0.76 \ 1.00 \ 0.76 \ 0.30 \ 0.21 \ 0.85 \ 1.00\} \\
\mu_{Q_6(\max)}(U_y) &= \{0.00 \ 0.30 \ 0.45 \ 0.57 \ 0.19 \ 0.00 \ 0.00 \ 0.18 \ 0.07 \ 0.90 \ 1.00\} \\
\mu_{Q_7(\max)}(U_y) &= \{0.00 \ 0.30 \ 0.45 \ 0.57 \ 0.19 \ 0.00 \ 0.00 \ 0.01 \ 0.07 \ 0.87 \ 1.00\} \\
\mu_{Q_8(\max)}(U_y) &= \{0.00 \ 0.30 \ 0.45 \ 0.57 \ 0.65 \ 1.00 \ 0.65 \ 0.20 \ 0.21 \ 0.87 \ 1.00\} \\
\mu_{Q_9(\max)}(U_y) &= \{0.00 \ 0.30 \ 0.45 \ 0.57 \ 0.65 \ 1.00 \ 0.65 \ 0.20 \ 0.21 \ 0.90 \ 1.00\} \\
\mu_{Q_{10}(\max)}(U_y) &= \{0.00 \ 0.30 \ 0.45 \ 0.57 \ 0.19 \ 0.00 \ 0.00 \ 0.18 \ 0.21 \ 0.87 \ 1.00\} \\
\mu_{Q_{11}(\max)}(U_y) &= \{0.00 \ 0.30 \ 0.45 \ 0.57 \ 0.65 \ 1.00 \ 0.65 \ 0.20 \ 0.07 \ 0.90 \ 1.00\} \\
\mu_{Q_{12}(\max)}(U_y) &= \{0.00 \ 0.30 \ 0.45 \ 0.57 \ 0.19 \ 0.00 \ 0.00 \ 0.28 \ 0.28 \ 0.87 \ 1.00\} \\
\mu_{Q_{13}(\max)}(U_y) &= \{0.00 \ 0.20 \ 0.08 \ 0.03 \ 0.00 \ 0.00 \ 0.00 \ 0.18 \ 0.09 \ 0.87 \ 1.00\} \\
\mu_{Q_{14}(\max)}(U_y) &= \{0.00 \ 0.30 \ 0.45 \ 0.57 \ 0.76 \ 1.00 \ 0.76 \ 0.30 \ 0.07 \ 0.87 \ 1.00\}
\end{aligned}$$

4. RESULTS

This section describes the results attained when applying the proposed methodology in order to determine the most suitable replacement functions or facilities at GMP. The Euclidean Distance (Kaufmann 1975) as a mathematical measurement can be used to calculate the adaptability of each replace function. The relative Euclidean Distance (UD) is defined in terms of a metric distance. We can apply this distance in measuring each replacement function and the shortest distance has been shown to be the most satisfactory facility. The relative Euclidean Distance (δ_j) can be defined as:

$$\delta_j = \frac{1}{n} \left(\sum_{u_y} [\mu_{Q(y^*)}(u_y) - \mu_{Q(y_{\max})}(u_y)]^2 \right)^{1/2} \quad \text{for } j = 1, 2, \dots, J, \quad J = 14,$$

where, n is the number of elements in the universe of discourse u_y ,

$\mu_{Q(y^*)}(u_y)$ is the ideal compatibility function in terms of the linguistic variable of *perfectly satisfactory* for an alternative facility j , and

$\mu_{Q(y_{\max})}(u_y)$ is the maximum compatibility function for the adaptability of an alternative facility j .

Consequently, the adaptability of the alternative functions or facilities for the redevelopment of GMP are represented in terms of Euclidean Distance (UD) as a metric measurement. According to the UD, the shortest relative distance can define the best adaptable function or facility. The results of the adaptability of each alternative facility are illustrated in Table 7. Thus, we find that leisure complex, suburban and express bus terminal, and city passenger terminal to connect the Incheon International Airport are the

most desired functions to be achieved from the redevelopment of the idle facilities, since they have the shortest relative Euclidean distance from the ideal linguistic values.

Table 7. Relative Euclidean Distance for All Selected Alternative Function

Priority	Alternative Replace Function	Relative Distance
1	f_{13} : leisure complex	0.12377141
2	f_4 : express bus terminal	0.12424988
3	f_1 : city passenger terminal	0.12621584
4	f_7 : theaters	0.14141089
5	f_3 : general aviation facility	0.14141302
6	f_{10} : wedding hall	0.14353291
7	f_6 : shopping mall and outlet stores	0.14376086
8	f_{12} : cultural and art center	0.14558717
9	f_2 : reserved for the int'l services	0.18507244
10	f_8 : business offices	0.18857483
11	f_{11} : foods and restaurant complex	0.18874840
12	f_9 : game lands	0.18964567
13	f_5 : exhibition and convention center	0.19547583
14	f_{14} : sports complex	0.19564326

5. CONCLUSION

This study was conducted to apply the fuzzy linguistic approach in order to assess the desirability of various potential functions or facilities at the Seoul Gimpo International Airport. The methodology proposed in this paper can provide a practical and applicable assessment of airport re-development alternatives. This approach has been investigated as even more useful and flexible to deal with adaptability associated with designated redevelopment objectives. Using the fuzzy theory, the dilemma of the quantitative forecasts and assessments can be resolved.

The relative importance of each redevelopment objective was gathered from three different points of view: experts in airport management and operations and regional development, airport vicinity residents, and air passengers. Members of each group assessed the importance of each redevelopment objective, and this information was then applied to the fuzzy linguistic approach. The results of the surveys show that the most important objective, as judged by respondents, was the profitability of the airport authority, whereas the next most important objectives were sociality, spatiality, connectivity and publicity.

The results also showed that the most attractive replacement facility would be a leisure complex. It was further determined that the next most significant function that the facilities could be used for are an express bus terminal, a city passenger terminal, a theater complex, etc. One important finding of this analysis is that the enforced airport roles such as express bus terminal and city passenger terminal were considered to be more important than commercialized activities by all groups of respondents.

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Economic analysis of airline alliances

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Abstract

A recent trend in aviation markets is the emergence of airline alliances. One could argue that at the national level the emergence of alliances is a continuation of the process of concentration and consolidation that was first characterized by the emergence of hub-and-spoke networks. The international aviation market is still subject to regulation, and airlines can only include foreign destinations into their networks by entering alliance agreements with foreign airlines. In this paper we find that full liberalization of specific international markets by means of a bi-lateral agreement results in higher welfare than the formation of an alliance. Carriers, however, will also in fully deregulated aviation markets most likely opt for an alliance.

Jel-code: R40

Keywords: Airline alliances, airline networks

1 Introduction

Throughout the world, the aviation market is in a constant hubbub; developments in the aviation sector tend to instigate strong reactions and necessitate new policies. A recent trend in aviation markets is the emergence of alliances. In the U.S. the emergence of alliances (between carriers in a national market) is a continuation of the process of concentration and consolidation that was first characterized by the emergence of hub-and-spoke networks. In the international aviation market, which is still subject to regulation, airlines may only have the opportunity to extend their networks to foreign countries by entering an alliance agreement with a foreign airline. This raises the question of whether or not airlines will also enter alliance agreements when they are free to fly to foreign destinations at their own discretion.

Alliances are reasons for concern in the press and at the governmental level at both sides of the Atlantic. The major concern is the potential anti-competitive effect of codesharing. Such concerns were for example expressed by U.S. airlines opposing the American Airlines/British Airways alliance during Congressional hearings in 1997 (Brueckner, 1997). The European commissioner for competition policy complained in 1997 that at least 13 North Atlantic routes were closed to any form of

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competition. The European Commission wanted to apply European competition laws also to alliances with non-European carriers. In 1998 British Airways and American Airlines were allowed to form an alliance, provided that they would relinquish 267 slots at London Heathrow and London Gatwick (representing about 5% of the total weekly landings and take-offs (in 1998)). Continental (and a number of other airlines) argued that this was not enough; it would need 140 slots just to operate a (competitive) route between London and New York. The value of the 267 slots was estimated to be worth around 750 million U.S. dollars.

The emergence of (international) alliances and the concerns over (international) alliances call for economic theoretical analysis of airline alliances: under what conditions will airlines enter a codesharing agreement, what will be the effects for the consumer, and should the authorities intervene to protect consumers. In this paper we formulate a simple model to analyze the effects of a (bilateral) liberalization of aviation markets on airline strategies and consumer benefits. We compare a base scenario with a scenario under which airlines are free to enter new (foreign) markets but are not allowed to enter an alliance agreement. We also compare the base scenario with a scenario under which the airlines enter an alliance agreement.

Literature on airline alliances is scarce. Brueckner (1997) finds that airline alliances and codesharing agreements may be socially desirable: although the fare increases in the interhub market due to collusion, fares in the interline markets decrease due to cooperative pricing¹. The airline operates a hub-and-spoke network, and the increase in traffic in the markets affected by the alliance increases traffic density on the relevant spokes. This in turn lowers the marginal costs of operating these spokes, and also has effect in markets not affected by the codesharing agreement. On balance, the positive effects of the alliance outweigh the negative, anti-competitive effect. Brueckner and Whalen (1998) also find that alliance partners charge lower fares than nonallied airlines. Under a codesharing scheme, the negative externalities from the uncoordinated (sub)fare determination are internalized²; this reduces the fare and increases demand. Then, due to economies of density, fares can decrease even further. Oum et al. (1996) find that a codesharing agreement between "non-leaders" increases the market leaders equilibrium output and lowers the equilibrium price. In a theoretical paper, Park (1997) analyzes two forms of alliances; parallel alliances (i.e. collusive alliances) and complementary alliances. Complementary alliances lead to an increase in welfare while parallel alliances decrease welfare when markets are sufficiently large. In this paper we analyze a "mixed-form" alliance. Park and Zhang (1999) study the British Airways/USAir, KLM/Northwest, Lufthansa/United Airlines and Delta/Sabena/Swissair alliances, and find that aggregate demand in North Atlantic markets increased due to the first three alliances, but decreased due to the Delta/Sabena/Swissair alliance. The benefits of an alliance are unevenly distributed geographically. Passengers in markets between gateways/hubs may be worse off due to decreased competition, while pas-

¹An interline market is a market which requires a transfer and is serviced by both airlines.

²Under the assumptions of the model, an increase in the (sub)fare of carrier A reduces demand and, as a result, the profitability of carrier B in the absence of an alliance.

passengers in connecting ("spoke") markets may be better off due to density effects and schedule convenience. Note that this distribution is the opposite of the distribution of benefits of hub-and-spoke networks. If the positive effects of network integration (the complementary aspect of an alliance) outweighs reduced competition on certain links (the parallel aspect), passengers in general are better off.

The outline of the paper is as follows. In Section 2 we provide a general discussion of airline alliances. In Section 3 we analyze airline alliances using a simple theoretical model. Section 4 concludes.

2 Airline alliances

2.1 Introduction

An alliance is a co-operation on route or network level between different airlines. This co-operation can take different forms. A full merger is the most extreme form of an alliance. Carriers coordinate their activities and complete control is in the hands of a single board. Mergers have not always been successful because overlapping networks offer less economies than interfacing networks (Button, 1997). Whereas mergers were an important aspect of the consolidation of the U.S. internal aviation market³, unidirectional or cross-equity holdings are important in the international arena⁴. Such alliances are obviously not as far reaching as full mergers and not as important measured in the number of agreements. Note however that for example the successful alliance between KLM and Northwest is a prime example of such an alliance. Other forms of alliances can involve coordination of flight schedules, loyalty programs and code-sharing⁵. Code-sharing allows carriers to sell seats on each other's flights using the carriers' own designator codes. This can be done through joint pricing of capacity or by allowing a carrier to buy and resell some of the other airline's capacity. In practice there are hundreds of alliances in various forms. The most important alliances are⁶:

² OneWorld: Aer Lingus, American Airlines, British Airways, Canadian Airlines, Cathay Pacific, Finnair, Iberia, Qantas

² Star Alliance: Air Canada, Air New Zealand, All Nippon Airways, Ansett Australia, Lufthansa, SAS, Thai, United Airlines, Varig

³34 new scheduled carriers entered the market between 1978 and 1992. Two of those new entrants remained in 1997 (Button, 1997).

⁴Note that international alliances of any type are still subject to bilateral agreements.

⁵These arrangements can of course also be included in mergers and equity holdings.

⁶These lists are not complete but contain the most important partners; for example, Air France reports to have a variety of partnerships with 35 partners. The exact type of agreement between the airlines is not always clear. American Airlines was one of the founding members of the OneWorld alliance, but also started a codesharing agreement with Sabena on the routes between Brussels on the one hand and Boston, Chicago and Washington Dulles on the other. Therefore, it is also added to the Qualiflyer Group here, although the agreements may be different.

- ² Global Wings: Alaska Airlines, Continental Airlines, Alitalia, KLM, Northwest Airlines, Air Europe
- ² Air France, Delta Airlines
- ² Qualiflyer Group: American Airlines, Austrian, Crossair, Delta Airlines, Lauda Air, Sabena, Swissair, TAP, Turkish Airlines

For more details on these alliances, see Park and Zhang (1999).

2.2 Benefits of alliances

The incentives for an airline to enter an alliance are similar to the incentives for a carrier to adopt a hub-and-spoke network. Following the deregulation of the U.S. aviation markets a large body of literature on the emergence of hub-and-spoke networks has appeared. Three important factors mentioned in the literature explaining the emergence of hub-and-spoke networks are cost factors, demand factors and entry deterrence.

Because the number of direct connections is reduced in hub-and-spoke networks, densities in the remaining (spoke) markets are higher. Economies of density may then reduce the average cost per passenger. Moreover, the fixed costs of operating a route can be spread over more passengers. Economies of density are an incentive to an airline to reduce the number of connections so as to increase density on the remaining connections. For empirical evidence on the existence of economies of density, see for example, Brueckner et al. (1992), Caves et al. (1984) and Kumbhakar (1990). Because in a hub-and-spoke network, passengers in an indirect market and passengers in a spoke market may be on the same aircraft (and densities on spoke routes may increase), therefore the use of larger aircraft may be necessary. Morrison and Winston (1985) show that economies of scope (economies of vehicle size) can indeed warrant adoption of a hub-and-spoke network⁷. By entering an (international) alliance, an airline is able to increase the densities in its spoke markets and reduce its fixed costs in the markets with a code-sharing agreement: an airline can reduce its operating costs by entering an alliance. Moreover, production indivisibilities can be an incentive to enter an alliance just as they are incentive to adopt a hub-and-spoke network (see also Levine, 1987). A high frequency may be necessary to compete for passengers with a high value of time, but a number of aircraft seats on each flight may not be needed by these high-priced passengers, and may have to be sold at a discount (the excess capacity exists due to the presence of, in the words of Levine, "schedule and equipment indivisibilities"). The number of seats offered at a discount varies from flight to flight, and this tends to destabilize the duopoly (Levine (1987) uses a duopoly example to make his point). Airlines may prefer to merge in order to reduce the number of excess seats.

⁷In a hub-and-spoke network, an airline faces the joint costs of transporting passengers in direct and indirect markets; although the markets may be different, they are served using the same aircraft ("production process"). If the joint costs decrease with aircraft size ("scale of production"), economies of scope are incurred.

Levine (1987) observes that new entrants do not appear to compete on the hubbing airline's spoke market. New entry seems to be limited to service to and from other hubs. Authors frequently observe in the literature that airlines may "dominate" an airport and that competition may be limited. "Barriers to contestability", such as frequent flyer programs, computer reservation systems or incentive commissions certainly are a cause for the lack of competition. These factors can give incumbent airlines an advantage over new entrants, thereby reducing the entrant's profit generating potential⁸. Oum et al. (1995) found that hub-and-spoke networks may be useful in deterring entry. Competition only seems to take place for traffic between hub cities and connecting traffic (inter-hub competition). An incumbent airline can channel traffic from many origins on a spoke market, thus leaving an entrant with a small market share. Zhang (1996) finds that invading a competitor's local markets may reduce the entrant's profit in his original hub-and-spoke network. By entering a code-sharing agreement the airlines reduce competition and are able to increase their (joint) market share in the markets subject to the agreement. Due to network effects, the airlines may also be able to increase their market share in the remaining (spoke) markets.

Brueckner and Zhang (1999) show in a theoretical model that the frequency in a hub-and-spoke network is higher than in a fully-connected network. Some passengers, however, may choose not to fly in a hub-and-spoke network, given the duration of the indirect flight. Higher frequencies may attract a greater number of passengers. Although an alliance partner may actually reduce its actual number of flights, by selling tickets on its partner's flights, it can increase its frequency from a marketing perspective, and hence attract more passengers. Moreover, by linking the partners' networks and schedules, schedule convenience for passengers that had to travel on two airlines improves.

After this general discussion of airline alliances we continue with a theoretical analysis in the next section.

3 Theoretical analysis of airline alliances

In this section we present a theoretical analysis of international airline alliances, for example on the trans-Atlantic market. The analysis concerns three scenarios. The first scenario is the "base scenario". In this scenario the airlines are only allowed to operate a service to one foreign destination ("gateway"), and no alliance is allowed. Following a bilateral agreement, airlines are allowed to operate flights to other foreign destinations. There are two options. In scenario II, the airlines invade the competitor's network; airlines choose not to enter or are not allowed to enter an alliance. In scenario III the airlines enter an alliance.

⁸Note that the benefits arising from computer reservation systems and commissions to travel agents may be limited by legislation.

3.1 Model description

Assume that we have two airlines which operate networks as in Figure 1, this is base scenario, which we will call scenario I.

Figure 1 about here

Airline a operates a hub-and-spoke network with A as the hub. One of the destinations in a's network, B, lies in a foreign country. Airline b also operates a hub-and-spoke network and has B as its hub. A is airline b's foreign destination. Passengers traveling from C to D have to use both airlines. We assume the cost per link is a quadratic function of the number of passengers using the link: $C = Q + \frac{\mu}{2}Q^2 + f$, where Q is demand and f is the fixed cost per link⁹. In this setting airline a's profits are:

$$\begin{aligned} \frac{1}{2} \pi^a &= p_{AB}^a q_{AB}^a + p_{AC}^a q_{AC}^a + p_{BC}^a q_{BC}^a - \frac{\mu}{2} (q_{AB}^a + q_{BC}^a)^2 - \frac{\mu}{2} (q_{AC} + q_{BC})^2 - 2f \end{aligned}$$

Airline b's profits are symmetric to airline a's profits. Note that we assume that all markets are priced separately. As a result of for example an open skies agreement between the two countries the two carriers are allowed to serve the other foreign destination from their own hub¹⁰. If the airlines decide to do so noncooperatively they are in effect invading each other's markets; this is scenario II. Airline networks for this scenario are depicted in Figure 2. Note that all markets are now competitive. For example, airline b operates an indirect route between A and C and competes with airline a which operates a direct route. Both airlines also operate two new indirect markets next to the new direct market.

Figure 2 about here

Corresponding profits are:

$$\begin{aligned} \frac{1}{2} \pi^{II} &= p_{AB}^a q_{AB}^a + p_{AC}^a q_{AC}^a + p_{AD}^a q_{AD}^a + p_{BC}^a q_{BC}^a + p_{BD}^a q_{BD}^a + p_{CD}^a q_{CD}^a - \frac{\mu}{2} (q_{AB}^a + q_{BC}^a + q_{BD}^a)^2 - \frac{\mu}{2} (q_{AC}^a + q_{BC}^a + q_{CD}^a)^2 - \frac{\mu}{2} (q_{AD}^a + q_{BD}^a + q_{CD}^a)^2 - 3f \end{aligned}$$

⁹This specification is quite common in the aviation economics literature; see e.g. Brueckner (1997), Brueckner and Spiller (1991), Park (1997) and Zhang (1996).

¹⁰In effect the airlines are restricted to operate a hub-and-spoke network, while a link between, for example, B and D is also a (theoretical) option. Optimality of the hub-and-spoke network is studied by Pels (2000). Here we assume the airline chooses to operate a hub-and-spoke network; we return to this later (footnote 13).

In Figure 4 we compare scenarios I and II for $f = 0$ ¹³. We see that airline a will not invade airline b's markets if both θ and μ are relatively high; in that case profits in scenario I are always higher. If f increases, the area in which scenario I is more profitable increases; see Appendix C, Figure C1. In scenario II airline a operates one extra direct link. Revenues have to be high to compensate: Q and P must be relatively high. When μ is low marginal costs ($MC = 1 + \mu Q$) and with it marginal revenues are relatively high. But when μ is high marginal costs and prices are low: airline a may not generate sufficient revenues under scenario II; and scenario I will be preferred. Even though it extracts revenues from three extra markets (AD, BD and CD), the high value of μ combined with the downward pressure of competition¹⁴ on prices leaves airline a with a loss.

Figure 4 about here

This result is similar to the result obtained by Zhang (1996), who finds that an invading airline's total profits may decrease as result of invasion of the competitor's local markets¹⁵.

It is always more profitable for airline a to enter an alliance. This is no surprise, as competition is eliminated from the AB-market. Moreover, under this scenario airline a is able to sell tickets in the AC and CD-markets and shares the fixed costs of the AB-route with airline b. Finally, network effects allow airline a to obtain higher profits due to economies of density.

In Figure 5 we compare profits in scenario II and scenario III, again for $f = 0$. We see that only if θ and μ are low, the fully-competitive scenario (II) will be preferred by the airline. In scenario III there is no competition, and as a result prices are higher and, ceteris paribus, demand will be lower compared to scenario II. In scenario III, less direct links are operated, allowing the airlines to profit from economies of density. But when θ and μ are low and demand is low, costs are relatively high because there is little opportunity to exploit density effects. In that case, the positive effect of higher prices on profits may not balance the negative effects of relatively high costs and lower demand in scenario III. However, if f is sufficiently high it is always optimal to enter an alliance agreement (under which fixed costs are lower); see Appendix C, Figure C2, where the indifference curve lies outside (below) the feasible parameter space. Above the curve, scenario III is more

¹³The assumption $f = 0$ is common in the literature. Pels (2000) shows that a fully-connected network is most likely the optimal network rather than a hub-and-spoke network for $f = 0$. The assumption $f = 0$ may thus lead to a situation where optimal strategies in a sub-optimal networks are analyzed. If we assume that due to legal or other constraints airline a can only serve destination D from its hub in scenario II, we can make this assumption. Moreover, if f increases, a hub-and-spoke is likely to become more profitable (Pels, 2000), and the point we try to make in this paper does not change (see Appendix B).

¹⁴Remember that in scenario II all markets are competitive.

¹⁵Note that Zhang (1996) analyzes a different network. In Zhang's network, there are two airlines that both operate a three-node HS network. There is competition only on the indirect market.

profitable. Hence inside the feasible parameter space, it is always more profitable to enter an alliance agreement.

Figure 5 about here

From the analysis in this section we conclude that an airline will "expand its horizon" if it gets the opportunity to enter new (foreign) markets. Assuming that the parameters f , ϕ and μ are sufficiently large, the airlines will enter an alliance agreement. An important question is then what the effects for the consumers will be.

3.3 Welfare effects of airline alliances

In this section we compare prices and consumer surplus in the different scenarios. Consumer surplus in scenario II is always higher than consumer surplus in scenario I inside the feasible parameter space. This is straightforward, because prices are likely to be lower under scenario II because of density effects and increased competition. To compare scenarios I and III and II and III respectively, we plot $CS_x \mid CS_y = 0$ inside the feasible parameter space, where CS stands for consumer surplus and x and y are different strategies.

In Figure 6 we see that at low levels of ϕ and μ , consumer surplus is lower under scenario III than it is under scenario I. Elsewhere inside the feasible parameter space, consumers prefer scenario III (i.e. an alliance). In scenario III, competition is reduced compared to scenario I (which leads to higher prices). On the other hand, by linking the networks, new markets are opened, and there are opportunities to exploit economies of density, which can lead to lower prices. The latter effect only outweighs the former if ϕ (demand) and μ are sufficiently high.

Figure 6 about here

Brueckner (1997) finds that codesharing increases welfare for most parameter combinations, but the networks analyzed are different from the networks analyzed here. Brueckner compares scenarios I and III for the case where both airlines operate hub-and-spoke networks with three spoke markets, one of which is the intercontinental market on which both airlines compete. In our model, we have one less spoke market but by entering an alliance agreement, an airline can open up new markets. This is not possible in Brueckner's model.

In Figure 7 we see that consumer surplus in scenario II is higher for almost all parameter combinations. Only if μ is close to its maximum value, there is a (small) region in which consumers would prefer scenario III. Although airline a (and also airline b) will opt for an alliance if f is sufficiently high, consumers prefer the "fully competitive" scenario II. Comparing scenarios II and III, there are two countervailing effects. First, in scenario II all markets are competitive. In scenario III there is no competition; airlines collude or have local monopolies. Therefore prices can be expected to be higher in scenario III. On the other hand, in scenario III airline a operates one less direct link (AD). Passengers in the AD

and CD-markets therefore have to travel one extra link. This increases the number of passengers on the AB; AC and BD links, and lowers the prices in all markets in which these links are used. It turns out the latter effect is not strong enough to balance the former effect unless μ is very high. Thus passengers are most likely better off in scenario II.

Figure 7 about here

4 Discussion

Whereas the emergence of hub-and-spoke networks had a downward effect on prices on indirect and interhub markets, alliances are likely to increase prices in these markets due to collusion between former competitors; unpublished results show that P_{AB} is always higher under scenario III than under the other two scenarios. This does not mean that in general consumers are by definition worse off under scenario III. Based on consumers' surplus, scenario II is always preferable, although at low values of θ and μ the fare in the AB-market can be higher under the fully competitive scenario (II) than under scenario I as a result of density effects. At high levels of θ and μ , scenario III can result in substantial benefits to the consumers compared to scenario I.

The authorities may have the intention to protect consumers in either the AB-market or, in a naive approach following the conjecture that alliances are always harmful because they eliminate competition, in all markets. If they do so by simply not allowing airlines to enter alliances, to encourage the airlines to adopt the fully competitive strategy, we see that at high levels of θ and μ the airlines do not choose to invade their competitor's network; i.e. the airlines stick to the strategy of scenario I. However, at these levels of θ and μ it is likely that consumers will prefer the codesharing scenario over the base scenario. Although the authorities have the intention to protect consumers, in this case the consumers would actually be better off if the authorities would not intervene. Whether or not the government should intervene (i.e. forbid an alliance) then depends on the parameter values. If levels of demand and density economies are high the government should not intervene.

Two remarks are in order here. First, as already pointed out, the authorities may decide to protect consumers in the AB market. This may then happen at the expense of the consumers in the other markets; the remarks above about the undesired policy effects are based on total consumer surplus. Second, in this paper, consumers are better off if the prices are lower. Network effects have influence (due to economies of density), but frequency plays no part. As indicated in Section 2, aggregate frequencies may be higher if airlines enter an alliance agreement, to the benefit of passengers. Scenario III might become more attractive to passengers if frequency is also considered. Including frequency in the analysis is therefore an important point on the research agenda.

The research agenda that follows from this paper is as follows. As indicated above, more realistic models, that include frequency, should be used to determine

whether the conclusions of this paper will continue hold; see e.g. Pels et al. (2000) for models based on discrete choice demand systems, in which fare and frequency are endogenous. However, such models are far more complex than the simple specification use in this paper, and even with this specification, analytical comparison of strategies is ruled out. The main conclusion of this paper is that, although passengers on average prefer a fully competitive scenario, it is unlikely that airlines will adopt that scenario. The authorities will then have to decide whether or not to intervene, and have to be very careful not to make the passengers actually worse off. Theoretical and empirical analysis of airline alliances to support policy is necessary to prevent such an occurrence.

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A Feasible parameter spaces

In comparing the different scenarios we have the following limiting values of θ .

	I	II	III
I	i	$\frac{16\mu i 9}{8\mu^2 i 3}$	$\frac{5\mu i 6}{2\mu^2 i 3}$
II	$\frac{1}{2\mu}$	i	$\frac{16\mu i 9}{8\mu^2 i 3}$
III	$\frac{\mu i 2}{\mu(4\mu i 5)}$	$\frac{\mu i 2}{\mu(4\mu i 5)}$	i

The requirement of nonnegative outputs requires that θ is larger than the values right upper corner of the above matrix. For example, comparing scenarios I and II, the minimum value of θ is $\frac{16\mu i 9}{8\mu^2 i 3}$. The requirement of nonnegative marginal costs implies that θ is smaller than the values in the lower left corner of the above matrix. The second order conditions for profit maximization are: $\mu < \frac{1}{3}$ in scenario I, $\mu < \frac{1}{5}$ in scenario II and $\mu < \frac{9}{11}$ in scenario III.

B Optimal prices and quantities

In scenario I airline a's optimal quantities and prices are:

$$Q_{AB}^a = 2 \frac{(\mu i 1) [(\mu i 1) \theta + 1]}{(7\mu i 11)\mu + 3}$$

$$Q_{AC} = \frac{(2\mu i 3) [(\mu i 1) \theta + 1]}{(7\mu i 11)\mu + 3}$$

$$Q_{BC} = i \frac{(2\mu^2 i 3) \theta + 6 i 5\mu}{(7\mu i 11)\mu + 3}$$

$$P_{AB}^a = \frac{[(5\mu i 7)\mu + 1] \theta + 2(\mu + 1)}{(7\mu i 11)\mu + 3}$$

$$P_{AC} = \frac{1 [(12\mu i 17)\mu + 3] \theta + 3 i 2\mu}{2 (7\mu i 11)\mu + 3}$$

$$P_{BC} = \frac{1 [(8\mu i 11)2\mu + 3] \theta + 6 i 5\mu}{2 (7\mu i 11)\mu + 3}$$

Scenario II

$$Q_{AB}^a = \frac{2[(4\mu - 3)4\mu + 3] \otimes - 3 + 4\mu}{9(4\mu - 1)(2\mu - 1)}$$

$$Q_{AC}^a = \frac{2[(8\mu - 9)2\mu + 3] \otimes + 4\mu}{9(4\mu - 1)(2\mu - 1)}$$

$$Q_{AD}^a = \frac{2[(8\mu - 9)2\mu + 3] \otimes + 4\mu}{9(4\mu - 1)(2\mu - 1)}$$

$$Q_{BC}^a = i \frac{2(8\mu^2 - 3) \otimes - 16\mu + 9}{9(4\mu - 1)(2\mu - 1)}$$

$$Q_{BD}^a = i \frac{2(8\mu^2 - 3) \otimes - 16\mu + 9}{9(4\mu - 1)(2\mu - 1)}$$

$$Q_{CD}^a = i \frac{2(4\mu^2 + 3)2\mu - 3 \otimes + 6 - 16\mu}{9(4\mu - 1)(2\mu - 1)}$$

$$P_{AB}^a = \frac{1[(4\mu - 3)10\mu + 3] \otimes - 8\mu + 6}{9(4\mu - 1)(2\mu - 1)}$$

$$P_{AC}^a = \frac{1[(16\mu - 9)4\mu + 3] \otimes - 20\mu + 9}{9(4\mu - 1)(2\mu - 1)}$$

$$P_{AD}^a = \frac{1[(16\mu - 9)4\mu + 3] \otimes - 20\mu + 9}{9(4\mu - 1)(2\mu - 1)}$$

$$P_{BC}^a = \frac{1[(16\mu - 9)4\mu + 3] \otimes - 20\mu + 9}{9(4\mu - 1)(2\mu - 1)}$$

$$P_{BD}^a = \frac{1[(16\mu - 9)4\mu + 3] \otimes - 20\mu + 9}{9(4\mu - 1)(2\mu - 1)}$$

$$P_{CD}^a = \frac{1[(44\mu - 21)2\mu + 3] \otimes - 32\mu + 12}{9(4\mu - 1)(2\mu - 1)}$$

Scenario III:

$$Q_{AB}^a = 2 \frac{[(3\mu - 5)\mu + 2]^\circ + 2(\mu - 1)}{(11\mu - 18)\mu + 4}$$

$$Q_{AC}^a = \frac{[(3\mu - 8)\mu + 4]^\circ + 2\mu - 4}{(11\mu - 18)\mu + 4}$$

$$Q_{AD}^a = \frac{(\mu^2 - 2)^\circ + 4 - 3\mu}{(11\mu - 18)\mu + 4}$$

$$Q_{BC}^a = \frac{(\mu^2 - 2)^\circ + 4 - 3\mu}{(11\mu - 18)\mu + 4}$$

$$Q_{CD}^a = \frac{(\mu^2 - 2)^\circ + 4 - 3\mu}{(11\mu - 18)\mu + 4}$$

$$P_{AB}^a = \frac{[(8\mu - 13)\mu + 2]^\circ - 2\mu + 2}{(11\mu - 18)\mu + 4}$$

$$P_{AC}^a = \frac{1}{2} \frac{[(19\mu - 28)\mu + 4]^\circ - 2\mu + 4}{(11\mu - 18)\mu + 4}$$

$$P_{AD}^a = \frac{[(12\mu - 18)\mu + 2]^\circ + 4 - 3\mu}{(11\mu - 18)\mu + 4}$$

$$P_{BC}^a = \frac{[(12\mu - 18)\mu + 2]^\circ + 4 - 3\mu}{(11\mu - 18)\mu + 4}$$

$$P_{CD}^a = \frac{[(12\mu - 18)\mu + 2]^\circ + 4 - 3\mu}{(11\mu - 18)\mu + 4}$$

C Additional analysis

In Figure C1, where $f = 1$; we see that the area in which profits in scenario I exceed profits in scenario II is larger compared to Figure 1, where $f = 0$: This is not surprising, because in scenario II one more link is operated. If the fixed costs of this additional link are (very) high, the extra revenues resulting from need to be high to compensate. These revenues are, however, independent of the level of the fixed costs. Therefore, if f increases, scenario II becomes more and more unattractive to the airline. In Figure C3 we see that, for similar reasons, scenario II is no longer an alternative for scenario III if f increases; if f is too high, the indifference curve falls outside the feasible area and scenario III is always preferred. Hence, if f is high, the authorities need to be extra careful implementing a "naive" policy of simply not allowing an alliance to protect consumers; airlines are more likely to stick to scenario I.

Figures C1 and C2 about here.

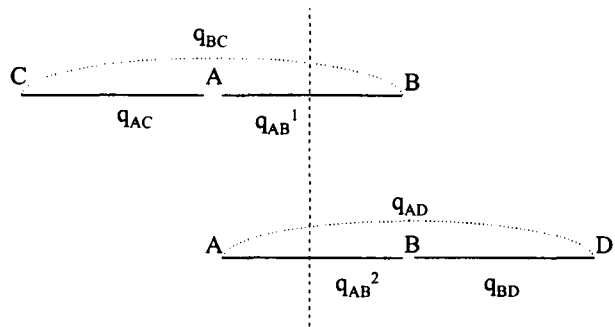


Figure 1 Airline networks, scenario I

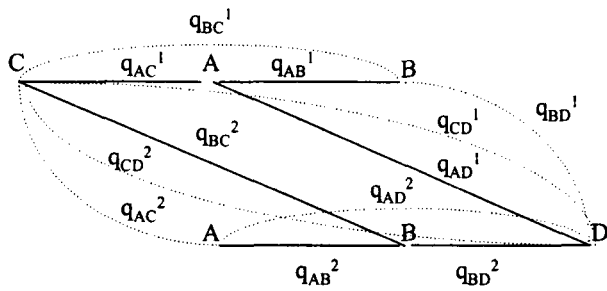


Figure 2 Airline networks, scenario II

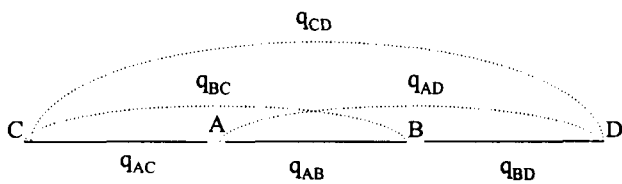


Figure 3 Airline networks, scenario III

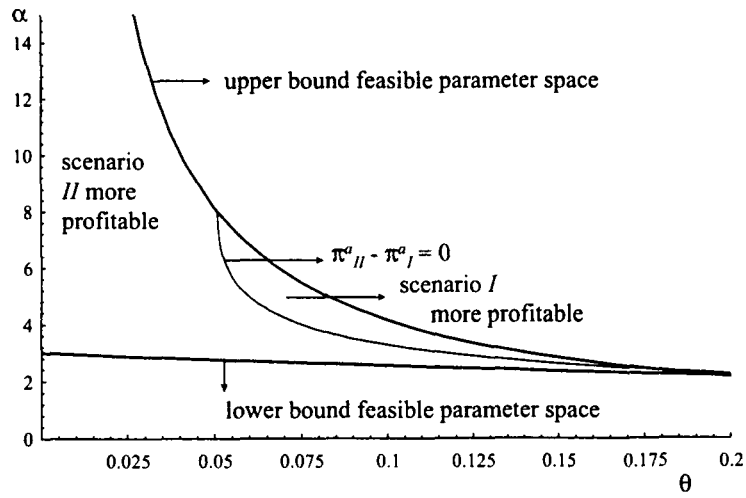


Figure 4 Comparison of profits in scenarios I and II, $f = 0$

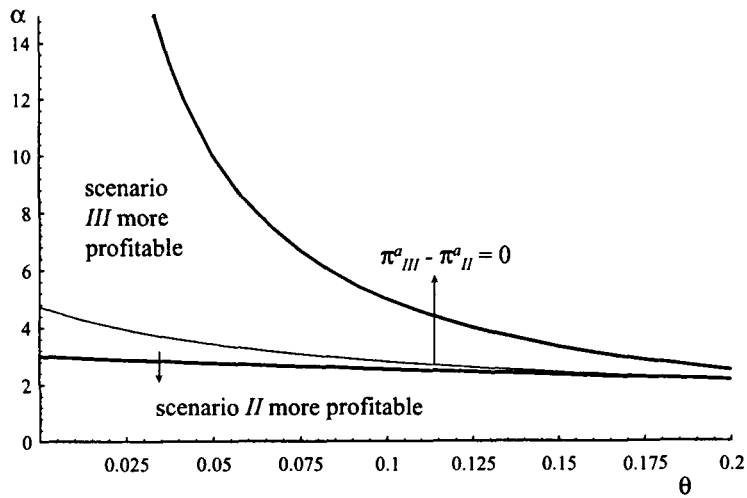


Figure 5 Comparison of profits in scenarios II and III, $f = 0$

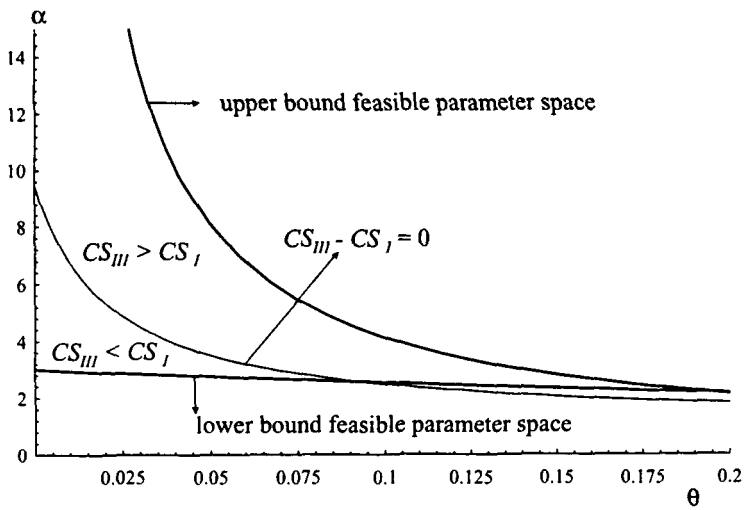


Figure 6 Comparison of consumer surplus in scenarios I and III

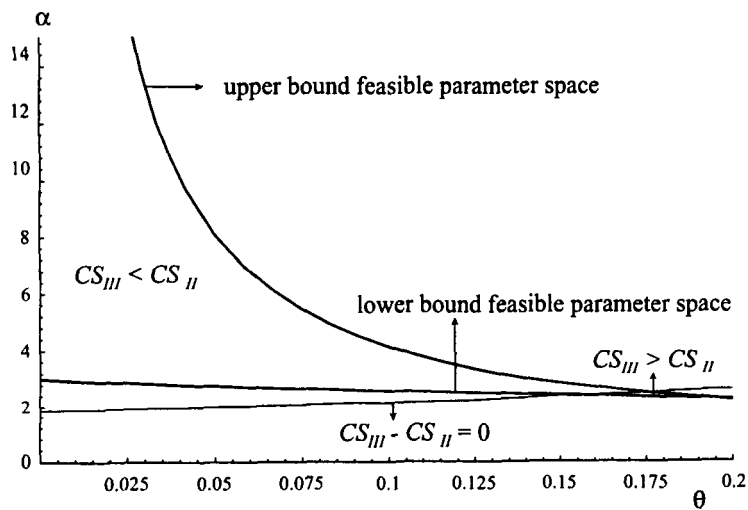


Figure 7 Comparison of consumer surplus in scenarios II and III

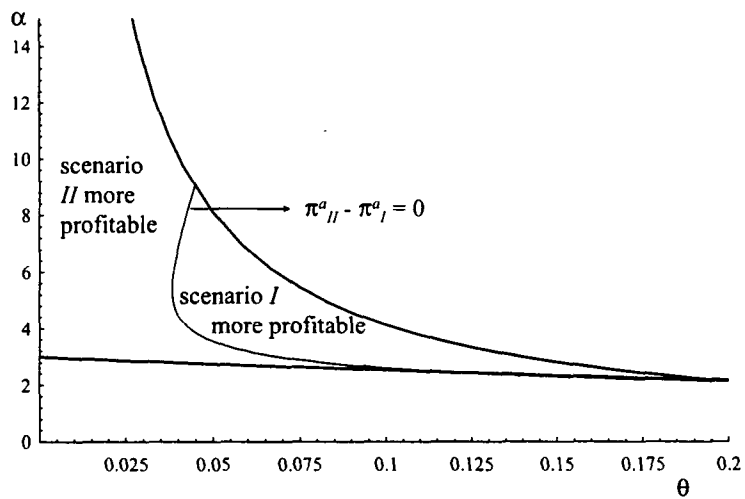


Figure C1 Comparison of profits in scenarios I and II, $f = 1$

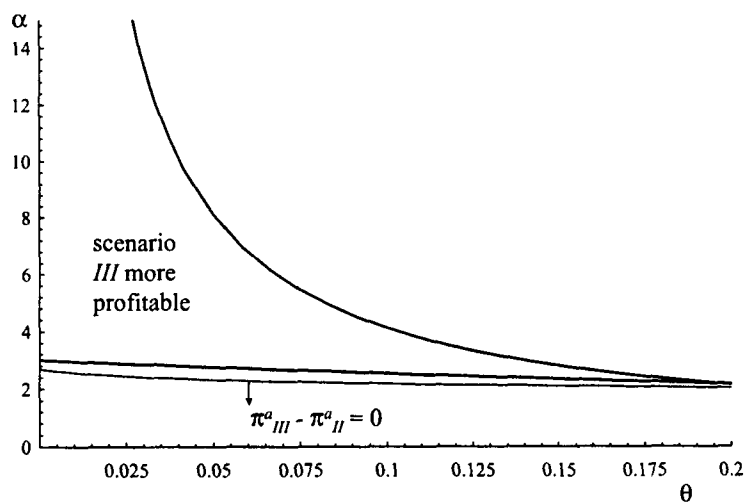


Figure C2 Comparison of profits in scenarios II and III, $f = 1$

The Aviation Cooperation between the two Koreas Preparing for the Reunification of the Peninsula

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- I. Introduction
- II. FIR and ATS route
- III. ATS Route between Tokyo and Beijing
- IV. Regular Flights through FIRs of the two Koreas
- V. Other Means of Aviation Cooperation in Preparing for the Reunification of the Korean Peninsula
- VI. Conclusion

※ The contents contained in this paper are the views and opinions of the author, and do not necessarily represent government policy.

Abstract

In the civil aviation field, there have been intermittent and indirect dialogues between the two Koreas through ICAO's intermediary role over the past couple of decades, mainly regarding the establishment of ATS routes passing through FIRs of the respective country. The continued stubbornness of DPRK to avoid any direct contact with ROK has prevented the two Koreas from achieving any meaningful agreement between them in this area. Since the Summit Meeting between the two Koreas in June 2000 where some special charter flights were allowed to transport President Kim and his entourage, there have been a quite a number of charter flights through an informal Yellow Sea airway carrying delegations of one of the two Koreas, mainly comprising dispersed family members for reunion events and members and troupe for some cultural exchange programs.

The first case of mutual cooperation is regarding the establishment of direct ATS route between Tokyo and Beijing which had been pursued since the late 1970s. Several players have been involved in this matter from the beginning, including the four States (i.e. ROK, DPRK, Japan and China), IATA (International Air Transport Association) representing the interests of the carriers who would like to use a shortcut between Tokyo and Beijing, and ICAO, responsible for coordinating the positions of the four States concerned. In the end, ICAO's initiative ended up not being realized due to ICAO's lack of understanding of the peninsula's political situation. As a result of the conclusion of the bilateral air services agreement, Korea and China established a direct route between Seoul and Beijing, not relying upon any outside parties.

The second case is regarding the establishment of a direct ATS route passing through Pyongyang and Taegu FIRs. The aeronautical authorities of ROK maintained the two principles regarding this matter: First, the safety of flight shall be guaranteed by all means and cannot be compromised by other factors. Second, operation on ATS route within and/or through FIRs shall be allowed to all civil aircraft of all States on the basis of the principle of non-discrimination. Therefore the establishment of a direct airway through the FIRs of the two Koreas was up to the determination of North Korean authorities. It seemed that considering that FIR is not airspace at all and the allowance of some flights to fly through its FIR would bring great economic benefits to a North Korean standard, the authorities finally agreed with its South Korean counterpart on the procedure on ATS cooperation. An inaugural flight was made on 23 April 1998 passing through transfer point of air traffic control between the Taegu and Pyongyang ACCs of the two Koreas.

In order to facilitate the aviation cooperation between the Koreas, the number of charter flights by airlines of either Korea should be increased so as to develop into scheduled flights, hopefully in the near future. Normally an air services agreement is needed in order for either party to allow a carrier or carriers of the other party to commence scheduled services. Before both Koreas could have a full-scale cooperation such as having scheduled services, there could be many ways and means to encourage cooperation in the civil aviation field. For example, the two governments can allow people, from government or the private sector, involved in civil aviation to meet each other, on such occasions as seminars, workshops and informal meetings. Airlines can reach commercial agreements before formal consultations between the governments take place.

I. Introduction

On 15 June 2000, Air Force No.1 and a charter plane flew to Soonan Airport of North Korea from Kimpo of South Korea passing through a Yellow Sea airway to transport President Kim Dae-Jung and his entourage who would attend the historic Summit meeting between the heads of the Koreas. Before that event, regular flights had been made through Flight Information Regions(FIRs) of the two Koreas. These two events were not well predicted beforehand because of a dramatic and rapid rapprochement between the Koreas since President Kim took his office in 1998.

On 17 Sep. 1992, representatives of the respective governments of the two Koreas signed the Agreement on Reconciliation, Non-Aggression, Exchange and Cooperation between the Republic of Korea (ROK) and the Democratic People's Republic of Korea (DPRK) (hereinafter referred to as "Agreement"). At that time, the atmosphere for mutual cooperation seemed to be so good that some people made a hasty prediction that the two Koreas would be reunited sooner rather than later. Actually Para. 3 of Article 1 of the Agreement stipulates that the two Koreas shall try to establish an air route between Kimpo and Soonan as the exchange and cooperation continue and military confrontation is diluted. Of course there are numerous items of cooperation and exchange other than aviation cooperation in that Agreement.

In the civil aviation field, there have been intermittent and indirect dialogues between the Koreas through ICAO's intermediary role over the past couple of decades, mainly regarding the establishment of ATS route passing through FIRs of the respective country. The continued stubbornness of DPRK to avoid any direct contact with ROK has prevented the two Koreas from achieving any meaningful agreement between them in this area. Since the Summit Meeting, there have been a quite a number of charter flights through an informal Yellow Sea airway carrying delegations of one of the two Koreas, mainly comprising dispersed family members for reunion events, and members and troupe for some cultural exchange programs.

II. FIR and ATS route

Article 1 of the Convention on International Civil Aviation (hereinafter referred to as "the Convention") stipulates that the contracting States recognize that every State has complete and exclusive sovereignty over the airspace above its territory.¹⁾ And the Convention primarily deals with civil aviation issues relating the airspace over the territory of a Contracting State.²⁾ As the airspace can be only delineated over territorial land and waters³⁾, the territory is a key concept in the international civil aviation.

For various reasons and purposes, the jurisdiction over the airspace is extended to certain areas over the high seas beyond the airspace over the territory. Limited Identification Zone⁴⁾, ADIZ (Air Defense Identification Zone)⁵⁾, and FIR (Flight Information Region) are such

¹⁾ The territory of a State is deemed to be the land areas and territorial waters adjacent thereto under the sovereignty, suzerainty, protection or mandate of such State.(Article 2 of the Convention)

²⁾ Articles 1,2,5,6,7,8,9,10,11,12,13,15,24,25,27,28,36 of the Convention

³⁾ 12NM is the internationally established width of the territorial waters.

⁴⁾ The zone where special or enforced attention by the military authorities is not needed for the defense purpose under normal circumstances. Therefore, when in the state of emergency, enforced alert is resumed.

⁵⁾ The zone which the adjacent State unilaterally set for the defense purpose. It is not in force vis-a-vis

examples of extended areas. Those extended airspace over the high seas, particularly FIR is mainly dealt with through Annex to the Convention.⁶⁾ A similar analogy is found at sea, which extends to the high seas beyond territorial waters. Exclusive Economic Zone (EEZ) and Continental shelf belong to such examples.

FIR, including the airspace over the territory, is the most important airspace concept for its wide range of implications regarding the airspace of the adjacent State. It is defined as "an airspace of defined dimensions within which flight information service and alerting service are provided".⁷⁾

FIR is established, because of the actual needs to provide air traffic services to aircraft in airspace over high seas. The jurisdiction and responsibilities of the adjacent State within FIR are to provide air traffic services (including flight information and alerting service) to aircraft as long as it is within FIR. In addition, the adjacent State is responsible for search and rescue within FIR. Normally the region for ATS (air traffic services) and SAR (search and rescue) is duplicate.

ATS route, on which air traffic control unit provides air traffic services within the FIR under its jurisdiction, is also established, made public through AIP (Aeronautical Information Publication), and made available internationally for the use by aircraft who wants to use it. The objectives of providing air traffic services are to prevent collisions between aircraft on the maneuvering area and obstructions on that area, to expedite and maintain an orderly flow of air traffic, to provide advice and information useful for the safe and efficient conduct of flights, and to notify appropriate organization regarding aircraft in need of search and rescue aid, and assist such organizations as required.⁸⁾

Even though the airspace over territory and FIR are very different from each other, States regard both as the same in actual sense. Whereas air traffic control unit requires a permission to the aircraft which is going to enter the airspace over the territory, the said unit only requires the aircraft which is going to enter FIR to submit a flight plan. In practice, there would be no substantial difference between the airspace over territory and FIR in respect of the treatment of the aircraft, because in case that air traffic control unit does not accept the flight plan, the safety of operation would not be guaranteed within FIR.

Adjacent States mutually decide the border of FIRs. Under normal circumstance, the two States draw the middle line of the two territories. However, adjacent States sometimes engage in the negotiations to draw the border between the FIRs, for example under the circumstances which one of air traffic control units lacks sufficient ability to handle traffic within its control, or the adjacent State has the economic difficulty providing the relevant services.

The procedures for establishing a FIR are as follows: an agreement between adjacent States, notification of the agreement to the ICAO Regional Office, Report of the agreement to

other States in respect of its legality.

⁶⁾ Article 12 of the Convention stipulates that "Over the high seas, the rules in force shall be those established under the Convention." In order to implement this provision, ICAO shall adopt and amend from time to time, as may be necessary, international standards and recommended practices and practices (SARPs) dealing with rules of the air and air traffic control practices. In practice, Annex 2 (Rules of the Air), and 11 (Air Traffic Services) mainly deal with the relevant SARPs for this purpose.

⁷⁾ Annex 11 (Air Traffic Services) to the Convention on International Civil Aviation

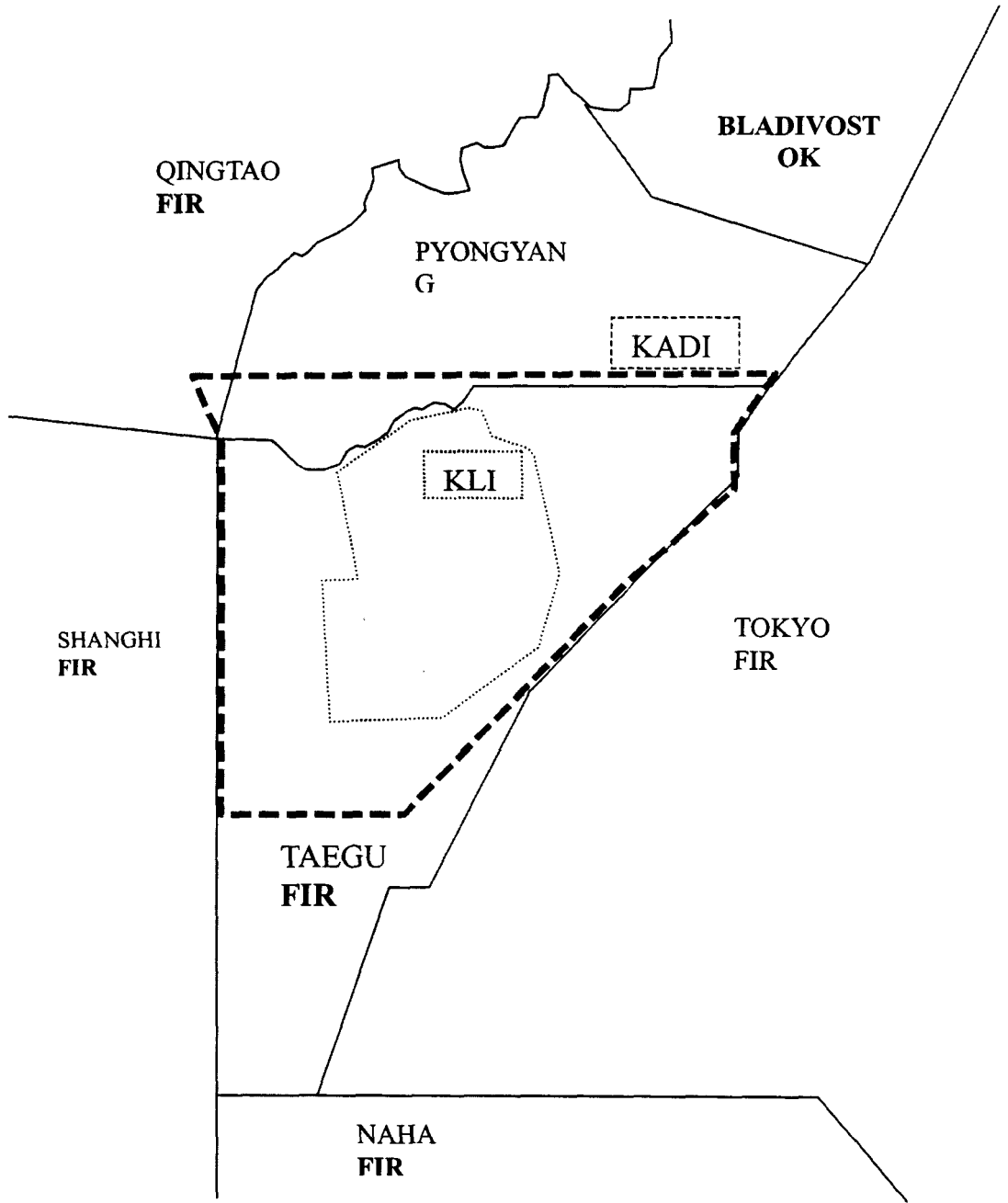
⁸⁾ Article 2.2 of chapter 2 of the Annex 11 to the Convention

the ICAO Council for approval, and promulgation through AIP. Those portions of the airspace over the high seas or in airspace of undetermined sovereignty where air traffic services will be provided shall be determined on the basis of regional air navigation agreements.⁹⁾ When the adjustment of existing FIR is needed, the interested States can ask other States, if necessary through ICAO, to do so. ICAO is obliged to accommodate the positions of interested parties. The procedures for establishing ATS route are basically the same as those for FIR.

There have been many cases in many parts of the world of the border disputes regarding FIRs. India and Bangladesh finally agreed to draw the middle line between their territories after a prolonged dispute. In the case of Singapore and Indonesia, they resolved FIR border issue without creating noise. Hongkong has been refusing the return of a portion of FIR to Vietnam.

⁹⁾ Article 2.1.2 of Chapter 2 of the Annex 11 to the Convention

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III. ATS Route between Tokyo and Beijing

There has been a long pursuit of establishing direct ATS route between Tokyo and Beijing since the late 1970s. Several players have been involved in this matter from the beginning, including the four States (i.e. ROK, DPRK, Japan and China), IATA (International Air Transport Association) representing the interests of the carriers who would like to use a shortcut between Tokyo and Beijing, and ICAO, responsible for coordinating the positions of the four States concerned.

A593, a corridor airway passing through the southern part of Taegu FIR was established in 1963 in accordance with an agreement between South Korea, China and Japan and ICAO, in order to make an airway between Japan and China. Because of the absence of the diplomatic relationship between ROK and China, they agreed that air traffic services shall be provided by the air traffic control agencies of Japan and China, making use of a segment of Taegu FIR.

This issue was virtually resolved, as the designated airlines of Korea and China commenced operation using a direct route between Seoul and Beijing in Dec. 1994, some time after the two countries reached an air services agreement in June 1994. This agreement was reached after a series of bilateral negotiations which had been conducted for three and a half years.

The ROK's position with regard to this matter is very clear and simple. ROK is very open-minded and liberal in that it would allow any foreign carriers, which are interested in using this route, to do so unless such flight is restricted by other factors (for example, China's air traffic management capacity to deal with traffic), and it would not oppose foreign carriers of overflying the territory of DPRK.

Dr. Assad Kotaite, President of the ICAO Council, has tried to play a role of mediator among the four countries concerned since the early 1980s.¹⁰⁾ However, it would be very difficult to say that ICAO's efforts brought forth substantial fruits to the solution of this matter. ICAO may not have basically understood the political nature the situation regarding this issue. Moreover, it has seemed that the complex and delicate nature of this matter, which seemingly stems from the political relations among the four countries concerned, in particular between the two Koreas, prevented ICAO from providing any meaningful solutions.

This was well manifested throughout many of ICAO's initiatives and the developments thereof up to now. In 1981, Dr. Kotaite visited DPRK and agreed, with its authorities, to the Memorandum of Understanding which encouraged to establish a direct route between Tokyo and Pyongyang. ROK reacted to this surprising initiative with a counterproposal that the two Koreas respectively establish a direct route transcending half of the Korean peninsula between Tokyo and Beijing with the same distance at the nearly same time. The political situation surrounding the Korean peninsula did not allow four countries concerned to implement the two different direct routes mainly because of the then hostile relationship between ROK and China on the one hand, and Japan and DPRK on the other hand.

¹⁰⁾ We are not sure if Dr. Kotaite, who represents the ICAO Council, was properly mandated from any ICAO bodies including Assembly regarding this issue. Or has he been carrying out this job as a personal capacity? Even though, in accordance with Article 54 of the Convention, the Council shall.....(n) Consider any matter relating to the Convention which any contracting State refer to it, it is not clear whether four or any State concerned referred this matter to the ICAO Council.

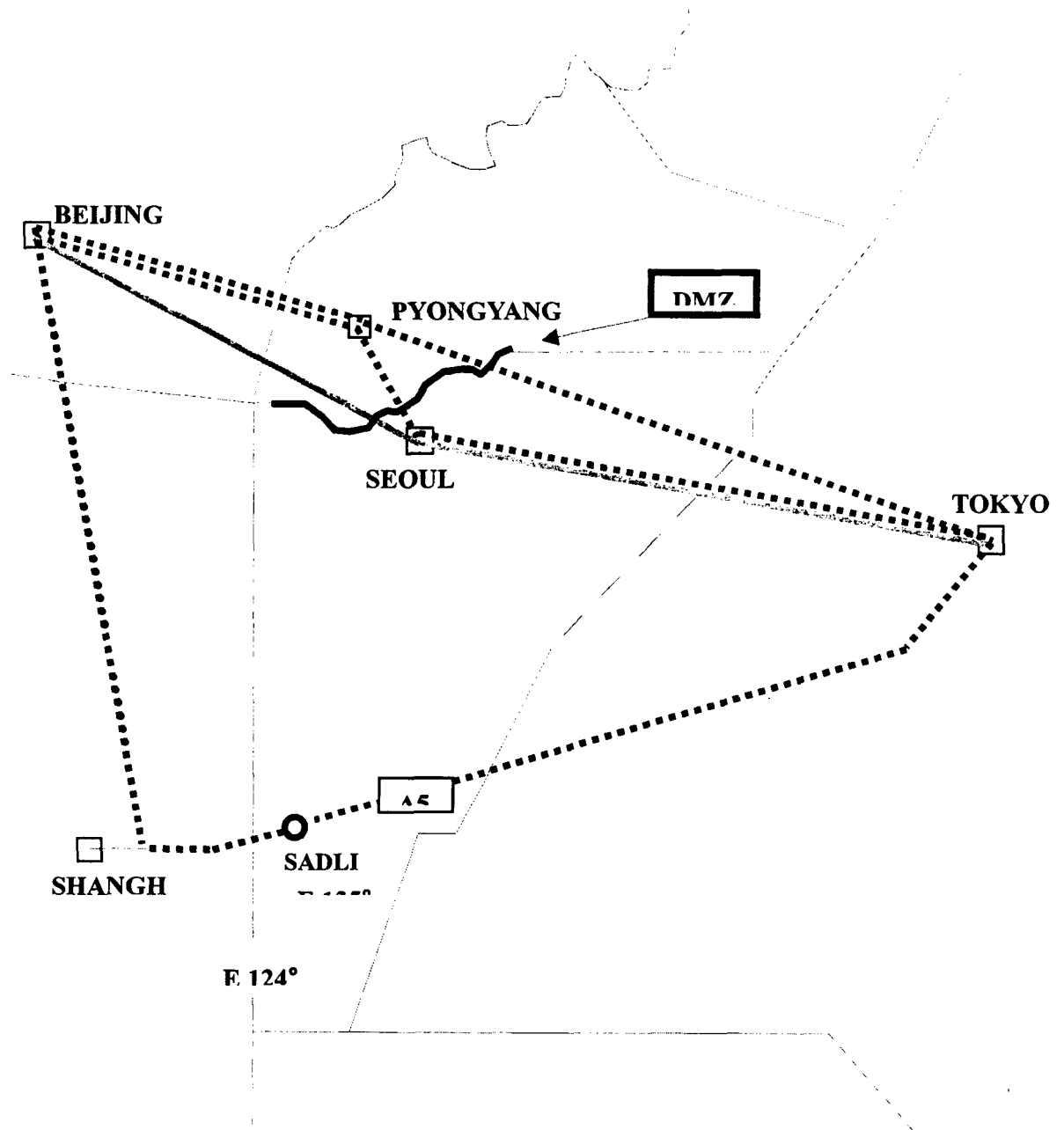
In 1988, Dr. Kotaite made a new proposal that a single direct route be established passing ROK and DPRK between Tokyo and Beijing in order to implement his earlier initiative in a different way. However, his new proposal had much more difficulty being implemented compared with the former ones. He may have underestimated the political and military confrontation between the two Koreas. ROK expressed its position that both Air Traffic Control agencies of the two Koreas must conclude an agreement regarding air traffic services and install a direct speech circuit in order to ensure the safety of flight.

In the end, ICAO's initiative ended up not being realized due to ICAO's lack of understanding of the peninsula's political situation. As a result of the conclusion of the bilateral air services agreement, Korea and China established a direct route between Seoul and Beijing, not relying upon any outside parties.

Japan and China are usually in a position to be allured to use the situation of a divided Korean peninsula in their favor. Moreover, they would not object to ICAO's initiative as long as it would not have any harmful effect on their interests. Furthermore, as the two Koreas have always remained competitive against each other, each generally attempts to save face vis-a-vis international organizations in order to enhance its own image, or at least not to lose its reputation. Naturally the resolution of this issue has long been delayed because of the political situation surrounding the Korean Peninsula and the cautious diplomacy of the four countries concerned.

We have learned a very important lesson from this experience. ICAO is not a political body, but mainly a body dealing with technical matters, which would not usually involve political considerations. In this respect, ICAO committed an error in that they intervened in a basically political matter.

Japan ↔ China Direct Airways



IV. Regular Flights through FIRs of the two Koreas

In December 1994, the Director General of the General Civil Aviation Administration of Civil Aviation (GACA) of DPRK, made an announcement that DPRK was willing to open its airspace to all civil aircraft of all States and that it would join the International Air Services Transit Agreement (IASTA). As a follow-up, GACA accepted the IASTA and became a party thereto as of 8 Feb. 1995.

The background of this apparently bold gesture may be that they became frustrated at the situation where most foreign carriers would use the newly established Seoul-Beijing route between Tokyo and Beijing as a result of an agreement between ROK and China, avoiding overflight of North Korean airspace.

The ROK's position regarding this matter is very open-minded and just to the international aviation community as already shown in the case of ATS route between Tokyo and Beijing, in that it would welcome any foreign carriers of using this route, except where other factors on the part of China make it impossible, and it would not oppose the establishment of a direct air route between Pyongyang and Tokyo. In spite of its announcement, no country was permitted to fly into DPRK airspace except the countries such as China and Russia, the aircraft of which had already flown even before the DPRK authorities expressed their willingness to open airspace.

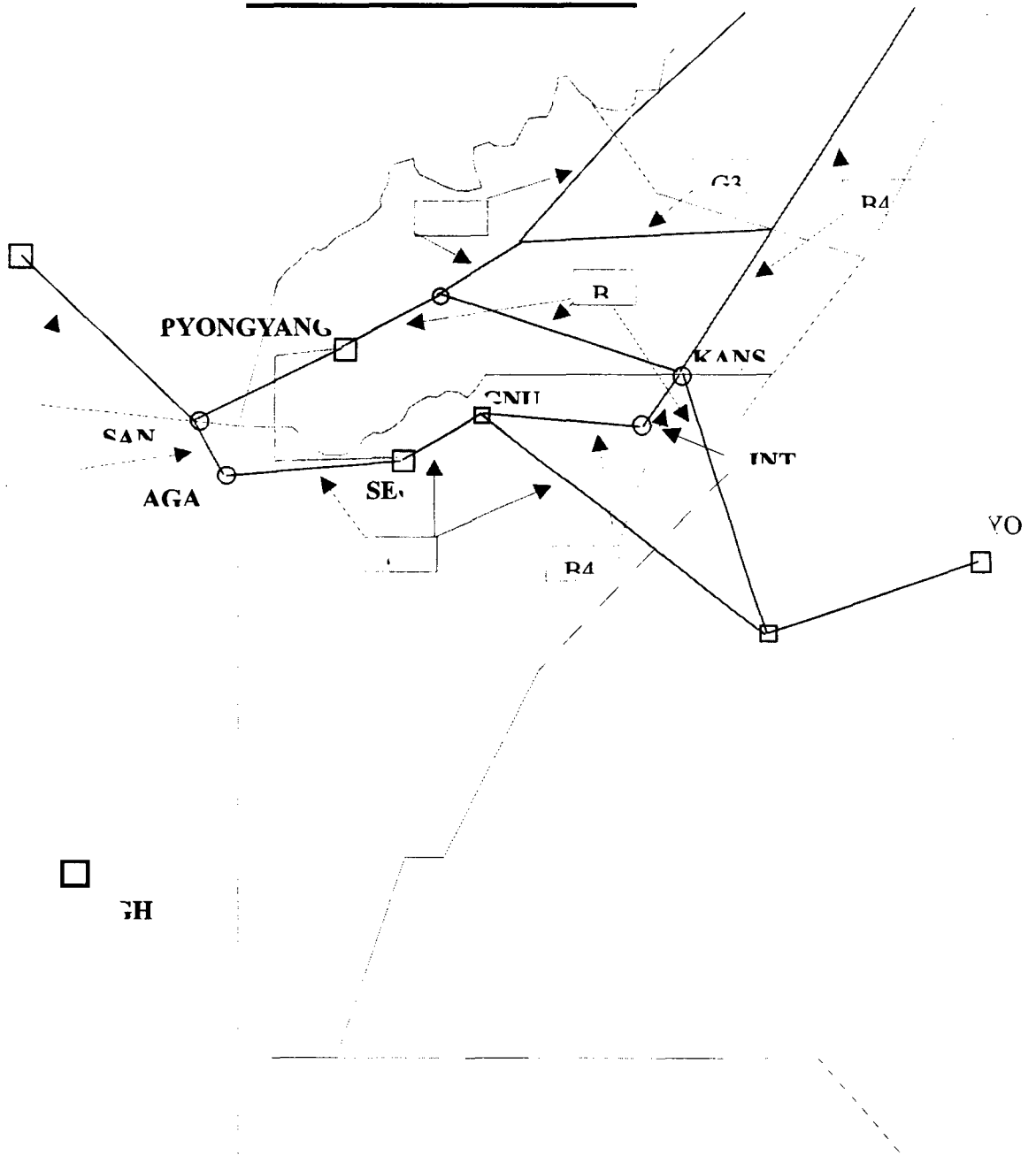
However, a pressure has been made to aeronautical authorities of DPRK from IATA representing some airlines who wished to use a shortcut route between ROK and North America. On the part of airlines, the establishment of a formal airway makes them save time and fuel, resulting in some economic benefits. Two U.S. carriers, namely Delta and Northwest, sought permission to fly through the Flight Information Region (FIR) of DPRK, to that of ROK after they had reportedly gotten a permission from the DPRK authorities.

The ROK Aeronautical Authorities have not allowed the U.S. carriers to do so because the relevant ICAO regulation requires that both ATC authorities conclude an agreement on the cooperation regarding air traffic services, and install a direct speech circuit (telephone links) between them. Moreover DPRK authorities must permit the overflight in nondiscriminatory manner to every foreign carriers including ROK carriers. In short, the aeronautical authorities of ROK maintained the two principles regarding ATS route: First, the safety of flight shall be guaranteed by all means and cannot be compromised by other factors. Second, operation on ATS route within and/or through FIRs shall be allowed to all civil aircraft of all States on the basis of the principle of non-discrimination. Therefore the establishment of a direct airway through the FIRs of the two Koreas was up to the determination of North Korean authorities.

At the initial stage, North Korean authorities were reluctant in opening up its FIR towards foreign carriers, seemingly out of its defence and security consideration. It seemed that considering that FIR is not airspace at all and the allowance of some flights to fly through its FIR would bring great economic benefits to a North Korean standard, the authorities decided to go ahead to have talks with its South Korean counterpart aiming at establishing a direct air link. Anyhow, a series of talks regarding the establishment of a regular airway through the Pyongyang FIR and Taegu FIR v.v. have been arranged between the two aeronautical authorities under the sponsorship of ICAO to enable the establishment of an airway B476 and the operation of scheduled flights of airlines of ROK and some foreign countries including USA.

An inaugural flight was made on 23 April 1998 passing through transfer point of air traffic control between the Taegu and Pyoungang ACCs of the two Koreas. Since then, daily contacts have been made without any problem using a direct speech circuit between personnel of the two ACCs, according to the Agreement on the Cooperation between them.

AIRWAYs THROUGH TAEGU & PYONGYANG FIRs



V. Other Means of Aviation Cooperation in Preparing for the Reunification of the Korean Peninsula

The aviation relationship between the two Koreas should and cannot but go in tandem with the overall development of the North-South relationship. The overall relationship between the Koreans have gone through ups and downs, allegedly towards better relations in the long run. The best policy is that in spite of short-term fluctuations of their relationship, the two Koreas must strengthen mutual trust and accumulate experience of exchange and cooperation step by step in preparation for the reunification of the peninsula. The cooperation in the civil aviation field between the two Koreas shall be conducted for longer term benefits.

First, the number of charter flight by airlines of either Korea should be increased so as to develop into scheduled flights, hopefully in the near future. To this end various events such as family reunion and cultural and sports exchange should be organized as often as possible.

Once operators have accumulated experience of charter flights, they will be able to try scheduled air services. Normally an air services agreement is needed in order for either party to allow a carrier or carriers of the other party to commence scheduled services. Therefore, mutual trust should be built and strengthened in order to conclude this kind of agreement. When time comes, both Aeronautical Authorities of the two Koreas would determine the points to be served, capacity and frequency, and the other related matters. Possible points to be served would be Seoul, Pusan, Kwangju, Taegu, Cheju, etc. of South Korea, and Pyongyang, Shineuju, Chongjin, Wonsan, etc. of DPRK.

Another possibility, if both Aeronautical Authorities could not reach an agreement for some reasons, the airlines of both Koreas could make some form of commercial agreement which shall be subject to government approval.

Even before scheduled services have been introduced, aviation cooperation can be implemented on a small scale. For example, aviation business to transport passengers between Kumkang and Sorak Mountain would be able to facilitate mutual exchange and understanding. The unification of terminology used in civil aviation is also another important task. Some training programs for aviation personnel may be useful tools in helping each other to better understand the other.

In sum, the aviation cooperation between the two Koreas can be conducted in various forms until the two Koreas are reunited. I would like to emphasize that aviation cooperation is a very important means to shorten the journey to the reunification of the Korean Peninsula.

VI. Conclusion

It is my firm belief that aviation cooperation in many forms between the Koreans until the reunification of the peninsula would facilitate the exchange of people and goods, thereby restoring mutual trust and ties.

Before both Koreas could have a full-scale cooperation such as having scheduled services, there could be many ways and means to encourage cooperation in the civil aviation field. For example, the two governments can allow people, from government or the private sector, involved in civil aviation to meet each other, on such occasions as seminars, workshops and informal meetings. Airlines can reach commercial agreements before formal consultations

between the governments take place. Lastly, I would like to urge the ROK and DPRK authorities to have regular contacts to discuss what both aeronautical authorities can do to promote aviation cooperation until this peninsula is reunited.

A Study on the Air Transport Cooperation in Northeast Asia between China, Japan and Korea

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1. Introduction¹

For a considerable period of time, the air transport has been regarded as a special economic activity with its own regulatory system, particularly in that all states relate air space to their sovereignty and national security. And bilateral regulatory system based upon reciprocity has been dominant in international air transport industry.

As almost all sorts of economic activity have a strong tendency to transcend national borders these days, the economic globalization has now become a firmly rooted phenomenon throughout the world. Free trade and fair competition is a prevalent concept in so far as economic activity is concerned.

Responding to these global economic trends, the international air transport has been and will be deregulated and liberalized further. Particularly, bilateral and sub-regional liberalization of air transport market has been remarkable. Also, the multilateral liberalization of air transport services through WTO GATS frame has been discussed.

The most likely scenario of deregulation and liberalization at present is an expanding patchwork of phase-in liberalization in the field of air transport industry, both

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¹ The viewpoints and suggestions discussed in this paper may be inconsistent with the position of Korean government.

through bilateral agreements and through regional multilateral agreements.

In the context of those rapid changes in the global marketplace, there has been an increasing awareness to develop stronger aviation links in the Northeast Asia between China, Japan and Korea. With regards to realizing the concept and the approaches to it, several challenges are expected due to different viewpoints among countries of the region. However, the air transport industries in the Northeast Asia should not isolate itself from the global trends. There needs a paradigm shift from the traditional concept in the region.

This paper identifies the needs of sub-regional air transport liberalization in Northeast Asia between China, Japan and Korea, and reviews the strategies and practical measures for air transport liberalization in the region.

2. Overview of regulatory changes in international air transport

At the 1944 Chicago Conference on International Civil Aviation, the United States pressed for an open, multilateral regime for post-war international air services. However, the proposed multilateral regime on commercial air transport rights for international air transport services was not adopted at this Conference. Since then, bilateral air services agreements between the countries have governed all commercial aspects of international air transport services.

Bilateral agreement typically regulates number of designated airlines, routes, capacity, pricing, and other doing business. Bilateral agreements are based upon the principle of reciprocity, a fair and equal exchange of traffic rights between countries. Each international airline faces a complex web of bilateral air services agreements signed by its government. The existence of these bilateral agreements has greatly

constrained the freedom of individual scheduled airlines and has limited competition in the international air transport industry.

Presently, however, the international air transport industry is going through regulatory changes. Liberalization in bilateral and also in sub-regional air transport market was increased. Each government is reviewing discussion for multilateral air services agreements in a global context through WTO GATS Annex on Air Transport Services.

Deregulation of air transport started from U.S. since 1978. Gradually, other countries' domestic air transport industries and ultimately the international industry have felt the effects of the U.S. experience. The United States has taken "open skies" policy in international air transport. The first U.S. "open skies" deal was signed in September 1992 with the Netherlands. In February 1995, Canada and U.S. signed an "open skies" agreement with a three-year phase-in provision. In January 1997, Singapore became the first country in Asia to sign an "open skies" agreement with U.S., and Korea signed "open skies" agreement with U.S. in June 1998. And, recently on May 1, 2001, the multilateral "Open-Skies" agreement among U.S.A, Brunei, Chile, New Zealand and Singapore was signed. As of May 2001, The United States has concluded total 53 "open skies" agreements with nations in Europe, Asia, Africa, and Central and South America.

The EU countries liberalized their air transport market through three-package program on a gradual base and eventually got rid of the restraints on traffic rights to their own domestic routes (Cabotage rights) as of 1st of April 1997.

The General Agreement on Trade in Services (GATS) of WTO, which was concluded in December 1993 after several years' negotiation, includes the Annex on Air Transport Services. However, in the Annex, the agreement shall not apply to measures affecting traffic rights and services directly related to the exercise of traffic rights,

except only a few ancillary services such as aircraft repair, selling and marketing of air transport services, and computer reservation systems. It was provided that the Council for Trade in Services shall review periodically, and at least every five years, developments in the air transport sector and operation of this Annex with a view to considering the possible further application of the Agreement in air transport sector.²

Currently, discussion for applying GATS more extensively to air transport sector is limited to non-scheduled services, leasing, express package delivery and air cargo. However, it is widely recognized that in view of the disparities in socio-economic and competitive situations in the world, there is little prospect in the near future for a global multilateral agreement for the exchange of hard rights.

With the growing convergence of economic, safety and now environmental issues in world wide air transport industry, there are strong supports for keeping regulation of all these issues under the same umbrella. Also, at regional level, it has been proved that bilateralism and multilateralism can co-exist, and each region may accommodate different approaches to international air transport regulation.

In the last ten years, groups of States have created multilateral air services agreements on the regional level based on membership in their respective groups. The cases of sub-regional multilateral agreements of Caribbean Community, CLMV (Cambodia, Lao People's Democratic Republic, Myanmar and Vietnam), ACAC (Arab Civil Aviation Commission), COMESA (Common Market for Eastern and Southern Africa), Central African Economic Union, and ECA (Economic Commission for Africa) are good examples reflecting the new trend of sub-regional multilateral approach to the air transport services.³

In terms of airlines, the world airlines have formed strategic alliance with other

² WTO, Annex on Air Transport Services, *General Agreement on Trade in Services*, Updated in April 1997.

carriers to expand routes, increase capacity, save cost, and improve service quality. These strategic alliances between airlines have also been formed partly to circumvent restrictions imposed by bilateral air transport agreements and foreign ownership restrictions.

3. Air transport markets in Northeast Asia

3.1. Overview of economies of Northeast Asian nations

Economies of Northeast Asian nations have experienced remarkable growth since the end of World War.. In terms of export, China, Japan, Korea combined consists 13.6% and in terms of imports, they consist 10.3% in the world in 1999. The population of the three nations combined represents 24% (a fourth) of 5,978 million in the world.

<Figure-1> Major economic indicators of selected nations

Classification		China	Japan	Korea
Population (thousand)	1999	1,266,840	126,505	46,858
	2000	1,277,558	126,714	47,275
GDP (billion USD)	1999	9,912	43,489	4,067
	2000	10,800	N.A	4,574
GDP per capita (USD)	1999	782	34,377	8,680
	2000	845	N.A	9,675
Exports (million USD)	1999	195,150	419,367	143,686
	2000	249,297	479,249	172,268
Imports (million USD)	1999	165,788	311,262	119,752
	2000	206,132	379,511	160,481

Source) OECD, *Main Economic Indicators*, 2000, IMF, *International Financial Statistics*, 2000. UN, *World Population Prospects*, 1998.

³ ICAO, *Annual Report*, 1999.

In terms of tourist, total number of passengers to and from the three nations amounted to 59,257 thousand in 1998.

<Figure-2> International inbound & outbound tourists of selected nations

Classification	China ¹⁾		Japan ²⁾		Korea ³⁾	
	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound
1996	5,601	22,765	16,694	4,244	4,649	3,684
1997	5,936	23,770	16,802	4,669	4,542	3,908
1998	6,505	25,073	15,806	4,556	3,067	4,250
1999	N.A	27,047	16,357	4,901	4,342	4,660
2000	N.A	N.A	17,818	5,272	5,508	5,322

1) World Tourism Organization (www.world-tourism.org), 2000.11.

2) *Annual Statistics*, Immigration Bureau, Ministry of Justice, Japan, 2001.

3) *Korea Tourism Statistics*, Korea National Tourism Organization, 2001.6

<Figure-3> Scheduled air traffic in ton-kilometers of selected nations

(Unit: million ton-kilometers)

Classifications	Domestic & International				International			
	World ranks	1999	1998	Change (%)	World ranks	1999	1998	Change (%)
Japan	2	22,348	20,896	7	4	16,144	14,905	8
Korea	6	13,138	11,605	13	5	12,425	10,929	14
China	9	10,115	8,893	14	14	3,845	3,047	26
Sub-total		45,601	41,394	10		32,414	28,881	12
World-total		368,800	348,470	6		246,230	231,410	6

Source: ICAO, *Annual Report to the Council*, 1999, p. A-43.

The air transport market in Northeast Asia has experienced tremendous growth during the past two decades. In 1999, China, Japan and Korea combined accounted for 12.3% of the global air transport market in terms of traffic ton-kilometers (passenger & cargo) which represents 10.1% increase over 1998. It outstrips world increase rate 6% during the same period.

3.2. China

The potential of the air transport market in China is huge. Indeed, China, with its large population and along with its economic development, will undoubtedly play a more important role in the world civil aviation in the future. China is expected to surpass Japan in scheduled air passenger volume as the combined share of China and Hong Kong in the region.

Since reform and opening to the outside world, the civil aviation industry of China has maintained a fairly rapid rate of growth. By the end of 1999, the whole industry had a total of 877 aircraft of various types, among which are 510 air transport aircraft. A total of 1,093 air routes were operated, including 965 domestic air routes and 128 international air routes. Domestic air routes served 132 cities and international air routes served 61 cities in 34 countries and regions.

Since economic reform and opening up, the growth rate of the civil aviation of China has been 3.2 times that of the world average. The rank of the total volume of traffic and the total volume of passenger traffic carried by the scheduled flights of China rose from the 37th place in 1978 to the 9th place and 6th place respectively in 1999 among the Contracting States of the International Civil Aviation Organization (ICAO).

By 1999, China had 143 airports for the operation of air services, including 19 air ports available for the operation of large airliners such as B747, 103 airports available

for the operation of B737 and A320, and 37 airports available for international operation. In October 1999, the new Shanghai Pudong International Airport (SPIA) commenced its operation with capacity of handling 20 million passengers annually. With the opening of Pudong, Shanghai became the first city in China to have two international airports.⁴

The civil aviation industry has actively implemented the policy of reform and opening-up, and has taken a series of important steps. In early 1980s, the civil aviation industry was changed from the military system and embarked on the road of running as enterprises. In mid 1980s, the industry carried out the reform of management system, organized air transport enterprises, and separated airports from airlines.

Since 1990s, government functions have been further separated from those of enterprises. At the same time, the reform of enterprises has been deepened, the operation mechanism of enterprises has been adopted, and a modern system of enterprises has been established. Strategic reorganization has been carried out in air transport enterprises; airport and air traffic control system has been reformed. The whole industry has opened wider to the outside world. By the end of 1999, total 363 aircraft were acquired through financial lease, and the use of foreign funds of US\$18.1 billion was agreed. Total 66 joint ventures were set up, and US\$16.6 billion of foreign government loans were utilized.

It is forecasted that in the first 10 years of the 21st century, the air transport of China will maintain a growth rate of around 8%. Air transport will occupy a greater share in the overall transportation system of the country, and the rank of China among the Contracting States of ICAO with respect to the volume of total air traffic is expected to be further advanced.⁵

In the airline industry of China, several strategies to improve competitiveness of the

⁴ *Jane's Airport Review*, December 1999/January 2000, p.27.

⁵ <http://caac.gov.cn/Century>

industry have been discussed continually including consolidation of the industry,⁶ maintaining a competitive market, and having the residual claim and control right be paired as much as possible. One effective strategy discussed is to encourage China's carriers to engage in strategic alliances with foreign leading carriers. The management and marketing skills of these leading carriers, in addition to access to their extensive route networks, will be beneficial to the Chinese partners. Progress has been made in this aspect. In 1998, Air China entered a code-sharing agreement with Northwest Airlines whereas China Eastern signed code-sharing agreements with American Airlines and All Nippon Airways, respectively.⁷

3.3. Japan

Japan has been the region's dominant travel market. In 1999, Japan ranked 2nd in the world in air traffic ton-kilometers (passenger and cargo). Japanese air transport market was developed in a strictly regulated environment in the past, but a policy stream toward deregulation of air transport since the 1980s has brought to fruition of substantial liberalization on this market. There are now eight scheduled carriers operating in Japan. Japan Airlines (JAL), All Nippon Airways (ANA), and Japan Air System (JAS) are the three earliest. Japan Asia Airlines (JAA) and Nippon Cargo Airways (NCA) offer only international services. Japan Trans Ocean Airlines (JTA) and Japan Air Commuter (JAC) are solely domestic carriers, and Air Nippon (ANK) is

⁶ Confirming a widely reported consolidation blueprint, the Civil Aviation Administration of China (CAAC) said at the end of April 2001 that nine airlines under its wing would merge into three groups led by the nation's biggest carriers, Air China, China Eastern Airlines and China Southern Airlines. The mergers are key to Beijing's goal of forging a strong and internationally competitive airlines sector out of a fragmented industry that presently features more than 30 airlines and has long been dogged by overcapacity, reckless price war, heavy indebtedness and poor records of safety and service. *Orient Aviation*, June 2001, p.30.

⁷ Hongmin Chen & Anming Zhang, "The Prospect of Air Transport Industry and Strategies for Open Skies in China", in *The 1st International Seminar on Air Transport Cooperation in Northeast Asia*, Jeju

mainly domestic but operating an international route between Fukuoka and Taipei. JAA and JTA are subsidiary of JAL, NCA and ANK is of ANA, and JAC is of JAS.

In 1998, newly established two carriers entered into the domestic market, which are Skymark Airlines and Air Do (Hokkaido International Airlines). Skymark operates only in Tokyo-Fukuoka route and Air Do in Tokyo-Sapporo. These carriers are very small and flights are very few, but their fare strategy is very aggressive.

The Japanese government has persistently taken a rather traditional stance on international air transport. However, a turning point was made in 1986 when the Council on Transport Policy submitted a report that suggested a new policy. The background to this report was the provisional agreement with the United States made the previous year, which allowed more Japanese and U.S. carriers entering the market between two countries. By this agreement, ANA and JAS became international carriers, and United Airlines, American Airlines and Delta Airlines obtained access to Japan.

Although this provisional agreement was not a liberal agreement giving carriers freedom in terms of capacity and pricing, it triggered changes in Japanese air transport policy. It was the starting point for relaxing entry conditions and expanding capacity in international air transport market.

In March 1998, Japan and U.S. agreed a new MOU. The essence of the MOU was to introduce greater competitive environment into the air transport market between two countries. The new agreement allows for full right carriers to choose any city pair market between two countries if there is no landing slot problem, to exercise beyond right more freely than present⁸ and to take use of code sharing even between the same country's carriers. The new agreement was concluded with substantial compromise of two countries, but it is sure that competition among carriers will increase and increased

Island, Korea, February 25-26, 1999.

⁸ While there remained preconditions on using beyond right for both countries, these conditions are not

competition would benefit consumers as well as air carriers themselves.⁹

3.4. Korea

During the past two decades, Korea has emerged as one of the largest air transport markets in the world. In 1999, the Republic of Korea ranked 11th in the world in passenger-kilometers, 3rd in cargo ton-kilometers, and 6th in total traffic volume. Over the past decades, Korea recorded one of the highest air traffic growth rates in the Asia-Pacific region. The average annual growth rate from 1990 to 2000 for the international air passengers was 7.3 percent, and the annual growth rate of international air cargo volume during the same period was 9.6 percent.

In 2000, the number of international air passengers carried to and from Korea was 19.4 million representing a 16.1 percent increase over 1999. Also a total of 22.5 million domestic passengers flew in 2000 which represents a 6.5 percent increase over 1999.

Although the development of civil aviation dates back to 1948 when the Korean National Airlines (KNA) initiated its air services between Seoul and Busan, much progress did not take place until 1969 when the KNA was privatized and reorganized as Korean Air. Civil aviation development in Korea was given another boost with the introduction of the second private carrier, Asiana Airlines in 1988.

As of May 2001, Korea signed bilateral air services agreements with 78 countries, and based upon these agreements, the two Korean national flag carriers and 44 foreign airlines operate 1,092 scheduled international flights weekly between Korea and 104 major cities in the world.

restrictive.

⁹ Hirotaka Yamauchi, "Air Transport Policy in Japan: Policy Change and Market Competition", *The 1st International Seminar on Air Transport Cooperation in Northeast Asia*, Jeju Island, Korea, February 25-26, 1999. pp.26-28.

In order to accommodate increasing air transport demands, Korea has constructed the new Incheon International Airport which successfully commenced operations on 29 March 2001. With two runways and state-of-the-art facilities, it is capable of operating 24 hours a day. Incheon International Airport is fast becoming a major hub airport in Northeast Asia for worldwide international air transport routes.

4. Approaches to air transport cooperation in Northeast Asia

4.1. Need for liberalizing air transport in Northeast Asia

Until recently, most of the national government in the region tightly regulated civil aviation industries and restricted their citizens' overseas travels. Under the restrictive bilateral regime, each government has controlled market entry, capacity and pricing of airlines and thus fragmented networks and less competition were resulted in the region.

Countries in the region hope to develop their airports as a hub in Northeast Asia. Successful implementation of hub strategy requires liberalization of air transport market. The regional air liberalization promotes their economies by stimulating flows of passenger and cargo between countries involved. It enables airlines to allow to set up efficient network and to protect the market from the carriers in other continents and to enhance bargaining power in the inter-continental airline alliance. The consumers in the region will enjoy the benefits of more various flight schedules, air routes, price, services, etc. by liberalization. Finally, the liberalized air transport services would greatly affect the whole national and regional economy positively since the opportunity for tour businesses and foreign investments in the region will be expanded, facilitating the flows of passenger and cargo. Therefore, the liberalization of air transport market in

the region will be beneficial to all participants: airlines, consumers, and governments.

In addition, by strengthening the international air transport cooperation and finally concluding sub-regional multilateral agreement in Northeast Asia, other important benefits are expected as follows.

1) Provide a momentum for enhanced competition and terms for the future regulatory regime in the air transport market; a sub-regional multilateral agreement mirrors the spirit of economic cooperation and permits liberalized trade in international air services among nations involved. By expanding the bilateral to the sub-regional multilateral level, the new agreement will help enhance competition in sub-region and provide the terms for the future regulatory regime in international markets.

2) Expand carrier access to equity financing; most bilateral agreements require that substantial ownership of designated carriers be vested in either that carrier's homeland governments or its nationals. However, this requirement has made it difficult for many carriers to obtain cross-border financing. The sub-regional multilateral agreement substantially relaxes the traditional ownership requirement¹⁰, thus enhancing carriers' access to outside investment in the region.

¹⁰ Regarding the ownership of airlines, the option of using a criterion based on "headquarters, central administration or principal place of business" regardless of the traditional concept of substantial ownership and effective control is receiving some support. However, the former has not been accepted to most nations, mainly because it was regarded as an unacceptable means of gaining market access; differing interpretations of the terms involved could subject it to abuse; and it might lead to "flag of convenience" with lack of regulatory control, although it was recognized in this connection that the Chicago Convention confers responsibility for safety regulation on the State of registry. See ICAO, *Report of the World Wide Air Transport Conference on International Air Transport Regulation: Present and Future*, Montreal, 23 November – 6 December, 1994, p. 23-25. It is noteworthy that, in 1993, the bilateral air services agreement between Korea and Hong Kong applied the concept of principal office of business or headquarter instead of the traditional concept of substantial ownership and effective control. See Kim Kyu Sun, *A study on the aviation policy for the 21st century*, Korea Airports Authority, 1997. pp.56-57.

3) Streamline and harmonize international aviation relations; aviation is currently governed by thousand of bilateral agreements between more than 180 countries. The sub-regional multilateral agreement will provide a streamlined and harmonized mechanism for broader exchanges of aviation opportunities for the future.

4.2. Cases of sub-regional multilateral air transport cooperation

In the last ten years, groups of States have created multilateral air services agreements on the regional level based on membership in their respective groups. Most of these regional or sub-regional arrangements are aimed at fostering cooperation and liberalizing air transport regulation among member States. In 1998, the multilateral Agreement Concerning the Operation of Air Services within the Caribbean Community (CARICOM) entered into force. Four States in Southeast Asia; Cambodia, Lao People's Democratic Republic, Myanmar and Vietnam (CLMV) reached an agreement on the establishment of a liberalized sub-regional regime for air transport services among themselves.¹¹

In 1999, the council of Arab Transport Ministers of the Arab Civil Aviation Commission (ACAC) reached an agreement to liberalize intra-Arab air services over a period of five years. In Africa, the 21 States that form the Common Market for Eastern and Southern Africa (COMESA) reached an agreement to phase in liberalization in air transport within the sub-region. Also, the Council of Ministers of the Central African Economic Union adopted an agreement on liberalizing air transport between its six member States. At a meeting of the Economic Commission for Africa (ECA), African Transport Ministers adopted a region-wide provisional aviation agreement to liberalize

¹¹ ICAO, *Annual Report*, 1998.

the African skies with the aim of reaching full integration by 2002.¹²

In 1999, the leaders of the Asia Pacific Economic Cooperation (APEC) endorsed a proposal by its Transportation Working Group aimed at increasing competitive air services within the region. The proposal would reduce restrictions on market access for both passenger and air cargo services, and would allow for multiple airline designation and cooperative arrangements.¹³

And, recently on May 1, 2001, the multilateral "Open-Skies" agreement among U.S.A., Brunei, Chile, New Zealand and Singapore was signed.

The cases of sub-regional and multilateral agreements of CARICOM, CLMV, ACAC, COMESA, Central African Economic Union, and ECA could be good examples reflecting new trend of sub-regional multilateral approach to the air transport services. And more successful examples for regional multilateral approach to the trade in air transport services are those cases of North America and EU.

1) North America

In February 1995, the U.S and Canada signed an "open skies" agreement with a three-year phase-in provision. This case is appreciated as a successful example of air transport market liberalization. Before signing agreements, Canada had feared that its own national carriers would be structurally disadvantaged as compared to the major U.S carriers on the following reasons. First, U.S carriers have well-developed continental services network supported by a large population and strong and numerous hub airports. Second, since the majority of transborder travelers originate from or

¹² ICAO, *Annual Report*, 1999.

¹³ However, Asia Pacific Region is very wide and there are deep gaps and differences in the field of politics, economic scale, culture, and religion, etc. Therefore, liberalization in air transport market in Asia Pacific region could be progressed on sub-regional and gradual basis.

destined to eight major cities in Canada, U.S carriers would be able to reach over 80 percent of Canadian transborder market cost-effectively by extending their spokes to these Canadian cities from their U.S. hubs.

In order to remedy the situation and create a level-playing field, the two countries agreed on the following measures. First, U.S. carriers' entry into major Canadian markets (Toronto, Montreal and Vancouver) was to be relaxed gradually over a three-year phase-in period while allowing Canadian carriers into the U.S. Market from day 1 without any limitation. Second, the U.S. guaranteed that Canadian carriers get some additional airport slots and gate spaces at the congested U.S. airports such as Chicago and LaGuardia in New York. The three-year anniversary report published by the U.S. DOT in 1998 indicated that Air Canada did outstandingly well and Canadian did very well during the first three years. The total U.S.-Canada transborder passenger traffic increased by 37.2 percent during the period.

2) EU

From April 1997, the EU created a single aviation market. Any EU-registered carrier has the right to run domestic services within any of the EU's 15 member countries, as well as in Norway and Iceland. The single European aviation market thus became the world's largest single air transport market with more than 370 million potential passengers. Negotiations on foreign carrier's access to EU member states remain with individual members of EU.

In addition, many of EU members have been pursuing liberal bilateral agreements with non-EU States, including the "open skies" agreements with U.S. There also "Transatlantic Common Aviation Area" proposal has been reviewed between EU and the U.S. government. The "Transatlantic Common Aviation Area" was proposed by the

Association of European Airlines and suggests the liberalization of various regulations on the international air transport services between EU and U.S. that is the world's largest and most competitive market.

4.3. Viewpoints of Northeast Asian nations on the liberalization

Northeast Asian countries' views on and approaches to the liberalization of trade in air transport services are different, mainly due to the size, competitiveness and other characteristics of their own air transport industries.

4.3.1 China

In terms of geography and population, China holds the key for shaping air transport networks in the region. But China does not have strong carriers. Even the big three carriers of China (Air China, China Eastern, and China Southern) are small in the global standards. China Southern and China Eastern have been pro-active in developing international routes, but they still need to build their size and reputation in international market.¹⁴ Partly due to its uncompetitive carriers, the Chinese authority has taken restrictive approaches in international air transport policy. This has significantly slowed progress of air transport liberalization of the region.

From May 1994, foreign investors were allowed to invest in China's aviation industry, including equity stakes in airlines and airports. This was motivated by China's

¹⁴ In this context, consolidation blueprint has been widely reported in China. (Refer to note # 6.) According to the Xinhua news agency, upon completion of the consolidation between China's airlines, the China Southern group would emerge as the largest, with a fleet of 180 aircraft and 606 flight routes. The Air China group would have 118 aircraft and 339 flight routes and the China Eastern group would have 118 aircraft and 437 routes. *Orient Aviation*, June 2001, p.30.

desire to achieve international air transport standards so that China's airlines could compete in global markets as well as meet domestic demands. China Eastern and China Southern was listed on New York and Hong Kong stock markets.

Although China has opened its aviation sector to foreign investments, it has been cautious in liberalizing its aviation sector, particularly in the international market. And it seems that China does not want to open its market too fast. China's restrictive policy in international air transport reflects the state of development of China's aviation industry. The policy is intended to protect China's uncompetitive carriers.

In January 1996, the agreement signed with the U.S. opened the first non-stop direct flight from the U.S. to Beijing. One of the most important aspects of the agreement was that it opened the door for codesharing between Chinese and the U.S. carriers. Consequently, American Airlines and China Eastern signed a memorandum of understanding in February 1997 for codesharing. Since then Air China has become the first Chinese airline to fully enter into an international alliance with Northwest Airlines and its partners Continental, Alaska and America West Airlines, China Southern has established codesharing operation with Delta Air Lines. More recently, Qantas Airways and China Eastern signed a commercial agreement for codesharing.

In addition, starting from January 1, 1999, the Chinese government is not to interfere with the operation of Air China and its alliance with Northwest, allowing the airline to be responsible for its own profits and losses, and giving the company more freedom.

In April 1999, China signed a new aviation agreement with the U.S., which is expected to significantly expand commercial air services between the two nations. Under the new agreement, scheduled flights will double, growing from 27 to 54 per week for each country's carriers. However, the U.S. government understands that neither Chinese government nor its carriers are ready to agree on anything close to an

“open skies” bilateral.¹⁵

4.3.2. Japan

Japan is the most economically advanced country in Northeast Asia. However, its airlines are not cost competitive in international markets, mainly due to high input costs. Japan thus takes on rather conservative view on air transport matters.

At the 4th ICAO Worldwide Air Transport Conference in Montreal, Canada, November 1994, Japanese delegate said that ‘while liberalization may produce more efficient airline management, low fares, increased traffic, and greater networking between airlines, it also leads to predatory pricing, capacity dumping, a retreat from thin routes, and a tendency toward oligopoly’¹⁶. This attitude of Japan on air services liberalization was once more confirmed when Japan attached an Annex on the ‘The Future of International Air Transport Policy: Responding to Global Change’, which was reported by the steering group to the OECD international air transport project. Japanese view in the Annex was that the liberalization is not defect free, and in some cases it has a tendency toward the creation of monopolies or oligopolies, aggravation of unlevelled competition conditions, and loss of effective participation of countries.¹⁷

This means Japan has taken a conservative attitude towards international air service liberalization. This is, to a large degree, due to the severe shortage of airport slots and the lack of competitiveness of Japanese carriers.¹⁸

After lengthy and intense negotiation, Japan and U.S. signed a new MOU on air transport services on March 14, 1998. The new agreement provides for unrestricted U.S.

¹⁵ Tae Hoon Oum & Chunyan Yu, *Shaping Air Transport in Asia Pacific*, Ashgate Publishing, 1999, pp.111-114.

¹⁶ *Ibid.*, p. 105.

¹⁷ OECD, *The Future of International Air Transport Policy*, OECD, 1997.

– Japan and beyond rights for the so-called incumbent carriers: United, Northwest, Federal Express, Japan Airlines, All Nippon Airways and Nippon Cargo Airlines. Under the agreement, further liberalized agreement will take effect automatically after four years if a fully liberalized agreement is not in place by then. Slot allocation at Tokyo Narita Airport, however, was not addressed by the new agreement, so carriers may still have some difficulties exercising the new rights.

4.3.3. Korea

With regard to the deregulation and liberalization of air transport market, domestically and internationally, the basic position of Korea is a gradual and progressive one. Korea has been considerably progressive in shaping liberalized air transport system. In 80's and 90's, Korea has actively responded to liberalization and globalization of air transport sector.

Korean government privatized “Korean National Airlines” as the “Korean Air” in March 1969. And, second carrier “Asiana Airlines” started its business from February 1988 as a full private company. The entry of the second carrier boosted competition in the number of flight frequencies, pricing and other services in the market.

The government also established Incheon International Airport Corporation in February 1999, which is responsible for construction and operation of new Incheon airport and it is pre-stage for privatization of the new airport. Incheon International Airport commenced its operation successfully on 29 March 2001. Korea is also planning the establishment of Korea Airports Corporation to make restructuring of existing Korea Airports Authority and for the purpose of financial self-supporting and

¹⁸ Oum & Yu, *op. cit.*, p.105.

more effective management. In June 1998, remarkable achievement was made; that was Open Skies Agreement with U.S.

At the 4th ICAO Worldwide Air Transport Conference in Montreal, Canada, November 1994, the delegation of Korea presented that, under the ICAO regime of the last 50 years, civil aviation industries have been well developing and ICAO has been dominant in matters concerning air transport industries on the multilateral system. Noting that Korea has accommodated the new trend of liberalization on a gradual basis, the Korean delegate suggested that ICAO should adopt and discuss "Progressive introduction of Full Market Access in air transport services" as an agenda item at the ICAO General Assembly meeting which is held 3-year basis.¹⁹

It is noteworthy that, in 1993, the bilateral air services agreement between Korea and Hong Kong applied the concept of principal office of business or headquarter instead of the traditional concept of substantial ownership and effective control.²⁰ Also, in the Asia-Pacific multilateral fora, Korea civil aviation authority favored liberalization in Asia. For example, at the 'First Regional Cooperation Forum for International Air Transport in Asia and Oceania' held in Kyoto, Japan, February 1996, attended by delegates from 13 nations of Asia and Oceania, Korean delegate presented a progressive paper. It suggested two alternatives: either consider multilateral liberalization throughout Asia; or allow the more aggressive groups to form an open skies bloc among themselves, with others free to join later.

Republic of Korea initiated 1st international seminar on Air Transport Cooperation in Northeast Asia in Jeju Island on February 1999. Many experts of civil aviation authorities, academe and institutes of three countries (China, Japan, and Korea)

¹⁹ Kim Kyu Sun, *A study on the aviation policy for the 21st century*, Korea Airports Authority, 1997, pp. 114-115.

²⁰ *Ibid.*, pp. 56-57.

participated at the seminar. Some positive and some conservative approaches to liberalization of air transport market among China, Japan and Korea were exchanged in a very free manner.²¹ In the seminar, Korea also delivered progressive attitudes toward sub-regional air transport cooperation in Northeast Asia.²²

4.4. Impediments to liberalization in Northeast Asia²³

1) Competitiveness gap between airlines

There are significant gaps in competitiveness between airlines in the region. As a result, countries with weak airlines fear that their carriers could lose out in a competitive system if international or sub-regional air transport were liberalized. Those countries and their airlines thus take a protective and passive approach in bilateral and multilateral negotiations. For the time being, it is difficult, if not impossible, to expect Asian countries to agree to a substantially liberalized air transport bloc without some

²¹ Hirotaka Yamauchi, "Air Transport Policy in Japan: Policy Change and Market Competition", Hongmin Chen & Anming Zhang, "The Prospect of Air Transport Industry and Strategies for Open Skies in China", in *The 1st International Seminar on Air Transport Cooperation in Northeast Asia*, Jeju Island, Korea, February 25-26, 1999. At the seminar, Japan presented a conservative view on the liberalization of the air transport market in the region. And China suggested a compensation measure to be provided for weak airlines of China and advocated an incorporation of bilateral air negotiation into more comprehensive bilateral or even multilateral trade negotiations in goods and services. This Chinese view of incorporation of bilateral air negotiation into more comprehensive trade negotiations is very similar to that of Professor Oum of University of British Columbia (see, Tae Hoon Oum & Chunyan Yu, *Shaping Air Transport in Asia Pacific*, Ashgate Publishing, 1999, pp.172-173.). However, this approach is unrealistic in that; 1) the regulatory regime and business patterns in air transport industry are quite different from those of other industries, 2) it is almost impossible in the economic and political context to estimate and exchange the values of air transport services with other industries.

²² Jong Hur, "Toward Liberalization in Asia Transport Between China, Japan, and Korea", in *The 1st International Seminar on Air Transport Cooperation in Northeast Asia*, Jeju Island, Korea, February 25-26, 1999.

²³ Professor Oum of the University of British Columbia in Canada lists the impediments to liberalization in Asia as 'differential capability of airlines in different countries', 'weak consumer power', 'different political system and military use of air-space and airports', 'high cost airlines of Japan', and 'uncompetitive Chinese carriers'. Tae Hoon Oum & Chunyan Yu, *Shaping Air Transport in Asia Pacific*, Ashgate Publishing, 1999, pp.167-168.

guarantee of equitable gain sharing among the nations involved.²⁴

The principle of 'equal opportunity', which is advocated by countries with strong airlines, is not acceptable to countries with weak airlines. In the short run, the principle of 'equal benefit' with key incentives for carrier to become efficient and competitive is the way to liberalize air transport market in Northeast Asia.

2) Physical constraints in major airports

The physical restriction such as airport time slots and airspace congestion could be used as an excuse to restrict foreign carriers' access to the airports, particularly of each capital cities, and also the situation may seem unchanged in Tokyo. However, each countries of the region newly constructed or expanded their hub airports in their capital or secondary cities. A more open system could be adopted for these airports.

3) Compensation issues

If carriers in a certain country are less efficient or structurally disadvantaged than other countries' carriers, it may be desirable to devise a method of compensation for those carriers in the more competitive market environment. However, with regards to the method of compensation, some disputes are expected due to different viewpoints among airlines of the region. Commercial agreement between the airlines of the region could be an appropriate method for compensating those weak airlines. Through commercial agreement for codesharing or revenue pooling between airlines in the region, weak airlines could reduce the fear for the more competitive market. This is

²⁴ Ibid.

important especially when dealing with Chinese carriers. It is possible for Korean and Japanese carriers to compensate Chinese carriers in such a way that the benefit from the liberalized markets be shared equally with Chinese carriers through individual commercial agreements.

For other example, when the U.S-Canada "open skies" agreement was signed, both of the two major Canadian carriers (Air Canada and Canadian Airlines International) had an alliance relationship with at least one major U.S. carrier. Air Canada had the alliance with United while Canadian had an equity alliance with American Airlines. These alliance relationships reduced some fear of Canadian carriers on the "open skies" agreement with the U.S.

4.5. Approaches to air transport liberalization in Northeast Asia²⁵

4.5.1 Strategies of liberalization

1) Gradual and progressive approach

Since carriers in a certain country are less competitive than other countries' carriers, and nations have different national regulatory goals and policies, it may desirable to approach to the liberalization of air transport market in the region gradually and progressively with suitable safeguards. The coexistence of different regulatory regimes is a basic principle for the evolution of future regulatory arrangements for international air transport in the region and the world. Also coordinating the interests between nations involved is very difficult, if not impossible, and time consuming work.

²⁵ The viewpoints and suggestions discussed in this paper may be inconsistent with the position of Korean government.

Also, in approaching to the air transport liberalization in the region, the role of governments should be confined to making principles and regimes in which individuals (airlines, airports, consumers, etc.) can move and compete freely in the market.

To liberalize easier items first and then move toward more difficult items could be desirable. Relaxing bilateral agreements between nations, relaxing charter and air cargo services and relaxing scheduled services to and from secondary and local airport could be easy items. And also the operation of shuttle services between capital cities could be very practical and beneficial to both consumers and carriers involved.

2) Safety Net

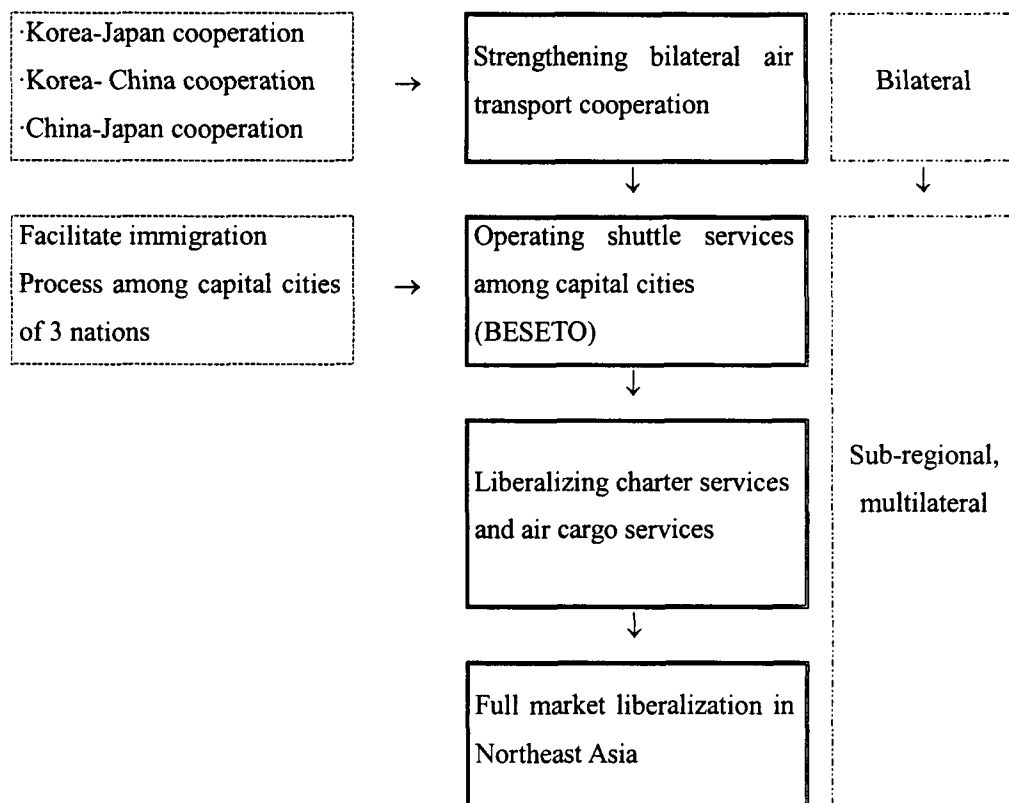
Safety net is extraordinary measure to ensure a fair competition in achieving a gradual, progressive, orderly and safeguarded liberalization of international air transport market. One proposed future regulatory arrangement would be that parties would grant each other full market access rights for use by designated air carriers, which cabotage and so-called 7th freedom right exchanges are optional. Each party would have the right to impose a time-limited capacity freeze as an extraordinary measure in response to rapid and significant decline in that party's participation in a country-pair market. Safety net would play very important role in persuading and inducing the unsure countries to participate in the liberalization process. Therefore, the safety net concept requires a close attention in making policy decisions regarding the liberalization of air transport services.

Also, it would be useful to devise a Dispute Resolution Mechanism. In the case of a disagreement between each party as to whether or not a proposed or actual pricing or capacity action by a designated airline constitutes a practice proscribed by the code of conduct for healthy sustained competition in the region, the parties could immediately

consult formally or informally. If they agree that the action is contrary to the code, either could act to end it promptly. If they disagree, either could implement the dispute resolution mechanism. Implementation would occur through use of impartial air transport experts selected from the nations involved with pre-determined criteria. In the mechanism, three or five person panels could be used for immediate fact-finding and adjudication.²⁶

4.5.2. Practical measures for air transport liberalization between China, Japan and Korea

<Figure-4> Practical measures for air transport liberalization between China, Japan and Korea



²⁶ ICAO, *Report of the World Wide Air Transport Conference on International Air Transport Regulation: Present and Future*, Montreal, 23 November – 6 December, 1994, p. 17.

1) Strengthening bilateral cooperation

The liberalization in Northeast Asia would be feasible when it starts from enhancing the level of bilateral cooperation in the first place. There exist differences in viewpoints on sub-regional air transport liberalization among three countries of the region. Some governments and airlines have concerns about the competitiveness gaps between airlines in the region. Therefore the liberalization should progress based on cooperative system among three countries about traffic right, route structure, frequencies, marketing through existing each bilateral agreements.

Therefore, liberalizing bilateral agreements between nations of the region should be considered first. In the phase of strengthening bilateral cooperation of the region, it is most urgent to find out how to countermeasure the competitiveness gap between airlines of the region. Also, some measure for solving capacity constraint in some major airports should be studied.

2) Operating shuttle services among capital cities

Based on gradual liberalization of bilateral agreements of the region, it needs to operate shuttle services among capital cities. Beijing, Seoul and Tokyo (BESETO) are the centers of politics, economy, culture and tourism of the region, where the most active passenger and cargo interchanges happen. The shuttle services between capital cities could be operated in the form of public charter or scheduled charter and should be operated regardless of capacity (gauges and frequencies) restriction articulated in the bilateral agreements.

<Figure-5> Major airports of capital cities of selected nations

(As of 2000)

Classification	Beijing Capital	Tokyo Narita	Seoul Incheon	Tokyo Haneda	Seoul Gimpo
Distance from city center	25km	66km	52km	16km	17km
Traffic performed (Passengers in thousand)	21,659	27,389	N.A	56,402	36,727
Aircraft movements performed	187,190	134,521	N.A	256,394	236,272
Capacity (Passengers in thousand)	N.A	2,300	30,000	50,000	34,650
Capacity (Aircraft movements)	N.A	130,000	240,000	230,000	226,000
Airlines operating	58	46	(46)	15	(2)
Cities connected	281	365	(104)	N.A	(15)
Expansion plan	Terminal 2 completed in 1999	2 nd Runway (2,500m) in 2002	Additional two runways, one passenger terminal, and four remote concourses will be added by 2020.	Terminal and Runway, Renewal and Expansio n	Excessive Capacity after becoming dedicated domestic airport.

Source) OAG, *Flight Guide*, April, 2001, and each airports' homepage

* Number in () parenthesis indicates the status of April 2001.

3) Liberalizing charter services

Charter services could play an increasingly important role in international air transport, given the fast growth of leisure traffic and tight regulations on scheduled services. Most governments tend to be more flexible towards charter services than scheduled services. For example, the U.S, Canada, Australia, and many European

nations deregulated their charter markets first. Opening of charter markets first helped deregulate scheduled service markets by allowing all participants (consumers, carriers and policy makers) to experience the benefits of deregulation. That is, lessons about deregulation were learned from the charter market.²⁷ Therefore, it is desirable to liberalize charter services first in the region.

4) Liberalizing air cargo services

The rapidly growing air cargo sector could benefit significantly from deregulation. For example, given the severe directional traffic imbalance in air cargo movements, deregulation of this sector would improve efficiency by allowing carriers to use back-haul space more efficiently than under the regulated system. Since most countries are more flexible towards cargo than for passenger issues, attempts to relax air cargo services is likely to be successful in the region.

5) Full market liberalization in Northeast Asia

After gradual and progressive approaches to liberalization have some fruits by strengthening bilateral cooperation and the recognition on the necessity of liberalization of air market is fully enlarged, it needs to conclude a sub-regional full market liberalization in Northeast Asia as a final step. It would be similar to those of EU and North America. However, the sub-regional multilateral agreement in the region should not be an exclusive bloc to the outside economies. It needs to be a regime of 'Closer and Cooperative Air Transport Relation', with others free to join later.

²⁷ Oum & Yu, *op. cit.*, p.175.

5. Summary and conclusion

The global economy moves toward accepting two different trends: globalization and regionalism. The globalization taking the whole world into single global market is progressing in a rapid speed while the regionalism trying to cooperate among regional or like-minded countries based on geographical, cultural and economic adjacency is far more enlarging. In fact, these two conflicting movements have a common recognition that the continuous progress of national and world economy would be ensured through mutual cooperation between countries based on open market economy.

The global economy moves toward accepting two different trends: globalization and regionalization. Responding to these global economic trends, international air transport has been and will be deregulated and liberalized further. Particularly, bilateral and sub-regional liberalization of air transport market has been remarkable. These can be best represented by the U.S.-oriented bilateral “open skies” agreements. Also the trend for shaping sub-regional liberalization is outstanding in recent 10 years heading from Americas to EU, Asia, Oceania, Middle East, and Africa. The most promising channel for further deregulation and liberalization in the international air transport would be the coexistence of multiple regulatory regimes of bilateral, sub-regional and multilateral.

In the context of those rapid changes in the global marketplace, there has been an increasing awareness to develop stronger aviation links in the Northeast Asia between China, Japan and Korea. With regards to realizing the concept and the approaches to it, a variety of challenges are expected due to different viewpoints among countries of the region. However, the air transport industries in the Northeast Asia should not isolate itself from the global trends. There needs a paradigm shift from the traditional concept

in the region.

Since it is impossible to achieve consensus among all Asian countries on liberalization of air transport market, liberalization among a few like-minded countries should be negotiated first. This would demonstrate benefits of liberalized air transport market as follows. First, it enables airlines of the region to construct effective route network and to increase their competitiveness against outer-region. Also, through constructing effective intra-regional network, they could increase global bargaining power in inter-continental alliances. Second, the consumers in the region will enjoy the benefits of more various flight schedule, air routes, price, services, etc. Third, it would greatly affect the whole national and regional economy positively since the opportunity for tour businesses and foreign investments in the region will be expanded, facilitating the flows of passenger and cargo. Therefore, the liberalization of air transport market in the region is beneficial to all participants: airlines, consumers, and governments.

The air transport liberalization in Northeast Asia should be approached by gradual and progressive basis with safety net. There need some supplementary measures for uncompetitive airlines as well as time for preparing for reaction to competitive market. Therefore, bilateral cooperation between each nation should be strengthened first. Based upon the enhanced bilateral cooperation, operating of shuttle services between capital cities (BESETO), liberalizing charter services and air cargo services should be approached step by step on sub-regional multilateral basis.

As a final step, it needs to conclude a sub-regional full market liberalization agreement in the form of 'Closer and Cooperative Air Transport Relation' in Northeast Asia, with others free to join sooner or later.

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