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A Benchmarking of Operational Efficiency in Asia Pacific International Cargo Airports

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Contents

Abstract

This paper compares operational efficiency of major cargo airports in the Asia Pacific region. The multi-dimensional scaling cluster analysis by R-square method was used as the benchmarking tool to provide airport management with a means to examine various aspects of their operational efficiency against those of other airports. Ten operational efficiency factors for the clustering and efficiency estimation of airports in the Asia Pacific region were used in a regression model to overcome the complexity of multi-dimensional scaling approach. The resulting classification is used to identify the efficiency benchmarks of leading air cargo airports which have implications for Incheon airport in Korea.

Key Words : Asian Pacific Cargo Airports, Operational Efficiency Index, Multidimensional Scaling Analysis, Benchmarking Practices, Regression Model

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I. Introduction

Recently, the business paradigm of air transport management has shifted from providing basic public service to commercial operation emphasizing on customer service. The concepts of commercialization and privatization in air transport management have appeared as the most remarkable issues, which forced airports worldwide to strategize their operation tactics to provide better service to their customers. Airports will therefore need to find a model of appropriate practices from different perspectives. Besides, benchmarking by constantly monitoring, comparing and assessing airports' operations has been developed as a tool for airport managers to adapt and efficiently manage the changing market requirements, such as privatization, commercialization and furthermore, the formation of global alliances and de-regulation in the aviation industry.

The Air Transport Research Society (ATRS) first presented the Global Airlines Benchmarking Report in 2001. In this report, the measurement metrics of the operational performance which consider different characteristics of airports and their management strategies were used to provide an accurate interpretation of significant results. The Global Airlines Benchmarking Report presented by ATRS in 2003 differentiated the size and ownership of 90 main international airports in South America, Europe and Asia and evaluated their operational performance by various productivity indicators such as unit cost, cost competitive factors, and other financial factors (Oum and Yu, 2004).

Further from the study of Oum and Yu (2004), there are several objectives that this paper aims to achieve. Firstly, we propose a meaningful comparison of airport operational efficiency. Secondly, the relationships between the efficiency measures and airport characteristics as well as operational strategies in order to better understand the observed differences in airport clustering will be investigated. Next, how different airport group management strategies and how air cargo handling facilities impact on airport group evaluation will be examined. Finally, this paper aims to group the studied airports in terms of their cargo operations efficiency using the Multi-dimensional Scaling analysis. Based on this, leading air cargo airports in the Asia Pacific region can be benchmarked by analyzing and comparing their cargo operational efficiency performance, of which the results can help to determine the direction for

Airport in the Asia Pacific region in the future. Particularly, one of the purposes of this study is to present a suggestion for Incheon Airport to be a primary freight hub for the Asia Pacific region by analyzing and comparing the cargo operational efficiency performance. The remainder of this paper is organized as follows. Firstly, the literature review including a description of best practice benchmarking of airport performance and methods used to collect and analyze data are presented in section 2. Section 3 elaborates on airport clustering using the Multi-dimensional Scaling method. Section 4 discusses the results from data analysis, while Section 5 presents the conclusion on current airport benchmarking practices as revealed by this paper.

II. Literature Review

It is of paramount importance for airports to know the best practices among various airports' operations within the aviation industry so that they can provide the best possible services in the most efficient manner to their customers. This also helps to highlight how their performance is compared to the best industry practices so that corrective actions can be implemented accordingly.

Although the topic of measuring and comparing the performance of airports has been studied by many researchers, it is a difficulty in comparing the output data of the link between air-cargo operations and the associated facilities. To overcome this difficulty, the operational efficiency concept using various operational efficiency indicators was introduced and used by various researchers. Generally, measuring the airport's operational efficiency is conducted using the financial index measurement and was based on the Work Load Unit (WLU) which was defined for the aircraft and freight. The most typical measurement indicators for air-cargo business include the total cost per WLU, operating cost per WLU, labor cost per WUL, total revenue per WLU and aeronautical revenue per WLU (Doganis, 1978, 1983, 1992; Doganis and Graham, 1987; Graham, 1999). Graham (2001) applied the measurement indicators of labor cost per WUL, cost per WUL, non-aeronautical revenue per WLU, and revenue per employee to compare the operational performance of European major airports. These measurement indicators play a significantly important role as a starting point in determining the operational performance of airports.

The UK Civil Aviation Authority (CAA, 2000) suggested that airports should continuously benchmark their service and cost factors in order to improve their performance and attract customers and freights to their airports. Apart from those measurement indicators, there are others indicators which have been used to measure other activities associated with the airport such as the benchmarking of retail activity performance in airports. In this connection, the Global Airport Retail Activity Research conducted in 1998 and 2001 had applied the gross retail sales, retail yield and gross retail sales per square meter as a measurement indicator for 31 different airports (Cerovic, 1998; Favotto, 2001). Meanwhile, in terms of methodology, the research on airport benchmarking and measurement of airports performance has used various techniques such as Data Envelopment Analysis (DEA), Malmquist index, Variable Factor Productivities (VFP), Meta Frontier Model, Stochastic Frontier Model, and Endogenous-weight TFT method. Various studies have been conducted by applying a single or combination of the methods listed above. For instance, Yoshida and Fujimoto (2004) applied both Endogenous-weight TFT and DEA methods to evaluate the airport operational performance using input and output parameters. In this study, input attributes include airport facilities (runway, taxiway, cargo terminal and passenger terminal), labor service (passenger handling volume, cargo handling volume, loading and unloading of baggage/freight) and other input parameters such as outsourced service, consultant service. Output attributes consist of freight, aircraft and the movement of aircrafts.

Oum and Yu (2004) used the annual data during 2000-2001 in the Global Airport Benchmarking Report published by ATRS to compare several important operational factors. The factors which were taken into consideration are productivity and efficiency performance, unit cost competitiveness and financial data. Meanwhile, Assaf (2009) employed a meta frontier model to analyze and compare the technical efficiency of large and small scale airports in the United Kingdom. The interesting feature of this model is that it calculated the technical difference in evaluating the operating efficiency that led to the accuracy increase in comparing the efficiency between airports.

Lam et al. (2009) analyzed the operational efficiency performance of major airports in the Asia Pacific region. They used DEA model and combined the external macro-economic indicators with price factors. Meanwhile, based on the data collected from 1998 to 2006, Yang (2010) rated the efficiency performance of 12 different international airports in the Asia Pacific region using the DEA and Stochastic Frontier Analysis (SFA) methods. In addition, most previous studies related to the analysis of operational efficiency performance of major airports used the DEA method in general (Sarkis, 2000; Martin and Roman, 2001; Lin and Hong, 2006; Barros and Dieke, 2007; Fung et al., 2008; Barbot and Sochirca, 2008).

The above studies raise a concern whether it is possible to directly compare data, as airports have different factors such as different expenditure items and development environments (Graham, 2001; Humphreys and Francis, 2000a, b). Also, the International Civil Aviation Organization (ICAO 1991) argued that although benchmarking the performance of different airports is possible, the different features that individual airports have should also be compared (Cave and Gosling, 1999). Although the use of individual airport indicators to present and benchmark operational efficiency results has been conducted in previous studies, this paper employed the R-Square method which proves the reliability and validity by using multi-dimensional scaling to apply to cluster analysis. In addition, this paper looks into the similar features of the similar airports, differentiates them then benchmarks the higher tier airports in the competitive set. This method has some advantages against other methods since it takes into account the dissimilarity that previous studies have neglected. By so doing, this paper provides a differentiated approach compared to previous studies to analyze operational efficiency of airports.

III. Categorizing Airports through Multi-Dimensional Scaling

1. Overview and the Reason behind the Application of Multi-Dimensional Scaling

The Multi-Dimensional Scaling method is used when the unit of analysis is made out of more than one attribute and it is also called cognitive analysis. This method uses the statistical analyzing method of different related attributes of the unit of analysis by visualizing the complex relationships in a more-than-two-dimensional area. This method uses results from the overall evaluation to disassemble the complex relationships using multidimensional scaling. The purpose is to convert the collected data from similar units of analysis to be measured in the multi-dimensional scaling. In this research, multidimensional scaling method by the use of efficiency index factors of major cargo airports in the Asia-Pacific region was chosen to convert collected quantitative data into a measurement that can be used in the multidimensional area. Unlike the factor analysis or the cluster analysis method, this technique is the same as the discriminate function analysis or the cluster analysis. However, by using the R Square, the reliability and feasibility is measurable. Also, there is an advantage that the abbreviated results can be expressed visually in the multi-dimensional area to clearly analyze the unit of analysis.

2. Categorizing the Airports and Attributing Measurement Criteria

This research uses the data of cargo handling performance during the 2008-2009 period from the aeronautical information website[1)] and the annual report of each airport in the Asia Pacific region to rank 11 airports in this region. Based on previous studies in the literature, the linkage factors of revenue growth, facility costs, growth, facilities and frequency were derived accordingly.

Firstly, to derive the efficiency indicators of cargo airports, we separated Asia Pacific' s major international airports by the number of runways, gates, area of the cargo terminals, landing grounds, number of cargo aircraft operations, number of airline flights, and routed destination cities. Based on the studies of Oum and Yu (2004), Assaf (2009) and Yoshida (2004), this paper explores the operational efficiency factors of various cargo airports by using the number of international air cargo traffic/runways, international air cargo traffic/number of gates, international cargo traffic/area of cargo terminal. For measuring the efficiency of frequency, we applied the number of international cargo traffic/airline flights and international cargo traffic/routed destination

1) www.airportal.co.kr

cities. Also, to measure the operating profit rate and the annual growth of the international cargo traffic, the international cargo traffic/landing charge (US dollar) was applied accordingly.

3. Data Analysis

To derive 10 elements of airport efficiency, we referred to the studies of Gillen and Lall (1997;, 2001), Pels et al. (2001); Fernandes and Pacheco (2002); Martin-Cejas (2002); Pels et al (2003); Sarkis (2000); Yoshida (2004); Oum and Yu (2004) and Fung et al.,(2008) and added two more elements: number of serviced air cargo carriers, number of serviced cities to consider the criticality of airport network for air-cargo shipments.

Table 1-1 and 1-2 shows the analysis results of data collected from the websites of 11 airports in the Asia Pacific region during 2009-2010.

<Table 1-1> Statistical data for international air freight in Asia Pacific airports 1

Classification	HGK	PEK	PVG	ICN	SIN	TPE
Ratio of frequency of Air freighter (%)	13.4%	0.0%	13.9%	14.8%	5.8%	14.5%
Profit rate in 2009 (%)	37.9%	8.1%	26.2%	36.9%	28.4%	27.8%
Average annual increase of air cargo traffic (%)	-0.39%	25.72%	2.64%	1.70%	-2.84%	-5.53%
Air cargo traffic ÷landing charges(US dollar per tonnage)	1,130.4	204.5	599.4	657.9	512.3	453.5
Air cargo traffic ÷ number of airport runway	1,692,657	316,519	618,496	770,961	830,362	679,152
Air cargo traffic ÷number of gate	33,189	3,860	24,414	20,468	14,317	39,950
Air cargo traffic ÷Area of air Cargo terminal	19.91	1.88	5.01	10.10	7.55	21.91
Air cargo traffic ÷/number of serviced air cargo carrier	37,615	8,116	37,110	37,305	20,759	64,681
Air cargo traffic ÷number of serviced city	22,569	3,385	8,878	13,686	8,304	9,303
Air cargo traffic ÷the number of flight availability	12	1	6	12	7	10

Note: Hong Kong (HGK) ; Beijing (PEK); Shanghai (PVG); Incheon (ICN); Singapore (SIN); Taipei (TPE); Bangkok (BKK); Tokyo (NRT); Sydney (SYD); Osaka (KIX); Melbourne (MEL)

<Table 1-2> Statistical data for international air freight in Asia Pacific airport 2

Classification	BKK	NRT	SYD	KIX	MEL
Ratio of frequency of Air freighter (%)	3.7%	13.2%	2.3%	11.6%	0.0%
Profit rate in 2009 (%)	-10.8%	26.8%	55.9%	17.9%	25.9%
Average annual increase of air cargo traffic (%)	-1.63%	-5.18%	1.60%	-9.08%	0.25%
Air cargo traffic ÷landing charges(US dollar per tonnage)	571	312.4	127.4	81.5	79.9
Air cargo traffic ÷ number of airport runway	503,101	924,383	133,735	283,717	104,007
Air cargo traffic ÷number of gate	19,729	33,614	9,330	13,840	4,522
Air cargo traffic ÷Area of air Cargo terminal	9.09	8.93	1.11	1.87	1.09
Air cargo traffic ÷/number of serviced air cargo carrier	21,874	22,546	8,536	9,457	5,778
Air cargo traffic ÷number of serviced city	12,578	10,103	4,136	8,345	3,467
Air cargo traffic ÷the number of flight availability	4	10	1	5	1

Table 2 shows the standardized data value for the comparative analysis of collected input data. Because there is a big difference in the variance of data collected by the multi-dimensional scaling and the direction and units of attribute is different, the collected data could not be compared directly. Hence, we adopted a common method of standardization which is to subtract the variable mean from data and then dived by the standard deviation of the variable.

<Table 2> Standardized statistical data for international airports in the Asia Pacific region

Classification	HGK	PEK	PVG	ICN	SIN	TPE	BKK	NRT	SYD	KIX	MEL
Ratio of frequency of Air freighter (%)	79.11	8.25	81.09	84.86	33.08	83.62	21.84	78.27	15.65	69.79	8.25
Profit rate in 2009 (%)	76.69	15.32	51.49	74.78	56.59	55.22	1.65	52.86	96.26	32.66	50.84
Average annual increase of air cargo traffic (%)	45.39	99.72	58.66	54.56	34.94	24.72	40.02	25.95	54.15	14.10	48.19
Air cargo traffic ÷landing charges(US dollar per tonnage)	98.51	26.25	71.32	77.04	61.73	54.77	68.31	27.18	19.22	13.61	12.30

Air cargo traffic ÷ number of airport runway	99.11	24.82	49.57	62.82	67.68	54.92	39.49	74.77	13.89	22.58	12.48
Air cargo traffic ÷number of gate	86.70	9.43	65.03	52.37	32.65	95.27	49.94	87.44	19.43	31.25	10.38
Air cargo traffic ÷Area of air Cargo terminal	95.00	19.68	33.75	61.22	47.28	97.26	55.75	54.90	16.84	19.63	16.79
Air cargo traffic ÷ number of serviced air cargo carrier	76.05	17.54	75.17	75.51	40.92	98.66	43.34	44.82	18.15	19.54	14.39
Air cargo traffic ÷number of serviced city	99.10	13.28	45.34	77.49	41.25	48.41	71.02	54.19	16.42	41.54	13.60
Air cargo traffic ÷the number of flight availability	91.43	11.11	52.16	90.53	55.45	80.82	28.25	79.19	11.53	38.75	10.13

Further from above analyses, the airports in the Asia Pacific region were also grouped according to the efficiency of their air cargo operations using the Multidimensional Scaling analysis of SPSS (version 18.0) program. This would help to determine the direction where Incheon Airport in Korea should head in the future with the consideration of the position of Asia Pacific' s major air-cargo airports. Typically, to determine the appropriate number of dimensions in the analysis, we used the proximity data in two ways. To find out how long the distance should apply between the similar targets in the mapped multidimensional accumulation, we used the appropriate scaling within the dimension for the s-stress. If the s-stress value cannot be measured, the interpretability plays an important part in deciding the number of dimensions. The more dimensions, the better the statistical fit, but the more difficult it is to interpret the results. Therefore, Table 3 shows that when the area is one dimension level, S-stress is 0.15423 and as it evolves to two and three dimensions, the value decreases to 0.02082 and 0.00199 respectively. This made us determine that the two dimensional analysis is the most appropriate measurement for this study.

<Table 3> Deciding the number of dimension by S-stress value

Number of dimensions	S-stress(Kruskal)	Improvement
1	0.15423	
2	0.13342	0.02082
3	0.13143	0.00199

Table 4 Summaries the data using the multi-dimensional scaling. Data structure represented the spinning asymmetry matrix which consists of 10 rows and 11 columns. Ratio scale is used to determine data measurement level.

<Table 4> Data choice option

Number of Rows	10	**Measurement level**	Ratio
Number of Columns	11	**Data Metrics Shape**	Symmetric
Number of Metrics	1	**Conditionality**	Matrix

In this paper, the relation of the final stress level is 0.12817 for credibility and validation, and the R-Square value which shows the suitability appeared in the high level of 0.95325. These results are summarized in Table 5.

<Table 5> Verified validity

Maximum Iterations	30	**Convergence Criterion**	0.0010
Minimum S-stress	0.005	**R-Square**	0.95325
Stress value	0.12817	**Iteration number**	2

IV. Analysis

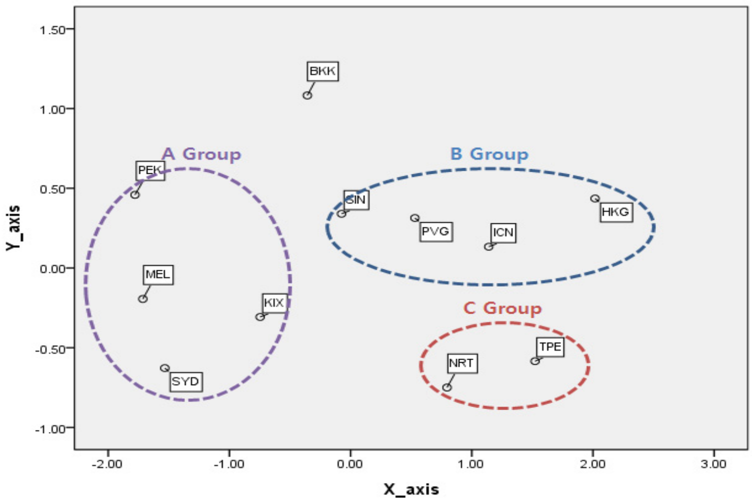
1. Results of the Classification of Airports by Similarity Groups

The operational performance results of 11 airports in the Asia Pacific region using the Euclidean distance matrix are shown in Table 6. Using two-dimensional analysis as a base, the three groups of airports possessing similarities are categorized accordingly as shown in Figure 1. Considering the distribution and attributes of operational efficiency in individual cargo airports, the X-axis can be assumed to mean the efficiency of air-cargo handling and the Y-axis can be assumed to mean the transport frequency in each airport, as reflected in Figure 1. The three groups are categorized according to similar characteristics. Group A includes Beijing, Melbourne, Kansai and Sydney; group B consists of Changi, Pudong, Incheon and Hong Kong, and group C contains Narita, and Taipei. Bangkok airport was not categorized in any of these groups since it has a characteristic of an independent airport.

<Table 6> Two-dimensional position of airports in the Asia Pacific region

Stimulus NUMBER	Stimulus (AIRPORT) NAME	1-dimension	2-dimension
1	HKG	2.0173	0.4358
2	PEK	-1.7795	0.4587
3	PVG	0.5303	0.3136
4	ICN	1.1397	0.1333
5	SIN	-0.0742	0.34
6	TPE	1.522	-0.5845
7	BKK	-0.3568	1.0819
8	NRT	0.7955	-0.7496
9	SYD	-1.5332	-0.6278
10	KIX	-0.7464	-0.307
11	MEL	-1.7146	-0.1944

<Figure 1> Location of airports in the two-dimensional analysis

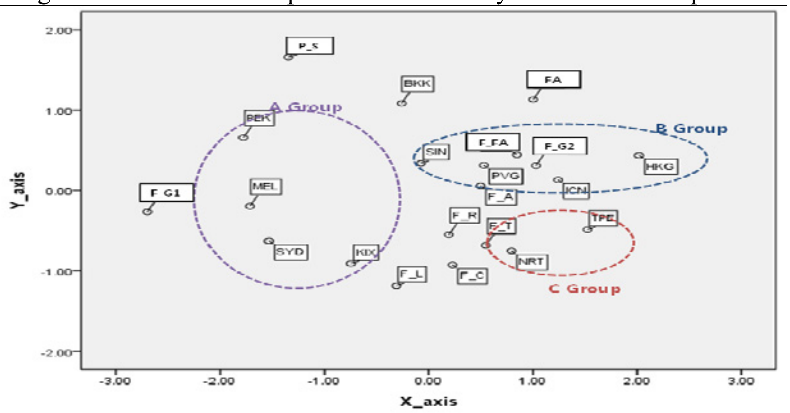


2. Analysis of Efficiency Indicators of Individual Airports

It is futile to present a significant result just by grouping similar airports using the multi-dimensional scaling analysis. Therefore, this paper also compares the difference of variance between individual airports by using the Euclidean distance matrix to measure the similarity. The efficiency indicators which similar airports have were simultaneously mapped in the two-dimensional area using the multi-dimensional scaling analysis. As a result, Figure 2 visually shows the relationship between 11 individual airports and 10 efficiency indicators in the two-dimensional area. Figure 2 demonstrates the relationship between the operational tendency of each airport and the efficiency indicators. When each airport is rather close to each efficiency indicators, the operation of each airport tends to the efficiency indicator which is more close approach.

For example, Incheon international airport has a relatively high relationship with efficiency indicators such as international air cargo traffic/number of gates, international air cargo traffic/the number of flight availability, international air cargo traffic/serviced air cargo carrier, but shows a low relation with ratios such as ratio of frequency of air freighter (%), international cargo traffic/number of runways, international cargo traffic/number of serviced city, international cargo traffic/ area of air cargo terminal using the data of 2009.

<Figure 2> The relationship between efficiency indicator and airports



Note : FA (Ratio of frequency of Air freighter), P_S (Profit rate in 2009) , F_G1(average annual air cargo increase), F_L(international air cargo traffic/landing charges), F_R(international air cargo traffic /number of runway), F_G2(international air cargo traffic/number of gate), F_T(international air cargo traffic/cargo terminal area), F_A(international air cargo traffic /number of serviced air cargo carrier), F_C(international air cargo traffic/serviced city), F_FA(international air cargo traffic/the number of flight availability)

Furthermore, in this paper, we also used the multidimensional scaling analysis to position an objective attribute vector in the two-dimensional area. With this method, the individual airport' s coordinated data could be derived. Assigning the coordinated data of each individual airport as independent variables and data collected corresponding to specific attributes of airports as dependent variables, feature vectors could be established by the measure of regression coefficients. The results from the regression analysis become the axis of independent variables and cosine of the feature vectors. In the two-dimensional map, the independent variable X' s standardized regression or x-axis becomes the cosine value and the independent variable Y' s standardized regression or y-axis becomes the cosine value. Using these two values, the direction of what was used as the dependent variable can be derived. By using the attribute vectors in the perpendicular projection, the attribute level of individual airports can be derived. For example, Figure 3 shows the profit rate in 2009 of individual airports. It can be seen from this figure that that the level of profit rate in 2009 was the highest in Taipei (TPE), followed by Narita (NRT), Hong Kong (HKG), Incheon (ICN), Kansai (KIX) and Sydney (SYD).

<Figure 3> Attribute vector of Profit rate in 2009 in individual airports

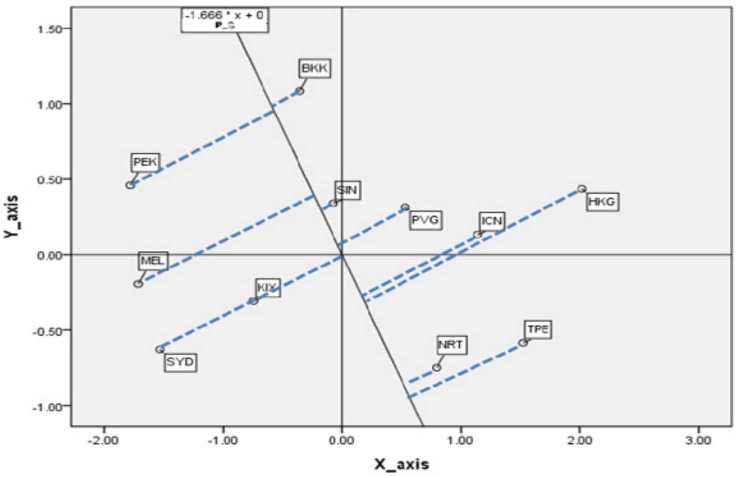


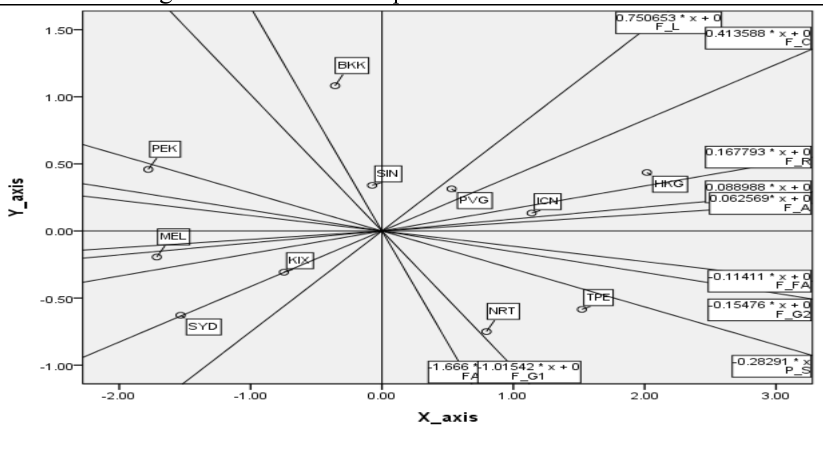
Table 7 shows the R- square value as a regression result in Figure 3 to verify the property vector. It can be seen from this table that the R-square value for all indexes fits well with the exception of the profit rate in 2009 and average annual increase of air cargo traffic.

<Table 7> Regression result for standard coefficient

Efficiency index	Standardization Coefficient		slop	R square
	Dimension1	Dimension2		
Ratio of frequency of Air freighter (%)	0.312	-0.52	-1.66667	0.81
Profit rate in 2009 (%)	0.866	-0.245	-0.28291	0.367
Average annual increase of air cargo traffic (%)	-0.389	0.395	-1.01542	0.306
Air cargo traffic ÷landing charges(US dollar per tonnage)	0.766	0.575	0.750653	0.919
Air cargo traffic ÷ number of airport runway	0.888	0.149	0.167793	0.811
Air cargo traffic ÷number of gate	0.924	-0.143	-0.15476	0.874
Air cargo traffic ÷Area of air Cargo terminal	0.899	0.08	0.088988	0.815
Air cargo traffic ÷/number of serviced air cargo carrier	0.911	0.057	0.062569	0.834
Air cargo traffic ÷number of serviced city	0.839	0.347	0.413588	0.833
Air cargo traffic ÷the number of flight availability	0.964	-0.11	-0.11411	0.94

Furthermore, Figure 4 shows the indication of coordination values as independent variable of the attribute level to be the dependent variable by standardizing through x and y axes through multiple regression analysis. The attribute vector shows it passes through the center point. From the project perpendicularly of the attribute vectors, we are able to determine competitive airports. Once a straight line is marked in a perpendicular point of the attribute vector of individual airports, the attribute value of the airport is higher when the line is close to what the vector is directing.

<Figure 4> Individual airports and attribute vectors level



We ranked each airport based on the vectors level of operational efficiency factors in Table 8. First of all, the 2009 data of the ratio of frequency of air freighter (%), profit rate in 2009, average annual growth of air cargo traffic (%) show the highest level in Taipei (TPE), Narita

(NRT), Hong Kong (HKG), and Incheon (ICN). Other efficiency indicators show the highest in Hong Kong (HKG), Taipei (TPE) and Incheon (ICN). Therefore, it can be seen that the operational efficiency performance of Incheon airport is low compared to that of Hong Kong and Taipei airports.

<Table 8> Comparison of efficiency index of individual airport

Efficiency factors	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th
Ratio of frequency of Air freighter(%)	TPE	NRT	HKG	ICN	SYD	KIX	PVG	SIN	MEL	PEK	BKK
Profit rate in 2009 (%)	TPE	HKG	NRT	ICN	PVG	SIN	KIX	BKK	SYD	MEL	PEK
Average annual growth of air cargo traffic (%)	TPE	NRT	HKG	ICN	PVG	KIX	SYD	SIN	MEL	BKK	PEK
Air cargo traffic ÷landing charges(US dollar per tonnage)	HKG	ICN	PVG	BKK	TPE	SIN	NRT	KIX	PEK	MEL	SYD
Air cargo traffic ÷ number of airport runway	HKG	TPE	ICN	NRT	PVG	SIN	BKK	KIX	PEK	SYD	MEL
Air cargo traffic ÷number of gate	HKG	TPE	ICN	NRT	PVG	SIN	KIX	BKK	SYD	MEL	PEK
Air cargo traffic ÷Area of air Cargo terminal	HKG	TPE	ICN	NRT	PVG	SIN	BKK	KIX	SYD	PEK	MEL
Air cargo traffic ÷/number of serviced air cargo carrier	HKG	TPE	ICN	NRT	PVG	SIN	BKK	KIX	SYD	MEL	PEK
Air cargo traffic ÷number of serviced city	HKG	ICN	TPE	PVG	NRT	BKK	SIN	KIX	PEK	MEL	SYD
Air cargo traffic ÷the number of flight availability	HKG	TPE	ICN	NRT	PVG	SIN	BKK	KIX	SYD	MEL	PEK

3. Characteristics of the Grouped Similar Airports

The characteristics of the three different grouped airports were compared using the efficiency indicators such as growth, cost, efficiency of facility, frequency and efficiency of linkage. The results are presented in Tables 9 and 10. Group A shows high revenue and efficiency in frequency, but the efficiency performance of cargo operations is relatively low. This may be because of the saturation of the ability of cargo handling. In terms of growth and profitability, the competitiveness is relatively low so it is classified as the group that has a low cargo efficiency performance. Also, this group has a competitive disadvantage in terms of location and competitive freights.

Linkage, revenue, growth and cost-efficiency were low for Incheon Airport which is included in Group B. However, the overall efficiency in cargo operation performance of this airport had been rated high. Furthermore, in the future, there is a high possibility that Incheon Airport remains as the Asia Pacific' s hub for cargo airports based on cargo growth and high earnings. The growth level of Hong Kong Cargo Airport especially shows that it should be the benchmarked airport amongst all when comparing the cost, facilities, and efficiency in the linkage to its competing airports.

Group C shows stagnancy in revenue and growth; however, it is very steady in terms of the linkage of international freight, cost, facility and efficiency of frequency. Nevertheless, the relatively low profit and slow growth show that the operational efficiency of the cargo airports in this group will be instable. However, because it shows high efficiency performance when comparing to Taipei Airport (TPE) and Narita Airport, it is necessary to review the current freight related trends.

<Table 9> Mean Data of the Categorized Airport Groups

Attribute	Efficiency factors	A Group	B Group	C Group	BKK
		PEK, MEL, SYD, KIX	PVG, ICN, SIN, HKG	TPE, NRT	
Benefit	Profit rate in 2009 (%)	54.04	48.39	25.33	40.02
Growth	average annual air freight increase (05~09)	17.85	77.15	40.97	68.31
Cost	Air cargo traffic ÷landing charges	18.44	69.80	64.84	39.49
Facility	Air cargo traffic ÷ number of airport runway	17.62	59.19	91.35	49.94
	Air cargo traffic ÷number of gate	18.24	59.31	76.08	55.75
	Air cargo traffic ÷Area of air Cargo terminal	17.41	66.91	71.74	43.34
	average	17.76	61.80	79.72	49.68
Linkage	Air cargo traffic ÷/number of serviced air cargo carrier	21.21	65.80	51.30	71.02
	Air cargo traffic ÷number of serviced city	17.88	72.39	80.01	28.25
	average	19.54	69.09	65.65	49.64
Frequency	Air cargo traffic ÷the number of flight availability	60.58	35.85	50.03	73.53
	The number of flight availability ,2009 (%)	48.77	64.89	54.04	1.65
	average	54.67	50.37	52.04	37.59

<Table 10> Ranking of the Categorized Airport Groups

Attribute	Efficiency factors	A Group	B Group	C Group	BKK
		PEK, MEL, SYD, KIX	PVG, ICN, SIN, HKG	TPE, NRT	
Benefit	Profit rate in 2009 (%)	1.00	2.00	4.00	3.00
Growth	average annual air freight increase (05~09)	4.00	1.00	3.00	2.00
Cost	Air cargo traffic ÷landing charges	4.00	1.00	2.00	3.00
Facility	Air cargo traffic ÷ number of airport runway	4.00	2.00	1.00	3.00
	Air cargo traffic ÷number of gate	4.00	2.00	1.00	3.00
	Air cargo traffic ÷Area of air Cargo terminal	4.00	2.00	1.00	3.00
	average	4.00	2.00	1.00	3.00
Linkage	Air cargo traffic ÷/number of serviced air cargo carrier	4.00	2.00	3.00	1.00
	Air cargo traffic ÷number of serviced city	4.00	2.00	1.00	3.00
	average	4.00	1.00	2.00	3.00
Frequency	Air cargo traffic ÷the number of flight availability	2.00	4.00	3.00	1.00
	The number of flight availability, 2009 (%)	3.00	1.00	2.00	4.00
	Average	1.00	3.00	2.00	

4. Suggestions

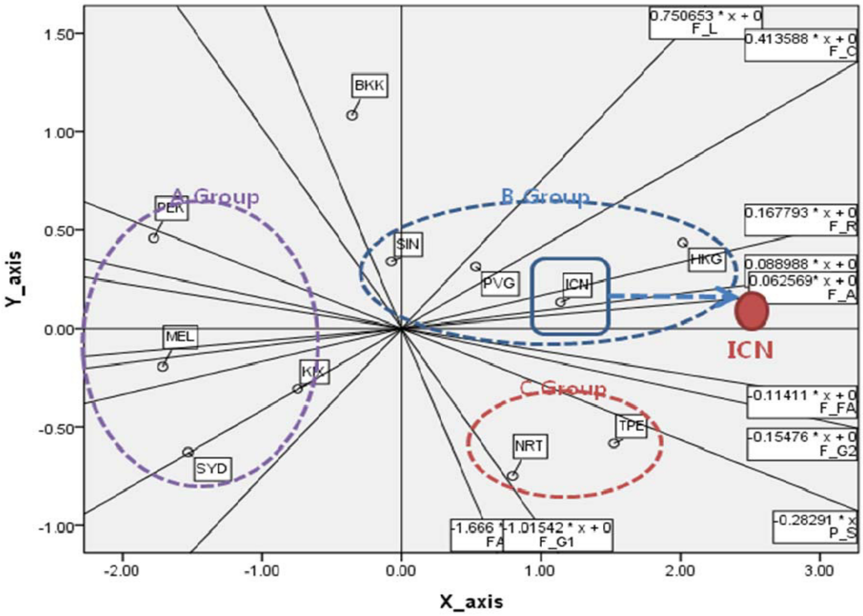
Based on previous studies and the multi-dimensional scaling analysis that used the input data for efficiency indicators of freights using expert surveys, the attribute vectors and similar grouped airports within the positioning map were reviewed. As shown in Figure 4, for Incheon Airport to become an Asia Pacific’s main freight hub, it needs to be in the similar position as to Hong Kong Airport. Incheon airport may need to monitor the cargo-related indicators, policies and plans similar to those in Hong Kong airport, which are explained as follows.

Firstly, Hong Kong Airport’s profit and growth are similar to those of Incheon Airport, however its cost management, facilities, linkage and efficiency of frequency are much better. Secondly, comparing the important data and processing performance of the air cargo, cargo handling in 2011 of Incheon airport decreases by 2.54 million tons. From 2001 to 2011, the average annual growth rate of cargo handling was 6%. The handling of transshipment processed 1.158 million tons which experienced a decrease of 1.5% in comparing to the previous year, 45.6%. Meanwhile, Hong Kong airport handled 2.94 million tons in 2011, an increase of 6.6%, and the total number of air freighters was 510,000, an increase of 10% annually. As seen in Table 12, the linkages of Hong Kong international airport are over 100, linking 160 cities and 40 different cities in China which shows its advantage and predominance in frequency of flights and landing points. However, in terms of facilities, such as runway, number of gates, the area of the cargo terminal, Incheon airport is more advantageous.

<Table 11> The comparative analysis of freight operation efficiency between Hong Kong and Incheon Airports

Main Fact for freight		**HKG**	**ICN**	**Comparison**
number of flight availability, 2009		288,169	200,692	HKG higher than ICN
number of cargo flight availability		38,688	29,641	HKG higher than ICN
International cargo handling(TON), 2009		3,349,693	2,267,551	HKG higher than ICN
Post cargo handling (TON), 2009		35,620	45,332	ICN higher than HKG
The number of serviced air cargo carrier		100	68	HKG higher than ICN
The number of serviced cities		160(40)	162 (32)	Alike
Landing charge (B-747, 395ton, US dollar)		2,295	3,515	HKG higher than ICN
The number of runway		2	3	ICN higher than HKG
The number of gate		102	113	ICN higher than HKG
Cargo terminal area (㎡)		170,000	229,000	ICN higher than HKG
Factors	**Efficiency Attributes**	**HKG**	**ICN**	**Comparison**
Benefit	Profit rate in 2009 (%)	37.9%	36.9%	Alike
Growth	average annual air freight increase (2005~2009)	-0.39%	1.70%	ICN higher than HKG
Cost	cargo/landing charge (US dollar per ton)	1,130.4	657.9	HKG higher than ICN
Facility	cargo/runway	1,692,657	770,961	HKG higher than ICN
	cargo/gate	33,189	20,468	HKG higher than ICN
	cargo/terminal area	19.91	10.10	HKG higher than ICN
Connectivity	cargo/serviced air cargo carrier	37,615	37,305	Alike
	cargo/serviced cities	22,569	13,686	HKG higher than ICN
Frequency	cargo/the number of flight availability	11.75	11.52	Alike
	Ratio of frequency of Air freighter (%)	13.4%	14.8%	ICN higher than HKG

<Figure 5> Direction in which Incheon Airport should go to in terms of freight operations efficiency



Thirdly, a software development strategy to enhance the operational efficiency of air cargo should be noticed. Currently, Hong Kong International airport operates the Asia Airfreight Terminal (AAT), Hong Kong Air Cargo Terminal (Hactl), DHL Central Asia Hub, Air Mail Centre, Airport Freight Forwarding Centre, Marine Cargo Terminal (MCT), Trade port Logistics Centre and has built a new cargo terminal. Hong Kong Airport is promoting growth in the area of air-cargo, and to manage the integrated cargo terminals, they have established the Cargo Facilitation Committee which includes Hong Kong Customs Service, AAT, Hactl, DHL, CPSL (Cathay Pacific Services Limited), Carrier Liason Group, Hong Kong Forwarder and Logistics Association. Other than integrating the air cargo systems, they also hold regular meetings every quarter to review the freight operations efficiency and manage the strategy indicators to meet the targets. Additionally, introducing Free Port, Regulated Agent Regime (RAR) enhances security, simplifies the clearance system, and applies international law, finance, banking, insurance for progression and competitiveness of the freight operation efficiency.

Normally, multi-dimensional scaling can simple classify, it is difficult to explain for definition of each dimension and limited for successful result. To overcome this problem, this paper applied regression modeling for the result of multi-dimensional scaling. The result of regression model provides standard regression value and guided the direction of attribute vector of operational efficiency. Based on the attribute vector, the operation tendency of each airport and competitive relationship among airports could be examined, and it also provides clear definition of each dimension. In additions, guided attribute vector directions have shown to be improved for the operation of Incheon airport in the long term planning, and this supports to establish air cargo logistic strategy for this airport.

V. Conclusion

This paper presents the measurement and comparison of air-cargo operational efficiency of major airports in the Asia Pacific region. It also examines the effect of airport facility, labor service and outsourcing service on airport’ s operations. The measured efficiency indicators are affected by many factors, some of which are criterion for the clustering of airports into three groups. Group A showed high profit and frequency of efficiency, but the freight operational efficiency was relatively low. Group B showed high linkage, profit, growth and cost efficiency and facility efficiency, however low frequency efficiency. Hong Kong international airport comes under group B which showed high growth of international freight handling as well as cost, facilities and linkage efficiency compared to other airports, and this benchmarks itself as the leading airport. We chose two air ports(Hong Kong airport and Incheon international airport) as a fine example in group B to compare the efficiency.

Even though the profit and growth efficiency are similar between these two airports, the cost, facility, linkage and frequency efficiency are higher for Hong Kong international airport. Specifically, Hong Kong has more than 100 linkages to 160 cities as well as 40 cities within China which make it more advantageous. Besides, the frequency of flights, landing and processing performance of Hong Kong airport are also better than those of Incheon airport. However, in terms of the number of runways, gates, area of the freight terminal, and facilities, Incheon airport shows better results. This comparison summary shows that although Incheon Airport possesses competitive facilities, it is disadvantageous in terms of operational efficiency compared to Hong Kong Airport. Furthermore, Hong Kong airport operates five logistical airport terminals now. In addition, their new cargo terminal would be the most important aviation center for Mainland China, providing efficient and reliable air cargo services with the highest standards of safety and security.

Group C showed a stagnant growth, but also a steadiness in international freight handling linkage, facility and frequency efficiency. In this group, Taipei Airport showed high efficiency compared to Narita. Hence, Narita international airport could review their operational efficiency using Taipei Airport' s data as a reference.

Therefore, it can be concluded that the performance improvement of air cargo facilities can create competitive advantage. It can also offer potential to improve the efficiency of airport operations across the range of challenges on cargo terminal handling issues.*

Appendix A

<Table 13> List of sample airports

Airport Code		Airport name	city
1	HGK	Hong Kong Chek Lap Kok International Airport	Hong Kong, China
2	PEK	Beijing Capital International Airport	Beijing, China
3	ICN	Incheon International Airport	Incheon, SouthKorea
4	SIN	Changi International Airport	Singapore, Singapore
5	TPE	Taiwan Taoyuan International Airport	Taoyuan,Taiwan
6	BKK	Bangkok International Suvarnabhumi Airport	Bangkok, Thailand
7	NRT	Narita Airport	Tokyo, Japan
8	SYD	Sydney Kingsford smith Airport	Sydney, Australia
9	KIX	Kansai Internation Airport	Osaka,Japan
10	MEL	Melbourne Airport	Melbourne, Austrailia

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