BENCHMARKING COMPETITIVENESS

OF CARGO AIRPORTS

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SUMMARY

To understand the dynamics of the competition among airports and to stay ahead, the airport management needs to monitor and improve performance by referencing to and learning from other organizations. This has emerged as an even more prominent issue for Asian airports, which enjoy high growth as well as face the challenges coupled with the opportunities. This study is conducted to formulate a systematic approach for comprehensive airport benchmarking and to provide insights to the airport management for performance improvements. This study is focused on air cargo and Asian airports to contribute to these two less researched areas.

Firstly, a benchmarking framework is constructed for comparing the competitiveness of cargo airports against each other. A set of factors that are considered influential to an airport's competitiveness was identified, and then they were structured into a hierarchy of 7 core factor groups and an algorithm is formulated to compute the competitiveness index for the airports under comparison. The framework thus developed can be applied to airports in different geographical locations and during different time periods.

Next, the framework is put into practice by benchmarking the top 10 Asian cargo airports. Scores for each core factor group were computed and rankings of each core factor as well as overall competitiveness were derived. The benchmarking results depict a clear picture of the competitive landscape and provide rich information on the underlying details of each airport's competitiveness. The competitiveness index is tested against the conventional airport measures, such as traffic and financial performance. The relatively high correlation shows our framework is able to reveal the general perspectives on the competitiveness of airports while offering more insights into the factors that influence the performance.

An in-depth analysis is conducted to distill best practice and implications for performance improvement from the platform built upon the framework and benchmarking results. An innovative competitiveness matrix helps airports benchmark against the role models that operate in similar environment. Since the experiences in improving airport performance are more relevant, the chances of successful best-practice learning are higher.

Key words: Air cargo, airport management, benchmarking, competitiveness, Asian airports, cargo hub

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LIST OF ABBREVIATIONS

AAT	Asia Airfreight Terminal
ACE	Air Cargo Excellence survey
ACI	Airports Council International
ACCESS	Advance Clearance for Courier and Express Shipments System
ACCS	Air Cargo Clearance System
ACES	Air Cargo EDI System
AFSCA	Asian Freight and Supply Chain Awards
ASRS	Automated Storage/Retrieval System
ATRS	Air Transportation Research Society
CAAS	Civil Aviation Authority of Singapore
CIAS	Changi International Airport Service
DEA	Data Envelopment Analysis
EDI	Electronic Data Interchange
EPIC	Electronic Payment and Invoicing for Cargo
FTZ	Free Trade Zone
HACTL	Hong Kong Airport Cargo Terminals Limited
HKIA	Hong Kong International Airport
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IIA	Incheon International Airport
IT	Information Technology

KLIA	Kuala Lumpur International Airport
KOTI	The Korean Transport Institute
MSC	Multimedia Super Corridor
OLS / COLS	Ordinary / Corrected Ordinary Least Squares
O-D	Origin – Destination
PRD	Pearl River Delta
RFID	Radio Frequency Identification
SATS	Singapore Airport Terminal Services
SFA	Stochastic Frontier Analysis
TFP	Total Factor Productivity
TLI-AP	The Logistics Institute – Asia Pacific
ULD	Unit Load Device

CHAPTER 1: INTRODUCTION

The process of benchmarking has been used by private sectors for a long period of time, but its spread to the airport industry is rather recent. However, the airport industry is changing rapidly due to the combined influence from air transportation deregulation, airport privatization and commercialization, airline alliance formation and strengthening. All these influences have changed industry dynamics and brought airports into more direct competitions and forced them to think like a business instead of mere infrastructure providers as traditionally were done. To understand the dynamics in the competition and stay ahead, the airport management needs to monitor and improve performance by referencing to and learning from other organizations. Within the airport industry, cargo business is increasingly becoming the focal point since global manufacturing has driven up a large demand to transport goods faster and more safely. Among the regions around the world, Asia particular bears high expectation as the largest offshore manufacturer which generates vibrant economic activities. However, despite such attention on Asian airports, they do not have the necessary tools to measure performance and compare with others in order to bring themselves to greater heights. This study is exactly targeted to address these deficiencies and to further the airport benchmarking research with two particular areas of focus, Asia and cargo.

1.1 Focus of the Study

Compared to other regions, the need for benchmarking is more pertinent to Asia, which attracted attention from all over the world but whose performance is yet to catch up with its fast growth. In 2003, Asia, particularly China, has achieved 8.5% and 10.6% growth rate respectively in air cargo, thus leading the world air cargo industry. Such high growth is expected to sustain in the near term as investor and consumer confidence remains strong (Boeing, 2004). However, the promising opportunity may not guarantee success for every airport in the region. To take advantage of the high air cargo growth, Asia airports need to constantly improve all aspects of management, quickly respond to the fast changing market, and be aware of industry trends thus anticipating the emerging opportunities and challenges.

Asia will need to put in a lot of effort to catch up with its counterparts elsewhere around the world. A quick look at the airport evolution cycle reveals that Asian airports are still in a very early stage of development as compared to Europe and North America. U.S. officially deregulated air transportation in 1978. The European Union launched liberalization in the 1980s. Asia just started the process with many privatizations still waiting to be carried out. As such, Asian airports are yet to understand the new rules of the game, and learn the experience and lessons from American and European airports in order to become more matured players in the market. However, the good side of being in the early stage is that new market demands are more likely to shield Asian airports from stagnation and over supply

(BCG, 2004). There will be plenty of room for them to explore their own way of success and for most of the airports to blossom.

Cargo business has intricate differences from the passenger sector and is arguably more complicated. Historically, cargo has been a complimentary business for airlines and airports. Only the spare capacities are allocated to cargo usage, and thus cargo was by no means regarded as a main revenue source. However, with the astonishing growth in cargo traffic and increasing price pressure from the passenger sector, airlines and airports realize the significance of cargo business in their overall performance and have started to focus on cargo market opportunities. On average, cargo revenue represents 15% of total traffic revenue, with some airlines aiming to earn well over half of their revenue from this source (Boeing, 2004). More attention is now shifted towards cargo and the management desires to acquire systematic means for strategy and operations involving cargo. Such a need in the industry calls for a closer look at the cargo airport management in order to take advantage of the emerging opportunities, exploit cargo market and maximize the profitability involved.

For Asian airports, cargo business has an even more critical role. Among the top 30 airports in terms of passenger traffic, only 6 Asian airports managed to be on the list. However, when counting cargo traffic, Asia firmly took up 12 seats, with Hong Kong nearly bypassing Memphis to be the world’s No.1. The stake Asian airports have in the cargo business is high, and so are the rewards. They will enjoy more benefits if they focus on improving the cargo facility and services.

1.2 Objectives and Benefits

Noticing the fact that there is a lack of systematic approaches for comprehensive benchmarking of airports, this study first constructs a framework to compare the competitiveness of cargo airports[1] against each other. The framework developed will be generic to all cargo airports and thus can be used in geographical locations other than Asia, and for different time periods. Next, the framework is put into practice by benchmarking a number of selected Asian airports. The results will provide information on the airport ranking within Asia and the details of its competitiveness in all the areas being rated. The framework and benchmarking results build a platform for the last step, which is to distill best practice and implications for performance improvements.

The outcome of this study will benefit a number of parties involved in the air cargo industry. The most direct beneficiary will be the airports under examination. Under the increasingly fierce competition in the Asia-Pacific region, airports must constantly be aware of their performances compared to the best practice in the

[1] In this report, Cargo Airports refer to both types of airports 1) which are dedicated to cargo transportation only 2) which are for both passenger and cargo, however only the cargo sector is of interest to the context of this report.

region. They also need to understand the best practices over various dimensions in airport operations in order to craft strategies to enhance its competitiveness. This study will present an objective comparison and ranking of their performance using scientific approaches. One prominent advantage this study offers is embedded in the comprehensive framework which breaks down the performance into a set of core factors and sub-factors. Such an approach, as opposed to the common general ranking, gives critical information to perform detailed analysis on the current airport management and the foundation for suggesting improvement and policy implications.

Echoing the call for expansion into the lucrative Asian market and taking advantage of globalization, most air carriers as well as logistics companies are planning to locate air hubs or expand operations in Asia. The benchmarking results are useful for such airport service users in a double-fold way. For those who wish to move into Asia market, they need to choose the airport that provides the best services at the lowest cost, so as to satisfy the needs of their customers and ensure their own profitability. In order to capture the growing market and synchronize with the market trends, they also need to balance the current development status of the airport with its future growth. The results of air cargo benchmarking in this study will be very useful to assist them in the decision making. For those who already have some presence in Asia, the benchmarking results serve as a good evaluation of the airports they have operations in. Through such measures and analyses, airlines and logistics companies have a better understanding and realistic view of the airport performance and its competitiveness. Therefore, they can promptly adjust their corporate plan to capture the opportunities brought about by the airport development, as well as preempt the threats or disadvantages at their operating airports.

This study provides a very flexible and open answer to which airport is more competitive. On one hand, through rigorous computation and analysis, the scores for each sample airport are highly informative and can be off the shelf for executive decision making. On the other hand, it leaves much room for users to incorporate their specific interests and needs. Decision makers can take the semi-processed analysis results as the input to their own analysis and jumpstart in their company-specific study, instead of collecting raw data from scratch.

Liberalization of air transportation industry and commercialization of airports have made airport performance a focus for regulatory bodies and investors. Investors are interested to increase returns on investment and to identify emerging business opportunities (ATRS 2004, 2005). Government agencies are responsible for regulating the airport charges and ensuring the health of the industry as well as the social welfare at large. Aviation industry, different from other traditional industries, heavily relies on government regulation and monitoring. Governments have a large stake and high responsibility in the booming of its airports. Therefore it is to their interest to understand airports' current performance as compared to others in the region. Besides the efficiency evaluation, this study also provides in-depth analysis on the influences of managerial strategies, which could provide additional insight on how to bring airports to a higher competitive level.

1.3 Organization

This report will try to capture the thought process and analytical details of the study on cargo airports. It is organized in the following manner to present the factual findings along with the detailed discussions. Chapter 1 introduces the topic and answers why this particular topic is of interest and benefit to both academia and industry. It also briefly touches upon the outcome of the study. Chapter 2 reviews the past works, both on methodology and various issues in the subject area, with the purpose of informing readers of the state of the art and identifying the area where this study could contribute its findings and views. Chapter 3 draws a roadmap of this study that explains the steps we have conducted for data collection and analysis as well as the methodology used for various tasks. Chapter 4 depicts a comprehensive description of the airport competitive landscape in Asia. It traces the reasons for Asia’s high growth, its opportunities and challenges, and provides the background for the in-depth discussion in the later chapters. Chapter 5 focuses on the theoretical part of the benchmarking, in which the framework is described in detail. Various core factors and sub-factors are defined and its measurement, impact on airport competitiveness and interdependence with other influences are explained. After the list of factors, we demonstrate a scoring system which synthesizes the contribution from all factors and gives each sample a single score. Chapter 6 puts the sample Asian airports into the framework for evaluation and comparison. The input data and results are explained in detail. In Chapter 7, the implications from the benchmarking results are further discussed. A simple tool, the competitive matrix is introduced, which gives more insights in drafting strategies for airports to improve performance. Finally, the chapter concludes the thesis by highlighting the key points.

CHAPTER 2: LITERATURE REVIEW

Overall, air transportation is a fairly new industry in Asia and air cargo has an even shorter history. During the recent years, the industry observes a sharp increase in market demand and the extremely fast growth in air transportation, which attracted academic and research communities. However, very few studies have been dedicated to this area despite the increasing interest among the various parties. In this section, we will provide an overview of the significant past studies in the areas of airport and cargo research.

2.1 Challenges in Airport Study

A number of factors should be attributed to the lack of published study on Asian airports. The first and most prominent factor is the lack of relevant data. The majority of the airports collect only the general statistics on cargo traffic and facility, and often without any detailed break-down. Most of them do not have a formal system to measure its service quality and customer satisfaction. When it comes to financial figures, different airports follow very different accounting formats and fiscal year, which causes possible inconsistency in the data. Secondly, there is no widely recognized methodology or model for measuring airport's performance. Thirdly, the management scheme varies drastically across countries, and even for the same airport, the ownership may have gone through or is going through commercialization and corporatization. All these changes resulted in different business practices, making it difficult, if not impossible, to compare airports across different countries over a time period.

If airport comparison has been neglected for the above reasons, even less attention has been given to air cargo business because historically, air transport was dominated by passenger business and air freight was often considered as a by-product of passenger services (Kim and Ye, 2003). There is also a tendency to mention air cargo issues only at a superficial level in previous studies due to the complexity and the specific characteristics of cargo business.

2.2 Air Cargo

Despite all the difficulties mentioned above, a few researchers have pioneered the study on air cargo. This and the following section will provide a comprehensive review of their works.

From economic and strategic perspective, cargo liberalization is the center of most of the discussions. Zhang and Zhang (2002a) employed a multi-market oligopoly model to compare the impact of liberalization on all the cargo carriers and mixed passenger-cargo carriers. They concluded that unilateral cargo liberalization will harm mixed carriers of the home country if foreign carriers produce the two outputs separately. This finding suggested that separation of air cargo and passenger rights might be fraught with difficulty in Asia due to the dominance of mixed carriers and their heavy reliance on cargo revenue.

The same implication for the Asia market was emphasized in a general discussion of issues on liberalization of air cargo services in international aviation (Zhang and Zhang, 2002b). This paper also showed that all-cargo carriers may have different routing needs than passenger carriers and thus require different sets of air traffic rights from those needed by passenger carriers.

Kasilingam (1996) discussed in detail the complexity of developing and implementing air cargo revenue management. This paper highlights the fundamental difference between cargo revenue management and passenger yield management, along with their intricate relationship with passenger yield management. The study is specific to combination air carriers, which have both substantial passenger and cargo businesses and operate combi fleets. This is the dominant characteristic of Asian cargo market.

Due to historical differences in air transportation development and business environment, Asia has developed a unique air cargo system. The Logistics Institute – Asia Pacific (TLI – Asia Pacific) published a research paper, describing every element in the entire cargo business chain, and the technical aspects of each part. It also dedicates substantial sections to Singapore’s air cargo sector, providing a good background understanding on its industrial landscape (TLI-AP 2000).

2.3 Airport Benchmarking

Airport performance benchmarking is a more established research topic in North America and Europe. U.S. first started airport deregulation and over the last two decades, a great deal of efforts has been directed to measure the performance of airports. Gillen and Lall applied Data Envelopment Analysis (DEA) on a panel of 21 U.S. Airports over a five year period for efficiency measurements (Gillen and Lall, 1997). They improved upon the past performance measurements which were restricted to accounting terms, and constructed performance indices on the basis of multiple outputs produced by multiple inputs.

The analysis conducted by Sarkis on operational efficiency of major airports is focused on U.S. airports as well (Sarkis, 2000). But his study evaluated 44 airports and considered a more comprehensive variable set of inputs and outputs. Kamp et al. benchmarked German airports with DEA (Kamp et al. 2004). The relative efficiency of European airports was measured by Pels et al (Pels et al. 2001).

Instead of using direct objective data, Aldler and Berechman collected subjective data on airport quality defined from airlines' viewpoint (Aldler and Berechman, 2001). The model determines the relative efficiency and quality of airports, factors that have a strong effect on the airlines' choice of hubs. DEA is again chosen as the key methodology. This study covered 26 airports mainly in Western Europe, North America and a small part of Asia.

At a global scale, only Air Transportation Research Society (ATRS) has conducted such a wide range performance measurement. The third annual airport benchmarking report published in 2004 covers 102 airports, among which 27 are located in the Asia-Pacific region (ATRS 2004). Supported by its members including top industry and academic experts in all areas of aviation industry, this report can be regarded as the most comprehensive study in the field. Its framework and methodology for unbiased and consistent performance comparison is of great value to research.

Besides academia, airport and cargo industries are extremely interested in evaluating airports’ performance so as to promote good practice and improve the industry in general. Three of such performance evaluation campaigns have received wide recognition and authoritative reputation. This study referred to their evaluation criteria in constructing the benchmarking framework.

Building on the success of IATA's Global Airport Monitor, IATA and ACI jointly launched AETRA in December 2003. AETRA[2] is an airport customer satisfaction benchmarking program involving 66 airports worldwide. It is based on a self-completion questionnaire that covers all aspects of passengers' on-the-day

[2] AETRA is taken from Latin word “aethra” meaning the upper air, clear sky and is not an acronym (AETRA website).

airport experience and is distributed to passengers at the departure gate (AETRA).

In 2005, the Asian Freight and Supply Chain Awards (AFSCA) reached its 19th year and have been widely regarded as the most authoritative award for the industry in Asia (Cargo News Asia, 2005). AFSCA listed a set of criteria that captures the essence of cargo services and is of good reference for performance measurement.

For cargo terminal, the following criteria are considered:

- Clearly set performance standards and the clear communication of these standards to the shipper, logistics service provider or airline.
- Satisfactory and timely resolution of problems should the above standards not be met.
- Timely and adequate investment in new terminal infrastructure to meet future demand.
- Effective and easy-to- use IT systems.
- Minimum criteria Over 10,000 tonnes of cargo handled per annum.

For airport:

- Provision of suitable cargo-related infrastructure.
- Cost-competitive, cargo-friendly fee regime.
- Timely and adequate investment in new infrastructure to meet failure demand.
- Facilitation of air cargo ancillary services, including logistics and freight forwarding facilities, either on-airport or off-airport.

- Minimum criteria Over 10,000 tonnes of cargo handled per annum.

Another evaluation initiated by a trade magazine is Air Cargo Excellence (ACE) Award by Air Cargo World. Though relatively new, its concise and yet comprehensive evaluation criteria covered all aspects of cargo transportation. In March 2005, ACE presented the first global results. Airports are divided into subcategories based on how many tonnes they handle annually, and were rated by carriers, charter operators, integrators and forwarders. The criteria defined for airports in its survey are:

- Performance: Fulfills promises and contractual agreements, dependable, prompt and courteous customer service, allied services - ground handling, trucking, etc.
- Value: Competitive rates, rates commensurate with service level that the customers require, value-added programs.
- Facilities: Apron, warehousing, perishables center, access to highways and other transportation modes
- Regulatory Operations: Customs, security, FTZ

Air Cargo World collected responses from cargo transportation customers and compiled to an average ranking for each airport on each category.

2.4 Asia Airport Studies

Air transportation, especially the cargo business, is much younger in Asia and all the countries are still experimenting to establish a system that is suitable for their economic and political situation. Among all, Korea is one of the most proactive countries in driving the nation to excel in air transportation. The Korean Transport Institute (KOTI), the government think tank for transportation, initiated a series of focused studies on air cargo logistics development in Korea and Northeast Asia at large.

Kim and Ye carefully assessed the current state of air cargo industry and infrastructure in Korea in terms of its competitive strengths and weaknesses (Kim and Ye, 2003a). The study also examined institutional and operational obstacles that may hinder the development of air cargo transportation. Based on the extensive and comprehensive coverage of all players in the air cargo industry, the suggestion on policy implications for future development is well substantiated.

Kim and Ye also presented an analysis of the competitive strengths and weaknesses of air cargo industry in Korea as a whole. Their analysis includes not only airports, but also airlines, custom offices, shippers, forwarders, and various players in the air cargo business (Kim and Ye, 2003a).

In a separate study, they compared the development of Korea's air cargo industry with the other two Northeast Asian countries, Japan and China (Kim and Ye, 2003b). The comparison is based on empirical statistics, with no sophisticated analytical methodology being used. However, the conclusions are well-supported and convincing because the analysis covered a wide range of cargo aspects, including cargo volume, cargo terminal facilities, cargo terminal operating conditions, operators, and cargo customs. This study suggested co-operations in air cargo field among the Northeast Asian countries and policy implications similar to the earlier study, for Korea to strengthen its competitiveness in air cargo industry.

KOTI strongly advocates making Incheon International Airport (IIA) the regional logistics hub in Northeast Asia. Soon after its opening in 2001, a bold plan to develop it into a ‘Winged City’ covering IIA and its vicinity was crafted. Using the regional cluster model, the strategies are aimed to incrementally develop Incheon into not only an air transportation hub, but also a total logistics hub and international business center (Lee and Yang, 2003).

Kwon and Park reiterated the ‘Winged City’ strategy in their presentation on Korea’s initiatives in airport development and air cargo logistics (Kwon and Park, 2004). The study emphasized that the success of being a regional air logistics hub depends on IIA’s capability of attracting a critical mass of global logistics service providers. Besides the physical facilities, spatial factors, demand factors, service factors and managerial factors are considered as a whole package in the development plan.

Concerned with monopoly power being possibly abused, the efficiency of the Delhi international airport, its efficiency was compared with other domestic airports in India under different management and ownership schemes (Mathur, 2004). The trends of air traffic in India were studied and a 10-year forecast was given on the air traffic. The paper also discussed various models of airport privatization and commented on the cost and benefit of each model.

The competition among airports in Southeast Asia was studied by Bowen (Bowen 2000). He examined the impact of international air transport accessibility over a period of close to three decades. He argued that the development of air transport networks has been shaped by national governments using airline liberalization and airport development.

Since the fast growth of China's cargo market, scholars have shifted some attention and resources to the study on air cargo of China, Hong Kong and Taiwan. In the case study of Hong Kong as an international air-cargo hub, Zhang constructed a conceptual framework that is useful for the discussion on international airfreight hub (Zhang, 2002). The air cargo pattern is examined in terms of local, gateway and hub effects. Using this framework, the discussion on cargo flow, competition, and supply and demand can all be incorporated systematically within the overall competitiveness analysis. In the study, he also compared Hong Kong with several domestic and international airports, with respect to each type of traffic: local traffic, gateway traffic with Pearl River Delta (PRD) airports, and hub traffic with Shanghai, Singapore and Taipei. This competitiveness analysis provides a valuable basis for the discussion on whether Hong Kong will lose its superior hub status in anticipation of fast development in the region.

The issues surrounding Taiwan's cargo development are centered at Taiwan's political instability and its relationship with mainland China (Zhang et al., 2004, Lin and Chen, 2003, Tsai and Su, 2002). Tsai and Su applied analytical hierarchy process to assess the political risks after undertaking a qualitative risk survey. The study concludes that both micro and macro factors are important to the development of an air hub in Taiwan, with cross-straits relationship, air logistics infrastructure developments to be particularly crucial (Tsai and Su, 2002).

The cross-straits trade has increased tremendously since 1990s when Taiwan enterprises injected large amount of investments to mainland China, particularly to the PRD region. However, the absence of direct links across the Taiwan Strait presents a great obstacle to further development on either side. The possible establishment of 'san tong' inspired a study to model optimal Taiwan-mainland air link. Lin and Chen used connectivity measurements and applied branch-and-bound algorithm to a related mathematical model. The a transit based network for direct air link across straits was constructed based on the computation results (Lin and Chen, 2003).

Due to the intricate structure and distance from international community, China's air cargo and aviation have rarely been considered in the research area. Hui et al. pioneered the study on China's air cargo flows (Hui et al., 2004). They went though a painstaking process to collect statistics on China's aviation and air cargo industry. The paper identifies the major air transport hubs in the six regions and examines the cargo movement between them. Having experienced the difficulties in comparing cargo data between mainland China and Hong Kong or other international air hubs, they pointed out several areas for data system improvement. Despite the data problems, they constructed a domestic route network and an international route network, which would contribute to a better understanding of China's cargo flow and implication on relationship between major airports.

Zhang et al. wrote 'Air Cargo in Mainland China and Hong Kong', a book exclusively on air cargo in mainland China and Hong Kong and it has been the only comprehensive publication on this topic (Zhang et al., 2004). Zhang et al. provided detailed information on China's aviation industry and policy, which has not been seen in other studies. Four major air hubs, namely Beijing, Shanghai, Hong Kong and Guangzhou, are analyzed in the context of the domestic network at large as well as regional/international market. Information Technology (IT) is covered in length to highlight the importance of role of IT in achieving better efficiency and service quality at air hubs. Liberalization of international aviation policy is strongly suggested to keep up with the fast growth in air cargo service demand and the trend of globalization in general.

One of the few studies that cover area beyond a single country is an analysis of competitive strengths of 8 major international airports in Asia (Park, 2003). This study used a multi-decision criteria approach for the analysis. Deriving from Porter's 'Five Forces', Park examined five core-factors that determine the competitive advantage of an airport. The factors are spatial factors, facility factors, demand factors, service factors and managerial factors. This study is more focused on passenger transportation as indicated by several passenger-oriented competitive advantage factors.

As a follow-up study, Park repeated the analysis for 6 major airports in Northeast Asia (Park and Park, 2004). This study is one of the first to separate cargo and passenger services. The methodology for competitiveness analysis on passenger service is the same 'Five-core-factor' approach as his previous study. In the second part, the study attempted to apply DEA to analyze relative competitive status of the airports in the cargo service. Despite the lack of previous research regarding air cargo hubs, the study presented a well structured process of variables selection. After a screening from documents related to air cargo, a panel of 35 air transportation experts participated in the survey to make a final decision on the variables. This set of variables can be a good reference value for our cargo efficiency analysis.

However, such a simplified approach is relatively weak to support any judgment. A good rule-of-thumb for applying DEA is to include a minimum set of data points in the evaluation set (Sarkis, 2000, Boussofiane, et al. 1991). The evaluation set, defined as the product of the number of inputs multiplied by the number of outputs, which in this case is five, while the number of data points is six, marginally bypass the requirement. The result reflects the weakness due to a small number of data points. Neither the CCR[3] model nor BCC model is able to discriminate the six airports meaningfully. The defect in Park's second study implies that any focused study on few number of airports should not apply DEA and similar numerical methodology.

[3] DEA is a nonparametric method in operations research and econometrics for multi-variate frontier estimation and ranking. CCR is a model assuming constant returns to scale developed by Charnes, Cooper and Rhodes in 1978. BCC is a model with variable returns to scale, developed by Banker, Charnes and Cooper in 1985.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Common Benchmarking Methods

Benchmarking is a process used in management, particularly strategic management, in which organizations evaluate various aspects of their processes in relation to best practice, usually within their own sector. This then allows organizations to develop plans on how to adopt such best practices, usually with the aim of increasing some aspects of performance. The key objective of benchmarking is to identify the ‘best practice’ and measure the ‘distance’ between the subjects under investigation and the best practice. By completing these two steps, the subject will be able to find out its areas for improvement and possible ways to move closer to the frontiers of best practice. However, there exist very different means of benchmarking. Here they are being roughly grouped into two categories.

3.1.1 Quantitative Methods

Traditionally, benchmarking studies have been in favor of quantitative methods. Essentially this involves selecting quantitative measures that facilitate performance evaluation among entities or over time for the same entity. Ideally the measures need to be chosen in such a way that the data collection process is cost effective, accurately reflects reality and provides insights into potential progress. However, the benefits from benchmarking using this type of methods are limited by two factors. Firstly, regardless of the choice of methodology, the input into such a benchmarking exercise is data only. Consequently, its reliability is limited by the data quality to a large extent. Secondly, different entities are influenced by different environmental factors, which are the particular set of circumstances surrounding the entity and may not be captured accurately by numerical data alone.

Quantitative benchmarking methods can be divided into partial methods and general methods. Partial productivity measures reflect output relative to a single input. They are easy to compute and interpret. They also provide the flexibility that measurements can be constructed on an ad-hoc basis and they focus on a specific area which is of the most interest. However, each partial indicator can only provide the measure on a single aspect of the operational performance. Also, one output is usually influenced by the level of other inputs being mixed in the production process. For example, the improvement in labor productivity could be the result of a genuine improvement in labor efficiency or a move to outsource certain functions (ATRS, 2004, 2005). Therefore, one indicator cannot give full information on the performance. Nevertheless, a complete range of partial productivity measures can still provide a general impression of the efficiency level when viewed with caution.

All airports are characterized by multiple inputs and multiple outputs. When measuring efficiency, general methods are more suitable as they are able to take into account the fact that each output is produced with multiple inputs. Several commonly used general methods are Total Factor Productivity (TFP) and Frontier methodologies, such as

Ordinary / Corrected Ordinary Least Squares (OLS / COLS), Stochastic Frontier Analysis (SFA), and Data Envelopment Analysis (DEA).

TFP does not suffer from the shortcomings of partial productivity measure, but data requirements are much more demanding. In addition to physical inputs and outputs, this method also needs information on prices for aggregating inputs and outputs. The ATRS 2004 report used Variable Factor Productivity (VFP) as an indicator of airport overall productivity. It is computed by aggregating other partial productivities using variable cost shares as the weights. It measures how efficiently an airport utilizes variable inputs for a given level of capital infrastructure and facilities (ATRS, 2004).

OLS or COLS are regression-based approaches to measure performance. The underlying principle is to find a line of best fit to the observed data points, and the line represents the average efficiency that occurs at each level of outputs. This technique requires a specification of the function governing the relationship between inputs and outputs. SFA differs from other deterministic frontier approaches in that it can accommodate data noise, but at the expense of requiring the specification of the production function as in other techniques and strong assumptions on the error distribution.

The review of past studies on airport efficiency measurement reveals that DEA is the most popular method and has been favored in various applications (Gillen and Lall, 1997). DEA is a linear programming based technique, where inputs and outputs can be defined in a very general manner. It does not require the knowledge of any production function or behavioral assumptions. However, as a non-statistical technique, it is prone to data errors. Within the realm of DEA’s application in airport efficiency evaluation, there also has been reported a potential deficiency due to a small number of decision-making units (Sarkis, 2000). The simple efficiency scores may result in a set of false positives, which weigh heavily on a single input or output (Sarkis, 2000). With the concept of cross-efficiencies and cross-efficiency matrix introduced by Sexton, this bias can be restored by a procedure for discriminating between true efficient airports and false positive airports (Sexton et al. 1986).

Methods such as TFP and DEA also belong to the MCDA problem set. However, in this study, we will not make direct comparison with other methodologies commonly used in MCDA, because most of them require large amount of quantitative data, which may not be easy to obtain in the context of this study. Nevertheless, it might be an interesting topic to explore if abundant data sources are available.

3.1.2 Qualitative Methods

Quantitative methods can only accommodate variables that are measured by absolute numbers. Qualitative methods offer alternatives that attempt to overcome this limitation.

Among most qualitative methods, survey is one of the most widely used tool to investigate the subjects. The questionnaire can be customized to fit the needs and focus of the benchmarking. When properly analyzed, the survey results could reveal many insights. The challenge is to reach to a sizable survey sample in the targeted population.

Expert assessments and case study comparisons are other common approaches used by many regulators (CAA, 2000). They are used to assess performance, efficiency, productivity gains and cost functions, and the benchmarking in this area often takes the form of a focused case study comparison. Though not as rigorous as mathematical approaches, the in-depth comparisons and analyses have the advantage of being able to take into account of a wider range of data and information which cannot be used in an econometric study. Such an approach not only identifies and measures the differences between the airports under study, but also provides additional explanatory information on the causes of performance differences.

Another common technique is the maturity grid. The main idea of the maturity grid is that it describes in a few phrases the typical behaviors exhibited by a firm at a number of levels of 'maturity' for each of the several aspects of the area under study. This provides the opportunity to classify what might be regarded as good practice (and bad practice), along with some intermediate or transitional stages. The concepts of process or capability maturity are increasingly being applied to a range of activities in many areas, both as a means of assessment and as part of a framework for improvement.

3.2 Roadmap for this Study

The review of benchmarking methodologies reveals that none of these approaches could depict a comprehensive picture on the performance of the subject, or an unbiased view on performance differences across the subjects. In the topic of benchmarking cargo airports, we have identified some areas that needs significant improvement. Firstly, there is a lack of a comprehensive set of metrics to assess the airport competitiveness. This study proposed such a set comprising of seven most important factor groups. Secondly, scholars have by far conducted benchmarking from a very quantitative perspective. However, often in the industry, airports need to consider a wide range of key performance indicators, many of which may not fit into a traditional mathematical model. In this study, we try to combine the qualitative techniques with the quantitative ones, so as to create synergy from the strengths of both and to compensate the weaknesses of both by complementing each other.

The current benchmarking study is being executed in three stages as explained in the following sections.

3.2.1 Developing Benchmarking Framework

The first step is to develop a comprehensive framework for benchmarking cargo airport performances. The goal of this framework is to provide a foundation upon which various factors that are considered to be influential to airport competitiveness can all be addressed and integrated in a systematic way. To better understand the needs of airport customers, we carried out a small study on the decision process of cargo carriers in locating operating airports. The study was primarily through secondary materials and studies from other scholars. This process gives many insights into what the customers look for in an airport and these factors in turn become an important set of determinants to its competitiveness. Apart from getting to know the needs of customers, we also extensively reviewed the other literature regarding airport performance to identify the elements that are considered influential to an airport’s competitiveness. The results provide the basis for populating a list of factors that can measure airport performance in various areas. Based on both the primary and secondary research, a general skeleton of the benchmarking criteria was structured. A hierarchy is constructed with those factors as the basic building blocks and eventually all are covered by seven core factor groups, as shown in the following figure.

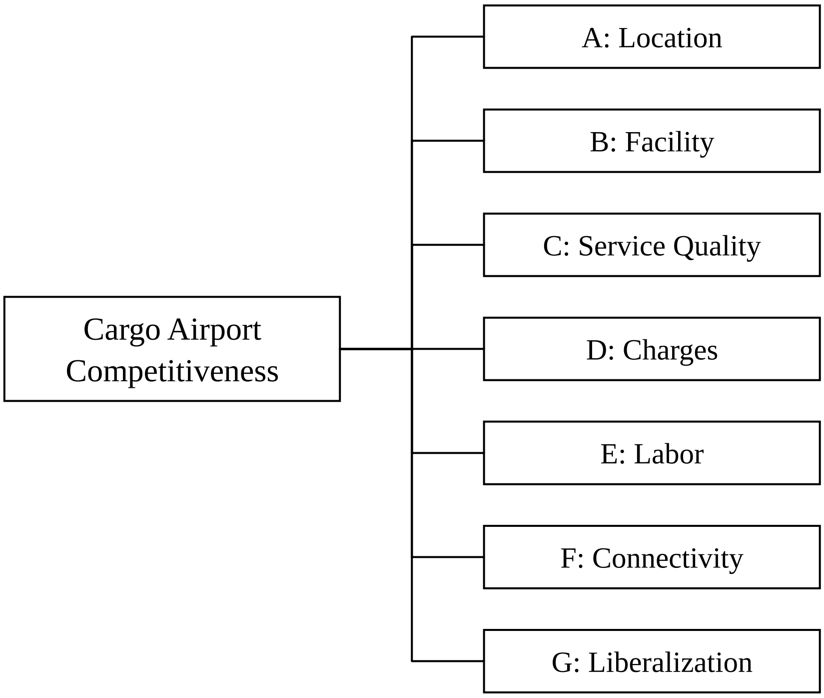

Figure 3.1 Competitiveness Benchmarking Core Factors

Next. within each group, the core factor is further broken down into levels of sub-factors. The factors and sub-factors are selected and screened by considering the following criteria: how feasible the data can be obtained, how objective the evaluation can be, besides the most fundamental criterion, how capable the factor is to reveal the competitiveness. During the formulation process, experts from industry and academia are consulted. Their feedback and suggestions were incorporated into the next phase of development, so that the benchmarking framework is refined through several rounds of iterations. The choice of factors, their impact on airport competitiveness and the hierarchical structure are explained in detail in the following chapter. The table below gives a preview of the core factors and the expansion within each factor group. Every factor and the use in benchmarking competitiveness will be explained in length in the following chapters.

Table 3.1 Overview of Competitiveness Factors

A: Location	A1: Geographical Position	A11: Accumulative distance to major markets A12: Tonne-kilometers to major markets
	A2: Economic Position	A21: City GDP A22: City population
	A3: Environmental Issues	A31: Operation hours A32: Weather condition
B: Facility	B1: Air-Side	B11: Runway B12: Ramp area
	B2: Terminal	B21: Warehouse B22: Parking bays B23: Special cargo storage B24: Material handling
	B3: IT	B31: Cargo labeling B32: EDI
	B4: Inter-Modal Link	
	B5: Logistics	B51: FTZ B52: Airport logistics park
C: Service Quality	C1: Performance Standard	
	C2: Cargo Tracking	
	C3: Cargo Safety	
	C4: Cargo Processing Time	
	C5: Truck Queuing Time	
	C6: Customs Clearance	
D: Charges	D1: For Airlines - Landing Fee	
	D2: For Cargo Agents – Warehouse Storage Fee	
E: Labor	E1: Employee Productivity	
	E2: Labor Cost	
	E3: Knowledge and Skills	
F: Connectivity	F1: Operating Airlines	F21: No. of cities with direct flight F22: Weekly flight frequency
	F2: Air Network	
	F3: Cargo Forwarders	
G: Liberalization	G1: Aviation Policy	
	G2: Airline Market	
	G3: Ground Handling	

After finalizing the seven core factors and the sub-factors grouped under them, we devised a way to assess the airports with a scoring system and integrate the scores into a single competitiveness index as the overall evaluation result of the airport. Then the competitiveness index is tested against airport traffic and financial performance, the two common measures of airport performance. The hypothesis is that the competitiveness index, if based on a well-crafted benchmarking, should have high correlation with the other two measures, which to certain extent reflects the competency of an airport and reveals the industry's perspectives.

3.2.2 Benchmarking Top Asia Airports

To demonstrate the practical use of the framework and to answer the question 'who is the best', we designed the second step to assess and compare the sample airports. The two main issues are choosing sample airports, of which the criteria will be explained in more depth in the later chapter, and collecting data.

It is acknowledged that the level of difficulty in collecting data regarding airport performance, particularly cargo, is extremely high (Zhang 2003, Zhang 2004). In this research, we collected data from various sources. The main contributors are the websites of individual airports and airport operators, where we obtained description of airport facilities, traffic statistics, annual reports and other published information. To complete the dataset so as to avoid the problem of inconclusive results due to the missing data of certain airports, we also explored other channels. We contacted the relevant research or technical planning departments of all the airports in the list to request for data that is not available in the public domain.

We have also tried to extract information from third party publications. The airport performance data and financial figures are partially from Digest of Statistics – Airports and Route Facilities published by International Civil Aviation Organization (ICAO), Annual Traffic Data published by Airports Council International (ACI) and Airport Benchmarking Reports published by ATRS.

Several problems with data might still exist due to various reasons, and data inconsistency is the major concern. Unlike US or EU, Asia does not have any organization that oversees airport operations and mandates statistics collection of airports. Different airports may have very different management schemes and reporting systems, and so are the data format and availability. To complicate the matter further, most airport operators outsource the cargo services to specialized companies, often more than one, which increases the diversity in the scope of services and operations. Another issue is in the financial information. Some airport operators are private or state-owned and no financial report is released to the public. Different countries follow different accounting systems and certain items are not comparable cross board.

To maximize the data quality and completeness, we adopted a few measures. As far as possible, we use data from the same source for one factor to avoid problems arising from different definitions. We also double check with the data sources for the scope and measurement of each factor, especially those less common ones. When multiple sources are available, we always check the data across the sources for discrepancy. We would accept a certain degree of differences in quantitative data. But in the case where there is obvious discrepancy, we usually go back to the data source for clarification on their term definition and measure methods. If that is not possible, we are inclined to use the more conservative data. In some occasions, missing data is estimated in order to complete the dataset and thus be able to generate final analytical results. When such cases occur, the assumptions are verified with experts to ensure that the estimated data is reasonable and will not lead to skewed or meaningless results.

3.2.3 Competitive Strategy

The most compelling goal for benchmarking is not only to be informed of where the airport stands, but more on how to improve its performance given the business opportunities and operational constraints. We adopted two perspectives to analyze the benchmarking results. By focusing on one specific factor, we zoom into the building blocks of competitiveness and understand the differences in performance with respect to that particular factor. The top performer and bottom performer receive extra attention and we explored further to find out the possible causes for the ranking. Such an analysis provides insights on how well each airport is doing on that factor and why this is so. Similarly, by focusing on one specific airport, we look at its performance assessed from all the aspects. This provides a good understanding on what it has done well, what has contributed to the positive evaluations, and perhaps more insightfully, what are the few areas it should improve in order to receive the best return on investment.

Considering differences in the operation environment and some external attributes, we intend to categorize the airports into subgroups. By limiting the discussion within the subgroup, the practice sharing and strategy learning within the group are more meaningful and practical. We surveyed academic researchers and industry experts to select the candidates for the two dimensions in the 2x2 competitive matrix. Then we segregate the sample airports based on the data collected on those two dimensions and distill the strategies with the information from both the benchmarking results as well as the competitive matrix. The exact methodology for constructing the matrix and placement of airports are elaborated in the last chapter.

CHAPTER 4: ASIAN AIRPORT LANDSCAPE

In order to provide the context and background of Asia airport benchmarking, the following sections will give an overall view of the airport industry in Asia. Airports in Asia have attracted much attention from the world in the recent years. Here we will describe the airport boom, look into the reasons behind the fast growth and point out both the opportunities and challenges.

4.1 Growth Opportunities and Drivers

The advantages of a hub-and-spoke network have long been recognized by airlines. Traffic is consolidated at a hub to take advantage of economy of scale and density, which provides airlines the opportunity to offer services to more destinations with higher frequency and lower cost. There are also tremendous benefits to the host city/country as shown in several studies (Button and Stough 2000, Doganis 2002, Oum and Yu, 2000). Due to the large amount of business activities at the logistics hubs, they become the generator of substantial revenues and employment. The rule of thumb is that every 1 million passengers flow is equivalent to USD100 billion and 2500 jobs. Hubs may also serve as a gateway linking domestic economy with other nations or economic regions. Therefore, the development of transportation and logistics hub offers distinct benefits. The business operations become more efficient due to economy of scope since serving multiple markets through a consolidation point is more efficient and offers more frequent services than direct point-to-point services. The transportation involved becomes more convenient and cost-effective with hubs compared to a linear network because of the coordinated transport connections and higher service frequency.

In contrast to Europe and North America where there is an oversupply of hubs, Asia is still in the early stage of air traffic life cycle (BCG, 2004). Coupled with the high growth in cargo demand, there is a strong need for air cargo hubs in Asia and most airports will enjoy a significant growth in the near future. Also, as the airports just start to open up and transform, they have plenty of room for improvement and development. Figure 4.1 shows the competition landscape of airports in Asia.

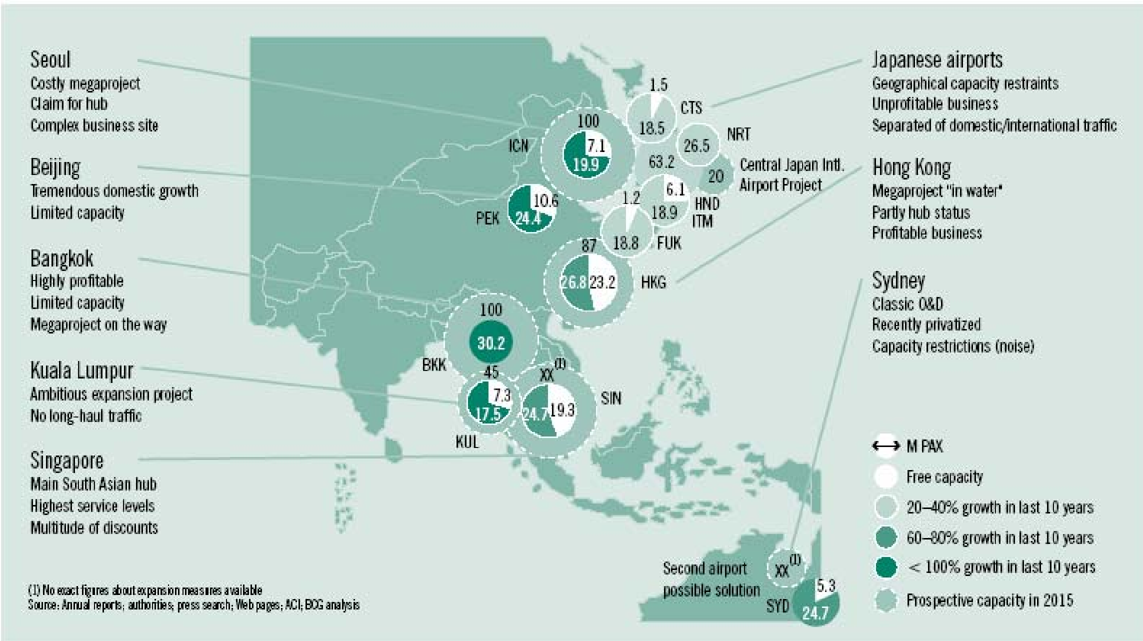

Figure 4.1 Asian's Competition Landscape of Airports

The high growth of Asian airports is not a simple event limited to the aviation industry. Instead, air cargo is also closely integrated with a number of economic activities. Any change in those areas will affect the cargo business and reciprocally, air cargo development influences those activities. The following sections take a close look at the major driving forces that will also be crucial for analysis in the later stage.

4.1.1 GDP

In general, it is believed that the change in cargo traffic can be attributed to the change in economy trend, though a gravity model developed by Matsumoto shows a relatively small value of the GDP parameter for cargo flow. He reasoned it with GDP's lessening importance in explaining air traffic flows (Matsumoto, 2004). However, Boeing research still firmly claims that a strong correlation exists between the world GDP growth and the increase in air cargo traffic (Boeing, 2004). As cargo demand is largely stimulated by international trade, air cargo growth will most likely happen with more active global economic activity. In the past few years, air cargo industry has improved services, raised the awareness among shippers, and increased recognition of air cargo benefits to global enterprise. All these factors create opportunities for air cargo growth to continue outpacing GDP growth.

4.1.2 Just-in-Time Supply Chain Management

A more widely recognized factor is globalization and just-in-time (JIT), the new paradigm in supply chain management. This trend has extremely important implications on air cargo industry development, for the manufacturing power houses, noticeably China and several countries in Southeast Asia. The change goes beyond just increasing cargo volume, but more profoundly, it has a long term impact on commodity composition, traffic flow pattern, and network formation.

Driven by globalization, logistics has played an increasingly important role in many businesses. The need to efficiently and economically manage logistics shifted the management framework from in-house logistics management to outsourcing and/or strategic alliances. Multinational logistics enterprises emerged to meet this demand. Among the innovations that have advanced logistics systems and management, third-party logistics has gained a profound standing. In order to expand beyond the domestic market and also to fulfill customers' needs of transferring goods and materials worldwide, these logistics companies developed a global network for transportation. This network is still expanding to reach more places in shorter time. Such expansion and development present an excellent opportunity for air transportation.

The integrated, just-in-time (JIT) production and distribution systems would not have emerged without the advancement in air cargo industry. In turn, the new logistics management paradigm further pushes the air cargo in general, and air express in particular, the fastest growing area in the cargo sector. Product life spans are shortening in a variety of industries. To stay ahead of the competition, companies need to cut down inventories and minimize the time-to-market. Therefore, more and more of them will have to rely on air transportation for moving materials and products. Two trends emerged in response to this need. One trend is virtual warehousing, whereby companies keep goods in transit and nearly eliminate storage space for holding goods. The other more popular strategy is to locate fulfillment centers worldwide, at places which possess a comparative advantage in one particular type of production activity. The strategy, called ‘international fragmentation’, i.e. outsourcing various production blocks to countries that possess a comparative advantage, is facilitated by the increase in global mobility and decline in trade barriers (Zhang, 2003). As a result, the demand for international links, in terms of transportation services, increased dramatically, and air cargo services are motivated to be more efficient and at better quality.

4.1.3 Liberalization in Aviation Industry

Another force that should not be underestimated is the push towards more liberal airport management and air cargo services. In the last few years, a number of airports in Asia were commercialized. Airport management has been granted more autonomy to make both short-term and long-term operation decisions. Governments tend to encourage healthy competitions and introduce foreign participants who may bring in more expertise and improve airports.

The new air service agreements also changed the relative position of airports. Recently Singapore, Korea and Taiwan have negotiated bilateral agreements with US on seventh-freedom traffic rights on cargo services. China has long persisted a conservative attitude towards international aviation policy, but this is becoming more liberal partly due to China's accession to WTO. Those airports, which have been deprived from international route expansion despite the other advantages, now will have the chance to win back business.

4.2 Increasing Competition among Asian Airports

Most cities and/or countries with established logistics infrastructures in Asia Pacific have all recognized the benefits and the needs to develop as a dominant transportation hub for the region. The high growth in air cargo in the Asia market has further fueled the intensity of the competition. Major airports are all promoting themselves as the hubs for air cargo, claiming it is the gateway to the vast area in Asia, not just the local catchment. Each major city, Narita and Kansai in Japan, Seoul in South Korea, Shanghai and Hong Kong in China, Bangkok in Thailand, Taiwan, and Singapore all have made strategic plans to heavily invest on transportation infrastructures and to improve efficiency in the movement of freight. Besides physical facility expansion, the airports are also very aggressive in promoting information technology deployment to enhance service quality.

A close look at the cargo traffic ranking of top Asian airports provides a clear picture of their global position and the changing trends. The following table shows the Asian cargo airports that are in the top 30 worldwide from 2000 to 2004.

Table 4.1 Asia Airports in the Worldwide Top 30 Cargo Airports

2000		2001		2002		2003		2004	
Airport	**Rank**	**Airport**	**Rank**	**Airport**	**Rank**	**Airport**	**Rank**	**Airport**	**Rank**
Hong Kong (HKG)	2	Hong Kong (HKG)	2	Hong Kong (HKG)	2	Hong Kong (HKG)	2	Hong Kong (HKG)	2
Tokyo (NRT)	4	Tokyo (NRT)	5	Tokyo (NRT)	3	Tokyo (NRT)	3	Tokyo (NRT)	3
Seoul (SEL)	5	Singapore (SIN)	9	Incheon (ICN)	6	Incheon (ICN)	5	Incheon (ICN)	5
Singapore (SIN)	9	Incheon (ICN)	15	Singapore (SIN)	7	Singapore (SIN)	10	Singapore (SIN)	8
Taipei (TPE)	16	Taipei (TPE)	16	Taipei (TPE)	14	Taipei (TPE)	14	Taipei (TPE)	11
Osaka (KIX)	19	Osaka (KIX)	18	Bangkok (BKK)	17	Shanghai (PVG)	17	Shanghai (PVG)	14
Bangkok (BKK)	23	Bangkok (BKK)	19	Osaka (KIX)	20	Bangkok (BKK)	19	Bangkok (BKK)	19
Beijing (PEK)	25	Tokyo (HND)	23	Tokyo (HND)	23	Osaka (KIX)	23	Osaka (KIX)	22
Tokyo (HND)	26	Seoul (SEL)	26	Beijing (PEK)	25	Tokyo (HND)	24	Tokyo (HND)	24
		Beijing (PEK)	25	Shanghai (PVG)	26	Beijing (PEK)	26	Beijing (PEK)	28
				Guangzhou (CAN)	28	Kuala Lumpur (KUL)	29	Kuala Lumpur (KUL)	29

Source: ACI 2005.

Overall, Asian airports are on the rise in the ranking. In the five year period of 2000-2004, the big airports such as Hong Kong, Narita and Singapore, retained their reputation as the top cargo airports not only in Asia, but also in the world. More and more new Asian players, such as Shanghai Pudong airports, Kuala Lumpur airport, new Incheon airport, also get into the worldwide top 30 airports in cargo traffic, as a result of the aggressive investment and promotion. For example, before the opening of new Pudong airport, Shanghai (Hongqiao airport) was never near to the top 30 airports. However, right after the structural adjustment and route allocation, Pudong airport immediately occupied a seat in the top 30 cargo airport list in 2002. In 2003, its rank jumped ahead by almost 10 and stayed relatively stable in the top 20. The impact from its fast growth certainly reached many places in Asia and it has been regarded as a strong rival by most of the major airports in Northeast Asia. The Asian fast pace sees no slow-down at the moment, with Chinese airports reaching double digit growth consecutively in the past few years.

CHAPTER 5: FRAMEWORK FOR BENCHMARKING CARGO AIRPORTS

From an economic perspective, the airport industry has just got onto the track of open market and liberalization, especially in Asia. Compared to their counterparts in Europe and North America where the air cargo and logistics industry has reached a more mature state, many airports in Asia just emerged to assume bigger roles in the industry chain. There are many areas they need to work on in order to improve competitiveness. To achieve this, the airport must first know how to measure competitiveness.

From an academic perspective, the airport industry provides an interesting specimen for organization management and operation efficiency study for its intricate interface to multi-users and its fundamental position in economy. On one hand, with the liberalization, airports are run more like a business. New revenue channels, which are not exactly tied up with aeronautical functions, are being explored and exploited. On the other hand, the airport carries functions and responsibilities which are more than the pure economical value. Due to its large scale and significance in the transportation value chain, the success of an airport has huge impact on society and much ripple effect. To measure its competitiveness, compare with other airports of its kind and suggest cause of differences, is bound to be controversial and will trigger many debates from methodology to information sources. But such a framework for benchmarking can spearhead a series of studies on industries which underwent a similar transformation. It could shed light on the way academia adopt to approach such topics.

Metrics are necessary to properly measure competitiveness and to provide a baseline for comparing with other airports. The factors that have significant impact on competitiveness are organized in a theoretical framework. Using this framework, the scores on performance measure can be calculated and with more descriptive information, the differences between airports and possible reasons for such differences can be explained.

The most compelling use of the benchmarking results is for companies to learn from the best. It is commonly believed that the closer a company is to the best practice, both in the practices it adopts and in the operational outcomes that result, the more likely it is to achieve higher business performance. Ulusory's extensive survey on various sectors of Turkish manufacturing strongly supported this hypothesis (Ulusory, 2001). Therefore, a benchmarking framework is extremely useful for companies to identify their relative positions, their strengths and weaknesses, and more importantly, understand how they can move closer to the best practice in the industry. Similarly in this study, the results of benchmarking is to identify the strengths and weaknesses of the airports under investigation. This is achieved by answering some important questions:

- What factors influence the performance of cargo airports?
- How can the competitiveness be measured and compared across different airports?
- How can airport management strategize and operate to make the airport more competitive?

The proposed framework in this study will be able to answer the above questions and provide a tool for benchmarking. It is designed to capture the main elements of competitiveness highlighted in the literatures, and issues emphasized by practitioners and researchers. The model comprises a set of indicators that can be used to measure the competitiveness of an airport with regard to its air cargo business. They assess the airport from both objective and subjective perspectives. The essential purpose of the benchmarking framework is to develop a model of air cargo hub competitiveness that identifies the key success factors, and to use the model to explain the differences, thus enabling airports to craft strategies to improve competitiveness.

Due to the fact that different countries or airports adopt very different ownership schemes, organizations with similar names could assume drastically different functions under different operational environment. Here we would like to define the term airport management used in this study. It refers to the party who is in direct control of airport operations and air transportation policy. The scope of functions encompasses facility planning and management, ground handling and policy setting. For some airports, the addressed party is then the airport authority which covers all the functions, while in some cases, that will include the civil aviation agency as the policy setter and privatized companies as ground handlers.

There exists no consensus on the definition of competitiveness and the measurements on it. Broadly, it can be viewed as high, rising returns to the stakeholders of the entity. In the context of airport benchmarking, performance can be defined by both qualitative variables which are more skewed towards measuring the service offered to clients and quantitative variables which are more skewed towards measuring the cargo operations (Chen, 2004). We extensively reviewed past studies that directly addressed issues concerning terminal designs and operations at a micro level as well as air transportation and policy at a macro level. Also, interviews were conducted with practitioners in the airport, logistics companies and academia. Collectively, we identified a number of factors affecting a cargo airport's competitiveness, which can be grouped into seven core factor groups. The following sections will explain in detail 1) what the factor means 2) how it may be measured 3) how it determines the competitiveness 4) what potential issues might relate to it.

5.1 Location

Several studies reveal that location is the top level factor that determines the attractiveness of an airport (Gardiner et al, 2005a, 2005b; Zhang, 2003). The airport location is examined by carriers based on how much business opportunities they can explore, and the business opportunities are largely determined by the geographical position and even more importantly the economic position. To a certain extent, environmental issues play a role in restricting operation hours.

5.1.1 Geographical Position

The most compelling reason for a carrier to choose an air cargo hub location is to minimize the cost, which is directly related to the total distance to markets served (O'Kelly, 1998). It is identified that major airports in the USA are clustered on the coast to serve international routes or in the centre of the country to serve as a domestic hub (Gardiner et al., 2005a). Similar examples can be found in many other areas, such as the 'Golden Airport Zone' in Europe, which is the area linking Dusseldorf and Cologne (UPS hub) airports in Germany and Brussels (DHL hub) airport in Belgium. Central location in a region always has the unfair advantage in best serving a variety of markets.

Pertaining to Asia Pacific region, Schwieterman presented a simple yet informative and comparative analysis on express cargo hub location. Based on a minimum flight cost model, he found that to serve the 15 major Asian cargo markets, Hong Kong offers the most economic operation site for express service (Schwieterman, 1994). Indeed, in 2002, DHL set up a dedicated express cargo terminal at the new Hong Kong International Airport. With the hike of oil price, carriers are more sensitive to the flight cost and thus will give higher priority to sites that are close to the major customers. For serving inter-Asia region, Tokyo is superior to other competitors and thus has become the real center of not only North Asia but also the entire Asia (Kim et al., 2002)

Besides the flight distance, the tonne-kilometer is also an important indicator of location advantage. The cargo volume serves as a weight for each route and therefore, the heavily loaded routes are regarded as more important. The results help airlines choose the site that is close to all the major markets when selecting a cargo hub. Hence, as important as flight distance is the tonne-kilometers associated with each airport. Flights to big markets will carry more cargo than those serving smaller markets. These routes represent the most lucrative opportunity for airlines, and so it is more appropriate to weigh these larger market more heavily in the analysis.

5.1.2 Economic Position

The degree of city/regional development, the size of airport hinterlands and the city network indicate the level of induced force of air transport demand. The potential ability of development can be estimated from the population and GDP.

The size and scope of the local origin-destination market largely influence freighters' choice of airports. The market includes both the local market and the neighboring catchment. With abundant local business opportunities, there is a significant saving on time and cost from shipping the cargo nonstop from origin to destination without sorting, loading and unloading. Busy passenger traffic also provides more belly space for cargo to be shipped to locations that do not have enough volume for freighters. In addition, air cargo carriers prefer to operate at airports near customers, and thus the stronger the local and regional customer base is, the more attractive the airport is as perceived by carriers.

The proximity criteria are dependent on the type of carrier and the airport function. According to Preisler, integrated express carriers define markets tightly, due to its time-definite service quality. The local catchment is up to 100 miles, implying that the airport must be close to the densest customer base. While all cargo carriers in collaboration with freight forwarders may be willing to truck greater distances, their definition for catchment can be up to 600 miles (Preisler, 2004).

In the last few years, the industry has seen abundant cases whereby the dynamic economical activities in the catchment nurtured the nearby airport. The prosperity of Hong Kong airport is largely attributed to the fast development of Pearl River Delta. So is the large traffic volume at Shanghai arising from the high growth of Yangtze River Delta (Zhang et al., 2004). Brazil and Hanoi’s high ranking in the fast growing airports due to the huge expansion of manufacturing sites and distribution centers also proves that local demand is an important indicator of the health of the airports.

The geographical location and economic position together helps to identify the role of an airport in the global network. The Boston Consulting Group analysis concludes that only airports with central location and large, affluent catchment areas will be eligible to become mega-hubs (BCG, 2004).

5.1.3 Environmental Issues

Related to location are the environmental restrictions. The primary airports are often located near the city and have noise limit issues, which present a strong threat to cargo operations. Unlike passenger flights, nighttime operation is much more important for cargo airlines, especially express operators. As Shaw has concluded, it is absolutely essential for airports to have completely unrestricted night-time access (Shaw, 1993). If noise and other environmental issues stifle growth at the primary airports, they will lose out to secondary airports. Such cases have already occurred in Europe and North America. DHL changed its plan of the European hub from Brussels Airport to Leipzig/Halle Airport in Germany, after Brussels rejected additional night flights and larger aircrafts (Ott, 2004). The noise restriction is measured in terms of airport curfew time.

Climatic condition can be of more importance to cargo over passenger flights as some shipments are strictly time-definite. Thick fog, strong winds and snow, which are found to be the most significant factors, can cause delays and airport closures (Huston and Butler, 1991).

5.2 Facility

The facility at an airport is the most visible attribute of its competitiveness. Airports are competing to build new facilities and giving a strong marketing on their state-of-the-art facilities. A survey of the freight operators who relocated their services from one airport in a region to another airport reasoned that within their decision control, the quality of facilities was the most important factor (Gardiner et al, 2005b).

5.2.1 Air-Side

On the airside, runway is the focal point. The introduction of new aircrafts imposed more demanding requirements on runways. Many airports are undergoing facility upgrading to accommodate the needs of new aircrafts. Singapore Changi airport has recently completed a 60 million dollar renovation on the existing facilities and infrastructures, which includes widening the runway and launching gates compatible with the new giant Airbus A380 (Payload Asia, 2005). A study conducted by the European Express Association confirmed the importance of sufficient runway length among many other key elements regarding airport facility (European Express Association, 1999). The common measures for air-side are the number of runways which reflects the capacity, and the length of runways which reflects the ability to accommodate wide-body aircrafts.

Another important element revealed in the European Express Association’s study is the apron/ramp area as an indicator of air-side capacity. Apron/ramp area is where ground handling crew perform loading and unloading operations. Having sufficient space at apron area is certainly essential for smooth and efficient ground handling.

Having sufficient infrastructure to support airport business is one matter, while making the best use of the existing facilities is a very different issue. In the race to build bigger and better airports as a response to the head-on competition, airport managements are easily prone to construct new infrastructures, which might be excess. There is an increasing concern that airports may have already overbuilt the physical capacities and yet neglected the managerial measures that increase the utilization and efficiency of the existing facilities (Yoshida & Fujimoto, 2004). Hence, comparing the facility efficiency of the airports is highly informative and provides a new dimension in measuring airport performance and competitiveness.

When facing a capacity shortage, airport management should first analyze the efficiency and identify the possible areas of improvement in maximizing the value of existing facilities before jumping into the conclusion of building new ones. Any investment in expanding capacity should be on a ‘needs-must’ basis and only when the airport is certain of the future demand. Some regional airports have already suffered from the burden of excess capacity. They often resolve the problem by passing the cost to the airlines in terms of higher charges, which eventually hurts the airports themselves. The mega hubs experience less of this problem as most of them are on the ride of the rising traffic curve, but they still need to be cautious of the possible occurrence of such a vicious circle. One example is the overexpansion of San Francisco airport. In contrast to their optimistic forecast of high growth, traffic actually retracted more and more year by year, forcing the airport to raise the airlines' landing and terminal charges by 23.8% (BCG 2004). The consequence is not hard to predict. Since nowadays airlines have more freedom in choosing airports, this surge in the cost will inevitably turn away certain airlines.

On the air-side, we consider the utilization of runway by taking into account the ratio of aircraft movement per runway. The ratio of cargo tonnage over ramp space may be an indication of ramp space efficiency. However, ramp space requirement depends more on the size and type of aircraft, rather than the mere operations, and therefore, we do not consider it as a fair measure.

5.2.2 Terminal

On the landside are the cargo terminal facilities. Airlines and freight forwarder mainly ask for sufficient warehouse space to accommodate sorting and distribution activities in the cargo terminal, along with adequate parking space to avoid congestion which can easily occur due the busy traffic around cargo terminals.

A basic indicator of terminal capacity is the warehouse area. Similar to the air-side facilities, efficiency is of paramount, especially for airports which may not have much space for expansion. The only practical way to meet the increasing demand is to stress on throughput, defined as the ratio of tonnage over warehouse area. This ratio is often used as a quick gauge of a terminal's capability.

Storage of special cargo, such as perishable cargo, live stock, dangerous goods, and high value goods, is indispensable for any modern cargo terminal. In this study, the capability of handling special cargo is measured in four areas:

- handling for large animals and equine
- refrigeration for cut flowers, perishables, and frozen goods
- hazardous materials (HazMat)
- bonded and secure storage.

Material handling is another indicator of the advance level of a terminal. Essentially the core component of a cargo terminal is the warehouse and similar to any other warehouse facility, the handling of goods determines the operation efficiency and quality. The state-of-the-art terminals use ASRS (Automated Storage/Retrieval System) to increase warehouse utilization and efficiency.

5.2.3 Information Technology

Air cargo industry is heavily paper based and involves a complex circle of parties. Information needs to flow along the supply chain smoothly and timely. Electronic Data Interchange (EDI) can help to reduce the paperwork and manual transfer, and hence increase the speed and minimize errors in the transmission. In collaboration with airlines, cargo terminals provide real-time on-line tracking system to freight forwarders and shippers.

Considering the large amount of goods flowing in and out of the terminal as well as the lack of uniformity, tagging and tracking the cargo can be a challenging task. The most widely used technology is barcode, which can be scanned by a handheld reader or detector on the conveyor belt that carries the shipment for consolidation or distribution. The latest technology, such as Radio Frequency Identification (RFID), which is an automatic identification method, relying on storing and remotely retrieving data using devices called RFID tags and radio, could greatly enhance the speed and ease for tracking of goods.

5.2.4 Inter-Modal Link

Air cargo relies heavily on other modes of transportations, and hence the distance from the airport to its inter-modal access point is highlighted as an important factor influencing the airport’s competitiveness. Indeed, inter-modal link is one of the most mentioned issues in airport infrastructure as signified by various airport users. In a survey to freighter operators serving Midland of UK, 92% respondents rated road connection to airports among the top three determinants for airlines locating at a particular airport (Gardiner et al., 2004). The primary reason for shippers to pay a premium on air transportation is in the expectation that its fast speed will offset the high monetary cost. However, as much as 80% of the air freight transit time is consumed actually on ground, during which a significant amount is spent on pick-up and delivery. If this process can be speeded up, there is a considerable time saving on the overall freight movement. As the goods are moved from and to the airport mostly by truck, good links to an uncongested road networks are clearly critical. The proximity from airport to highways is even more valued by integrators, who need to meet the fast overnight delivery requirements. Thus, in this study, we select the distance to highway as the indicator of the ease of an airport's inter-modal access.

5.2.5 Logistics Facilities and Supports

During our interviews with decision makers from logistics companies, they emphasized one factor that bears direct impact on their choice of airports, that is whether the terminal is designated as free trade zone (FTZ). Within FTZ, goods can flow freely without import or export tariffs. It is not only a big deduction on monetary cost, but most importantly a considerable saving in processing time. This is extremely beneficial for transshipment, which has achieved 1 hour turnaround time in Singapore Changi airport, due to the fact that the entire freight operation is conducted in FTZ. With the FTZ status, airports offer reduced cycle times and reduced administrative manpower costs associated with import and export procedures.

The logistics facilities on site are often not able to completely satisfy the scale and complexity for air cargo. Several airports have built airport logistics parks in the vicinity to provide more support. The logistics parks help to promote quick turnaround and value-added logistics activities that often are ideal for high technology, high value products and fulfillment of orders through electronic commerce. The existence and development of nearby logistics parks become another influential factor when airlines select a cargo hub.

5.2.6 Provision for New Facilities

Airlines' decision on airport location involves heavy investment and therefore, they demand long term potential from the selected location. To ensure the airport will be able to match their growth, they will consider whether the airport has expansion capacity and whether the airport has provisioned sufficient new facility for future growth. The airport's investment on new facility also shows the confidence of investors' over the growth at the particular airport. However, as mentioned before, airports of all size, particularly those regional airports, should be cautious in expansion. New investments should be made only if the future demand is certain.

In this study, the provision of new facilities will be used as an explanatory factor, rather than a comparative one for the following reasons. Firstly, as different airports have new investments in different aspects on different scales and will realize them under different timelines, it is not easy to compare them. Pure monetary comparison may run into the danger of ignoring the fact that different facilities have different impact on the airport’s capacity. Also, this study would place more emphasis on the current status rather than the less certain future. If the analysis reveals that the airport experiences a bottleneck at a certain type of facility, we will then take into account its expansion plan to see whether appropriate new capacity has been provisioned.

5.3 Service Quality

The airport is a facility provider, but it is more of a service provider, considering the large amount of complex processing needed to keep the seamless flow of cargo that comes in and out of the airport. At the core, the cargo terminal provides support and value-added services to the carriers and the customers. Those include import, export and transit cargo handling, cargo documentation handling, cargo tracing, cargo storage, Unit Load Device (ULD)/pallet handling, cargo palletizing, claims processing, surveys and mail handing, among which cargo handling and storage remain the core activities. A cargo terminal acts as a ground handling agent for the carriers, and at the same time, as connection to the air-side for freight forwarders. Thus it plays a critical role in the value chain and largely determines the service quality.

5.3.1 Performance Standard and Monitoring

Without clear definition, good service does not have any meaning. To maintain and improve service, airports need to have comprehensive performance standards as a quality guideline for ground handlers. Moreover, good service is not one-time-off, but a result of continual effort and commitment to better service quality. Therefore, there needs to be constant measuring and monitoring of the actual performance to ensure that the standards are indeed met. Airports, especially those large regional/national hubs, do not have the incentive to implement such measures due to a few reasons. They usually enjoy the benefits of monopoly, and are not afraid of losing customers because of poor services. Also, different departments have to cooperate closely in order to deliver the quality services. Without intervention from the general airport management or government, no one has enough power to balance the different interests among departments and impose punishments when the standards are violated. However, the airport customers regard the airport as a whole entity and require good services from end to end. Hence the regulatory bodies or symposium of the industry players have to take the responsibility.

In Singapore, the Civil Aviation Authority of Singapore (CAAS) mandates a set of service standards (CAAS). If the standards are violated, a severe penalty is imposed on terminal operators. Similarly in Hong Kong, HACTL (Hong Kong Airport Cargo Terminals Limited) and AAT (Asia Airfreight Terminal)'s performance is measured against a set of targets agreed by the industry (Hong Kong International Airport). Apart from the individual performance standard, Cargo 2000, an IATA (International Air Transport Association) interest group, brings airlines, forwarders and ground handlers to implement a quality management system that is to increase cargo efficiency, enhance customer service level and reduce operational cost (Cargo 2000).

5.3.2 Cargo Tracking

Cargo tracking is not a new concept in express cargo and has been gradually spread to general cargo since the increasing adoption of EDI. Providing cargo tracking gives forwarders and shippers vital information for business operations and planning. Cargo tracking is not a task that an airport alone would be able to complete, but a joint effort between airlines and terminal operators to provide easy and timely access and reliable information. Cargo 2000, the largest joint group of such nature with 25 major airlines and freight forwarders, sets the unique goal of implementing a quality management system for the worldwide air cargo industry. The group has reengineered the transportation process from shipper to consignee through a “Master Operating Plan”, which is the core of an industry-wide process control and report system. The last phase will enable real-time management of the transportation channel at an individual piece of shipment level. (Cargo 2000)

5.3.3 Cargo Safety

A large proportion of air shipment is high value goods, and so the safety issue is of paramount. If an airport has a bad reputation of mishandling cargo, it not only drives away potential clients, but also discourages existing clients. Cargo damages are mainly caused as a result of mishandling by less qualified workers or violate the instructions. The lack of suitable environment for special cargo also leads to the contamination of cargo that requires clean room environment. Tracing back to the cause of cargo damage and mishandling, the quality of labor force, terminal operation planning and facilities are found to have the highest impact. Besides damage rate, accuracy is also a main concern for shippers and airlines. Top airports in the world have all placed a very high priority on processing cargo safely and accurately. To highlight the attention on cargo safety, mishandling rate and breakdown of consignment are included as the key indicators in Hong Kong's performance standards.

5.3.4 Cargo Processing Time

Speed can be regarded as the single most important advantage of air transportation for cargo. Shippers are willing to pay a premium for the significantly faster delivery offered by air. To meet such expectations, airlines need to take care of the time spent in the air, but more critically is the time after the plane lands. Here airports have a critical role to play in terms of providing efficient ground handling services. A simulation showed that transshipment choice is more sensitive to time cost than monetary cost. In a particular O-D (Origin – Destination) traffic, cargo carriers are willing to pay USD1000 more in return for one-hour reduction in transport and processing time (Ohashi et al, 2004). The integrated carriers, whose business model is built upon speed, demand fast pass-through speed at terminals. This includes loading/unloading time, and cargo build-up/break. The speed might be of less importance to non-integrators, who are more concerned with cost, but they still require a processing time that does not affect the overall aircraft turnover time.

One neglected area that could have made a large contribution to speed up cargo processing is cargo lodge-in policy at the terminal. In most airports, cargo may be lodged in to the terminal either loose or palletized. Loose cargo requires extra space and work for build-up and should be discouraged from terminal operator’s viewpoint. However, it is observed that the percentage of loose cargo is as high as 90% even in one of the best international airports (Chew, Huang and Mok, 2000). Such large amount of labor-intensive workload will inevitably slow down the operation and lead to a higher possibility of delay and sometimes bump-off. In contrast to the common charging policy, terminal operators could charge carriers by actual workload rather than weight of the cargo, thus providing incentive for cargo palletization before lodging in. Innovative policies would then ease the work at the terminal and thus increase efficiency.

5.3.5 Truck Queuing Time

To freight forwarders, the speed bottleneck is often at the acceptance counter, due to two reasons space constraints and tedious paper work. If the terminal has limited space for forwarders to load and unload cargo, it will cause serious congestion and therefore the other customers have to wait till the space is cleared up. The other process that leads to long waiting time is completing the paper work at the acceptance counter. Manual work takes a much longer time and is more prone to mistakes. This can be improved by adopting computerized lodging system and integrated IT platform compromises to increase the efficiency and accuracy at the counter. Truck queuing time measures the average time the forwarder needs to wait at the acceptance counter for the cargo lodge-in. It is a good indication of the time cost for freight forwarders and is relatively easy to measure.

5.3.6 Customs Clearance

Tedious paperwork and long delays are always associated with customs clearance. It has been a far cry from shippers and forwarders to simplify the procedures and eventually cut down the clearance time. Many airports have started taking actions in this aspect. In Hong Kong, to achieve a seamless flow for air cargo, the cargo handling systems are integrated with Hong Kong Customs and Excise Air Cargo Clearance System (ACCS). This enables pre-arrival customs clearance that covers all types of cargo down to house airway bill level. In turn, ACCS is linked to the cargo terminal operators and express cargo integrators to ensure timely electronic interchange of data and customs status. In Kuala Lumpur, the Customs Department has introduced Pre-clearance. This allows agents to forward as early as one week in advance, the documentation and details of their inbound or outbound consignments for clearance. All these initiatives provide significant time saving and operation flexibility for cargo forwarders.

5.4 Charge

Several previous studies on marine ports have found port charge as a principal determinant, though the findings varied on the relative impact of service charge on the location decision. Tongzon cautioned that the importance of charges must be considered in the context of overall cost (Tongzon, 2003). This is further confirmed in our interviews with the practitioners in the air cargo industry. The customers certainly prefer a low cost location, but it is true on the basis that the service quality is not compromised. In certain cases, users are actually willing to accept higher costs in return for superior service (Murphy et al., 1992). These findings give deep insights on airport pricing. Even in today's highly competitive markets, if the airport is able to provide differentiated services that meet customers' needs, it can effectively minimize undercutting price in order to win customers. On the other hand, low charge may not guarantee a big customer base.

The two parties having most direct customer relationships with airports are airlines and forwarders (including integrators). Therefore, in evaluating airport charges, we consider two types of cost, one incurred by airlines and the other by forwarders.

5.4.1 Service Charges to Airlines

The airport service charge to cargo airlines includes various items such as fees for landing, aircraft parking and hangars, maintenance, security, cargo handling, and noise-related charge. As monopolies, airports have been able to pass on the cost of excess capacity and low efficiency to the carriers. Gillen and Lall found out that airport charges in the US typically represent 5-7% of airlines' total operating cost and a much higher corresponding percentage in Asia. There is a strong concern that the airport charge is out of the reasonable range and needs intervention to bring back the balance in the industry.

The airport charge reflects the costs of operations and maintenance of the airport. It also shows the level of government grants and subsidies in view of attracting airlines and increasing competitiveness. In the past, airlines have little negotiation power due to the airports' monopoly position. Nowadays, with deregulation and more transparent accounting, carriers have a choice over airport locations and have been demanding reduced airport charges.

The power shift has been shown in the reactions among airports. Singapore, being the industry leader, responded to the trend swiftly. A S$210-million Air Hub Development Fund was implemented to provide a competitive incentive package to attract new airlines to fly to Singapore and to encourage existing airlines to expand operations at Changi Airport. Under this incentive scheme, landing fees for airlines and warehouse/office rentals at Changi and Seletar Airports are reduced by 15% for three years starting 1 Jan 2003. According to the IATA Charges Manual, with the rebates granted under this Fund, Changi Airport's landing fees are the second lowest among major airports in Asia (Singapore Air Cargo Directory, 2005). To boost traffic recovery at Changi airport during the SARS period in year 2003, CAAS introduced an innovative Airlines Traffic Development Scheme, a S$114 million SARS relief package offering financial incentives to airlines and the airport businesses that have been affected by the outbreak (MOT, 2003).

Due to the complexity of calculating the exact amount of each item, the framework proposes using landing fee as a representative. It is a fairly accurate sample that reflects the level of total charges and has been used in several other studies on airport performance (ATRS 2002, 2003, 2004, 2005).

5.4.2 Service Charges to Forwarders

Storage and office rental fees are the costs incurred for cargo agents. Though they are of less significance than airport charge to airlines, they are certainly an effective tool to ease the cost pressure on companies and to encourage more logistics players to set up operations. While there exists fair amount of differences in property leasing and office rental, charges on warehouse storage are more consistent across airports. Therefore, property usage is omitted from the current framework and the level of charges to the freight forwarders is therefore represented by warehouse storage fee.

5.5 Labor

Terminal operations are highly labor-intensive, and thus the management of workers are of importantance. Internal management of labor at terminal involves labor allocation and scheduling. Unlike manufacturing industry, the workload at the terminal fluctuates largely with the peak and non-peak time cycles. To make matters more complex, the peak time cannot be predicted accurately due to the delay of flights on the air side and the high fluctuation of the time and amount of cargo lodging-in on the landside. Airport management needs to carefully study the workload distribution and adopt schedules that preempt the uneven workload. Human resource management directly affects the service performance and is one of the most important determinants. As the results of the success level of labor management will clearly be reflected in the service quality, therefore the internal management is not listed as a separate factor under labor to avoid double counting. However, this issue is worth mentioning for its high impact on service quality and operation efficiency.

On a macro level, several factors related to labor influence the attractiveness of an airport. They are issues independent from other core factors and have unique impact on an airport's competitiveness and attractiveness.

5.5.1 Employee Productivity

Labor productivity is a well-established measure for assessing the performance of a business. The labor productivity of a cargo terminal can be measured by tonnage handled per employee. However, different airports operate under different organizational structures and the scope of functions carried out by airport operators varies dramatically. The number of employees depends on the true labor productivity but also the range of services provided. Thus, the productivity ratio may not truly reflect the reality, but it still provides a rough indication if it is interpreted carefully.

5.5.2 Labor Cost

Labor cost was cited as a prime factor affecting airport quality, as revealed from a survey to airlines (Alder & Berechman, 2001). If the freighter needs to establish hub operations at an airport, a large number of staff is needed and the labor cost accounts for a significant portion of the overall cost. In this study, we use the average monthly wage for workers in the transport and storage industry as the indicator of the labor cost.

5.5.3 Skills and Knowledge

Other than costs, the quality of the labor supply is a key determinant of the competitiveness of a hub location. The personnel needed in the air cargo industry vary from the semi-skilled labor to logistics and transportation professionals. As logistics is still a relatively new field in Asia, the logistics talents are in short supply and most countries just start to establish related education and research institutes.

Singapore is regarded as the pioneer in grooming such needed professionals. In 2001, the Economic Review Committee urged the creation of a critical mass of logistics professionals in Singapore in order to sustain an advantage over other low-cost competitors (ERC, 2001). In response, the Economic Development Board set up The Logistics Institute-Asia Pacific (TLI-AP), a collaboration between Georgia Institute of Technology and the National University of Singapore, to promote knowledge intensive logistics/supply chain management projects to raise the logistics capabilities in Singapore. In 2004, TLI-AP launched its second five-year phase, further strengthening its research and education programs as well as improving its outreach to the industry.

5.6 Connectivity

A well-connected network shows the maturity of an airport's development, and its popularity among various users. In return, it attracts more players into the cargo business.

5.6.1 Operating Airlines

The portfolio of the airlines serving an airport determines the structure and spread of its air network and also the choices for shippers and forwarders. The ability to secure internationally reputable airlines reflects the attractiveness of the location. In this sub-factor, we consider not only the total number of airlines operating at the airport, which includes both the all-cargo airlines and the passenger-cargo combi airlines, but also the hubbing effect. The hubbing effect is measured by the number of airlines which use the airport as a major consolidation center for cargo. It is an important indicator of the airport's position in the cargo flow network.

5.6.2 Air Network

As pointed by Page and Gardiner, airports must have a deep knowledge of the way airlines do business in order to successfully attract and retain them (Page, 2003; Gardiner et al., 2005) Forwarders rely on the airport's connectivity to reach out to their customers and they thus value the density of the air network very much. When evaluating the air network, the first key attribute is the number of cities which an airport has direct flight to. With the economic return of scale, the hub-and-spoke network is the dominant pattern for transportation. Traffic is consolidated at the hub, which essentially provides the links to the other destinations. The more points a hub is connected, the more flexibility it has in routing the goods and possibly more ease in building up the volume large enough to enjoy economy of scale.

As part of the connectivity measure, frequency is the other important indicator. Same as the sea cargo, high frequency essentially provides shippers and forwarders higher flexibility in scheduling choices and lower transit time, and thus a more competitive carrier charge (Tongzon, 2002). Cathay Pacific concludes that the success formula for HKIA is its capacity, frequency, and network. Again, frequency is highlighted as the key factor that makes Hong Kong a big consolidation center (Lo, 2005).

5.6.3 Concentration of Cargo Forwarders

Freight operators regard airports that cluster a critical amount of forwarders more favorable since the forwarders are ultimately the customers. A high concentration of forwarders and airlines also indicates a high throughput. Thus the count of cargo agents/forwarders gives a good idea of how successful a location is. For example, Hong Kong which has a good combination of airlines and freight forwarders that offer a wide range of cargo services to meet the needs of all shippers (Lo, 2005).

The importance of having a critical mass at the airport is mentioned repeatedly during the interviews with logistics companies and carriers. Apart from the implication in attracting freighters and nurturing the air cargo logistics market, these airport users also initiate and drive the facility usage. A critical mass of forwarders and carriers gives the airport good returns on capital investment. The process to create such a critical mass is evolutionary. The key is to secure an anchor tenant, which can be a big shipper or large third party logistics (3PL) company, and this early adopter will jump-start the necessary process for building a critical mass.

5.7 Liberalization

The level of liberalization has a critical impact on the attractiveness of a location. Liberalization can be considered from three aspects.

5.7.1 Aviation Policy

Bilateral air service agreements dictate which airline can operate at what frequencies. In a way, aviation rights are present more as a restriction to the choice for airlines than as attractiveness. It is on the very first checklist when airlines are considering choosing an air cargo hub. For cargo airlines, a liberal environment is even more important because air cargo is directionally imbalanced and direct return routes will result in one leg losing money due to the lack of demand. Therefore, it is a common practice for airlines to operate triangular routes to maximize earnings. This requires the fifth freedom[4] of aviation rights. Thus, a country with more liberal aviation policies is more favored by airlines and enjoys busier cargo traffic. Due to the active movement of the Chinese government in expanding air service agreements, the Chinese airports' cargo traffic figures skyrocketed in the last 2 years, with 5 of the top 7 fastest growing sites located in mainland China (Air Cargo World, 2005).

Other than the direct increase in cargo traffic, a more liberal aviation policy enhances the nation's economic development as well. Kasarda and Green conducted a multinational statistical analysis on breaking the barriers in air cargo. Based on a comprehensive 63-nation sample, the study measured the correlation of economic development (GDP and foreign direct investment, or FDI) with aviation

[4] The Freedoms of the air are a set of commercial aviation rights granting a country's airline(s) the privilege to enter and land in another country's airspace. Fifth freedom refers to the right to carry passengers from one's own country to a second country, and from that country to a third country

liberalization, quality of customs and corruption. They found out that nearly 80% of the variance in GDP can be explained by the combination of the 3 factors, with aviation liberalization having the strongest effects (Kasarda & Green, 2004).

5.7.2 Airline Market

An open market allows more foreign carriers to participate in the competition in terms of both network and frequency. It is hard to assert that a low market share by dominant carriers is a sign of the openness of the market. However, empirical results showed that in general, the big airports usually have relatively low hub carrier dominance. In this study, the dominance is measured by the market share of hub carriers in terms of flight frequencies.

5.7.3 Ground Handling

As air cargo industry matures, carriers and forwarders are competing against each other on service variety, quality and price. On the other hand, cargo terminal handling must keep up with more demanding customers. Introducing competition into ground handling, which has long been a monopoly market, is a way to encourage service innovation, differentiation and cost effectiveness. With the demand for a competitive market for terminal services, the Hong Kong Airport Authority granted licenses to both HACTL and AAT, when Hong Kong International Airport prepared to open in 1998. After a period of seven years, the competition did not erode HACTL's profit, but rather made both companies profit and earned Hong

Kong International Airport good reputation in terminal services.

5.8 Competitiveness Index

The above sections have presented a comprehensive set of factors that have strong impact on a cargo airport's competitiveness. The table below summarizes the 7 core factors, and the sub-factors that make up the core factor groups. This will be the building blocks of the Competitiveness Index and are used to measure performance during benchmarking.

Table 5.1 Summary of Seven Core Factors

A: Location	A1: Geographical Position	A11: Accumulative distance to major markets A12: Tonne-kilometers to major markets
	A2: Economic Position	A21: City GDP A22: City population
	A3: Environmental Issues	A31: Operation hours A32: Weather condition
B: Facility	B1: Air-Side	B11: Runway (Number, Length, Efficiency) B12: Ramp area
	B2: Terminal	B21: Warehouse (Area, Efficiency) B22: Parking bays B23: Special cargo storage B24: Material handling
	B3: IT	B31: Cargo labeling B32: EDI
	B4: Inter-Modal Link	
	B5: Logistics	B51: FTZ B52: Airport logistics park
C: Service Quality	C1: Performance Standard (Existence, Enforcement)	
	C2: Cargo Tracking	
	C3: Cargo Safety	
	C4: Cargo Processing Time	

	C5: Truck Queuing Time	
	C6: Customs Clearance	
D: Charges	D1: For Airlines - Landing Fee	
	D2: For Cargo Agents – Warehouse Storage Fee	
E: Labor	E1: Employee Productivity	
	E2: Labor Cost	
	E3: Knowledge and Skills	
F: Connectivity	F1: Operating Airlines	F21: No. of cities with direct flight F22: Weekly flight frequency
	F2: Air Network	
	F3: Cargo Forwarders	
G: Liberalization	G1: Aviation Policy	
	G2: Airline Market	
	G3: Ground Handling	

The above hierarchical factor groups and measurements offer a systematic and comprehensive framework for evaluating the competitiveness of an airport with respect to cargo business. To further provide a meaningful measure on each core factor as well as the overall competitiveness, we propose a simple and yet informative scoring system. Firstly, for the sub-factors at the lowest level, the airports are ranked based on the underlying assumption, for example, the higher the labor productivity, the higher the ranking. Then, the rankings of the sub-factors are aggregated to the next level based on the sum of the sub-factor rankings. A weightage is applied to the sub-factors to reflect the relative importance among the sub-factor set in the overall impact of its parental core factor. The weight could be obtained from extensive surveys to the knowledge experts and practitioners. For simplicity, evaluators may also estimate the weight for a start and adjust it iteratively with data input and analysis. In case of partial data or biased information, the weightage can be a tool to reduce the influence of the imperfection of data. At the core factor level, the rankings of the sub-factors from the lowest level are summed up and subsequently, the total sum is normalized to a single score. The score is on a scale of 1 to 10, with 1 being very poor and 10 being excellent. Weightage can be used at this level too. In this study, all the seven core factors are perceived as equally important and have insignificant differences in their impact on the overall competitiveness of cargo airports.

The advantage of such a score is that it preserves the amount of performance difference between airports. In other words, the score provides information of how much better airport A is compared to airport B, while a simple ranking could only tell that airport A is better than airport B. Yet, the score should be interpreted as the relative measurement within the sample group, that is, a score of 10 means the best within the samples, but not necessarily superior when the comparing subjects are changed. Only if the samples cover all the airports in the world does the score represent an absolute assessment on the airport performance. In the last step, the rankings of the core factors are aggregated before being normalized into the final score — Competitiveness Index. The Competitiveness Index gives each airport a single measure that captures its performance of all the core factors. The following diagram illustrates the algorithm for the scoring system. The next chapter will demonstrate the computation with the actual rankings of top airports in Asia.

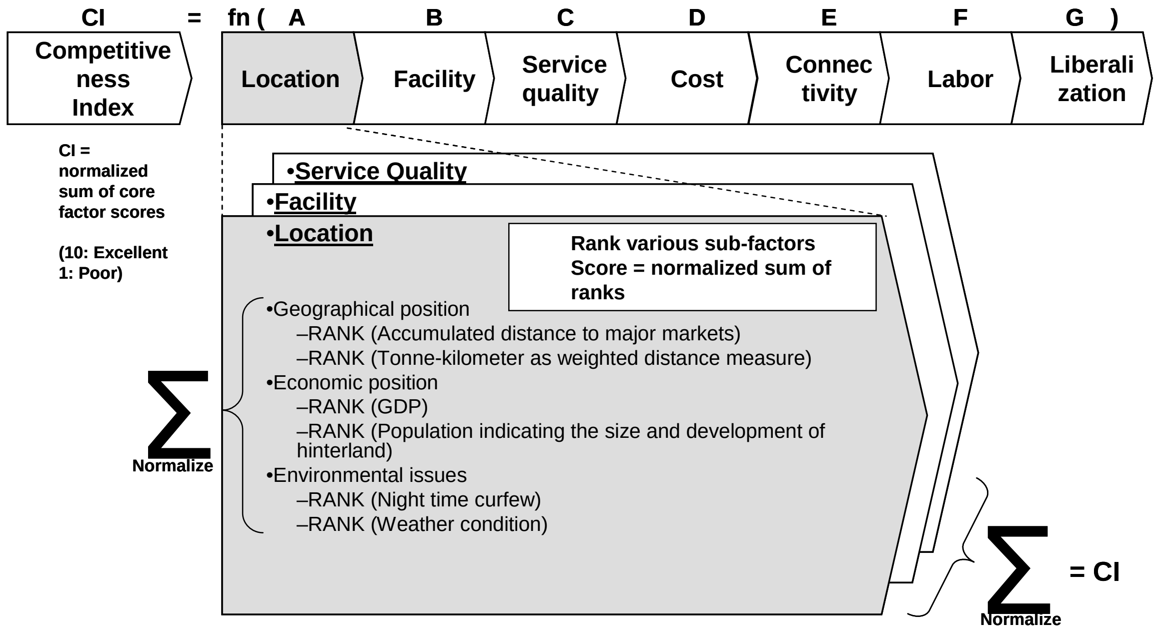

Figure 5.1 Algorithm for Scoring System

The advantage of the benchmarking method in this study lies in the Competitiveness Index. It is simple and easy for interpretation yet captures all the factors identified in the framework. The algorithm embraces similar guiding philosophy as in other multi-criteria decision analysis to overcome the challenge of aggregating non-comparable measures. In essence, it uses ranking so that different quantitative information can be combined and normalized rankings also make it possible to escalate the information to the next level for processing. The strength is it has a very light computation load and therefore possible to scale up for evaluating large volume of samples. It is also generic enough that it provides much flexibility in changing the factors and hierarchy. However, since the method is based on relative comparison within the samples, it would give more robust results only when the sample size is large.

5.9 Validity Test

As a test of its validity, a good evaluation method should produce results that are close to the general perception. From a mathematical viewpoint, correlation shows exactly how relevant two variables are. In this study, the variable under test is the Competitiveness Index and two common performance measures, Traffic and Financial Performance, are chosen to be the benchmarks as explained below.

Traffic volume is the most common measure in air transportation industry as a performance indicator. Since this study is focused on the cargo aspect, tonnage is an obvious choice for measuring traffic.

With the spread of corporatization and privatization, airports are running more like a business and management keeps a close eye on the bottom line. As such, the financial performance reflects the competitiveness of the airport from a different perspective. Net income is a basic indicator of overall financial performance, and is calculated as the difference between operating revenue and expenses. Following the format of FAA (Federal Aviation Authority) Airport Financial Report, the net operating income used here is essentially EBITDA (earnings before interest, tax, depreciation and amortization). Profit margin is another commonly used indicator of financial performance. It helps to mask the absolute size of the business and focus on the profitability. Unique to airport operations, the percentage of aeronautical revenue is an important indicator for its business health. With the reformation of airport management, airports are trying to make more money from the non-aeronautical channels so that they can reduce the service charge to airlines. In the last few years, many airport management went through significant change in corporatization and privatization, and so there is a lack of consistency in bookkeeping. In this study, four indicators are used to depict the financial performance of airports, namely, revenue, % of aeronautical revenue, profit margin and net income. To hedge against volatility, we collected the 3-year financial data in the period of 2002-2004 and took the average in the calculation.

Scores for Traffic and Financial performance are derived in the same way as the 7 core factors. The validity test is conducted based on the benchmarking results of the top Asian airports, which will be explained in detail in the next chapter. The correlation between Competitiveness Index and Traffic is 0.848, and the correlation between Competitiveness Index and Financial Performance is 0.696. Both correlations are significantly high enough to prove that Competitiveness Index is well aligned with Traffic and Financial Performance, and thus is a reliable indicator of airport performance. With this guarantee of validity, we are confident to put the benchmarking framework into practical use and the application on Asian airports is elaborated in the next chapter.

CHAPTER 6: BENCHMARKING ASIAN CARGO AIRPORTS

6.1 Airport Samples

Though the benchmarking framework is applicable to airports of all sizes, this study is dedicated to air cargo hubs and so we would limit the benchmarking targets to airports that fulfill the requirements to be a hub. The screening is based on the following three considerations.

The airports are in relative proximity in geographical sense, and therefore could possibly compete among each other. Though by ACI's definition of regions, Asia encompasses Oceania and West Asia, big airports such as Mumbai, Sydney and Auckland are not included in this research because they are of considerable distance from the other airports of our interest. Moreover, Matsumoto's study on international air network structure shows that these three airports are isolated from the extensive network formed by the other airports (Matsumoto, 2004).

The airport in consideration must be the main international airport serving as the gateway hub for the country or region. In other words, the airport is ensured to have a relatively sizable market and demand catchment. In view of their small percentage of international traffic, Shanghai HongQiao Airport and Tokyo Haneda airport are excluded. Guangzhou Baiyun International Airport is also not in the list though it is the third largest airport in mainland China. The main reason for such exclusion is that Guangzhou has long been eclipsed by Hong Kong. Moreover, in the call for further integration of Hong Kong with the Pearl River Delta, Guangzhou is more likely to be directed towards a more established domestic hub to avoid head-on competition with Hong Kong.

The airport in consideration must also have considerably large cargo traffic and established cargo services. We selected the top performers after consulting ACI's annual cargo traffic ranking from 2000 till 2004, and ATRS airport benchmarking report from 2002 to 2005. The final selected airport samples are 10 airports ranked in the top 30 cargo airports worldwide. Their basic information is listed below and their geographical locations are indicated in the map.

Table 6.1 Airport Samples

Country/Region	City	Airport Name	Airport Code
China	Shanghai	Shanghai Pudong International Airport	PVG
	Beijing	Beijing Capital International Airport	PEK
Hong Kong SAR	Hong Kong	Hong Kong International Airport	HKG
Japan	Osaka	Osaka Kansai International Airport	KIX
	Tokyo	Tokyo Narita International Airport	NRT
Korea	Seoul	Incheon International Airport	ICN
Malaysia	Kuala Lumpur	Kuala Lumpur International Airport	KUL
Singapore	Singapore	Singapore Changi International Airport	SIN
Taiwan	Taipei	Chiang Kai-Shek International Airport	TPE
Thailand	Bangkok	Bangkok International Airport	BKK

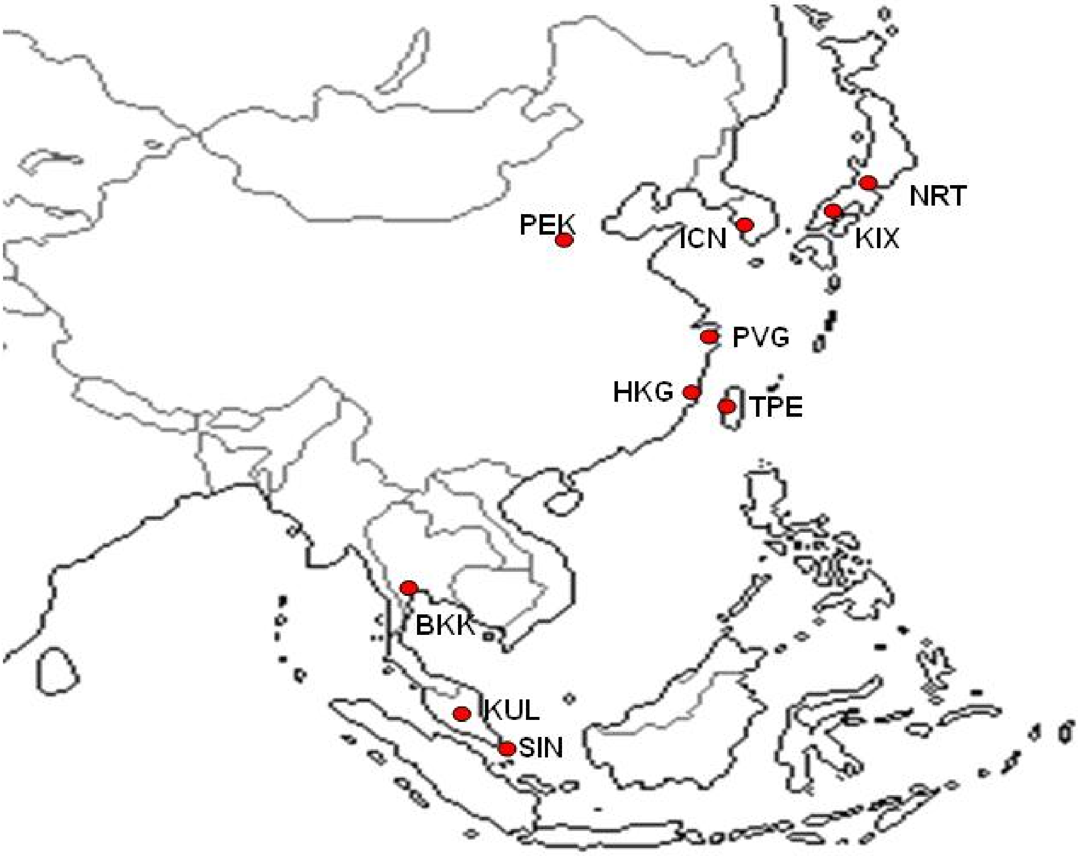

Figure 6.1 Map of Sample Airports

In the rest of the chapter, the results from benchmarking are presented along with the key findings and explanations.

6.2 Location

6.2.1 Geographical Position

The accumulative distance is used as a measure of the closeness of a particular airport to the large markets. In this study, we approximated it by the sum of the great circle distance from a particular airport to the 14 major cargo markets in Asia. These are the cities with the largest air cargo volumes, namely Hong Kong; Tokyo, Japan; Seoul, Korea; Singapore; Taipei, Taiwan; Shanghai, China; Bangkok, Thailand;

Osaka, Japan; Beijing, China; Kuala Lumpur, Malaysia; Guangzhou, China; Manila, Philippines; Shenzhen, China; Munbai, India.

Limited by data availability, the cargo volumes between city pairs are those reported in 2004 Statistical Report of Association of Asia Pacific Airlines (AAPA). AAPA is a dominant trade association of airlines in Asia Pacific region, with 17 members covering all the major airlines in the region except mainland China. In view of its extensive coverage, its statistics is a good representation of the traffic flow. However, as mainland Chinese airlines are not included, there is a data skew. We collected cargo volume distribution by routes from two major Chinese cargo airlines, Air China and China Eastern Airlines and we compensated the AAPA data with this additional data from the representatives of mainland China airlines. The geographical location results are shown in the table below. The accumulative distance and tonne-kilometer has been computed as a relative index again Singapore for easy comparison and interpretation.

Table 6.2 Geographical Location Index

Airport	Accumulative Distance (index SIN = 1)	Tonne-Kilometer (index SIN = 1)
BKK	0.814	0.630
HKG	0.565	0.934
ICN	0.709	0.870
KIX	0.776	0.317
KUL	0.992	0.435
NRT	0.883	0.951
PEK	0.744	0.523
PVG	0.599	0.547
SIN	1.000	1.000

TPE	0.568	0.522

Hong Kong topped the list as the best location in geographical sense. This coincides with the results from Schewieterman's model (Schewieterman, 2002). But when the distance is weighed by cargo volume, East Asian airports are in a more advantageous position, due to the heavier traffic flow from and to the cities. In general, the East Asia airports take the upper hand.

6.2.2 Economic Position

Economic position of the airport is captured by the population and GDP of its catchment. The actual data of the population and GDP are provided in the Appendix. The ranking on the economic position should be read with caution due to the definition of catchment area. There is no standard way for defining the scope of catchment area. As pointed by Preisler, the proximity criteria are dependent on the type of carrier and the airport function. In general, the immediate market for integrated express carriers has a smaller radius compared to all cargo carriers in collaboration with freight forwarders, who are willing to truck more distance (Preisler, 2004).

In this study, the host city of the airport is taken as the catchment. However, in reality, airports especially the international gateways, have a much larger market. For example, Shanghai's air cargo is largely fueled by the Yangtze River Delta, comprising of several most economically prosperous provinces, which contribute to

22% of China's GDP with a 2.2% land (Xinhua News Agency, 2002). In some cases, the particular airport might be the only one in the country having the capabilities required for certain large shippers or forwarders, and therefore, the catchment is almost the entire country. The reason for limiting the catchment to the host city is to cater for the data availability. In addition, some of the sample airports are located in the crowded economic developing belt, having neighboring airports sharing the pie. For long, Pearl River Delta has been the economic powerhouse of Hong Kong and Hong Kong has enjoyed the monopoly with no airport comparable to its superior capacity and quality. But this is changing fast with the neighboring Shenzhen Baoan international airport being named as the best emerging airport by Cargo News Asia in 2005 (Cargo News Asia, 2005b). The new Guangzhou Baiyun international airport opened in 2004 summer with the state-of-the-art facility and one third of the terminal charge compared to HKIA (Putzger, 2005). Hong Kong is facing serious competition from the neighboring cities, but in the short term, due to its superior service and well-established reputation, it would continue to take up the PRD as its catchment.

6.2.3 Environmental Issues

Japanese airports are mostly in the populated urban area and suffer a lot from noise restriction and night curfew. However, most new airports are located relatively away from the downtown area and therefore, have less noise problem. For example, Kansai International Airport, an ingenious architectural breakthrough built on an artificial island, is the first airport in Japan that operates 24 hours. Among the 10 sample airports, other than Tokyo Narita and Taipei Chiang Kai-shek having a night curfew from 2300 to 0600, all the other airports under study are able to operate around the clock thus avoiding the major noise restriction problem that troubles many big airports in the world.

All the cities have mild climate, except for the airports on the coastal areas that may be affected by typhoons in summer, causing delay or closure of the airport. Ideally, the weather condition is quantified by the number of days with unsuitable weather for flight operations or the historical data on the days of airport closure due to bad weather condition. However, limited by data availability, we rated the sample airports equally since none of them suffers from severe weather that threatens the safety of aircraft operations.

6.2.4 Overall Location Ranking

The rankings of the location category including the sub-factors are displayed in the table below.

Table 6.3 Rankings of Location Category

Airport	Geographical Location	Economic Position	Environmental Issues	Overall
BKK	8	9	1	8
HKG	4	5	1	5
ICN	6	2	1	3
KIX	2	2	1	1
KUL	6	10	1	9

NRT	9	1	9	7
PEK	4	5	1	5
PVG	3	3	1	2
SIN	10	8	1	10
TPE	1	7	9	3

We will use Location as an example to demonstrate the details of computing the overall rank. The remaining six core factors follow the same algorithm in obtaining the ranking.

First, each sub-factor at the lowest level, i.e. A11, A12, A21, A22, A31, A32 is ranked based on the raw data input, from 1 to 10 indicating the best to the worst. Then, the subtotal is calculated, which is simply the sum of the ranks within the particular sub-group, e.g. Subtotal of A1 = rank of A11 + rank of A12. Based on the subtotal, the sub-factors, i.e. A1, A2, A3, are ranked in the same way as before, 1 to 10 signifying the best to the worst. The sub-factor ranking are lighted in blue shaded cells in the table above.

To obtain the rank of the core factor A, we follow a similar procedure. Subtotals of all sub-factors are summed up with weight applied to each sub-factor group. In Location category, A1 and A2 has an equal weight of 1 and A3 has a weight of 0.5 for two reasons. Firstly, compare to geographical location and economic position for a city, the environmental issues are regarded as less influential, as long as it does not impose operation restriction. Under normal circumstances, a better environment does not necessarily increase the attractiveness of the airport to cargo airlines.

Secondly, the data inputs are largely from descriptive information and the quantification might not be an accurate reflection of the difference in cities. So a smaller weight could help to reduce the data bias. The weighted sums are now normalized to obtain Scores, which is in the range 1 to 10, 10 being the best and 1 being the worst. Final rank of factor A – Location is a simple sorting of all sample airports based on their scores. While Scores preserve the quantitative difference between samples, Ranks emphasis more on the order. Both presentations are highly informative to airport managers and decision makers.

Table 6.4 Detailed Rank and Score for Core Factor - Location

	Airports		BKK	HKG	ICN	KIX	KUL	NRT	PEK	PVG	SIN	TPE
A	Location	Rank	8	5	3	1	9	7	5	2	10	3
		Score	3.7	7.3	7.8	10.0	2.4	6.0	7.3	9.1	1.0	7.8
A1	Geographical position		8	4	6	2	6	9	4	3	10	1
A11	Accumulatvie distance		7	1	4	6	9	8	5	3	10	2
A12	Tonne-kilometer		6	8	7	1	2	9	4	5	10	3
	Subtotal		13	9	11	7	11	17	9	8	20	5
A2	Economic position		9	5	3	2	10	1	5	3	8	7
A21	Population (million)		7	6	4	5	10	3	2	1	8	9
A22	GDP (billion USD)		8	5	4	2	10	1	9	7	6	3
	Subtotal		15	11	8	7	20	4	11	8	14	12
A3	Environment issues		1	1	1	1	1	9	1	1	1	9
A31	Operation hour		1	1	1	1	1	9	1	1	1	9
A32	Weather		1	1	1	1	1	1	1	1	1	1
	Subtotal	0.5	2	2	2	2	2	10	2	2	2	10
Total			29.0	21.0	20.0	15.0	32.0	24.0	21.0	17.0	35.0	20.0

Looking at the result of Location ranking, overall, East Asian airports are ranked higher than the rest. The main reason for this is that compared to the Southeast Asian cities, Japan, China and Korea cities are more populated and have a larger economy, which promise a larger local market to be tapped on. Moreover, Tokyo and Incheon are situated on the east most edge of Asian continent, and are naturally the stops for consolidation and aircraft fueling before the cargo is taken over the Pacific Ocean. Singapore has the worst location, which re-confirms the results from Schewieterman's study on express hub locations in Asia, but this should be interpreted with care. Singapore is geographically located at the south tip of the economic region, which is relatively far from the major air cargo centers. Because of this, it does not have the advantage of tapping on O/D traffic, which is regarded as a more profitable source of air cargo. However, as Singapore is en route to Europe and North America and has the best facilities and services in the world, many airlines choose it as the transshipment hub. In fact, such transit traffic contributes a high percentage of the total traffic.

6.3 Facility

6.3.1 Air-Side

Most airports in the sample have 2 runways of full size, except for Kansai and Narita. Kansai has only one 3500m runway and is planning to build the second one in the near future. Narita though has 2 runways but one of them is only long enough for small size aircrafts. Many airports are still in the process of adding new runways, such as PuDong airport which eventually will have 5 runways. In terms of efficiency, Beijing is significantly higher than the rest probably due to its large number of aircraft movements.

6.3.2 Terminal

There exists a large disparity in warehouse space among the sample airports, with Taipei having over triple the size compared to Kuala Lumpur. However, Narita and Singapore are leading the way in space utility. PuDong is doing fairly well on warehouse efficiency as well, perhaps forced by the large volume coming in and out of the terminals. All the airports have built in or upgraded to the state-of-the-art warehouse facilities and technology, equipped with special cargo storage and ASRS for cargo storing and retrieving.

6.3.3 Information Technology

Due to sensitivity issues, there is no complete detail on the information systems deployed in the airports. We assessed the advancement of IT systems based on description in the airport annual reports, promotion materials available to the public. One good indicator of the level of technology deployed in the airport is the Electronic Data Interchange (EDI). For example, Singapore Air Cargo Division introduced various IT systems such as the Air Cargo EDI System (ACES), the Advance Clearance for Courier and Express Shipments System (ACCESS) and the Electronic Payment and Invoicing for Cargo (EPIC) to ease customs clearance procedures and movement. It pioneered the TradeNet System, allowing for traders to conduct trade declarations over the internet and speeding the approval process by controlling authorities. TradeNet will be linked to the country-wide Integrated Trade and Logistics IT platform. Other remarkable airports are Hong Kong and Incheon.

6.3.4 Inter-Modal Link

To provision for future expansion and avoid noise restriction, all new airports are located far from downtown. However, such a location choice imposes a challenge in connecting the airport to the main transportation grid. Most of the airports have recognized the critical role of easy airport access and built dedicate highways to link the airport to the main city and/or nearby industrial areas. For those airports constructed outside the city, inter-modal connection is given more emphasis in airport planning and marketing. Upon the opening of Incheon International Airport, access to the airport is facilitated by the newly constructed, 8-lane Incheon International Airport Expressway stretching 54.4 km and linking the airport to Seoul. Built on a reclaimed island, the access to Kansai International Airport all depends on the road/railway bridge, of which the upper roadway level is part of the Kansai Airport Expressway linking to the nearby Rinku Town.

6.3.5 Logistics Facilities and Support

More airports start to realize the necessity to have logistics facilities near to the site. On one hand, the airport provides the needed transportation infrastructure to the logistics or manufacturing companies in the logistics park. On the other hand, the booming activities close to the airport in turn create cargo business for the airport. Overall, the proximity helps to save both money and time tremendously.

The 26-hectare Airport Logistics Park Singapore (ALPS), opened in March 2003, was developed to promote the growth of logistics as a driver for air cargo shipments. Its establishment has heightened Changi airport and Singapore at large as a regional hub. It is strategically located within the airport FTZ where customs formalities are minimal. Thus, major third party logistics players can undertake rapid, value-adding replenishment and fulfillment activities for the entire region with greater efficiency as time and manpower relating to transportation and documentation are reduced. ALPS is almost fully occupied with tenants that are important players in the logistics industry.

In Hong Kong, the 30-hectare (74-acre) South Commercial District is composed of logistics facilities, including the world's largest stand-alone air-cargo and air-express facility and a 139,000-square-meter mixed-use freight-forwarding warehousing and office complex.

Kuala Lumpur International Airport was designed to provide the aviation foundation for Malaysia's Multimedia Super Corridor (MSC), a high-tech government, commercial, education, and residential zone. The entire cargo area is declared as a

FTZ.

In early 2004, China Capital Airports Holdings announced that it was proceeding with constructing a US$12 billion Airport City at Beijing Capital International Airport. The objective is to create the world's largest multifunctional development, leveraging the rapidly growing airport (expected to reach 80 million passengers in 2015, compared with 30 million in 2004) and serving as a logistical and commercial gateway for the 2008 World Olympics Games. Capital Airport City has a total planning area of 1 million square meters composed of a 600,000-square-meter airport operating zone, a 250,000-square-meter commercial and residential zone, and a 150,000-square-meter airport free-trade zone.

At Incheon, an Airport Support Community consisting of airport-related industries (primarily logistics), commercial services, and housing for airport-area employees and their families, which total up to 100,000 has been completed as the first phase of development. An additional 99.2 hectare (245-acre) commercial project under development is the Airport Free Zone. This international logistics and manufacturing zone is fully operational in 2006 (Karsarda, 2004).

6.3.6 Overall Facility Ranking

The rankings of the Facility category including the sub-factors are displayed in the table below.

Table 6.5 Rankings of Facility Category

Airport	Air-side	Terminal	IT	Intermodal	Logistics	Overall
BKK	4	7	6	8	9	9
HKG	1	1	1	1	3	1
ICN	7	2	3	1	3	4
KIX	10	7	5	1	9	8
KUL	8	9	6	10	1	9
NRT	3	2	3	1	3	2
PEK	2	10	8	1	3	7
PVG	6	6	8	1	3	5
SIN	8	5	1	1	1	3
TPE	5	2	8	9	3	6

The clear leader is Hong Kong as expected, dueto all the investment and effort in building the hardware such as basic infrastructure and the software such as the advanced IT system. Following closely is Narita, and then Singapore, which did not score well in air-side facilities due to the relatively cramped ramp space. Bangkok and Kuala Lumpur surprisingly have the lowest ranking due to different reasons. Bangkok is actually fairly good in the on-site infrastructure i.e. air-side and terminal facilities, but not in peripherals which help the airport to better connect to the outside and also get support. Kuala Lumpur on the other hand needs more improvement in the air-side, and terminal facilities and management. It also needs to look into building more linkages to connect the airport with other transportation modes.

6.4 Service Quality

Due to the reason that most airports have not started rigorous measuring and monitoring of service quality, there is no complete data available from airports with respect to the metrics defined in this benchmarking framework. Even in the case where airports do have performance reviews, different measurements are used at different airports. So it is not practical to collect first hand data from the airports. The second best choice is to survey the airport users and take their evaluations as a gauge of the service quality measurements of the sample airport.

In this study, the data input is taken from the Air Cargo Excellence (ACE) Survey conducted by the well-known industry magazine - Air Cargo World. The airports are rated by airport customers worldwide through four measures, and of particular interest to this study is the Performance. It is defined as “Fulfills promises and contractual agreements, dependable, prompt and courteous customer service, allied services - ground handling, trucking, etc.”, which is a fairly close reflection of the factors this study wishes to measure upon (Air Cargo World, 2006). The ratings for each airport, which are presented as an indexed score in the ACE survey, are used to calculate the score for Service Quality in this study and the ranking is obtained afterwards using the same algorithms as the other core factors.

The results are as shown in the table below.

Table 6.6 Rankings of Service Quality

Airport	ACE ranking	Rank
BKK	91.1	10
HKG	109.3	1
ICN	101.7	4
KIX	104.0	2

KUL	95.9	7
NRT	96.5	6
PEK	95.7	8
PVG	92.3	9
SIN	103.7	3
TPE	100.0	5

The results show a strong correlation between the high volume throughput at the airport and the service quality. For example, Singapore has implemented a strict performance measuring and monitoring procedure with standards shown in the table below.

Table 6.7 Cargo Service Performance Standards in Singapore

Activity	Performance Standards	Target (%)
Cargo Document Handling Availability of cargo documents (e.g. airway bills) for collection by consignees at the airfreight terminals.	Passenger Aircraft: Within 2 hours after actual time of flight arrival. Freighter Aircraft: Within 4 hours after actual time of flight arrival.	90% 90%
Physical Cargo Handling Availability of physical cargo for collection by consignees at the airfreight terminals.	Passenger Aircraft: Within 4 hours after actual time of flight arrival. Freight Aircraft: Within 6 hours after actual time of flight arrival.	90% 90%
Express Cargo Handling Availability of express cargo for collection	Within 1 hour after actual time of flight arrival (regardless of pax or freighter flights).	90%

The two ground handlers at Singapore airport, SATS and CIAS, have been performing up to the standards consistently over nearly a decade since the implementation of the performance measuring and monitoring procedure(CAAS). Singapore deserves the high praise it received from international airlines and logistics companies, and its good services are rewarded with high throughput and healthy financial records.

Hong Kong, as another leader in the industry, has also demonstrated its success strategy. The players involved agreed upon a set of performance standards industry wide as shown in the table below.

Table 6.8 Cargo Service Performance Standards in Hong Kong

	Indicator			
Landside			**CTO**	**Target %**
	Truck Queuing Time		30 mins	95%
	Export Cargo Reception		15 mins	95%
	Import Cargo Collection		30 mins	95%
	Empty ULD Release		60 mins	95%
In-Terminal	Cargo Breakdown			
	♦ General	<10 tons	2 hrs	95%
		10 - 50 tons	5 hrs	95%
		> 50 tons	9 hrs	95%
	♦ Perishable		60 mins	95%
	♦ Express		60 mins/30 mins	95%
	Mishandling Rates		1.5 in 10 000 shipments	N/A
	Number of consignment breakdown by nature ♦ Wrongly Forwarded ♦ Short-shipped ♦ Unlocated			
	Late-positioning		1 unit/1 000 Flts	N/A

Definition

1. Truck Queuing Time - The waiting time of a truck at the parking area to enter the cargo terminal operator's area.
2. Export Cargo Reception - The waiting time of a consignor/ shipper/ trucker, after having registered at CTO (Cargo Terminal Operator) reception points, to be served for the first piece of cargo.
3. Import Cargo Collection - The waiting time of a consignee/ trucker, after having submitted

Shipment Release Form (SRF) at import collection points, to receive the first piece of cargo.

4. Empty ULD Release Time - The processing time of a truck after arriving at the truck dock, to take the delivery of the first empty unit loading device (ULD).
5. Cargo Breakdown Time
   a. General Cargo - The time to complete the breakdown of general cargo after last unit of cargo acceptance at airside.
   b. Perishable Cargo - The time to complete the breakdown of perishable cargo after last unit of cargo acceptance at airside.
   c. Express Cargo - The time to complete the breakdown of express cargo after last unit of cargo acceptance at airside.
6. Mishandling Rates
   a. Wrongly forwarded: Cargo found at outport unmanifested.
   b. Short-shipped: Manifested cargo missing at destination but found at cargo terminal operators.
   c. Unlocated: Cargo unable to be located at the time of delivery or build up.
7. Late Positioning: Late handover of the export unit to ramp handling operators causing cargo being left out.

This set of performance standards not only set high expectations, but also define every detail in the process very well. Though not mandatory, the ground handlers at HKIA understand the importance of keeping up with world-class services and have achieved remarkable performances. Both HACTL and AAT reported achieving all targets in 2004 and a general increase in the processing speed in 2005, with AAT having a higher percentage that might be attributed to its relatively smaller size (HATCL, AAT). This accounts for Hong Kong’s high ranking in the ACE survey.

6.5 Charge

6.5.1 Landing Fee

The landing fee is represented by the fee for the typical Boeing 747-400, which is a common practice in the cost evaluation for air transportation. Airports usually do not publish their landing fee to the public, and we have to obtain the data from the ATRS report 2005. The landing fee of the typical Boeing 747-400 in 2003 at sample airports are provided in the Appendix. The two Japanese airports charge extremely high landing fee due to the congestion at the airports and high labor costs. The Chinese airports are surprisingly the second most expensive for airlines in terms of landing fee. It reflects the high demand for traffic flow in and out of China, and thus the airports can enjoy charge a premium charge. However, in the long run, the high charge may turn away potential customers and even drive away the existing airlines if they have other choices. We have seen such a concern at Hong Kong when the new Guangzhou Baiyun airport was completed. The general consensus in the industry is that the airport needs to increase the share of non-aeronautical business in the revenue, and then pass on the benefits to airlines so as to attract more traffic and expand the air network.

6.5.2 Warehouse Storage Fee

Storage charge is gauged by the 48-hour warehouse storage charge for 100kg cargo, taken from TACT (The Air Cargo Tariff) published by IATA. Many airports in the sample offer free storage up to 48 hours, giving forwarders and consignees much flexibility and convenience in scheduling cargo pick-up. Chinese airports charge the highest fee for storage, which again is probably due to the high demand. The storage fee for 100kg cargo within 48 hours at all sample airports are provided in the Appendix.

6.5.3 Overall Charge Ranking

The rankings of the Charge category are shown in the table below.

Table 6.9 Rankings of Charge Category

Airport	Landing Fee	Warehouse Storage	Overall
BKK	1	1	1
HKG	6	1	5
ICN	6	1	4
KIX	7	1	7
KUL	4	7	3
NRT	10	1	10
PEK	7	9	8
PVG	7	9	8
SIN	3	1	2
TPE	5	8	6

Bangkok appears as a clear cost leader in the group as it is in general a low-cost country. What is more remarkable is Singapore, which is ranked second. The airport authority has put in large amount of effort to lower the charge and ensure its cost competitiveness over the neighboring low-cost countries such as Malaysia and Thailand, which have imposed a serious threat on the cost front. The bottom performers are Narita due to its skyrocketing landing fee and the two Chinese airports for their high landing fee and warehouse charge.

6.6 Labor

6.6.1 Employee Productivity

We adopt a common partial measure of labor productivity. It takes work load unit[5](WLU) as output and number of employees working at terminals as input and the ratio indicates the productivity. Due to the fact that airport operators handle both passenger services and cargo services, WLU, which combines both passenger and cargo traffic, is a more appropriate measure of the output at terminals. The actual WLU data is provided in the Appendix. There is an extremely large disparity in the labor productivity. In general, the more developed a city/country is, the higher productivity it demonstrates. Such observation may be due to two reasons. Firstly, the workers are better equipped with necessary skills and knowledge and are more capable to deliver work. Secondly, the workers are more costly in the developed countries, and therefore, the management is more cautious in labor planning in such a way that the usage is optimized. As mentioned in the previous chapter, the business scope of airport management and the extent to which airports outsource some functions may have a large influence on the productivity ratio. Therefore, the partial measure on productivity should be interpreted with caution.

6.6.2 Labor Cost

Labor cost is estimated from the average salary in the logistics industry. It represents the cost for cargo airlines and freight forwarders, who have set up operations at the airport. Japan is badly hurt by its high labor cost, which is more than ten times to that of Beijing.

[5] Work Load Unit (WLU) is defined as 1 passenger or 100kg cargo.

In the case where the sample airport is situated in a more advanced city, data taken from national statistics reports may not truly reflect the cost of labor in the city. To avoid such a problem, city data is used for the two Chinese cities, and thus there should be no concern that cost is underestimated for these two cities, which are more developed than the rest of the country. The actual data of labor cost is provided in the Appendix.

6.6.3 Skills and Knowledge

In the logistics and transportation industry, there is so far no standard examination to qualify workers and professionals in this area. It adds much difficulty to quantitatively measure the knowledge and skill readiness of labor. We researched on the availability of educational programs and courses on logistics and air transportation industry, and also surveyed the industry experts and employers on their assessment of labor quality. Based on the information collected from various sources, scores were assigned to the sample airports.

6.6.4 Overall Labor Ranking

The rankings of the Labor category are shown in the table below.

Table 6.10 Rankings of Labor category

Airport	Productivity	Knowledge and Skills	Cost	Overall
BKK	6	7	3	5
HKG	2	2	6	1
ICN	4	3	7	3
KIX	5	3	9	7

KUL	8	7	4	9
NRT	3	3	9	4
PEK	10	10	1	10
PVG	9	7	2	8
SIN	7	1	8	5
TPE	1	6	5	2

Despite its relatively high cost, Hong Kong managed to obtain the best ranking for labor competitiveness. Though it can provide the cheapest labor, Beijing still has a long way to go in order to catch up on productivity and labor quality. The contrast between Hong Kong and Beijing provides a good insight, that is, counting on the low labor cost does not really give much advantage. After all, it is high productivity and adequate training and education that will help the airport build the competitiveness.

6.7 Connectivity

6.7.1 Operating Airlines

As expected, Hong Kong has the largest number of airlines flying in and out since it has been Asian's gateway for a long period time. The two Chinese airports are catching up quickly and have already won the same standing as Singapore. They actually do not have many airlines serving the city/region, but rather, their winning factor is in the large number of airlines hubbing at Beijing and Shanghai, which may be explained by the large amount of air cargo generated by manufacturing.

6.7.2 Air Network

Kuala Lumpur has a very low ranking in the number of cities connected and also a relatively low ranking in the number of airlines operating at Kuala Lumpur International Airport (KLIA). This is indeed a concern expressed by the managing director of Malaysia Airport Holding Bhd. The airport authority is trying to have more airlines coming from Europe and Australia to complete the air network, especially, British Airways and Qantas, which pulled out from KLIA during the 1998 financial crisis (Payload Asia, 2005). Singapore and Hong Kong top the ranking as expected, which is highly correlated to the concentration of airlines.

6.7.3 Cargo Forwarders

Information on cargo forwarders is not easily available and the freight center tenants change frequently. The subsequent analysis is based on the self-reported data from airports and local directory of cargo forwarders. Taipei, Singapore, Hong Kong and Incheon, which traditionally have active cargo industry, also have a large freight forwarder community. It creates much attractiveness to the airlines and this in turn helps the community to further benefit from the airline variety.

6.7.4 Overall Connectivity Ranking

The rankings of the Connectivity category are shown in the table below.

Table 6.11 Rankings of Connectivity Category

Airport	Cargo Airlines	Air Network	Forwarders	Overall
BKK	5	7	6	7
HKG	1	2	3	2
ICN	9	4	3	5
KIX	8	9	7	10

KUL	10	8	5	9
NRT	5	6	7	6
PEK	2	7	7	7
PVG	2	4	7	4
SIN	2	1	2	1
TPE	7	10	1	8

Once again, Singapore and Hong Kong, who have indeed invested tremendous resources to establish a well-connected network, are ranked highly. One insight from the ranking is that it takes time to build up a good connectivity and airports need to constantly review and improve in order to stay connected. Kansai, as a fairly new airport coupled with other issues such as cost, obtained the lowest rank.

6.8 Liberalization

6.8.1 Aviation Policy

Singapore scored high in aviation policy, followed by China, which may be perceived as a surprise. However, in recent years, China has been speeding up its ‘Open Door’ process. Over two dozens bilateral agreements were re-negotiated with much liberal cargo rights and a number of new air service agreements were signed. Cargo open sky policy with Australia, New Zealand and Thailand sets no limitation on 3rd, 4th, and 5th freedom rights on air traffic. US airlines are allowed to build cargo hubs with no limitation on 3rd, 4th 5th and 7th freedom rights[6]. 111 new weekly frequencies on all-cargo services will be added through 2010 (Wang, 2004).

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[6] 3rd freedom right refers to the right to carry passengers or cargo from one's own country to another.
4th freedom right refers to the right to carry passengers or cargo from another country to one's own.
7th freedom right refers to the right to carry passengers or cargo between two foreign countries without continuing service to one's own country.

6.8.2 Airline Market

With regard to hub carrier dominance, the two Japanese airports and Hong Kong lead the way while Singapore and Kuala Lumpur are lagging behind. However, the overall market share of dominant carriers in Asia is noticeably lower than that in North America and Europe (ATRS, 2005). Overall, all sample airports, except KLIA, are above the world-wide average. The dominant carrier and its market share of sample airports are displayed in the table below.

Table 6.12 Airline Market Share

Airport	Dominant carrier	Market share
BKK	Thai Airways	36.3%
HKG	Cathay Pacific	25.3%
ICN	Korean Air	37.0%
KIX	Japan Airlines	25.4%
KUL	Malaysia Airlines	58.3%
NRT	Japan Airlines	23.9%
PEK	Air China	37.2%
PVG	China Eastern	32.7%
SIN	Singapore Airlines	50.0%
TPE	China Airlines	29.0%

6.8.3 Ground Handling

Most sample airports have more than one ground handlers, except Narita and Kansai, whereby the airport authority covers nearly all the functions in the airport business value chain. The ground handler is often the subsidiary of the dominant cargo carrier in the hub, which is healthy for close coordination needed between airlines and terminals. The cargo terminal operators at the sample airports are listed in the table.

Table 6.13 Cargo Terminal Operators at Sample Airports

Airport	**Cargo Terminal Operator(s)**			
BKK	Thai Airways	Thai Airports Ground Services Co. Ltd (TAGS)		
HKG	Hong Kong Air Cargo Terminals Ltd (HACTL)	Asia Airfreight Terminal Ltd (AAT)		
ICN	Korean Air	Asiana Airlines	IIAC Foreign Carrier Cargo Terminal Co	
KIX	Kansai International Airport Co. Ltd (KIAC)			
KUL	MASKargo	KLAS cargo		
NRT	Narita International Airport Co. Ltd (NIAC)			
PEK	Beijing Ground Service Co. Ltd (BGS)			
PVG	Shanghai Pudong Intional Airport Cargo Terminal Co. Ltd (PACTL)			
SIN	Singapore Airport Terminal Services (SATS)	Changi International Airport Services (CIAS)		
TPE	Taiwan Air Cargo Terminal Ltd (TACTL)	Evergreen Warehouse & Storage Co.	Ever Terminal Co.	Far Glory Air Cargo Terminal

6.8.4 Overall Liberalization Ranking

Overall, Singapore and Hong Kong are ranked as the most liberal cargo hubs, while Bangkok will have to catch up particularly on international aviation policy. The results of evaluation on liberalization of the sample airports are shown in the table below.

Table 6.14 Rankings of Liberalization Category

Airport	Aviation Policy	Airlines	Ground Handling	Overall
BKK	9	6	4	10
HKG	5	7	2	3
ICN	6	2	4	1
KIX	7	3	7	7
KUL	4	10	4	9
NRT	7	1	7	5
PEK	2	8	7	7
PVG	2	5	7	3
SIN	1	9	2	1
TPE	10	4	1	5

6.9 Competitiveness Index

Based on the algorithm explained in the last chapter, the scores and rankings for each core factor are derived. These scores are then used to calculate the competitiveness index by a two-step process, which essentially involves aggregating and normalizing. The table below demonstrates the calculation for Bangkok on Location category. First, the score of A11 is added with that of A12 to obtain the subtotal for A1, that is, 13. It is then compared with the other 9 sample airports to obtain the rank, that is 8. The same procedure is then repeated for A2 and A3, which factors in a weight of 0.5 to reflect the less importance of A3. Next, the subtotals of A1, A2 and A3 sum up to the total for A, that is, 29. This is again compared with the total for A of other sample airports to obtain the rank for Bangkok on category A, that is, 8.

Table 6.15 Computing Rank of Bangkok on Location Factor

A	Location	Rank	8
		Total	29
A1	Geographical position	Rank	8
A11	Accumulative distance		7
A12	Tonne-kilometer		6

		Subtotal	13
A2	Economic position	Rank	9
A21	Population (million)		7
A22	GDP (billion USD)		8
		Subtotal	15
A3	Environment issues	Rank	1
A31	Operation hour		1
A32	Weather		1
		Subtotal (weight:0.5)	1

The scores are the result of normalizing the totals of all the airports, by forcing the lowest score, 35 from Singapore in this case, to 1.0, and forcing the highest score, 15 from Kansai, to 10.0. The rest of the scores are spread in the range of 1 to 10, with the relative distances proportional to the differences in their totals. The computation is shown in the table below.

Table 6.16 Computing Scores on Location Factor

Airport	Total	Score
BKK	29	3.7
HKG	21	7.3
ICN	20	7.8
KIX	15	10.0
KUL	32	2.4
NRT	24	6.0
PEK	21	7.3
PVG	17	9.1
SIN	35	1.0
TPE	20	7.8

To obtain the final Competitiveness Index, we aggregate the score all the seven core factors following a similar procedure as how rankings of sub-factors are aggregated within each core factor group. First, the scores of seven core factors with the assigned weight are summed up for each airport sample and then the sums are normalized to the range 1 to 10, 10 being the best and 1 being the worst. The sorted Index in descending order gives the final ranking of airport competitiveness.

In this study, we used equal weights for all the core factors as they all have important impacts on the competitiveness of an airport, and any bias or underestimation of a factor will prevent the final result from truly reflecting the reality. Nevertheless, an individual organization, be it the airport authority or logistics company, may have different emphasis on the factors. To cater to such organizational needs and priorities, they can simply assign different weights to the scores of core factors before aggregating. Thus, they could arrive at a competitiveness index based on their pre-requisites on sample airports.

The final result displays an interesting grouping effect. Hong Kong assumes the leadership role by a large margin. Singapore and Incheon are in the middle of the ranking. Singapore actually scored well in most of the factors, except for Labor. Its labor productivity pulled down the overall ranking. However, this has to be taken with caution because different airports report very different head counts. The rest of the airports fall into a cluster, within which the indices are very close to each other. The implication of the competitiveness index and rankings is further explained in the next chapter. In summary, they provide rich information and deep insights on the current standing of the airports and key areas they should improve for maximum return. The overall results of benchmarking are shown in the table on the next page.

Table 6.17 Overall Benchmarking Results

	Location		Facility		Service quality		Cost		Connectivity		Labor		Liberalization		Competitiveness	
	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Index
BKK	8	3.7	9	1.0	10	1.0	1	10.0	7	3.9	5	5.1	10	1.0	9	1.4
HKG	5	7.3	1	10.0	1	10.0	5	5.0	2	9.6	1	10.0	1	10.0	1	10.0
ICN	3	7.8	4	6.3	4	6.3	4	7.0	5	5.0	3	6.7	3	7.4	3	6.4
KIX	1	10.0	8	1.3	2	7.4	7	2.0	10	1.0	7	4.3	7	3.6	6	3.4
KUL	9	2.4	9	1.0	7	3.4	3	7.2	9	2.1	9	2.6	9	2.3	10	1.0
NRT	7	6.0	2	7.6	6	3.6	10	1.0	6	4.2	4	5.9	5	6.1	5	3.6
PEK	5	7.3	7	3.1	8	3.3	8	1.6	3	6.4	10	1.0	7	3.6	8	2.0
PVG	2	9.1	5	3.6	9	1.6	8	1.6	4	6.0	8	3.5	3	7.4	7	2.9
SIN	10	1.0	3	6.6	3	7.3	2	8.0	1	10.0	5	5.1	1	10.0	2	6.8
TPE	3	7.8	6	3.4	5	5.4	6	3.9	8	2.4	2	8.4	5	6.1	4	4.5

CHAPTER 7: RECOMMENDATIONS AND CONCLUSIONS

From the previous sections, airport managers would obtain a fairly comprehensive picture of where the airport stands in the spectrum of ten best airports in Asia. For those who are still lagging behind, an immediate task is to identify the areas that weaken the airport performance most and quickly rectify them in order to stay in the competitive market. However, different airports are governed by different managerial and ownership structure and are operating in different environments. The best practice in the entire group may not be applicable to certain airports and a crude imitation of the best practice will not yield meaningful results. Therefore, differentiating airports by their environmental factors is necessary to make the discussion more relevant.

7.1 Performance Matrix

Based on the past studies and interviews, two factors, namely catchment market size and strength of base airlines, emerge as the predominant issues that shape the environment an airport operates in. It is clear that the economic development and potential growth of the catchment market defines the source and size of the air cargo business.

The base airlines affect the airport performance in several ways. Firstly, the alliance that the base airline is in largely defines the outreach of the airport's network. Through code sharing and information exchange, alliance members enjoy the synergy of revenue and customer services, which benefits their respective hub bases as well. Secondly, since most of the base airlines have more than one-third of their market share in its home airport, the thriving or perishing of the airport is dependent on that of its base airline to a large extent.

Using the catchment market size and strength of base airlines as the two different dimensions, a 2x2 matrix is constructed to identify the position an airport is in and the correlation with its performance. In detail, the position of an airport is based on its index of the two dimensions, with the horizontal axis being the catchment size and the vertical axis being the strength of base airlines. The airport is marked by a circle, the size of which is the performance index derived from the previous benchmarking framework. In order to avoid direct correlation between the axis of the matrix and the performance measure, the location factor is removed in calculating the airport performance index. Taking the median of each dimension, the space is divided into 4 quadrants, representing 4 types of operating environments. The figure below shows the positions of the various airports along with their performance.

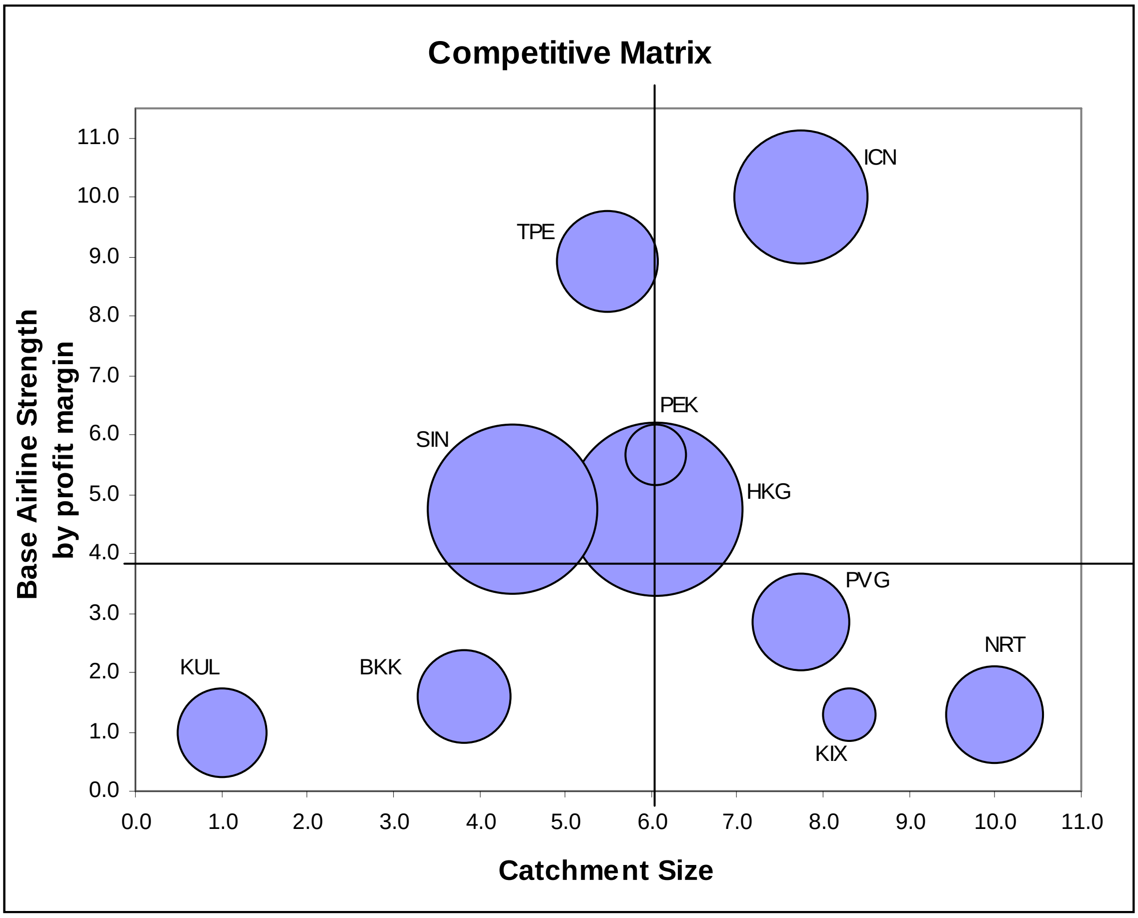

Figure 7.1 Competitive Matrix of Sample Airports

7.2 Strategic Implications

The airport performance matrix can be a tool for crafting both the short-term and long-term strategies.

In the short term, neither the size of catchment market nor the strength of base airlines will change much. Moreover, these factors are mostly beyond the control of airport management and so the position of the airport in the matrix is considered to have been fixed. Thus the management should zoom into the particular quadrant that the airport is in and compare its airport with the others within the quadrant. These are airports under very similar environments and therefore the practices and strategies are more applicable to them as a group. The airport under investigation could first compare its score of every core factor in the benchmarking framework and identify one or two factors that have a large gap in score to the best practice in this quadrant. Next, it can look more closely at various sub-factors within the core factor group and find out which particular sub-factor is pulling down its overall performance.

For example, Beijing and Hong Kong are very closely positioned in the competitive matrix. Both the airports are in the ‘Golden Quadrant’, which enjoys a sizable catchment area and has strong base airlines. However, in such a favorable environment, the airport performances are very different. Beijing could compare itself factor by factor with Hong Kong to find out the performance gap. As shown in the table below, the difference in the competitiveness is attributed to a few factors, such as Service Quality, Facility and Labor. Under the assumption that the strategies and practices of airports in the same quadrant are more transferable, Beijing could study the ‘best practice’ offered by Hong Kong and learn from it. Noticeably, Beijing’s Service Quality is lagging behind most and this can be the first area to improve upon. In fact, Beijing has recently started to take some action to improve its service quality at the cargo terminal. The Beijing airport authority brought in SATS, one of the best ground service providers in the world, as a partner in the a joint venture – Beijing Aviation Ground Services Ltd. This company has adopted the performance standards of SATS and is aiming to catch up on the quality of services.

Table 7.1 Comparison between Hong Kong and Beijing

		HKG	PEK	Difference
Location	Rank	5	5	
	Score	7.3	7.3	0
Facility	Rank	1	7	
	Score	10.0	3.1	6.9
Service quality	Rank	2	9	
	Score	9.5	1.5	8.0
Cost	Rank	5	8	
	Score	5.0	1.6	3.4
Connectivity	Rank	2	3	
	Score	9.6	6.8	2.8
Labor	Rank	1	6	
	Score	10.0	3.3	6.7
Liberalization	Rank	1	7	
	Score	10.0	3.6	6.4
Competitiveness	Rank	1	8	
	Index	10.0	1.7	8.3
Traffic	Rank	1	5	
	Score	10.0	5.1	4.9
Financial Performance	Rank	3	8	
	Score	8.3	5.2	3.1

7.3 Conclusion

Air cargo has shown an astonishing high growth in the past few years. The airport, being a critical component in the air cargo value chain, plays an extremely important role and demonstrates high complexity due to its intricate nature and external changes. Often as the monopoly in the region or country, airports have little incentive to increase its operation efficiency and provide better money-for-value services. However, the current global change in economic distribution and development has stirred up much heated competition among airports. Airports need to know where they stand in the competitive landscape and to understand how to improve and stay ahead of the competition. However, they lack any good tools to even measure their performance objectively, not to mention systematically identifing and analyzing the areas for improvement.

To contribute to the air cargo industry and to raise new discussions on benchmarking in academia, this study aims to firstly, build a comprehensive framework for benchmarking cargo airports, and then to use it in the Asian context where such evaluation and measurements are least established. We conducted a comprehensive analysis of the various factors and business processes that enable cargo airports to stay ahead of the competition. The benchmarking framework is constructed by synthesizing large amount of past research information on air cargo industry, benchmarking studies as well as our studies. It consists of 7 core factors, covering Location, Facility, Service Quality, Labor, Charge, Connectivity and Liberalization, and each of the core factor again comprises of a number of sub-factors. Feasible and objective measurements are well defined in the framework so that the framework is of practical value for the industry.

We also devised an algorithm that calculates a score for each core factor and further aggregates to a single competitiveness index for each airport. The score is simple to compute but is highly informative. It gives a good overall assessment that is very easy to understand and interpret. The validity test shows a fairly high correlation between the competitive index and two common performance measures of airports – cargo traffic and financial performance. This proves that our benchmarking framework is capable of evaluating cargo airports and is well aligned with the traditional measures of airport competitiveness. The proposed benchmarking framework has much more advantages over the existing measures by breaking down the contributing factors and thus making it feasible to conduct detailed analysis.

The review of the air cargo industry in Asia, in terms of growth, driving force and future potential established a good platform for an in-depth diagnosis. Ten top airports in Asia are chosen as the sample for benchmarking. Quantitative as well as qualitative data were collected from various sources and fed into the framework to derive the scores and rankings. We then supplement the benchmarking results with descriptive information on the states, development and policies of the sample airports. Such supplementary information aids in the discussion on the comparison between airports and the possible causes of the performance difference observed. The application of the benchmarking framework on Asia airport demonstrated the process of using such methodology in real world and practical value of it. The analysis provided a detailed description of the operations and individual characteristics of the various airports in Asia. It also presented a comprehensive study of the dynamics of the competitive landscape in Asia airport industry.

The best value of the benchmarking framework is that it provides a means for an airport to measure its competitiveness objectively and comprehensively, and more importantly for the airport management to take informed action to improve. To further capitalize on the analytical results from benchmarking and fine-tune its implications, we created a 2x2 competitive matrix that integrates the performance evaluation and airport's operational environment. With the segmentation of airports, practice sharing becomes more relevant and strategy crafting becomes more effective.

7.4 Future Work

This study is the first attempt to benchmark cargo airports in Asia using a comprehensive and meaningful approach. Despite the limited resources and data accessibility issues, this study has arrived at the first stage results and shed light on a few directions worth exploring.

In this study, we gave equal weight to all the core factors based on the assumption that all of them encompass a number of significant sub-factors and have important impact on airport competitiveness. Nevertheless, we strongly recommend conducting an extensive survey among the knowledge experts, industry practitioners and academic researchers to find out their views on the weights to be used. It will add much practical value to the framework and provide set of industry guidelines to airport management and logistics companies.

To demonstrate the practical use of the benchmarking framework and test its effectiveness, we benchmarked the top ten Asian airports. The benchmarking could be extended to a much larger number of airports in the region or around the world. It will be very interesting to see how the results differ from our current study with small sample. Such an extensive benchmarking will also provide more data points for the validity test and produce more convincing conclusions on the reliability and usefulness of the framework.

With more information in place, many interesting analyses on the benchmarking can be conducted and much more insights can be derived from the results. As an example, various statistical tests can help airports understand the correlation between different factors, among which of particular interest is those with the competitiveness index. It will give airports a good indication of what factor can help to obtain the most effective results with the least resource inputs.

As in all explorative work, this study is by no means the end of our research efforts on cargo airport benchmarking. We are fully aware of its challenging nature and also its potential contribution to air cargo industry. The current study has achieved its initial goal of providing useful tools and insightful recommendations for the cargo airports and starting the study in air cargo benchmarking for academia. We believe that this study has laid a good foundation for many future work to build upon, which will bring the subject to greater heights.

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APPENDIX SAMPLE AIRPORT DATA

Table A.1 Data on Catchment Area Population and GDP

		BKK	HKG	ICN	KIX	KUL	NRT	PEK	PVG	SIN	TPE
Population	million	6.32	6.9	9.85	8.84	1.42	12	13.77	17.11	4.24	2.63
GDP	billion USD	41.1	164.4	169.5	319.5	6.87	603.5	30.43	77.4	110	304.3

Table A.2 Data on Landing Fee and Cargo Storage Fee

		BKK	HKG	ICN	KIX	KUL	NRT	PEK	PVG	SIN	TPE
for airlines											
Landing fee	USD	1233	3915	2428	7643	1393.5	8777	4918.5	4918.5	1878.5	2949
for cargo agents											
Storage	USD	0	0	0	0	8.01	0	62	62	0	15.6

Table A.3 Data on Labor Productivity and Cost

		BKK	HKG	ICN	KIX	KUL	NRT	PEK	PVG	SIN	TPE
Productivity											
	WLU/employee	3758.6	7146.6	5763.8	5284.7	1731.3	6133.2	575.4	1453.6	2965.6	11072.8
	WLU	4694546	6846449	4541843	2578957	2770094	5495342	4156973	5603562	4831003	3709376
Cost	USD	262.63	1616.79	1634.35	2386.58	401.84	2386.58	197.65	256.49	1942.94	1495.81

Table A.4 Data on Airport Financial Performance

		BKK	HKG	ICN	KIX	KUL	NRT	PEK	PVG	SIN	TPE
2002											
Revenue	million USD	273.50	694.59	436.58	895.73	246.12	1,245.73	273.87	201.53	535.10	293.59
Aeronautical revenue %		23%	45%	49%	56%	67%	53%	43%	82%	37%	59%
Profit margin %		63%	49%	27%	18%	32%	32%	38%	54%	76%	69%
Net income	million USD	168.10	341.71	118.86	158.45	78.02	394.77	105.04	109.80	407.66	203.76
2003											
Revenue	million USD	289.25	647.13	497.60	908.67	236.73	1,274.87	273.89	214.72	498.60	287.89
Aeronautical revenue %		61%	50%	47%	57%	76%	53%	57%	92%	42%	59%

Profit margin %		50%	47%	30%	15%	25%	31%	30%	56%	22%	50%
Net income	million USD	145.58	301.41	149.00	138.88	58.74	395.06	82.84	120.55	109.53	143.78
2004											
Revenue	million USD	347.42	835.39	615.57	961.76	267.28	1,585.79	378.61	284.18	577.29	313.44
Aeronautical revenue %		62%	49%	48%	45%	72%	53%	57%	94%	40%	58%
Profit margin %		55%	57%	16%	20%	29%	24%	37%	60%	21%	70%
Net income	million USD	190.61	475.48	99.58	196.76	76.66	386.12	138.61	170.01	118.42	217.92
Average											
Revenue	million USD	303.39	725.70	516.59	922.05	250.04	1,368.80	308.79	233.48	537.00	298.31
Aeronautical revenue %		49%	48%	48%	52%	72%	53%	52%	89%	40%	59%
Profit margin %		56%	51%	24%	18%	28%	29%	35%	57%	40%	63%
Net income	million USD	168.10	372.87	122.48	164.70	71.14	391.98	108.83	133.45	211.87	188.49