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An Analysis of Airfreight Transshipment Connectivity at Suvarnabhumi International Airport

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Abstract
The greatest way of determining the attractiveness of an airport's services is through its connectivity. Connectivity is usually determined in terms of connectivity units (CNUs), which are obtained by multiplying a quality index with the frequency of flights to a given destination from the airport. The sum of connectivity units for different destinations gives the overall connectivity of the airport. This is the NETSCAN model which has been used in this research paper to determine the connectivity of Suvarnabhumi international airport in its operations as a hub. The connectivity was found to be low, 29.7 out of a maximum of 74 for the selected destinations and flight frequencies. It was however concluded that this cannot be taken to be the exact rating of the airport's connectivity with regards to air freight transshipment since only a very small percentage of the airlines it serves was considered. In addition to this, it was noted that a comparison should be made to determine the airport's competitive position.
Keywords: Connectivity Units, NETSCAN model and Air Freight Transshipment

1. Introduction

One of the most efficient and economic ways of freight transport is through air. Most of the cargo transported via air includes perishable goods such as horticultural products and foods. This shows that there is always need for minimum flight time to avoid losses that may occur due to preservative measures taken on the goods. In years prior to 2008, the issue of airfreight was one of the most profitable airline businesses. Airfreight rose by not less than 5% between 1995 and 2003 (Scholz, 2011). It was recognized as a major contributor to national GDP with Europe and Asia being some of the major transporters of airfreight. The situation however began to change drastically after 2008, probably due to the world-wide inflation that affected several countries' GDPs. The volume of airfreight fell by close to 20% in just a few months. This is however slowly being reversed in the current year, with air cargo rates increasing by higher percentages than passenger freight (De Wit et al, 2009). In airfreight transport, some of the aspects that can be recognized as differentiating cargo transport from air passengers are that; first, airfreight is unidirectional. The same country that exports coffee will transport coffee each time and there is no day that the recipient country will export coffee to the producer. Secondly, airfreight is heterogeneous in that the cargo that goes in any given direction can never be similar to that which comes from that direction. Consequently, in measuring the performance of an airport in terms of airfreight transport, several factors come into play (Yap, 2004). One of the major factors to be considered when determining the success rates of an airport is its connectivity. The connectivity of an airport is measured in terms of connectivity units which are calculated based on flight efficiencies and times (Burghouwt and Redondi, 2009). The connectivity of any airport is therefore dependent on the airlines it serves, its geographical location and the competition surrounding it. Quality indices range from zero to 1, where 0 is the quality index of a connected flight which takes the maximum allowed perceived total flight time while 1 refers to the quality index of that which takes the minimum flight time (Veldhuis and Kroes, 2002). In all cases, the latter is a direct flight from point A to B. There are two major forms of flight networks. The first is the point to point network where an aircraft leaves point A directly to point B without any stopping in between. Secondly, there is a hub and spoke network. In this case, an aircraft leaves point A, stops at point B then the cargo continues to point C. The cargo may be transported to point C using the same airline or a different one. When the same airline is used, a direct connection has occurred; otherwise the connection is indirect (Martin and Roman, 2004). Hub and spoke networks have been observed to be efficient since they provide a higher number of destinations from any given point. Suvarnabhumi international airport is one of the major airports in Bangkok. It is a major hub for Bangkok Airways, Thai Airways International, Orient Thai Airlines and Thai Air Asia. It offers both passenger and cargo services. The objective of this paper is to determine the connectivity of this airport in relation to cargo services (Paul, 2006). The structure of the paper involves; a literature review providing details on hub and spoke networks, models for connectivity measurement and freight transport. Section three of this paper covers the methodology to be used in analysis. The proposed model is the NETSCAN model which uses connectivity units. The methodology section also contains various data that will be analyzed and its relevance to this research paper. After the methodology, a discussion follows based on the findings of the research. This discussion explains the implications of the results obtained in the methodology section. Finally, the conclusion gives the closing line on the research findings and is used as a forum to provide limitations of the research as well as the recommendations for future research.

2. Literature review

Burghouwt and Redondi (2009) states one of the major problems faced by hub location and network configuration as that of competition especially in the Asia-Pacific region. This paper recognizes three types of network connectivity which can be measured as direct, indirect and hub connectivity (Burghouwt and Veldhuis, 2006). It further suggests that indirect travels cost more compared to direct travels. This brings about the issue of connectivity measurements. Passenger choices depend on the attractiveness of the available alternatives (Reynolds-Feighan and Maclay, 2006). This means that factors such as comfort also play a role in the choice of travel alternative. It is also suggested that fares for online connections in indirect flights are lower than those for off-line connections (Burghouwt and Veldhuis, 2006). Fare differentiation is reflected in route characteristics which describe the flight in terms of connectivity units. The connectivity units are therefore a measure of the attractiveness of the travel option. Similarly for airfreight transport, connectivity units can be used to determine the attractiveness of airports and hence determine the best transport alternatives (Reynolds-Feighan and Maclay, 2006). The airfreight industry has tremendously grown in the last 30 years. Due to this, it has become a somewhat independent industry, rather than a part of the airline industry (Bowen, 2004). The provision of air cargo services gives an airline an enabling mechanism (Matsumoto et al, 2008). Air cargo is relatively neglected due to the increase and concentration on air passengers as a form of long distance transport (Bowen, 2004). However, the growth of air cargo services has been undeterred by this as it has been tremendous in the last few years. Some of the most important characteristics of an air freight hub are its intermediacy and connectivity (Scholz & Cossel, 2011). This is because the availability of these air freight services also serves a role in the development of the logistics industry in areas close to the hubs (Ohashi et al, 2005). It therefore becomes a major contributor to the national GDP (Scholz, 2011). Factors that have contributed to the rapid growth of air freight services include; rapid growth in world trade, increase in knowledge intensive goods such as silicon chips with high value to weight ratios, reduction in air freight charges due to the introduction of longer range fuel-efficient freighter air craft (Bowen, 2000), and growing number of manufacturers of supply chain products. Competitiveness is one of the required characteristics of hub airports (Matsumoto et al, 2008). Suvarnabhumi international airport has increased in its competitive advantage due to the disastrous start ups of some of the potential competitors within the area (Bowen, 2004). Some other factors that determine the choice of alternative freight mode include; the geography of the airport, financial returns including fares, and transport certainty (Gardiner & Ison, 2008). All these factors are used to describe route characteristics which are reflected by the connectivity units (Scholz & Cossel, 2011). Kim (2007) explains that one of the main purposes of hub and spoke networks is the amplification of networks. This is done through the transshipment of cargo in the case of air freight. This enables the airlines to access more places compared to direct flights (Kim, 2007). Suvarnabhumi international airport is a major hub serving several airlines. It is the sixth busiest airport in Asia and a major hub for the transshipment of air freight. Its purpose as a hub has enabled it to service more than 96 airlines (Paul, 2006). This has increased the number of destinations accessible for air freight. In addition to this, it was designed by one of the best known architects in the world due to its importance in the Asian economy. Some of the other characteristics of airfreight include; involvement of numerous companies and concentration of customers (Kim, 2007). In measuring the connectivity of an airport, connectivity units are used. These units are a reflection of the attractiveness of the travel option represented (Bughouwt, 2009). There are several models that can be used to determine the connectivity units based on flight data and the results obtained from research (Redondi & Burghouwt, 2011). The most common model is the NETSCAN model which is based on the maximum predicted total time of flight (Kim, 2007). For indirect freight, this is normally higher compared to direct freight because it also includes the waiting time at the hub airport. The waiting time is affected by several factors which include; time-table co-ordination by the hub carrier (Burghouwt, 2005), frequency of flights, and the minimum connection time (Kim, 2007). The NETSCAN Model takes into consideration all these factors and uses them to determine the maximum predicted total time (MaxPTT). Although the NETSCAN model is the most common model for the determination of airport connectivity, other models also exist for the same. Some of the models include; wave system structure model (Kim, 2007), weighted connectivity model (Budde et al, 2008), Bootsma connectivity which is almost similar to the wave structure model (Redondi and Burghouwt, 2010), and Danesi connectivity (Danesi, 2006). The analysis of air freight using any of these models is significantly more strenuous due to the heterogeneity of air freight (Kadar & Larew, 2003). Consequently, there is generally lower flight frequency for cargo air craft compared to passenger planes. Hub connectivity is therefore the most common method for airport evaluation. Although geographical differences may be present in airports, connectivity units always give a base for the evaluation that does not depend on the geographical location of the airport itself (Kim and Park, 2012). Consequently, it is the most important aspect of air freight business. The connectivity of

Bangkok (Suvarnabhumi) airport is characterized by a competitive position to Europe (Doganis, 2002). It occupies the same position as Singapore.

3. Methodology

This research is based upon the analysis of air freight transshipment in the Suvarnabhumi international airport. The organization of this study will follow the structure in figure 1

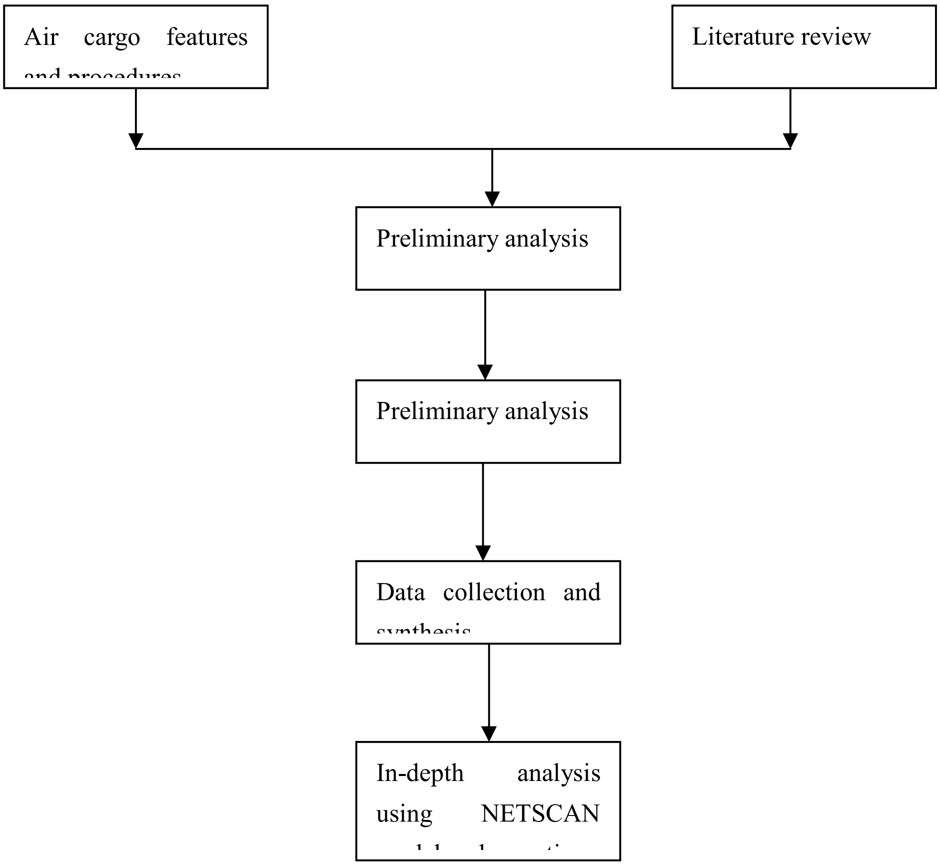

Figure 1. The concept of methodology

The literature review is to provide information necessary for the effective use of the proposed model in later stages of the paper. The information provided by the literature review will be information on network types, their advantages and disadvantages and the expectations of customers based on airport route characteristics. Apart from this, the literature will also provide secondary information regarding operation of hub airports and specifically on the issue of air freight. Also, the literature review will help to determine the different available models that can be used to determine hub connectivity and whether they are proposed to provide similar results. From the literature review, several models have been identified that can help to achieve the desired objective of analyzing airport connectivity (Matsumoto, 2007). All these models use the same general formula but have different multiplication factors. This means that using different models in a single airport analysis will yield very different results. However, when the same model is used to analyze several airports, the results will be comparative and can be used to determine the connectivity of one airport relative to another (Paleari et al, 2008). Also, in comparing the connectivity of different airports, the results are most likely to follow the same trend when different models are used (Paleari et al, 2008). For instance, when comparing Suvarnabhumi international airport and Don Mueang international airport which lies within the same geographical location, both the weighted connectivity model and the NETSCAN model show that Suvarnabhumi international airport has higher connectivity units than Don Mueang (Paul, 2006). The Air cargo base features belong solely to Suvarnabhumi international airport and are not in comparison with other airports. A combination of the literature review and the air freight features will provide a base for preliminary analysis. This will give direction as to the exact data that is required in the application of the NETSCAN model for analysis. In using this information, it will help to determine the cut-point conditions for the model. After preliminary analysis, data will be obtained from OAG and used in the analysis section to determine the connectivity of the airport. Lastly, the obtained data will be analyzed using the NESCAN model to determine the exact connectivity of the airport. When using the NETSCAN model, a quality index is assigned to every flight. This index is between 0 and 1, with 1 being the quality index of a direct flight. The quality index of an indirect flight has to be lower due to the extra time required for travel (Alderighi et al, 2007). This also applies for a direct multi-stop connection. It can be concluded therefore, that due to the en-route stops, the network quality is compromised for both passenger travel and freight (De witt et al, 2009). However, there is a maximum allowable additional travel time for which the quality index is 0. Any indirect connection between two points in a network gives a quality index of between 0 and 1. The calculation of the quality index is based on the maximum allowable travel time, which is a function of the theoretical direct travel time (Veldhuis, 1997). The latter is determined by geographical coordinates of both the origin and destination airports. It is also based on flight velocity as well as landing and take-off durations (Redondi and Burghouwt, 2010). These factors are used to determine the quality index which is then multiplied by the frequency of flight per unit time to determine the connectivity units (CNUs). The model is described by the following equations (Matsumoto et al, 2008);

MAXT = (3-0.075*NST) * NST
PTT = FLY + (3-0.075*NST)*TRF
QUAL = 1 - (PTT-NST)/(MAXT-NST)
CNU = QUAL * FREQ ……………………………….. Equation 1

Where:
MAXT = Maximum perceived travel time
NST = Non-stop travel time
PTT = Perceived travel time
FLY = Flying time
TRF = Transfer time
QUAL = Quality Index
CNU = Number of Connectivity Units
FREQ = Frequency

The normal non-stop travel time is calculated using the coordinates of the origin and the destination airports, and the velocity of travel of the aircraft (Malighetti et al, 2008). Speeds are assumed from tentative velocity data and some time is allowed for landing and take-off (Burghouwt and De Wit, 2005). This gives the normal non-stop travel time. The frequency of flight is determined on a weekly basis as the number of operations per week. This results in connectivity units based on a week's data. In order to achieve the desired results, some of the cut-point conditions that have been chosen include;

- Only online transshipments will be taken into consideration.
- Minimum transshipment time of 1 hr.

3.1 Data and results

The data used will be for the year 2010. The average weekly traffic will be obtained from the yearly traffic. The top 10 airlines that use Suvarnabhumi international airport as a hub were used in this analysis. Only international flights were considered. Among the top 10 airlines, those that engage in international freight haulage include; Thai Airways International, Thai Air asia, Bangkok Airways, Cathay Pacific Airways, China Airlines, Air China, EVA Air, Emirates, Jet Airways, and Singapore Airlines. Also, only top 10 cities will be considered for this analysis. These include; Singapore, Hongkong, Tokyo, Incheon, Kuala Lumpur, Taipai, Dubai, London, Ho Chi Minh City, and New Delhi.

Table 1: The frequencies of airline transshipments in Suvarnabhumi international airport per week in 2010 (AOT Air Traffic, 2010).

Airline	Possible Origins	Possible Destinations	Frequency Movement/ week	Gcd (km)	TRF (hrs)
Thai Airways	Hong Kong	Kuala Lumpur	9	2511	1
		Dubai	13	6895	3
		London	18	21601	12
		Ho Chi Minh	7	1506	1
		New Delhi	15	6717	2
Thai Air Asia	Hong Kong	Kuala Lumpur	3	2511	1
		Ho Chi Minh	2	1506	1
Bangkok	Hong Kong	Kuala Lumpur	1	2511	1
	Kuala Lumpur	Hong Kong	1	2511	1
EVA Air	London	Taipei	2	9790	2
	Taipei	London	1	9790	2
Emirates	Dubai	Hong Kong	1	6895	3
	Hong Kong	Dubai	1	6895	1.12

From these results, the connectivity units were calculated using equation 1. The sum of connectivity units for these airlines gives the connectivity of the airport since over 70% of its operations are concentrated within these airlines and in the mentioned 10 cities. The airlines which are not included in the results use only their origin besides the Suvarnabhumi international airport hence do not carry out online transshipments. The calculations performed are based on equation 1 and total frequencies for all the possible origins and destinations have been used to obtain the CNUs for the various airlines. The airport CNU is a sum of all the CNUs calculated. The NST is calculated from the distance and velocity of flight (Veldhuis, 1997). A Boeing 707 freight craft flies at a maximum velocity of 1010 km/ hr (Doganis, 2002). This velocity will be used in calculating the flight time (Miller-Hooks et al, 2004).

Table 2: Result of NETSCAN model

Airline	Possible Origins	Possible Destinations	FLY (hrs)	NST (hrs)	MAXT (hrs)	PTT (hrs)	QUAL (hrs)	CNU (hrs)
Thai Airways	Hong Kong	Kuala Lumpur	1.5	2.49	6.99	4.31	0.6	5.4
		Dubai	7.5	6.83	16.98	14.96	0.2	2.6
		London	10.3	21.4	29.86	27.05	0.3	5.4
		Ho Chi Minh	1.1	1.49	4.30	3.99	0.1	0.7
		New Delhi	5.5	6.65	16.63	10.5	0.6	9.0
Thai Air Asia	Hong Kong	Kuala Lumpur	1.5	2.49	6.9	4.31	0.6	1.8
		Ho Chi Minh	1.1	1.49	4.30	3.99	0.2	0.4
Bangkok	Hong Kong	Kuala Lumpur	1.5	2.49	6.9	4.31	0.6	0.6
	Kuala Lumpur	Hong Kong	1.5	2.49	6.9	4.31	0.6	0.6
EVA Air	London	Taipei	8.1	9.67	21.98	12.65	0.8	1.6
	Taipei	London	8.1	9.67	21.98	12.65	0.8	0.8
Emirates	Dubai	Hong Kong	7.5	6.83	16.98	14.96	0.2	0.2
	Hong Kong	Dubai	7.5	6.83	16.98	11.23	0.6	0.6
Total CNU								**29.7**

4. Discussion

From the results obtained in the analysis, the CNU for Suvarnabhumi international airport can be said to be within acceptable limits. The lowest value of the CNU is 0 while the highest is 74. Given that the CNU obtained is less than 50% of the maximum, it can be said that the CNU is low (Yap, 20040. However, this cannot be taken as the exact connectivity of the airport since the data used s only a tiny fraction of all the data available. It is also necessary that comparisons be made between Suvarnabhumi international airport and its competitors so that a decision can be made as to the exact attractiveness of the airport as a hub.

5. Conclusion

From this research paper, nothing much can be concluded. An analysis of the transshipment connectivity only gives the connectivity units for the Suvarnabhumi international airport. Without comparison with the airport's competitors, it is not possible to determine its position in the market. Future research should therefore concentrate more on making comparisons in order to determine needs for improvement.

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