Airport Connectivity Evaluation: The Study of Thailand

Apichat Sopadang

Excellence Center in Logistics and Supply Chain Management, Chiang Mai University

Chiang Mai, Thailand

Apichat@eng.cmu.ac.th

Tipavinee Suwanwong*

Excellence Center in Logistics and Supply Chain Management, Chiang Mai University

Chiang Mai, Thailand

Stipa992@gmail.com

Abstract

Air connectivity is key to opening a country's economic growth potential because it allows the country to tempt business investment and human capital. Meanwhile, the continued growth of Low-Cost Carriers (LCCs) has increased penetration into emerging markets. Thereby, these have made air travel more accessible. This paper aimed to evaluate airport connectivity of Don Mueang International Airport, Thailand which now can call the busiest LCCs international airport in the world (Based on 2015). Then, used that result compared to the other LCCs international airport in South-East Asia. The destination is the international airport in the country of ASEAN plus 3 Region. The NETSCAN Connectivity Index was used to evaluate the connectivity units in this paper. The result of shown the capability of Don Mueang International Airport to become one of the LCCs regional hubs for ASEAN plus 3 Region

Keyword — Air connectivity, Low-Cost Carriers, NETSCAN Connectivity Index

1. Introduction

At the very beginning of 20th century, Air industry started to aggressively competing one another. Not only Airline Company, but also Airport itself tries to play against others to survive in the rival. Airports are in the mobility business, partnering with airlines to connect their region to the wider world (Airport Council International, 2016). The better the airport is connected internationally, the more enchanting it becomes to its users and more than that enhancing the competitiveness. Surrounded by the various modes of transportation, Air transportation is one of the fastest modes. In Thailand, air transport is the important factor of the country recently, the benefit of the service and tourism. Because of the deregulation of airline industry, Thai domestic air transport incorporates one of the most growing markets in South-East Asia (Airport of Thailand, 2016). The policy and deregulation lead to the more operation in Low Cost Carriers (LCCs). Speaking of LCCs, Don Mueang International Airport has become the world's top airport in terms of budget airline passenger numbers. According to the president of Airports of Thailand (Airport of Thailand, 2016), Don Mueang has lapped up passenger growth over the past three years, with a 50% surge in passenger traffic in the first half of 2015 compared to the same period of 2014. Moreover, AoT also plans to expand the airport's capacity to handle 40 million passengers a year. Figure 1 represented the number of passenger movement for LCCs in Thailand, it shown that the number of the passenger has slightly increasing every year.

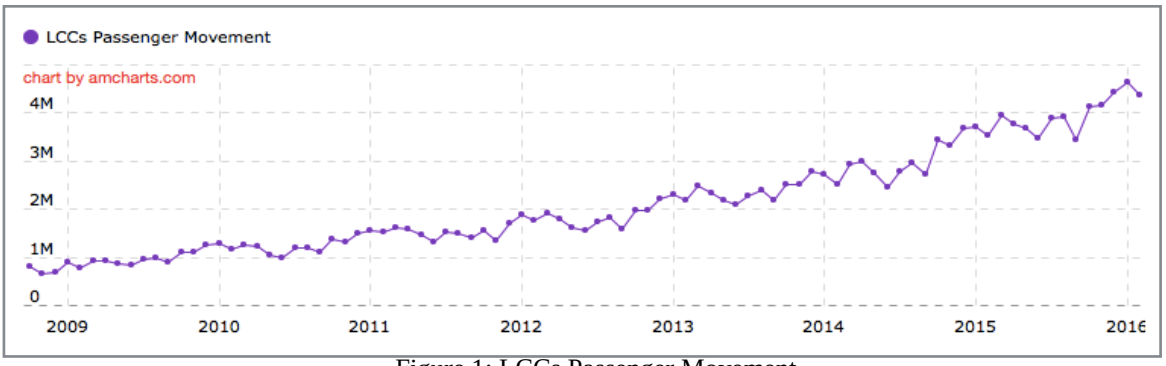

Figure 1: LCCs Passenger Movement

With this provided information, the airports have to increase the quality of its service, either focus on the operational performance, service quality performance or the connectivity performance. The objective of the paper is to evaluate the connectivity performance by using NETSCAN Model and use that information to compare with comparable International airports which is Klia 2, Kuala Lumper International Airport in the period of May 2-8, 2016.

2. Literature review

The competition between airports is an issue that has been discussed recently. With the number of airlines' aircraft increasing and the aviation transport market opening, the airports start to pay attention on their performances. The list of airports has been ranked by Skytrax, ICAO, or IATA in every year, which shown the competitive position of each airport. There are several indicators used to evaluate the airport performance, Connectivity is one of them. Air connectivity is the key to increase the country's economic growth potential. Several researches have been studies the airport efficiency performance based on the various factors such as number of passengers, number of cargo, or aircraft movement (Lovell CAK (1993) and Sopadang and Suwanwong (2016)). Those are the airport operational performance which can answer the question that how well the airport could performed.

To date, According to Malighetti, P., Paleari, S., Redondi, R (2008), Connectivity performance is one of the key factors that airport has to consider. An airport's connectivity determined how easy an airport can reach the rest of the world starting from a particular airport—direct or indirect flight. There are no standard evaluations of the airport connectivity units in the airport industry. However, there are several model were developed to measure the airport network connectivity. Table 1 below shows the some of the airport connectivity model which are very popular and suitable for the connectivity evaluation. The assumption from each model might difference, but the results are in the same direction.

Table 1: The list of research about airport network connectivity

Model	Assumption	Information requirement
Doganis and Dennis Connectivity Model (Doganis, R. and N. Dennis, 1989).	The model considered the number of flight connection for both direct and indirect flight. The result would be the minimum and maximum connecting time and routing factors	- Minimum connecting time - Total flights - Departure/Arrival schedules
Bootsma Connectivity (Bootsma, P.D.,1997)	The model considered minimum and maximum connecting time and categorised as "excellent", "good", and "poor". The result would be the performance of each airport.	- Flight schedule - Minimum connecting time - Airline schedule
WNX (Weighted Number of Connection) (Burghouwt, G. and J. de Wit, 2005	The model considered the number of direct indirect connections weights by their quality in terms of transfer and detour time	- Flight departure and arrival times, aircraft type

and Burghouwt, G. (ed.), 2007)		- Service Quality
NETSCAN (Veldhuis J,1997; IATA, 2000; and Matsumoto, H., J Veldhuis, J. de Wit, and G. Burghouwt, 2008)	The model considered the direct and indirect flight. Use that data the weights the connectivity units. The result would be the quality index of direct/indirect flight and the conclude to connectivity units of each airport	- Flight schedule - Transfer time - Minimum connection time - Great-Circle distance

NETSCAN model was first developed to evaluate Amsterdam/Schiphol International Airport (Veldhuis J., 1997). The research focused on the quality index and number of the connecting flights. Later on, in 2000, the NETSCAN Model was used by IATA to evaluate and compare airport's network connectivity globally. According to Burghouwt, G. and Veldhuis, J (2006), they also used this model to evaluate the competitive position of West European airports. Burghouwt, G. (2007) suggested that the indirect connectivity unit is determined by number of flight offered from the airport and the length of transfer time. Moreover it is also depends on another factors such as airline loyalty, price for the ticket, or airport facility (Burghouwt G. and Redondi, R, 2009 and Matsumoto, H., J Veldhuis, J. de Wit, and G. Burghouwt, 2009). According to Matsumoto, H., J Veldhuis, J. de Wit, and G. Burghouwt (2009), they compared and measured the primary airports in the Asia-Pacific Rim and more than that they also evaluated the position of each alliance, based on the result from the model.

This paper apply NETSCAN model to evaluate the connectivity performance for Don Mueang International Airport. The reason of choosing this model is because the model it popular and reliable. As mentioned that there are many research applied this model to evaluate their study, this including International Air Transport Association (IATA) has been used this model to evaluate connectivity globally in year 2000 (IATA, 2000). However, there is still the disadvantage of the model. Whenever time change, the result might be changed, because the model can evaluate the result only that time period. This model allows to benchmark the competitively position between Don Mueang International Airport and Kila 2, Kuala Lumper International Airport. The reason was both international airports served the LCCs airline; therefore, it would be a good match to compare. The result would show the ability of Don Mueang International Airport to perform the flight connectivity. In addition, Kila 2, Kuala Lumper International Airport is one of the potential competitors; this could be the advantage information for Don Mueang International Airport to build the suitable strategy to compete with the competitor.

3. Methodology

3.1 Connectivity Units Concept

According to Airports Council International, The connectivity performance (airport connectivity) is made up of all connections offered from the airport either direct or indirect via an intermediate hub. Hub connectivity represents the connectivity offered via (with a transfer at) the airport. Traditionally, connectivity is represented by the number of destinations or the number of direct flights offered from an airport. Passengers, sometimes, transfer at hub airports to final destinations, even with good direct flight are available (Matsumoto, H., J Veldhuis, J. de Wit, and G. Burghouwt, 2009). The NetScan model identifies all direct and indirect (one-stop) connections available on an airport. For this paper, the flight schedules of May 2-8, 2016 are used. Indirect flights are created by connecting two direct flights. This could be classified as; Flights operated from the same airline and Flights operated together with the alliance (with codeshare agreement). Figure 2 show the SEO NETSCAN connectivity modal retrieved from Airports Council International. Basically, the passenger would/would not prefer the indirect flight based on various factors. One who prefers direct flight might does not want to wait for long time; on the other hand, one who prefers indirect flight might consider the ticket price first because the ticket will cheaper. The quality index will range between zero to one. The quality of indirect flight will always to be lower than one since the transfer time is added. The result from the quality index will affect the connectivity units at the end (Burghouwt G. and Redondi, R, 2009 and Veldhuis J., 1997)

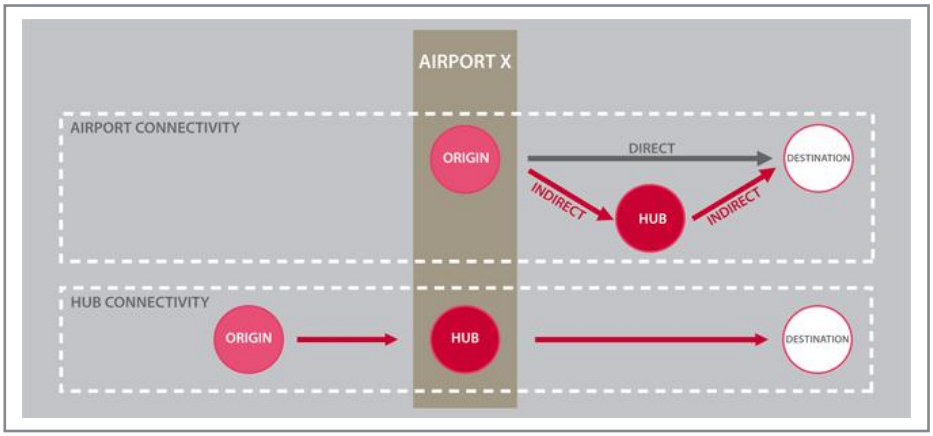

Figure 2: The SEO NetScan connectivity model

3.2 NETSCAN Model

To compute the connection quality index, the methodology can be applied to measure the airport connectivity units. The equation was retrieved from Matsumoto, H., J Veldhuis, J. de Wit, and G. Burghouwt (2009) presented below;

$$NST = (40+0.068*gcdkm)/60 \quad (1)$$

$$MXT=(3-0.075*NST)*NST \quad (2)$$

$$PTT=FLY+(3-0.075*NST)*TRT \quad (3)$$

$$QLX=1-((PTT-NST)/(MXT-NST)) \quad (4)$$

$$CNU=QLX*NOP \quad (5)$$

where;

NST = non-stop travel time in hours

gcd km = great-circle distance in kilometers

MXT = maximum perceived travel time in hours

PTT = perceived travel time in hours

FLT = flying time in hours

TRT = transfer time in hours

QLX = quality index of a connection

CNU = number of connectivity units

NOP = number of operations

3.3 Research scope

There are some limitations of this research, according to the information required from the model. The research scopes are presented below:

- The waiting time (transfer time in hours) was over than 1 hour and not more than 24 hours. According to Airport of Thailand (2016), it would take approximately 1 hour for the passenger to move from aircraft A to aircraft B for the transit. The maximum connecting time which was more than 24 hours is too long to persuade the passenger to but the ticket.
- Because of the flight schedule would be changed by season, therefore, this research examined the data at the period of May 2-8, 2016

3.4 Dataset Classification

Table 2 was the list of 20 ASEAN plus 3 International airports used for flight connectivity network evaluation. The data used in this analysis are from Official Airline Guide (OAG) and also from the airline website. The study area covered the international in ASEAN plus 3 region. The selected airports were the airports that most LCCs operated. In this study, both online and offline connections are considered. These mean the passenger transfer would be possible to take place between flight of the same airline or same airline alliance or different airline.

Table 2: List of 20 ASEAN plus 3 International Airports

Country	IATA code	Name
China	PVG	Shanghai Pudong International Airport
	CAN	Guangzhou Baiyun International Airport
	CTU	Chengdu Shuangliu International Airport
	SZX	Shenzhen Bao'an International Airport
Japan	KIX	Kansai International Airport
	NRT	Narita International Airport
	HND	Tokyo International Airport
	CTS	New Chitose Airport
	FUK	Fukuoka Airport
South Korea	ICN	Incheon International Airport
	PUS	Gimhae International Airport
Myanmar	RGN	Yangon International Airport
Lao PDR	VTE	Wattay International Airport
Cambodia	PNH	Phnom Penh International Airport
Singapore	SIN	Singapore Changi Airport
Indonesia	CGK	Soekarno-Hatta International Airport
Malaysia	KUL	Kuala Lumpur International Airport
Vietnam	HAN	Noi Bai International Airport
Brunei Darussalam	BWN	Brunei International Airport
Philippines	MNL	Ninoy Aquino International Airport

Direct Connections were directly retrieved from OAG and Airline website. Indirect Connections have been built using the algorithm. This algorithm applied by using minimum connection time and creating the maximum connecting time. In this study, we assumed that the minimum connection time was 1 hours and maximum connecting time was 24 hours. The NETSCAN model allocated to each direct and indirect connection a quality index, ranging between 0 and 1 (Matsumoto, H., J Veldhuis, J. de Wit, and G. Burghouwt, 2009)

4. Comparison of connectivity performance

Figure 3 shows the network connectivity split up in direct and indirect at the ASEAN plus 3 regions in May 2-8, 2016, departed from Don Mueang International Airport and Kila 2, Kuala Lumper International Airport. From the information below; the positive value referred to the good performance in term of performing the particular flight at the airport. Zero means there are no airlines operating at this period of time. Therefore, the connectivity units equal to zero. The negative value referred to the inefficient connectivity performance for that airport performing the particular flight. NETSCAN model focus highly on the transfer time or the waiting time that passengers might have to wait at the transit airport for the other flight. This factor has a high impact on connectivity value. If the transfer time is take too long, the connectivity units definitely are negative. For example, Don Mueang International Airport, the connectivity unit for indirect flight to Brunei Darussalam was -223.43. The transfer time was approximately 8 hours to 18 hours which was too long to wait for the another flight. Moreover, flight frequency was another importance key. Even though, airport offered many flight in one route but if each flight has a long transfer time, the connectivity unit might be negative also.

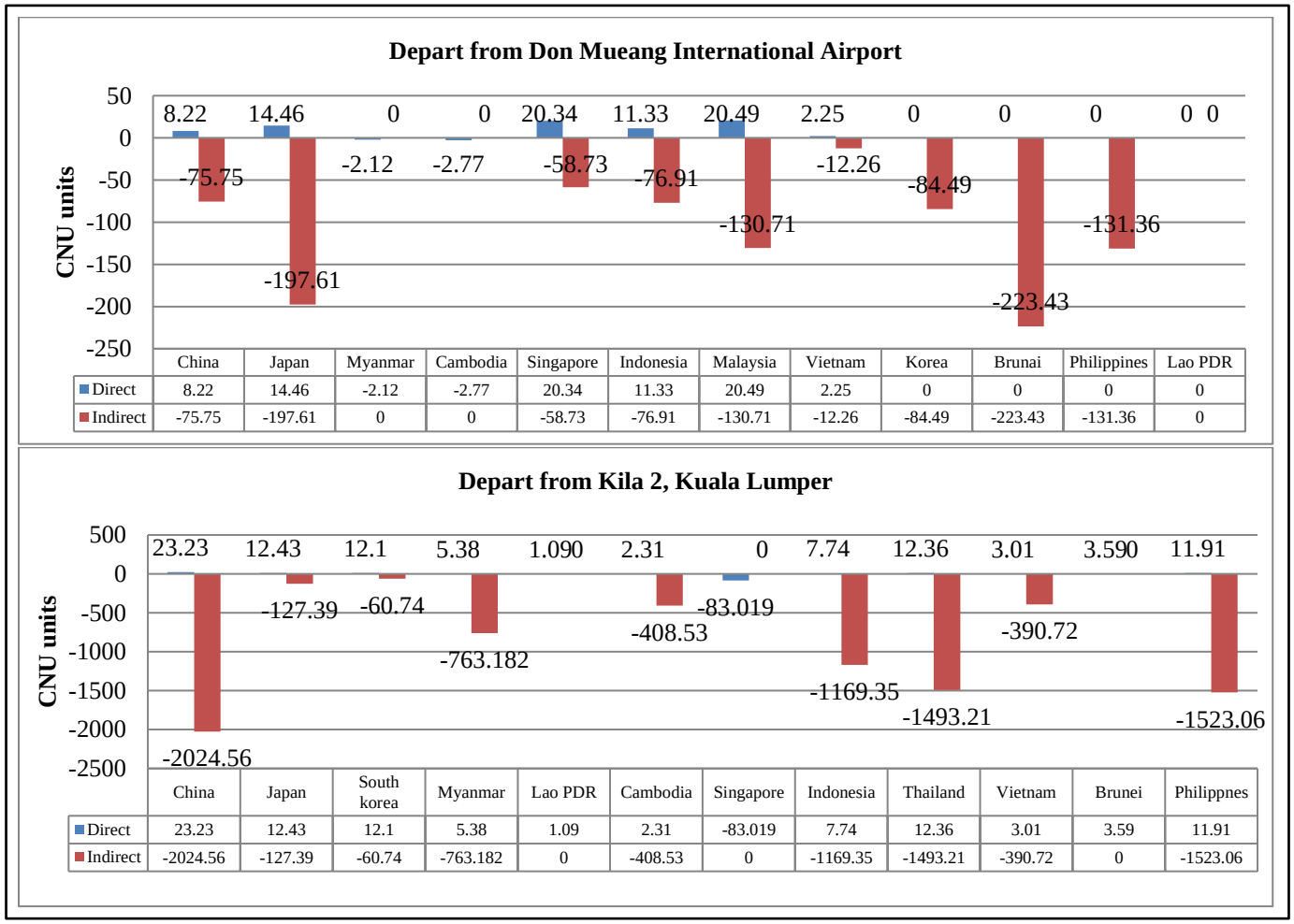

Figure 3: Connectivity Units of both airports

4.1 Country by Country comparison

For the direct flight, it showed that Kila 2 offered the flight to all the destinations. In addition, the connectivity units of Kila 2 for most destinations were higher when compared to Don Mueang International Airport; only Japan, Singapore, and Indonesia that has lower result. On the other hand, for the indirect flight, both airports are facing the same situation; every route was not in the position of good connectivity. This was because the connection time was too long; the maximum waiting time is approximately for 23.30 hours for the connecting flight. If Thailand willing to promote Don Mueang International Airport to become LCCs hub for ASEAN plus 3, it need

to be done by increasing the number of direct flight and also encourage the airline to open the new route, in order to gain the competitive market.

4.2 Airport connectivity comparison (overall performance)

Basically, when the direct flight increased, the indirect flight might drop automatically for that particular airport. Airline might prefer to have more direct flights between airports because of the passenger preference and the operating cost reduction. As from the figure 4 below, the overall network performance for both direct and indirect flight, Don Mueang International Airport is in the higher position comparing to Kila 2, Kuala Lumper International Airport. In airline business, there are 2 season change per year; therefore, for this season Don Mueang International Airport has a better connectivity performance.

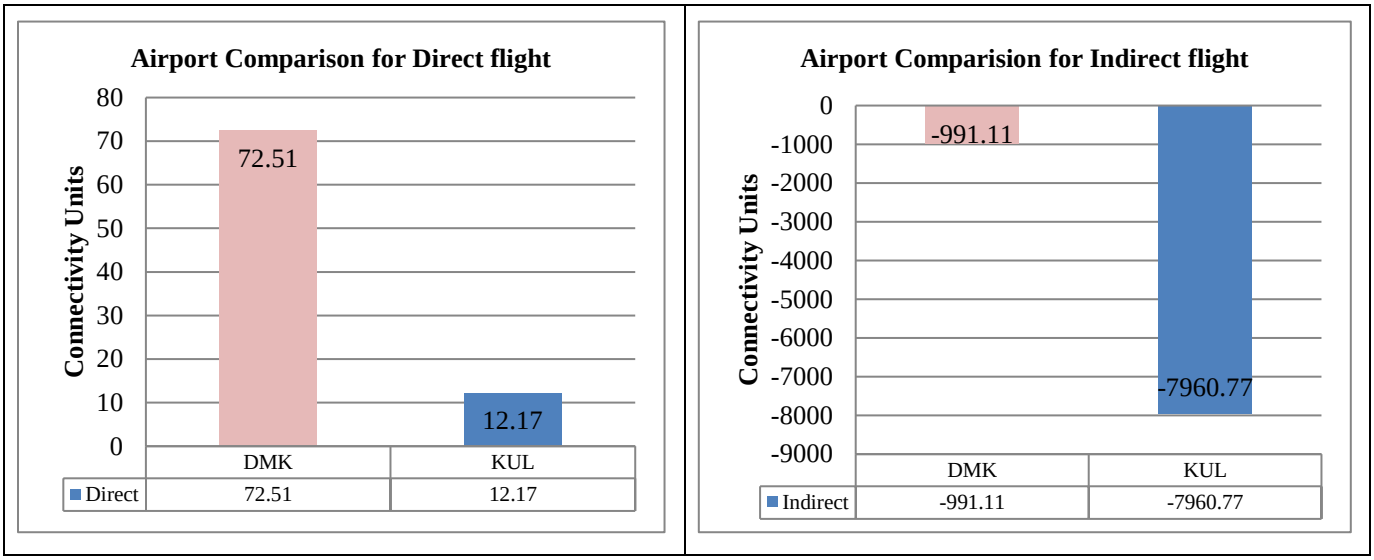

Figure 4: Airport Connectivity Performance Comparison

5. SUMMARY AND CONCLUSION

This paper aimed to evaluate the connectivity performance for both airports; Don Mueang International Airport and Kila 2, Kuala Lumper International Airport. We reviewed various connectivity models that have been used in academic literature. We decided to use NETSCAN Model for our paper because it received the good reference from IATA. The NETSCAN Model, therefore, used to measure the performance. The destinations were the country in ASEAN plus 3 region. From the result, we can conclude that Don Mueang international Airport has a capability enough to be one of the biggest LCCs hubs for ASEAN plus 3 region. For the indirect flight, Don Mueang International Airport facing the very low connectivity units, however, this is the gap that could be improved further. The Airport of Thailand can use this information to improve the performance to have a better serve to the passengers. There are some limitations of the model. Sometime passenger chooses the indirect flight might because of the ticket price and did not consider the long transfer time as the critical. However, the model included that critical factor into the model; the result might or might not the real connection performance for that airport. Another limitation would be the period of the study, the result here was just the result for this period of time. When the season changed, the result might be changed also. This was because the route or flight offered from each airline might change. Some airlines might added the new route or add more number of flight. According to that, the result will change definitely. For the future research, it should include the cargo into the model, because cargo is one of the important factors.

Reference

Airport Council International (2016), retrieved from http://www.aci.aero/

Airport of Thailand (2016), retrieved from http://airportthai.co.th

Bootsma, P.D. (1997). *Airline flight schedule development; analysis and design tools for European hinterland hubs*, PhD thesis, University of Twente, Utrecht.

Burghouwt, G. (2007). *Airline network development in Europe and its implications for airport planning*, Aldershot, Ashgate.

Burghouwt, G. and J. de Wit (2005). *The temporal configuration of airline networks in Europe*. Journal of Air Transport Management, 11(3), pp. 185-98

Burghouwt, G. and Veldhuis, J.(2006). *The competitive position of hub airports in transatlantic market. Journal of Air Transportation, 11(1)*. Pp. 106-30

Burghouwt G. and Redondi, R(2009*). Connectivity in air transport networks: models, measures and application*. Retrieved from http://aisberg.unibg.it/bitstream/10446/401/1/WPingGe01%282009%29.pdf

Danesi, A (2006). *Measuring airline hub timetable co-ordination and connectivity: definition of a new index and application to a sample of European hubs*. European Transport, 34, pp. 54-74

Doganis, R. and N. Dennis (1989). *Lessons in Hubbing*. Airline Business, March 1989, pp. 42-7

IATA(200). Global Airport Connectivity Monitor. Aviation Information and Research Department. IATA, Middlesex. UK

Lovell CAK (1993). *Production Frontiers and Productive Efficiency*. in Fried HO and SS Schmidt (eds.) the Measurement of Productive Efficiency: Techniques and Applications, Oxford U.K.: 3-67.

Malighetti, P., Paleari, S., Redondi, R(2008). *Connectivity of the European airport network: Self-help hubbing and business application*. Journal of Air Transport Management. 14. Pp. 53-65

Matsumoto, H., J Veldhuis, J. de Wit, and G. Burghouwt (2008). *Network performance, hub connectivity potential and competitive position of primary airports in Asia/pacific region*. Proceedings of the Air Transport Research Society Conference, Athens, July 6-10 2008

Matsumoto, H., J Veldhuis, J. de Wit, and G. Burghouwt (2009). *Air network performance and hub competitive position: evaluation of primary airports in East and Southeast Asia*. FEB: Amsterdam School of Economics Research Institute

Sopadang and Suwanwong (2016). *The analysis of airport operational performance: case study of Chiang Mai International Airport, Thailand*. Proceeding of the 2016 International Conference on industrial Engineering and Operations Management, Kuala Lumper, Malaysia, March 8-10, 2016

Veldhuis J. (1997). *The competitive position of airline networks*. Journal of Air Transport Management. 3(4). Pp. 181-8

Biography

Apichat Sopadang was born in Chiang Mai, Thailand. He graduated from Chiang Mai University, Thailand in 1987 with a degree in industrial engineer. For several years, he worked as a maintenance planning engineer in Electricity Generator Authority of Thailand (EGAT). He completed his Ph.D. from the Clemson University, USA in 2001. Following the completion of his Ph.D., he is working for Chiang Mai University as an Associate Professor and Head of Excellence Center in Logistics and Supply Chain Management (E-LSCM). He is a frequent speaker at industry and academic meetings. Dr. Sopadang also served as a consultant of Asian Development Bank (ADB) and The Japan External Trade Organization (JETRO).

Tipavinee Suwanwong is currently full-time Ph.D. student at Engineering faculty, Chiang Mai University, Thailand and also current lecturer at Mae Fah Luang University, Thailand. Ms. Suwanwong holds a Bachelor degree of Science degree in Engineering Management from Thammasat University, Thailand and a Master of Business Administration in Supply Chain Management from University of La Verne, USA.