Connectivity of Medium Airports in Thailand

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Abstract

Airports are expanding their facilities in respond to increasing number of passengers. Airport connectivity is one of indicators to evaluate airport performance. Airport connectivity can be define as the airline network of airport, related to frequency of flight and number of flights from origin to destination. Airport with good connectivity is attractive for passengers. This paper aimed to evaluate airport connectivity of medium sized airports in Thailand, which are Sakon Nakhon airport (SNO), Nakhon Phanom airport (KOP), Nannakhon airport (NNT), Phitsanulok airport (PHS) and Trang airport (TST) by using NETSCAN model during October, 2017. It was found that Phitsanulok airport (PHS) has the highest connectivity unit, with more frequency of flights.

Keywords
Airport connectivity, Local Airport, NetScan Connectivity Index

1. Introduction

Air transportation is one of the important factors of life quality improvement. It plays an important role in the economy and society of the world. It is a convenient, faster and safer transportation service than other mode of transportation. Nowadays, air transportation industry is growing rapidly, and customer are attractive to travel by air more than the past. Air transportation industry in Thailand also expands their capacity to fulfill the customer need. There are six airports that operated by Airports of Thailand Public Company Limited (AOT) and twenty-seven airports operated by the Department of Airports Thailand (DOA). According to Figure 1, the number of passengers that travelling by air in Thailand has increased 123% within this decade, there were 60 million passengers in 2010 and 139 million in 2016 (AOT and DOA, 2017). This phenomena emphasize the importance of air transportation in this decade with a bright future for business extension. The main players of the air transportation in supply chain encompasses aircraft manufacturers, airlines, airports, ground services and related industry. The airport serves the service for aircraft take-off, landing, passenger embarking and disembarking. To fulfil the customer satisfaction, the airports need to improve their performance of service quality, operational performance, airport connectivity and their facilities.

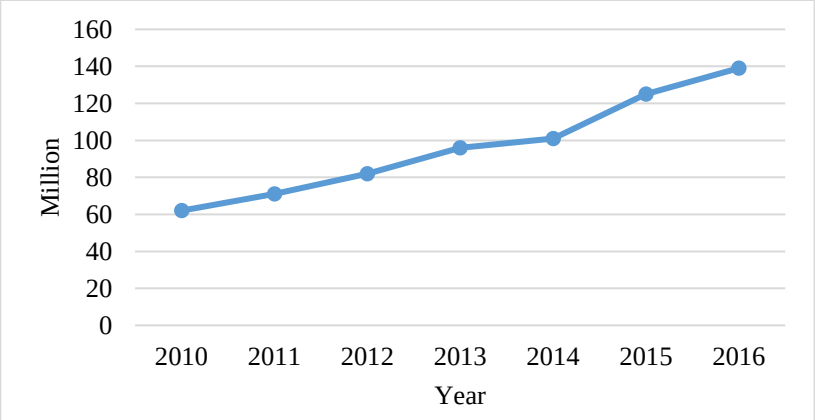

Figure 1. Number of air transportation passenger in Thailand
Source: Department of Airports Thailand and Airports of Thailand Public Company Limited (2017)

Airport connectivity is one of the important indicators to measure the airport's performance. Airport connectivity is the measure of how airport is connected to another airport. Good connectivity signifies that airport has various flights, high frequency of flight and short waiting time for transfer, lead to attractive for passengers. One of the most popular models to evaluate the airport connectivity is the NetScan model which was developed by Matsumoto et.al. (2009). The NetScan model covers the frequency of flight, number of flight and waiting time at the transfer airport.

Therefore, this study focuses on evaluating the airport connectivity and compare the connectivity unit of medium airports in Thailand that classified by hub type

2. Literature review

There are many indicators to measure the airport performance, such as airport service quality, operational performance and airport connectivity or airline network. The air transportation network has an enormous impact on economic, social evaluation and community welfare at the local, national and international levels (Paleari, et al, 2008). The airport's connectivity is the ability of airport to connect another airport. It determined how easy an airport can reach the rest of the world starting from a particular airport – direct or indirect flight (Sopadang and Suwannawong, 2016). Airport connectivity is the indicator for measuring the attractiveness of the airport, attractiveness is often expressed in utility functions, where variables such as available frequencies, travel times and fares are weighted (Matsumoto, et al, 2009). There are no standard evaluations of the airport connectivity units in the airport industry (Sopadang and Suwannawong, 2016). The most popular model to evaluate the airport connectivity is NetScan model, the variables are function of frequencies of flight, travel time and the necessity of a transfer at intermediate airport with indirect connection.

The NetScan model was developed to evaluate the competitive position of airline networks (Veldhuis, 1997). Kim (2007) evaluated the indirect connectivity of airfreight at Incheon international airport and analyzed the networks of the airport. According to Matsumoto et al. (2009), the model to evaluate air network performance and hub competitive position of primary airports in East and Southeast Asia had been developed and compared with the competitive position of the primary airport of the Asia Pacific rim. According Jantachalobon and Vanichkobchinda (2012) the NetScan model was used to analyze airfreight transshipment connectivity at Suvarnnabhumi International Airport. Jantachalobon et al. (2014) had analyzed the ASEAN international airport's airline network by using NetScan model. According Sopadang and Suwannawong, 2016 they had evaluated the airport connectivity of Don Mueang International Airport which now can call the busiest LCCs international airport in the world. Then, used that result compared to the other LCCs international airport in South-East Asia (Sopadang and Suwannawong, 2016) The NetScan have exclusively been employed to catch the purpose of this study as they considerably fit with the data source as proven by many studies. Moreover, the Airport Commission International (ACI) has also adopted the formulae in describing the European connectivity performance (Nugraha P., 2017)

The NetScan model is integrated model variable like the frequencies of flight, travel time and necessary for transfer (Kamtaeja, et al, 2014). The connectivity unit can be used to determine the attractiveness of the airport, and hence determine the best transport alternative (Reyold-Feigham and Maclay, 2006). Therefore, this paper uses the NetScan model to compute the connectivity unit and evaluate the airport connectivity.

3. Methodology

3.1 Connection type

There are three types of connections which have been distinguished from hub-and-spoke networks by Burghouwt and Veldhuis (2006). First, direct connection: flights that fly between origin and final destination directly (Fly direct from A to B). Second, indirect connectivity: flight that arrives at the intermediate airport and transfer from intermediate airport to final destination (Fly from C to E with a transfer at D). Third, hub connection involves links through a transfer point at the hub airport via intermediate airport as a hub (Fly from F or G via H to J).

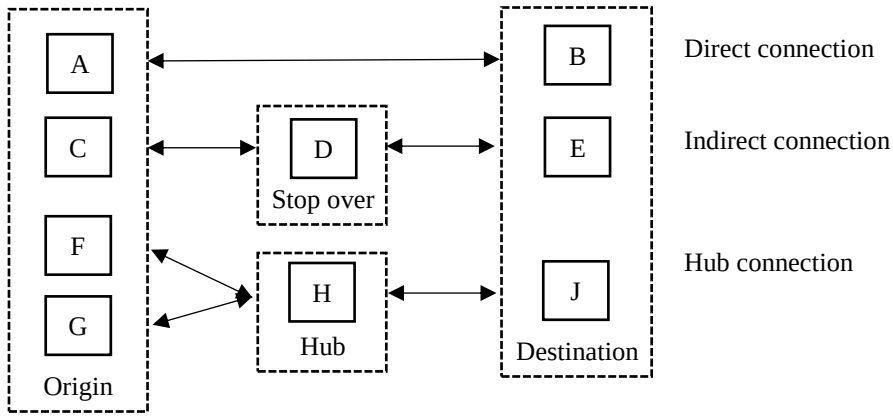

Figure 2. Variety of connections in hub-and-spoke networks
Adapt from Kim, 2007

3.2 Connectivity unit concept

Connectivity unit is the number that computed by NetScan model, it represents the quality of the route in term of airport connectivity. Connectivity unit can be computed via the model of both direct and indirect connection. The connectivity unit depends on the quality and frequency of routes. The quality index represents the attractive from passengers, the value are between 0 and 1. The quality index that closely to 1 means the airport is attractive to passengers. The low quality index represents the airport is not attractive for passengers.

3.3 NetScan model

The NetScan model is the application to compute the connectivity unit (CNU), first developed by Jan Veldhuis in 1997, Matsumoto, H., J. Veldhuis, J. de Wit and G. Burghouwt had developed the model to suitable in 2009, and the equations are below

$$NST = (40 + 0.068 * gcd\ km) / 60 \quad [1]$$
$$MAXT = (3 - 0.075 * NST) * NST \quad [2]$$
$$PTT = FLY + (3 - 0.075 * NST) * TRF \quad [3]$$
$$QUAL = 1 - (PTT - NST) / (MAXT - NST) \quad [4]$$
$$CNU = QUAL * FREQ \quad [5]$$

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

According to the connectivity unit concept, the NetScan model will assign the quality index to every connection, the value of quality index is between 0 and 1 which is the number that close to 1 is meant that connection has good quality and attractive for passengers.

3.4 Airport Categories classification

According to Federal Aviation Administration (FAA), the airport can be classified by their hub dimension into 3 categories which are large, medium and small. The table 1 below has shown the characteristic of each type of airport. This study focuses on the medium airports, which the percentage of annual passenger boarding is at least 0.25% but not more than 1%

Table 1. Commercial airport categories according to FAA's current classification

Percentage of Annual Passenger Boarding	Hub Type
1% or more	Large
At least 0.25%, but less than 1%	Medium
At least 0.05%, but less than 0.25%	Small

There are 33 airports in Thailand which are operated by 2 main authorities. Department of Airports Thailand (DOA) runs 27 airports where 6 airports are operated by Airports of Thailand Public Company Limited (AOT). This study focuses on small airports in Thailand, according to Federal Aviation Administration (FAA) airport can classify into 3 types which are large, medium and small depend on the percentage of annual passenger boarding. Table 2 is shown the airport classification by hub dimension of FAA

Table 2. Airport Categories Classification

Airport	IATA code	No. of passenger 2016	% of All Thailand Airports	Class
Buriram	BFV	197,988	0.14	S
Chiang Mai	CNX	9,446,320	6.80	L
Chiang Rai	CEI	2,060,200	1.48	L
Chumphon	CJM	93,567	0.07	S
Don Mueang	DMK	35,203,757	25.33	L
Hat Yai	HDY	4,004,665	2.88	L
Huahin	HHQ	12,076	0.01	-
Khonkaen	KKC	1,503,615	1.08	L
Krabi	KBV	4,081,203	2.94	L
Lampang	LPT	290,420	0.21	S
Loei	LOE	270,454	0.19	S
Mae Hong Son	HGN	55,368	0.04	-
Maesot	MAQ	174,612	0.13	S
Nakhon Phanom	KOP	372,026	0.27	M
Nakhon Ratchasima	NAK	89	0.00	-
Nakhon Si Thammarat	NST	1,503,576	1.08	L
Nannakhon	NNT	376,420	0.27	M
Narathiwat	NAW	241,721	0.17	S
Pai	PYY	6,046	0.00	-
Pattani		-	0.00	-

Airport	IATA code	No. of passenger 2016	% of All Thailand Airports	Class
Phetchabun		-	0.00	-
Phitsanulok	PHS	492,130	0.35	M
Phrae	PRH	72,274	0.05	S
Phuket	HKT	15,107,185	10.87	L
Ranong	UNN	102,228	0.07	S
Roi Et	ROI	334,957	0.24	S
Sakon Nakhon	SNO	348,213	0.25	M
Suratthani	URT	2,032,321	1.46	L
Suvarnabhumi	BKK	55,892,663	40.21	L
Tak	TKT	-	-	-
Trang	TST	648,979	0.47	M
Ubonratchathani	UBP	1,726,943	1.24	L
Udonthani	UTH	2,350,005	1.69	L
Total of Thailand Airports		**139,002,021**	**100.00**	

According to the FAA airport classification, the medium airports in Thailand are Sakon Nakhon airport (SNO), Nakhon Phanom airport (KOP), Nannakhon airport (NNT), Phitsanulok airport (PHS) and Trang airport (TST). Thus, this study focuses on evaluating airport connectivity of medium airports in Thailand, then SNO, KOP, NNT, PHS and TST are taken into account. The selected airports are located in different region in Thailand is shown in Figure 3

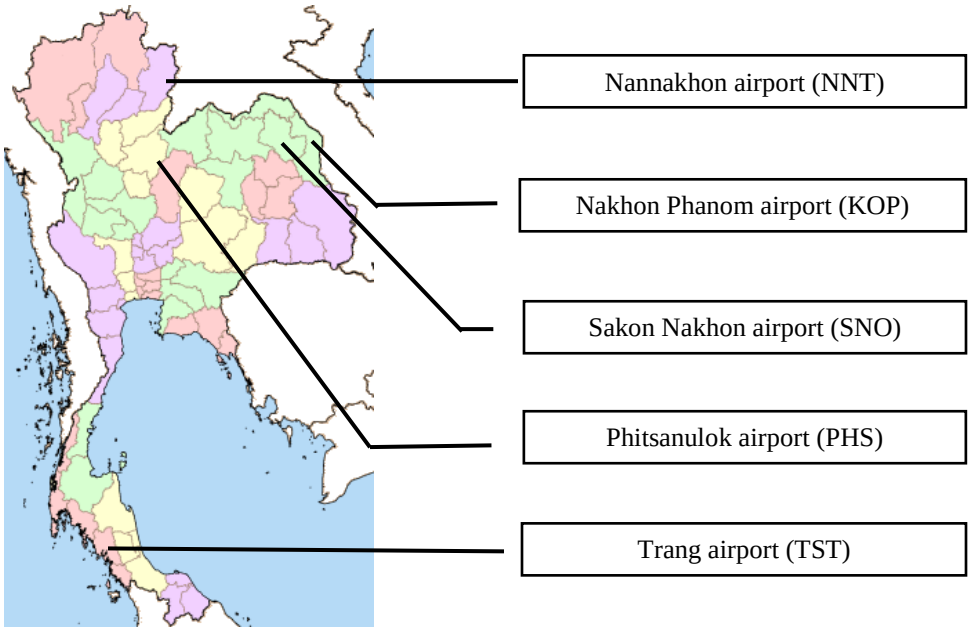

Figure 3. The location of medium airports in Thailand
Source: Researcher (2017)

3.5 Scope of research

- Specification of minimum and maximum time of waiting for transfer at the intermediate airport between 1 and 24 hours.
- The scheduled flights during October, 2017 were considered in this study.

4. Result and discussion

4.1 Airport connectivity

The connectivity unit (CNU) that computes via NetScan model represents the connection efficiency of the airport. According to Figure 4, the medium airport with the highest connectivity unit is Phitsanulok airport (PHS) which is located in the northern region in Thailand, there are 3 airlines operate and at least 8 flights a day with 59.58 CNU per week. Phitsanulok airport has the highest number of CNU, mean passengers in PHS have many flights to select, and many choices for passengers can increase customer satisfaction. The airport with the lowest connectivity unit level is Nakhon Phanom airport (KOP) which is 29.74 CNU per week, there are 2 airlines operate in Nakhon Phanom airport with 4 flights per day. The medium airports in Thailand, which are Sakon Nakhon airport (SNO), Nakhon Phanom airport (KOP), Nannakhon airport (NNT), Phitsanulok airport (PHS) and Trang airport (TST) are serving the service from their origin to Don Muang Airport (DMK) only. There is no indirect route from the medium airports, because the flight distance is not long as the international flight and it's not attractive for passengers to choose an indirect connection to their destination.

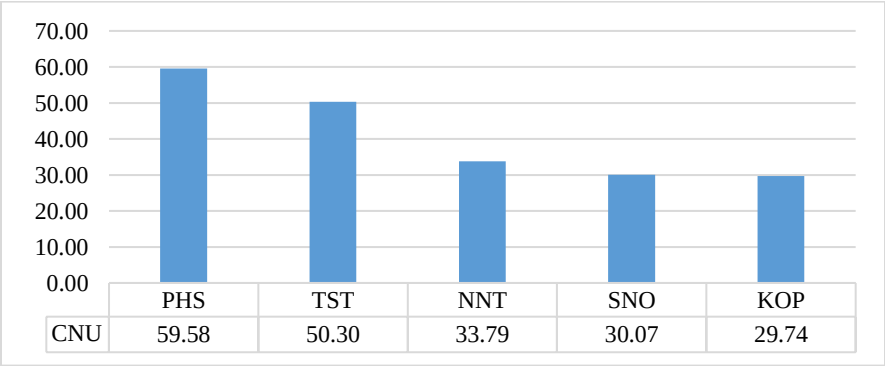

Figure 4: The connectivity unit of medium airports of Thailand
Source: Researcher

The number of passenger in TST higher than PHS, but PHS has connectivity unit more than TRT. Because the airport connectivity in direct connection dimension depends on the frequency of flights and number of flights. Phitsanulok airport (PHS) has 9 flights per week, Trang airport has 7 flights per week, and both of PHS and TST operated by low cost carrier in Thailand, which are Nok air, Air Asia and Thai lion air.

Although TST has lower connectivity unit than PHS, but overall capacity seat of TST is more than PHS. The airlines operates the different types of aircraft, Trang airport has 7 flight per week, there were 3 flights that use Airbus A320-216 aircraft type and 4 flights that use Boeing 737-800 to serve passengers. In the other hand, Phitsanulok airport has 9 flights per week, it contain with 3 flights that use A320-216 aircraft type, 3 flights that use Boeing 737-800 aircraft type and 3 flights that use Bombardier Dash 8 Q400 which is smaller aircraft than Airbus A320-216 and Boeing 737-800.

Air connectivity is the ability to serve the passenger to connect to another airports, high number of connectivity unit represent that airport has various flights to passengers. Passengers might have satisfaction for more choices of the flight to fly. But the high number of connectivity unit cannot define that airport can accommodates passenger more than another airport.

4.2 Airline networks

The connectivity unit (CNU) can define the airline network at the airports. According to table 3, there are 3 low cost carriers in medium airports market, which are Nok air, Air Asia and Thai lion air. Nok air operates 14 flights per week, which is the highest number of flight in 1 week. So Nok Air earns 94.07 CNU/week, which is the highest CNU level in the medium sized market.

Table 3. The connectivity unit of each airline

Airline	Total CNU	Number of flights
Nok Air	97.03	14
Air Asia	81.98	11
Thai Lion Air	24.46	4

5. Concluding remark

The objective of this study is to evaluate the airport connectivity of medium airports in Thailand, which are Sakon Nakhon airport (SNO), Nakhon Phanom airport (KOP), Nannakhon airport (NNT), Phitsanulok airport (PHS) and Trang airport (TST). The destination of medium airports is Don Muang Airport only, because the medium airports are operating only domestic flights and the flight distance is not too long, therefore the indirect connection is not necessary. The direct connection which is flown directly from origin to destination is attractive for passengers than a flight with transfer at intermediate airport. Because the medium airports operate only direct connection, thus the value of quality index of every connection from medium airports to Don Muang Airport is closer to 1, it represents the routes are attractive for passengers.

The connectivity unit can measuring the attractiveness of the airport and can define the competitive position of airline networks. The future study might select the airport which has many destination into account. The airport and airline can apply the airport connectivity concept to plan the strategy to improve the airline networks.

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References

Airports of Thailand Public Co.,Ltd. (2017, 10 25). *Annual Report / Sustainability Report*. Retrieved from Annual Report / Sustainability Report: http://airportthai.co.th/main/en/752-annual-report-sustainability-report

Burghouwt, G., & Veldhuis, J. (2006). The Competitive Position of Hub Airports in the Transatlantic Market. *Journal of Air Transportation*, 106-130.

Department of Airports. (2017, 10 25). *Air Transport Statistics*. Retrieved from Air Transport Statistics: https://www.airports.go.th/en/content/262.html

Federal Aviation Administration. (2017, 10 25). *Airport Categories*. Retrieved from Airport Categories: https://www.faa.gov/airports/planning_capacity/passenger_allcargo_stats/categories/

Jantachalobon, N., & Vanichkobchinda, P. (2012). An Analysis of Airfreight Transshipment Connectivity at Suvarnabhumi International Airport. *European Journal of Business and Management*, 141-147.

Jantachalobon, N., Vanichkobchinda, P., & Suthikarnnarunai, N. (2014). Airline Network Analysis of ASEAN International Airport Region. *The Open Transportation Journal*, 19-25.

Kamtaeja, S., Sopadang, A., & Chao, P. (2014). Evaliation of air connectivity of Chiang Mai airport. *The 6th International Conference on Logistics and Transport*, (pp. 80-86). Kuala Lumpur, Malaysia.

Kim, J. Y. (2007). *An Analysis of Airfreight Transshipment Connectivity at Incheon International Airport.* Korea: A Thesis submitted to Inha University.

Matsumoto, H., Burghouwt, G., Wit, J. D., & Veldhuis, J. (2009). Air Network Performance and Hub Competitive Position: Evaluation Of Primary Airports In East And Southeast Asia. *Journal of Air Transport Management*, 384-400.

Matsumoto, H., Burghouwt, G., Wit, J., & Veldhuis, J. (2008). Network performance, hub connectivity potential, and competitive position of primary airports in Asia/Pacific region. *Pacific Economic Review*, 639-650.

Nugraha, P. (11-20). Analysing Indonesian Air Connectivity Period of 2006 - 2016. *Journal of the Civil Engineering Forum, Vol. 3 No.1* , 2017.

Paleari, S., Redondi, R., & Malighetti, P. (2008). A comparative study of airport connectivity in China, Europe and US: Which network provides the best service to passengers? *Transportation Research Part E*, 198-210.

Reynolds- Feighan, A., & Maclay, P. (2006). Accessibility and attractiveness of European Airport: a simple small community perspective. *Journal of Air Transport Management, 12*, 313- 323.

Sopadang, A., & Suwanwong, T. (2016). Airport Connectivity Evaluation: The Study of Thailand. *International Conference on Industrial Engineering and Operations Management* (pp. 188-195). Detroit, Michigan, USA: IEOM Society International.

Veldhuis, J. (1997). The competitive position of airline networks. *Journal of Air Transport Management*, 181-188.

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