

EVALUATION OF AIR CONNECTIVITY OF CHIANG MAI AIRPORT

Supaporn Kamtaeja*, Apichat Sopadang, Poti Chao

*Logistics Engineering and Supply Chain Management Unit, Department of Industrial Engineering
Faculty of Engineering, Chiang Mai University, Thailand, 50200*

**Corresponding Author: supaporn.kamtaeja@gmail.com*

Introduction

The number of global air transport passengers has increased considerably from 10,975 to 19,125 million of passengers in 2003-2012 as presented in figure 1. Additionally, figure 2 shows the continuous rise of the number of passengers in air transport in Thailand from 2009 to 2012. Besides, due to the forthcoming ASEAN Economic Community (AEC) in 2015, free flow of goods, service, investment, capital and labor will have expected influences on ASEAN member states and would lead to a substantial increase in air transport. Specific policy of AEC, such as revisions in „Open Skies” policy, may lead to expansion in new route and higher flight frequencies.

Thailand has 6 main international airports under operating of Airports of Thailand PLC. Chiang Mai airport is an important international airport in the North of Thailand. It has 24 destinations. The available capacity of this airport is 8 million of passengers per years while at the present (2014) it serves around 5.4 million of passengers per year. Surely, the number of passenger throughput at this airport will increase due to the global air transport passenger trend and the forthcoming ASEAN Economic Community (AEC) in 2015. The understanding of air connection is the basis to realize current airport performance and it may lead to preparing the readiness for supporting the incoming higher demand in the near future. Therefore, evaluation of Chiang Mai airport in terms of its connectivity indices would be important in determining air travel connections available to the consumer at Chiang Mai airport. The aim of this study is to realize the connectivity performances of Chiang Mai airport in the accessibility perspective.

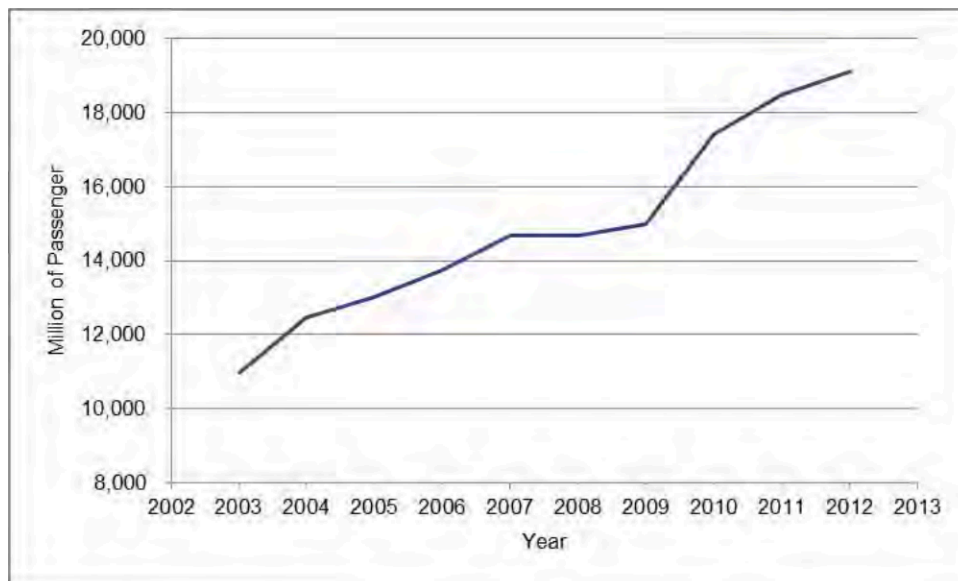


Figure 1: The world air transport, passengers carried (The World Bank, 2014)

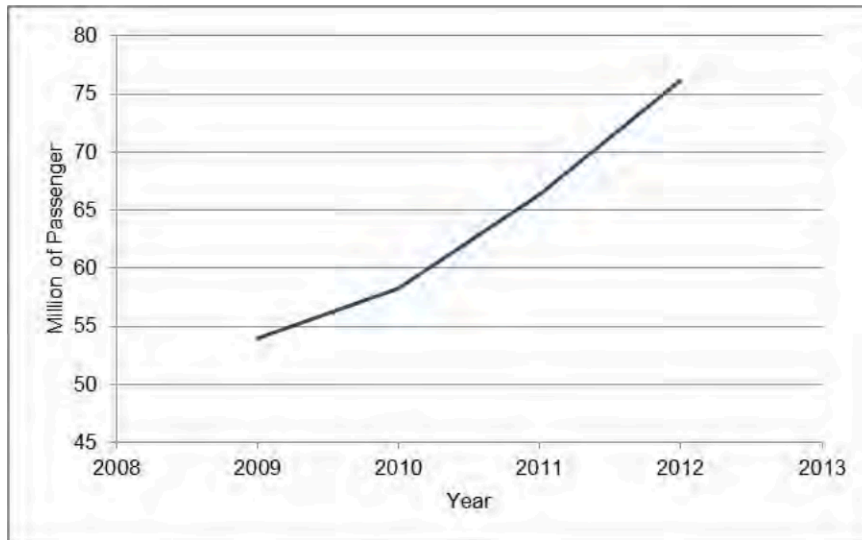


Figure 2: Air passenger throughput at 6 airports of Thailand under operating of Airports of Thailand PLC. (Airports of Thailand PLC., 2014)

Literature Reviews

There are some literatures concerning airport network study. In the framework of network analysis, airports represent nodes and individual routes represent the connections between them (Paleari et al., 2009). The resulting structure is interesting in terms of both topological features and what it reveals about network performance from the passenger's perspective (Paleari et al., 2009). Malighetti et al. (2007) have investigated the connectivity of the European airport network by employing a time-dependent minimum path approach to calculate the minimum travel time between each pair of airports in the network including flight times and waiting times of each alliance. Another research employing a time-dependent minimum path approach to measure airport connectivity is Paleari et al.'s paper (Paleari et al., 2009). They have done a comparative study of airport connectivity in China, Europe and US. This paper aims to analyze which network provides the best service to final passengers in term of travel time. The results showed no much difference in three networks. However, the principle of a time-dependent minimum path approach is 1) finding the number of connections lying of origin-destination quickest paths which the quickest path is the path involving the lower travel time from origin to destination (centrality perspective) and 2) finding the average travel time to reach any other airport in the network (accessibility perspective) (Burghouwt and Redondi, 2009). A time-dependent minimum path approach just focused travel times.

Another model for measurement connectivity performance of airport in the network is the NETSCAN model. Veldhuis (1997) has elaborated the origin and application of the NETSCAN model, the main variables in this model are frequencies and travel time. He had applied this model to analyze airline connections at Amsterdam airport. Additionally, the NETSCAN model was mentioned in the paper of Burghouwt and Veldhuis (2006). They measured the competitive position of hub airports in the transatlantic market by using the NETSCAN model. Matsumoto et al. (2009) have analyzed air network performance and hub competitive position of primary airports in East and Southeast Asia by using the NETSCAN model too. Besides, the NETSCAN model was mentioned in the working paper of Burghouwt and Redondi (2009). They have collected and analyzed the different of connectivity model used to measure the connectivity in air transport networks. They have identified the NETSCAN model to be a local connectivity model and also distinguished two basic perspectives on connectivity: (1) the accessibility perspective and (2) the centrality perspective (Burghouwt and Redondi, 2009). The NETSCAN model is the integrated model of variables like frequencies, travel time and the necessity of a transfer. Hence, this model is appropriate for measurement the airport connectivity to reflect number and quality of connections at a certain airport.

Definitions about air connection

There are some words or phase concerning the measurement of the air connections which have been described below:

Connection in air transport

Burghouwt and Veldhuis, (2006) have distinguished three types of connections: (1) Direct connections: flights between A and B without a hub transfer (e.g., from Amsterdam to Los Angeles) (2) Indirect connections: flights from A to B, but with a transfer at hub X (e.g., from Amsterdam to Los Angeles via Detroit) (3) Hub connections: connections via (with a transfer at) hub A between origin C and destination B (e.g., from Hamburg via Amsterdam to Los Angeles). In fact, hub connections are equal to indirect connections.

Connectivity

Burghouwt and Redondi (2009) said that according to graph theory, connectivity can be defined as the degree to which nodes in a network are connected to each other. Air transport research has brought forward a broad range of connectivity measures. Burghouwt and Redondi (2009) also cited Veldhuis, 1997; Burghouwt, 2007; Malighetti et al., 2008 that connectivity can be distinguished into two basic perspectives: (1) the accessibility perspective or (in)direct connectivity and (2) the centrality or hub connectivity perspective. Whereas the first perspective considers the number and quality of direct and indirect air travel connections available to the consumer at a certain airport, the second perspective measures the number of transfer opportunities available via a specific airport (see figure 3). Besides, Burghouwt and Veldhuis, (2006) also said that the measurement of indirect connectivity is particularly important from the perspective of consumer welfare. The concept of hub connectivity is particularly important for measuring the competitive position of airline hubs in a certain market.

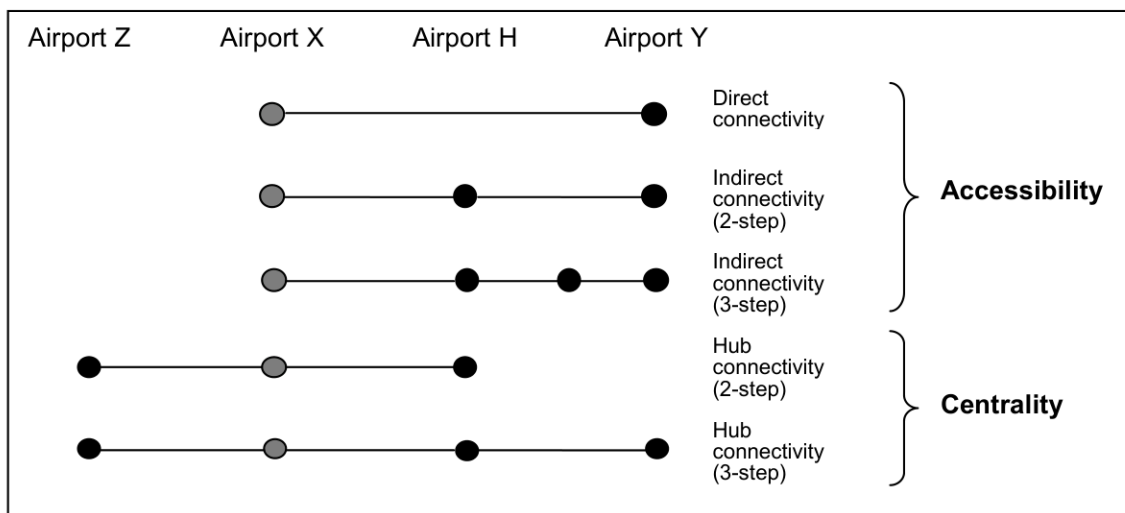


Figure 3: Type of connectivity at airport X (Burghouwt and Redondi, 2009)

On-line Connection

Business Dictionary (2014) defined on-line connection as change of aircraft not involving change of airlines. Additionally, Burghouwt and Veldhuis (2006) defined it as the transfer between two flights has to take place between flights of the same airline or global airline alliance.

Interline Connection

Business Dictionary (2014) defined it as air travel in which the same ticket covers different legs of the journey flown by different airlines.

Code share flight

It is two or more leg flight, covered by one ticket and sold by one airline, for a destination served not directly by it but through an affiliated airline (usually a commuter carrier). A code share flight uses the same two-letter carrier code during all legs of the journey. (Business Dictionary, 2014)

Method and Data

The NETSCAN model

From the previous researches (Veldhuis, 1997; Burghouwt and Veldhuis, 2006; Matsumoto et al., 2009), they said that the quality of an indirect connection is not equal to the quality of a direct connection. The operation of NETSCAN model is to quantify the quality of an indirect connection and scale it to the quality of a theoretical direct connection.

In air travel by plane, there are normally two connections for passengers (if the distance is long enough), direct or indirect connection. Passengers usually make a choice from the attractiveness of the available alternatives. Veldhuis (1997) said that attractiveness is often expressed in utility functions, where variables like available frequencies, their travel times and fares are weighted. He explained further that other factors like comfort, loyalty to airlines, specific preferences for certain airports or airlines do also play a certain role but they are hardly systematically available and even difficult to measure, so they are kept. For variable „fares“, he explained that fares on certain routes change sometimes by the day and advanced yield managing systems, used by some major airlines, result in large differences of fares, so a systematic and coherent fare information system, representing the actual fares paid, is also not available (for more information about fares, please see Veldhuis, 1997). Hence, the NETSCAN model is constructed from the correlation of variables like frequencies, travel times and the necessity of a transfer for indicate route characteristics. The output of calculation by the NETSCAN model expressed in so called „connectivity units“ (CNU).

From the studies of Veldhuis (1997) and Matsumoto et al. (2009), summarizing the following model has been applied;

$$\begin{aligned} \text{NST} &= (40+0.068*\text{gcd km}) / 60 & (1) \\ \text{MAXT} &= (3-0.075*\text{NST})*\text{NST} & (2) \\ \text{PTT} &= \text{FLY}+ (3-0.075*\text{NST})*\text{TRF} & (3) \\ \text{QUAL} &= 1- ((\text{PTT}-\text{NST})/(\text{MAXT}-\text{NST})) & (4) \\ \text{CNU} &= \text{QUAL} * \text{FREQ} & (5) \end{aligned}$$

Where NST is the on-stop travel time in hours, gcd km is the great-circle distance in kilometre, MAXT is the maximum perceived travel time in hour, PTT is the perceived travel time in hour, FLY is the flying time in hour, TRF is the transfer time in hour, QUAL is the quality index of an individual connection, FREQ is the frequency per week and CNU is the number of connectivity units.

This paragraph is description about a quality index, an important variable in the NETSCAN model, which Burghouwt and Veldhuis (2006) have said in their work. NETSCAN assigns a quality index to every connection, ranging between 0 and 1. A direct, non-stop flight is given the maximum quality index of 1. The quality index of an indirect connection will always be lower than 1 since extra travel time is added due to transfer time and detour time of the flight. The same holds true for a direct multi-stop connection: passenger face a lower network quality because of en-route stops compared to a nonstop direct connection. Additionally, if the additional travel time of an indirect connection exceeds a certain threshold, the quality index of the connection equals 0. The threshold of a certain indirect connection between two airports depends on the travel time of a theoretical direct connection between these two airports. In other words, the longer the theoretical direct travel time between two airports, the longer the maximum indirect travel time can be.

The conditions for using the NETSCAN model: (1) specification minimum connection time and a limit on the maximum connecting time, in the previous research, they specified 45-60 minutes connection times and 24 hour maximum connecting time. (2) Only on-line connections are considered as viable connections including code share flight (Veldhuis, 1997; Burghouwt and Veldhuis, 2006).

For evaluation air connectivity of Chiang Mai airport in accessibility perspective, the author used the NETSCAN model to calculate the connectivity indices in each flight between Chiang Mai airport and others. Next, summary is done for making total connectivity units in each route. The analysis only considers the connectivity between Chiang Mai airports and other airports in Thailand and in ASEAN. The return connections have not been considered in this analysis. The authors used the commercial flight schedules data in the third week of October in 2014 from „Wego“ and „Jetradar“ website (Wego, 2014; Jetrada, 2014). We only focus on passenger flight. Additionally, in this paper, the minimum connection time at a specific airport is 45 minutes and a limit on the maximum connecting time is 24 hours.

Research Findings

Figure 4 and figure 5 show the total direct and indirect connectivity units at Chiang Mai airport in the third week of October in 2014. As presented in figure 4, CNU of indirect connections are equal zero. In practice, there are indirect connections served to customers but the indirect connections are not attractive (quality index equals zero) for traveling in domestic routes. Because flight distances of these domestic routes are quite short, the theoretical direct travel time between two airports is small. Due to a small amount of theoretical direct travel time between these two airports, the maximum indirect travel time in each indirect connection is small. So, the travel time of an indirect connection exceeds its maximum indirect travel time easily. According to the NETSCAN model, the quality index of indirect connections of 8 routes equal 0. Surely, their CNU are zero too (see equation 5). There are 8 routes from Chiang Mai airport to airports in Thailand in the third week of October in 2014. All 8 destinations include Don Mueang airport, Hat Yai airport, Kra Bi airport, Mae Hong Son airport, Phuket airport, Samui airport, Suvarnabhumi airport and Udon Thani airport. Chiang Mai airport-Don Mueang airport route has the highest connectivity units (203 CNU). It means that this route has the highest number and quality of air travel connections available to the consumer. In other word, passengers have more choices to travel because it has more flights per week. Total CNU of the route from Chiang Mai airport to Suvarnabhumi airport is the second (112 CNU). The connectivity units of these two routes are high when compared with others. It may be because these two destinations are in the capital of Thailand, Bangkok. Noticeably, CNU of Chiang Mai airport-Don Mueang airport route is higher than CNU of Chiang Mai airport-Suvarnabhumi airport route almost two times. It may be because the demand of low cost carrier (Don Mueang airport is Thai hub of low cost carrier) on domestic traveling. Additionally, total CNU of the route from Chiang Mai airport to Phuket airport is the third (35 CNU). Phuket airport is in Phuket which is a famous province in tourism. The fourth is the route from Chiang Mai airport to Mae Hong Son airport (23 CNU) which is the nearest airport of Chiang Mai airport. Additionally, the remainder routes are the routes from Chiang Mai airport to Kra Bi airport (14 CNU), Hat Yai airport (7 CNU), Samui airport (7 CNU) and Udon Thani airport (7 CNU). These destinations are in the regions of Thailand. Kra Bi airport, Hat Yai airport and Samui airport are in the South of Thailand. And Udon Thani airport is in the Northeast of Thailand. Hence, the number of connections from Chiang Mai to these destinations is not high.

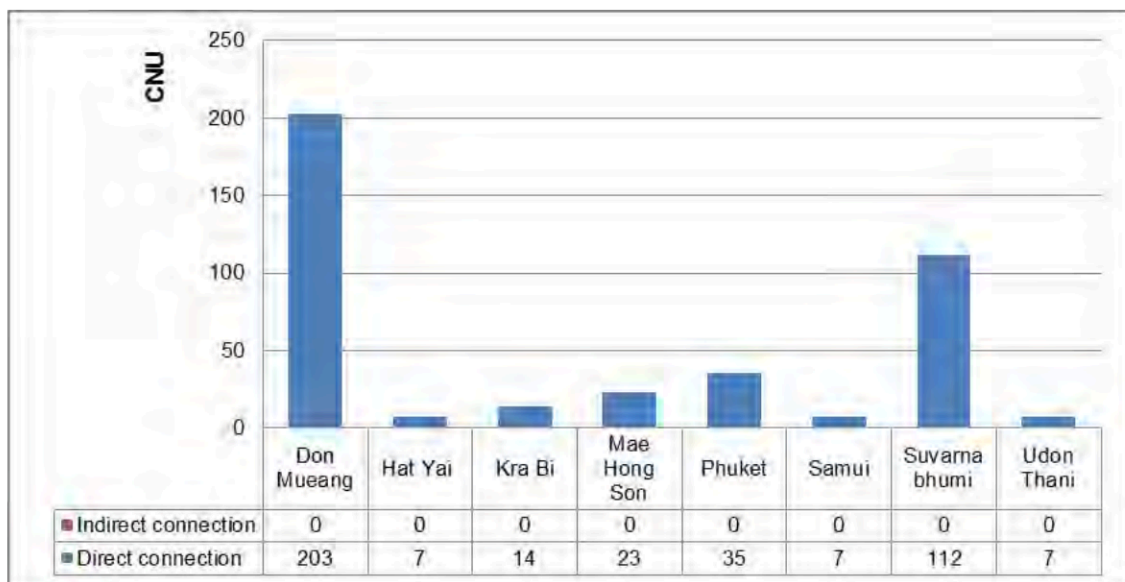


Figure 4: Connectivity units of 8 routes, from Chiang Mai airport to 8 domestic destinations in 2014.

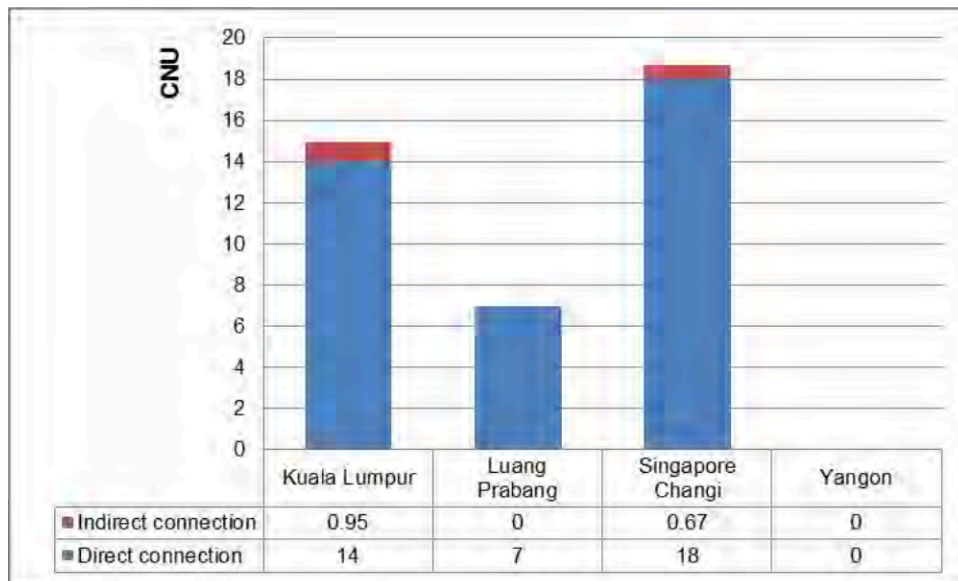


Figure 5: Connectivity units of each route, from Chiang Mai airport to airports in ASEAN market

Figure 5 presents total connectivity units of the routes from Chiang Mai airport to four destinations in ASEAN including Kuala Lumpur airport, Luang Prabang airport, Singapore Changi airport and Yangon airport. The number and quality of connection from Chiang Mai airport to Singapore is the highest. This route can serve high quality and frequencies to customer. The second is Chiang Mai airport-Kuala Lumpur airport route. Additionally, Chiang Mai airport-Luang Prabang airport route is the third of rank and the indirect connection in this route is not attractive to customer (CNU equals zero). Furthermore, there are not direct connections from Chiang Mai airport to Yangon airport (in October 2014 period). There are only indirect connections but they are not attractive to customers because of additional travel time. In ASEAN market, the ratios of indirect connectivity and direct connectivity are very low. They imply that direct connection is more appropriate to travel in ASEAN than indirect connection.

Summary findings

This study shows the connectivity performances of Chiang Mai airport in the accessibility perspective. Chiang Mai airport has 12 destinations composed of 8 domestic destinations and 4 ASEAN destinations. Domestic destinations include Don Mueang airport, Hat Yai airport, Kra Bi airport, Mae Hong Son airport, Phuket airport, Samui airport, Suvarnabhumi airport and Udon Thani airport. Additionally, ASEAN destinations consist of Kuala Lumpur airport, Luang Prabang airport, Singapore Changi airport and Yangon airport. For traveling in domestic market from Chiang Mai airport, direct connections are good for customer and indirect connections maybe not necessary. Additionally, for traveling in ASEAN market from Chiang Mai airport, direct connections are good for customers too and indirect connections can be some choices for customers in some route like Chiang Mai airport-Kuala Lumpur airport route. Indirect connection will be better if the connection time at a hub airport is low.

Acknowledgements

The authors gratefully acknowledge the Excellence Center in Logistics and Supply Chain Management (E-LSCM) for the general support and Graduate School of Chiang Mai University for the Financial Support.

References

- Airports of Thailand PLC. [Online] Available: <http://www.airportthai.co.th/corporate/th/investor-relations> (April 30, 2014).
- Burghouwt, G. and Redondi, R. 2009. Connectivity in air transport networks: models, measures and applications. Working paper. Department of Economics and Technology Management.
- Burghouwt, G. and Veldhuis, J. 2006. The competitive position of hub airports in the transatlantic market. *Journal of Air Transportation* 11(1), pp. 106-130.

- Business Dictionary. [Online] Available: <http://www.businessdictionary.com/> (June 14, 2014).
- Jetradar. [Online] Available: <http://www.jetradar.co.th/> (June 14,2014).
- Malighetti, P., Paleari, S. and Redondi, R. 2008. Connectivity of the European airport network: “Self-help hubbing” and business implications. *Journal of Air Transport Management* 14, pp. 53–65.
- Matsumoto, H., Burghouwt, G., de Wit, J. and Veldhuis, J. 2009. Air network performance and hub competitive position: Evaluation of primary airports in East and Southeast Asia. *Journal of Airport Management* 3(4), 384-400.
- Paleari, S., Redondi, R. and Malighetti, P. 2009. A comparative study of airport connectivity in China, Europe and US: which network provides the best service to passengers? Working paper. Department of Economics and Technology Management.
- Renner, M. “Global Air Transport Continues to Expand”. [Online] Available: <http://www.worldwatch.org/global-air-transport-continues-expand-0> (April 30, 2014).
- The World Bank. “Air transport, passengers carried”. [Online] Available: <http://data.worldbank.org/indicator/IS.AIR.PSGR/countries/1W?display=graph> (June 25, 2014).
- Veldhuis, J. 1997. The competitive position of airline networks. *Journal of Air Transport Management* 3(4), pp. 181-188.
- Wego. [Online] Available: <http://th.wego.com/schedules> (June 14,2014).