THE EFFICIENCY MEASUREMENT OF 6 THAILAND'S MAIN PUBLIC AIRPORTS BETWEEN 2007 TO 2019

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Abstract - This paper studies the efficiency changes of the 6 main public airports of Thailand from 2007 to 2019. The period covers from the year Suvarnabhumi Airport (BKK) opened until the year before the COVID-19 pandemic started. This paper employs the input-oriented CCR data envelopment analysis (DEA) model to measure the efficiency changes of Thailand's airports. The result shows that the airports that have a higher number of passengers and aircraft movements perform efficiently than the airports that have fewer passengers and aircraft movements.

Keywords - Efficiency Measurement, Data Envelopment Analysis (DEA), Air Transportation.

I. INTRODUCTION

The research focuses on the efficiency changes in the 6 main public airports of Thailand from 2007 to 2019 These airports include Suvarnabhumi airport (BKK), Don Muang International airport (DMK), Phuket International airport (HKT), Chiang Mai International airport (CNX), Hat Yai International airport (HDY), and Mae Fah Luang-Chiang Rai International airport (CEI). All of them operated by Airports of Thailand Public Company Limited (AOT). They are in the top 10 Thailand's busiest airports all the time and the big airport hubs in ASEAN.

Charnes et al. (1978) proposed a basic DEA model to measure technical efficiency levels of the firms that studied. This research employs that model called "the input-oriented data envelopment analysis (DEA)" model to measure the efficiency changes of the airports between 2007 to 2019. The period covers events that affected Thailand's economy such as the global financial crisis between 2008 to 2009 and flooding in Thailand in 2011. A few research studied the efficiency changing of the main airports of Thailand by applying the DEA model. Sopadang and Suwanwong (2016) employed CCR and BCC DEA models by applying CNX and 18 Asian airports in 2014. Rapee and Peng (2014) measured the efficiency scores of all main public airports in Thailand in 2014.

The next section discusses the data and methodology. Section 3 shows the result of this research. The last section is a conclusion.

II. DATA AND METHODOLOGY

A. Data

This research obtained the data from AOT's annual reports from 2007 to 2019. The input variables compose the number of workers, number of runways, apron area (meter squares), and terminal area (meter squares) at the individual airport. For the output variables, this research uses the number of passenger movements, the number of aircraft movements, and the amounts of cargo volumes shifted in tons. Table 1 shows the descriptive statistics of all variables.

Desriptive Statistics					
Input/Output	Variables	Maximum	Minimum	Average	Std. Dev.
Input	No. of employees	3259	105	774.59	933.18
Input	No. of runways	2	1	1.33	0.47
Input	Apron Area (meter squares)	1033000	28800	359842.83	421071.25
Input	Terminal Area (meter squares)	563000	14656	158410.45	207761.04
Output	No. of passengers	64711010	648783	15008488.94	2093598.13
Output	Aircraft movement	378886	5546	98548.17	111622.81
Output	Cargo Volumes (tons)	1500139	2287	229988.73	475124.33

Table 1. Descriptive statistics of all data used to estimate the technical efficiencies of the airports from 2007 to 2019.

B. Methodology

In this paper, we use the input-oriented DEA model to estimate the airport's efficiency scores. DEA model is a kind of nonparametric method that used mathematical or linear programming to analyze multiple inputs and outputs. Charnes et al. (1978) introduced a data envelopment analysis (DEA) to estimate the technical efficiency level by assuming a basic input-orientation assumption. The input-oriented DEA model can be defined as

$$\text{Min} \quad \theta_j = \theta^* \qquad (1)$$

$$\text{Subject to} \quad \sum_{i=1}^{N} \lambda_{ij}\, x_{ki} \le \theta_j x_{kj}, \quad k = 1, \dots, K$$

$$y_{mj} \le \sum_{i=1}^{N} \lambda_{ij}\, y_{mj}, \quad m = 1, \dots, M$$

$$\lambda_{ij} \ge 0, \qquad i = 1, \dots, N$$

Where θ_j or θ^* is input-oriented TE of the j^{th} airports.

x_{kj} is input set of the j^{th} airports.

y_{mj} is output set of j^{th} airports.

λ_{ij} is the intensity variable representing weights of all airports. $(i = 1, \dots, N)$ used to construct frontier for the j^{th} airports.

The value of θ^* ranges between 0 and 1. One indicates the airport operates as fully efficient, but

zero indicates fully inefficient. This research employs the DEAP program to estimate the result.

III. RESULT

Table 2 shows the overall technical efficiency levels of the 6 main public airports of Thailand from 2007 to 2019. The efficiency level of BKK in 2009 shows efficiency declined to 74.1%, the period of the global financial crisis, and recovered to more than 90% in 2010. From 2011 to 2019, the result shows that BKK can perform their operation fully efficient in 2012, 2018, and 2019 which technical efficiencies equal to 100%.

The efficiency of DMK in 2009 had an inefficiency score of 75.4%. That was caused by the global financial crisis in that year. The efficiency level of DMK was increased to almost 70% in 2011, the recovery period after the crisis. Then, dropped a lot in 2012 because of the end of the year 2011 or fiscal year 2012, Thailand was faced with flooding, and DMK had been flooded in that year. The efficiency level fell to 32.6%

The inefficiency levels of HKT in 2008 and 2009 were 12.3% and 22.7% because of the effect of the global financial crisis. From 2010 until 2019, the result shows that the levels of efficiency of HKT were higher than 90%.

For CNX between 2008 to 2009, the result shows that in the period of the global financial crisis, the technical inefficiencies of this airport had more than 30%. After 2014, the efficiency levels of CNX were higher than 90%, and in the years 2015, 2017, 2018, and 2019, CNX performed the performances at fully efficient.

For HDY between 2008 to 2009, the efficiency levels were slightly decreased. The average efficiency levels of HDY from 2007 to 2019 equals 53.5%. Because HDY and CEI are not airport hubs, no. of passengers and aircraft movements are much lower when compared with the other 4 airports. In 2007, HDY has technical inefficiency at 57.7%, but in the period of the global financial crisis, HDY has technical inefficiencies higher than 60% between 2008 to 2009.

From 2007 to 2013, the result shows that the levels of efficiency of CEI were below 30%. After 2014, the efficiency was slightly increased. In 2019, CEI had an efficiency level of 71.1%.

Technical Efficiency by using input-oriented CCR Model							
Year	BKK	DMK	HKT	CNX	HDY	CEI	Mean
2007	0.878	0.332	1.000	0.850	0.423	0.279	0.627
2008	0.934	0.437	0.877	0.690	0.393	0.299	0.605
2009	0.741	0.246	0.773	0.670	0.381	0.248	0.510
2010	0.931	0.287	0.982	0.796	0.463	0.255	0.619
2011	0.987	0.694	0.947	0.812	0.532	0.245	0.703
2012	1.000	0.326	1.000	0.909	0.576	0.286	0.683
2013	0.976	0.870	1.000	0.724	0.571	0.263	0.734
2014	0.927	0.895	1.000	0.839	0.578	0.357	0.766
2015	0.951	1.000	1.000	1.000	0.540	0.461	0.825
2016	0.988	0.978	0.929	0.985	0.590	0.512	0.830
2017	0.994	0.972	0.963	1.000	0.669	0.595	0.866
2018	1.000	1.000	1.000	1.000	0.641	0.684	0.888
2019	1.000	1.000	0.992	1.000	0.594	0.711	0.883
Mean	0.947	0.695	0.959	0.867	0.535	0.400	

Table 2. Levels of efficiency of 6 main public airports of Thailand from 2007 to 2019.

Figure 1 shows the average technical efficiency levels for the individual airport from the year 2007 to 2019. The result shows that the highest efficiency level between 2007 to 2019 is HKT which had technical efficiency of 95.9%, in other words, HKT had technical inefficiency at 4.1%. BKK, CNX, DMK, and HDY had efficiency levels at 0.947, 0.867, 0.695, and 0.535, respectively. CEI was the lowest efficiency, and technical inefficiency level equals 60%.

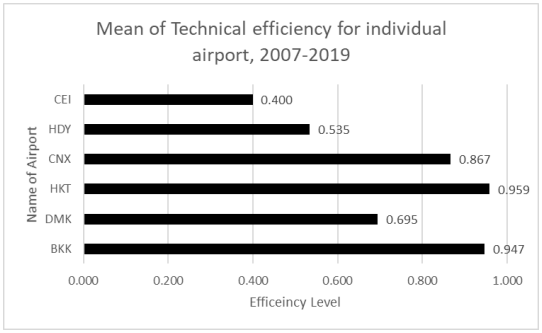


Figure 1. Means of technical efficiencies of the individual airport from 2007 to 2019.

IV. CONCLUSION

This study measures the efficiency levels of Thailand's main public airports operated by AOT from the year BKK opened until the last year before the COVID-19 pandemic happened. This is the first study in Thailand that applies the input-oriented DEA model with the longest period to estimate the efficiency scores of Thailand's airports.

The research shows that BKK is the highest efficient airport followed by HKT, CNX, DMK, HDY, and CEI between 2007 to 2019. DMK tends to improve its efficiency after the year 2010. This change made DMK was the world's largest low-cost carrier airport in 2015.

BKK, HKT, and CNX are the airports that have efficiency scores higher than 85 percent between our study periods. The reason is these airports are the airport hubs that served a higher number of passenger movements and aircraft movements than the other 2 airports as HDY and CEI. While DMK was faced with the shock from flooding in 2011, but after recover from that situation in 2012, DMK served the highest number of low-cost carrier passengers in Thailand and operated almost fully efficiently every year from 2013 until 2019. Lastly, CEI is the only airport that has an average efficiency score below 50 percent but the trend of efficiency improvement is increased after 2015.

This paper does not consider the recent data in 2020 that includes the big crisis called "the COVID-19 pandemic". The future research can contain this event and apply the time-series method to forecast the recovery trends of these airports after the crisis.

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