Table 1: Airports list

No.	Airport	Country	IATA Code	Note
1	Singapore Changi Airport	singapore	SIN	The top Skytrax world airport 2014
2	Incheon International Airport	Korea Rep.	ICN	
3	Hong Kong International Airport	Hong Kong	HKG	
4	Tokyo International Airport Haneda	Japan	HND	
5	Chubu Centrair International Airport, Nagoya	Japan	NGO	
6	Chengdu Shuangliu International Airport	China	CTU	Random selection
7	Gimhae International Airport	South Korea	PUS	
8	Kansai International Airport, Osaka	Japan	KIX	
9	Kuala Lumpur International Airport	Malaysia	KUL	
10	Ngurah Rai International Airport, Denpasar	Indonesia	DPS	
11	Noibai International Airport, Hanoi	Vietnam	HAN	
12	Penang International Airport, Penang	Malaysia	PEN	
13	Shanghai Pudong International Airport	China	PVG	
14	Tan Son Nhat International Airport, Saigon	Vietnam	SGN	
15	Xiamen International Airport	China	XMN	
16	Yangon International Airport	Myanmar	RGN	
17	Kunming International Airport	China	KMG	
18	Soekarno-Hata International Airport, Jakarta	Indonesia	CGK	
19	Chiang Mai International Airport	Thailand	CNX	Case study

The solution indicated the input-oriented efficiency of each airport. The measure of input-oriented efficiency specified how the input will give an impact to the output level. DEA can be piloted under the assumption of constant returns to scale (CRS) or variable returns to scale (VRS). This paper compared constant-return to scale (CRS) with variable-return to scale (VRS). If the result of both scales is not equivalent thus, the airport is insufficient to provide high operational performance. DEA allocate a score of 1 to a unit only when evaluations with other related units do not provide indication of inefficiency in the use of input or output. A score less than 1 means that there are inefficient units occurred. The CRS assumption is only suitable when all firms are operating at an optimal scale, whereas, The VRS assumption is appropriate when the firms are not operating at an optimal scale. The scale efficiency can be calculated by approximating both the CRS and VRS models and considering at the difference in scores

The score on both CRS and VRS are presented in the table 2: DEA efficiency score. We used the DEAP 2.1 software to analyze the results. DEAP 2.1 is used to construct DEA frontiers for the calculation of technical and cost efficiencies and also for the calculation of Malmquist TFP (Total Factor Productivity) Indices. However, in this paper, we only focused on the calculation of technical efficiency and u the result to the scale efficiency. This can generate the scale efficiency which is partly answering the question.

Table 2: DEA efficiency scores

Airport	IATA Code	CRS(TE)	VRS(TE)	Scale
Singapore Changi Airport	SIN	0.749	0.848	0.883
Incheon International Airport	ICN	0.637	0.826	0.771
Hong Kong International Airport	HKG	1.000	1.000	1.000
Tokyo International Airport Haneda	HND	1.000	1.000	1.000
Chubu Centrair International Airport, Nagoya	NGO	0.469	1.000	0.496
Chengdu Shuangliu International Airport	CTU	0.719	0.929	0.774
Gimhae International Airport	PUS	0.544	1.000	0.544
Kansai International Airport, Osaka	KIX	0.436	0.786	0.556
Kuala Lumpur International Airport	KUL	0.714	0.818	0.873

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Ngurah Rai International Airport, Denpasar	DPS	0.632	1.000	0.632
Noibai International Airport, Hanoi	HAN	0.485	0.840	0.577
Penang International Airport, Penang	PEN	0.377	1.000	0.377
Shanghai Pudong International Airport	PVG	0.639	0.816	0.783
Tan Son Nhat International Airport, Saigon	SGN	1.00	1.000	1.000
Xiamen International Airport	XMN	0.620	0.752	0.824
Yangon International Airport	RGN	1.000	1.000	1.000
Kunming International Airport	KMG	1.000	1.000	1.000
Soekarno-Hata International Airport, Jakarta	CGK	0.307	1.000	0.307
Chiang Mai International Airport	CNX	0.602	1.000	0.602

CRSTE-DEA efficiency

There are 19 Asean plus 3's airport considered in this paper. Table 2 represented the result of the model by using DEAP 2.1 software. The results were the input-oriented efficiency measurement. It was composed of CRSTE, VRSTE-DEA efficiency, and Score efficiency. Based on the result, there were 5 out of 19 airports which were allocated the CRSTE-DEA score of 1, meaning that they recorded as the efficient airports. Hong Kong International Airport and Tokyo International Airport Haneda yielded the full score, which may contradict that they are suffering from the congestion (For Hon Kong, 63,148,379 passengers with 846,000 square meter terminal size. For Haneda, 72,826,862 passengers in year 2014 with only 236,000 square meter terminal size). This could lead to the lower service quality in the future; even the airport itself has high operational performance efficiency. For other three airports which were Tan Son Nhat International Airport, Saigon, Yangon International Airport, and Kunming International Airport, the capacity of each of these airports performs to meet the demand and efficiently utilized. Move to the low efficiency scores, the most inefficient airport of the 19 airports regarding to the CRATE-DEA scores was Soekarno-Hata International Airport, Jakarta. The second most inefficient airport is Penang International Airport, Penang, followed by Kansai International Airport, Osaka, Chubu Centrair International Airport, Nagoya, and Noibai International Airport, Hanoi. One commonality of these airports is their terminal size which is slightly higher than the projected value and this problem may be knocking down their efficiency scores. Chiang Mai International airport, terminal size and check-in desks were the factors that exceeding the projected value, therefore, this leads to the inefficient scores.

VRSTE-DEA efficiency

Airports that generated full score of CRSTE- DEA are efficient in terms of both technical and scale efficiencies; thus, their VRS efficiency scores are also one, by structure. There are some airports whose rankings of CRSTE and VRSTE- DEA efficiencies are moderately different. For example, Penang International Airport, Penang, Soekarno-Hata International Airport, Jakarta, or Chubu Centrair International Airport, Nagoya are given full score for its VRSTE-DEA efficiency, even though it CRSTE-DEA efficiency is ranked at 0.377, 0.307, and 0.469, respectively. Meaning, the ''pure technical efficiencies'' of these airports evaluated by VRSTE are high, but their ''scale efficiencies'' are low, which effected in their low rankings in CRSTE-DEA efficiency. Similarity, some other airport such as Singapore Changi Airport or Chiang Mai International Airport are placed at higher position in VRSTE-DEA than in CRATE DEA. However, according to Yoshida and Fujimoto (2004), technical efficiency measured by VRSTE- DEA possibly will be overestimated and thus the scale efficiency is misjudged. Therefore, this paper will simply focus on the CRSTE-DEA efficiency score.

Clarification of the results

As the result presented earlier, we are next analyze Chiang Mai International Airport. The sensitivity analysis is use to conduct in this section. Because of we need to identify how to improve the input factors to have a better efficiency. Sensitivity analysis is the study of how the uncertainty in the output of a mathematical model can be assigned to different sources of uncertainty in its inputs. It is the process of recalculating out comes under alternative assumptions to determine the impact of variable. Moreover, the analysis also increased understanding of the relationships between input and output variables in a system or model. Based on the result above, the following information is the result that retrieved from the DEAP software; CRSTE-DEA efficiency

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Technical efficiency = 0.602
PROJECTION SUMMARY:

	Variable	Value	original movement	radial movement	slack value	projected
Passenger	Output	1	6213446.000	0.000	0.000	6213446.000
Terminal size	Input	1	33450.000	-13314.940	0.000	20135.060
No. of runways	Input	2	1.000	-0.398	-0.261	0.341
Lengths of runways	Input	3	3100.000	-1233.970	-1579.361	286.669
No. of gates	Input	4	11.000	-4.379	-3.209	3.413
Check-in desks	Input	5	59.000	-23.485	-34.491	1.024

Figure 2: DEAP result

The result shown that there were some inefficiency input factors which had slightly higher value than the projected value. This impacted the technical efficiency score of Chiang Mai International Airport. We examined variation of technical efficiency by applying the theoretical of sensitivity analysis. We attempted to modify the technical efficiency results. If the output was fixed and the change was in input, the result would change or not. This point will be discussed more below.

Increased the input value by 50%

Technical efficiency = **0.401**
PROJECTION SUMMARY:

	Variable	value	original movement	radial movement	slack value	projected
Output	1		6213446.000	0.000	0.000	6213446.000
Input	1		50175.000	-30039.940	0.000	20135.060
Input	2		2.000	-1.197	-0.461	0.341
Input	3		4650.000	-2783.970	-1579.361	286.669
Input	4		17.000	-10.178	-3.409	3.413
Input	5		89.000	-53.285	-34.692	1.024

Figure 3: DEAP result (increase)

The result, from the figure 2, present that if we increased the input value, the technical efficiency will decreased automatically.

Decreased the input value by 50%

Technical efficiency = **1.000**
PROJECTION SUMMARY:

	Variable	value	original movement	radial movement	slack value	projected
Output	1		6213446.000	0.000	0.000	6213446.000
Input	1		15725.000	0.000	0.000	15725.000
Input	2		1.000	0.000	0.000	1.000
Input	3		3100.000	0.000	0.000	3100.000
Input	4		6.000	0.000	0.000	6.000
Input	5		29.000	0.000	0.000	29.000

Figure 4: DEAP result (decrease)

For this case, Number of runways and Length of runways were fixed as the original data because an airport has to have at least one runway with the propel length of runways. The result shown that, if we decreased the rest of input by 50%, the technical efficiency score generated the full score.

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IV. CONCLUSION

This paper has adopted the DEA methods in evaluating the efficiency of airports and examined whether the current technical efficiency result of Chiang Mai International Airport are indeed effective or not. The paper has used a data set which consists of 19. Each observation was measured by five inputs (Terminal size, Number of runway, Length of runway, Number of gate, and Check-in desk) and only one output which was Number of passenger. However, this data set does not cover financial data because of data collection difficulty. DEA method presented here that there were relationship between input and output. Additionally, the efficiency measurement through the sensitivity analysis has confirmed that the efficiency of the airport will be lower if the input increased. Meaning, in the situation of the lower input-the higher output, the airport will get the full score if the airport operates in full capacity. As mentioned, the financial indicator was not considered in this paper, therefore, the result lean towards to the use of capacity efficiency and effectiveness. To be more productive, measuring the efficiency by taking the financial into account will be one of the future extension lead of the current research.

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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.

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