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A MODEL FOR ASSESSING SUITABILITY OF AIR CARGO HUB IN SOUTHEAST ASIA USING AHP AND TOPSIS

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This research aims to develop a model for evaluating the selection of air cargo hub in Southeast Asia. This is because there is no standard evaluation form for air cargo hub, and also to bring the factors that affect the air cargo hub to help improve the airports in Southeast Asia to become a hub for air freight in the future. To develop this research model. The factors which used as criteria for evaluation can divided two ways; factor can be counted are number and factor cannot be counted are number. The data obtained from interviews, questionnaire surveys, and statistics. Using Delphi technique and panel data linear regression model to determine the real factors of air cargo hub. The data for multi-criteria decision making are the guideline for creating the evaluation form by using the AHP method to help in weighting the importance of four main criterions; geographic criteria, economic criteria, operational criteria and other criteria. Two different decision-making methods; AHP and TOPSIS, were used to determine the significance and prioritization of air cargo hub. The result of this research can provide airports with useful references for operation management and formulation of development strategies.

Key words: Air Cargo Hub, AHP, TOPSIS, Delphi, Southeast Asia

INTRODUCTION

At present, in Southeast Asia, there is an ASEAN community called AEC. Since being air cargo hub, has benefited from a rapidly growing economy, employment of the population and international trade etc. So that countries in Southeast Asia would like to become an air cargo hub. Each countries in Southeast Asia has policies to promote air transport. However, there is no clear assessment of the suitability of air cargo hub. So if there is a standard, it will help make the assessment more clear. In addition, the airports that need to be an air cargo hub have improved the airport according to the criteria. At the same time, Boeing Company [01] is estimated that between 2009 and 2028, the average annual growth rate of air traffic growth will be 8.1% in the Asian market, which will make each country in Asia more adaptable to accommodate that growth. This paper is arranged into five sections. The second section provides an overview of existing methods and studies. The third section show the process of air cargo hub evaluation in Southeast Asia. The next section describes shows the result of the research and analysis of the selective air cargo hub for Southeast Asia. Finally, concluding remarks and discussions.

LITERATURE REVIEW

Several approaches have been proposed in the literature for selecting the air transportation center. Some of these methods and applications are mentioned Gardiner et al. [02] identify and evaluate the many factors that influence the choice of airports by airlines that provide air cargo services. This research is based on a survey of international airlines using non-scheduled air freight. There are several factors, such as return shipping, airport charges, and airport charges. Chao & Yu [03] conducted a quantitative assessment of the competitiveness of air transport using Delphi and AHP. The analysis found that Hong-Kong was competitive in air transport while Changi international airport is the most competitive airport with respect to airport facilities and operation. Lai [04] used AHP methodology incorporates the weight of input and output variables as data integration models (DEA) with 24 major international airports analyzed. Using this approach, policymakers and practitioners can effectively compare airport performance and make more informed decisions. Adenigbo [05] determine the factors that the shipping agent is most rated. The importance of choosing Abuja Airport Cargo Services. The questionnaire survey was conducted by sampling the members of the Nigerian Association of Customs Authorities (ANCLA) at the Abuja Airport to collect preliminary data. The study uses Factor Analysis (FA) and Multiple Regression (MLR) to analyze collected data. Airport capacity calculations show airport capacity, airport capacity, and customs performance are the most important factors that agents consider in picking up cargo through Abuja Airport. Xiong & Yu [06] analyze factors affecting the hub airport by using a hierarchical analysis process (AHP) and select the central airport according to the coverage scores of each airport. From airport selection and network routing optimization, this article has 25 variables used to evaluate the airport hub.

METHODOLOGY

This research is a mixed method research using quantitative research and qualitative research. The population used in this study was 10 airports in the Southeast region.

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The purpose of this study was to assess the suitability of air cargo hub in Southeast Asia using three main methods, namely multi regression analysis, Delphi technic and survey method. The AHP and TOPSIS methods are used to determine the relative weight of dimensions, and then convert into values. The competitiveness of each airport is calculated using the value and weight of each measure. Figure 1 summarizes the steps involved in the evaluation model, with the following details.

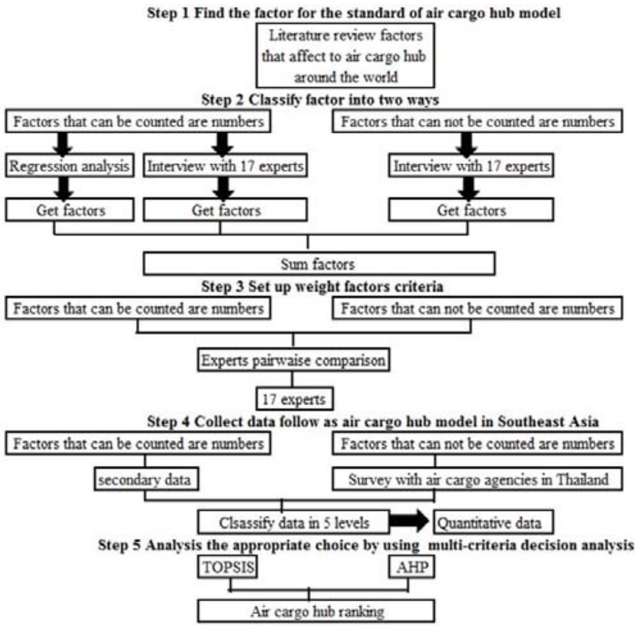

Figure 1: Steps of research methodology

1. Selection of factors related to the center of air cargo

Selection of factors is based on both qualitative and quantitative methods by reviewing literature from journals, books, airports' annual reports, various websites, and other historical documents relating to the factors affecting the choice of global air cargo. The results show that there are no standard factors used in air cargo hub assessment. The literature review found that there are 4 main factors and 24 sub-factors as shown in Table 1. Factors affecting air cargo hub. It can be divided into two parts.

1.1 Factors that can be counted are number

Two methods, namely Delphi and multiple regression analysis, were used. Panel data regression analysis by E-view version 8 used historical data for each of the 10 airports in the years 1997-2016. Pooled regression, fixed effect and random effect were used. Then, the model was selected using the Hausman test and redundant fixes effects test. Delphi technique is useful if you cannot find the information you want or lack of clear evidence [07]. The tool of this is interview with 17 experts on snowball technique. It divided into 5 groups: government, academia, air cargo agent, airport management, and economic policy. The study of California Junior Colleges Association, 1971 stated that if target teams were more than 17 or more, the error from analysis would be reduced. The Delphi process used to store data is as follows.

- Using survey method more than two times
- Later, explore each round. The expert will know the score (median) of the past round. And use the next round to consider.
- Factors are excluded when median (median) <= 4.5
- Find the answer to the consensus of the group. Based on the interquartile range of the group. When a quartile range is <= 1, it will stop the Delphi

1.2 Factors that cannot be counted are number

Use Delphi technique to find factors in air cargo hub. This is because the data is qualitative and cannot be analyzed by regression. Use the same analysis pattern as above.

2. Weighting factor criteria process

Finding each weight factor [28] with Saaty's [29] AHP method, 17 participants were used to collect the data, which was a group of experts. And the same procedure as a series of screening factors related to factors affecting the air cargo hub by Delphi. Analyze data prioritize each factor and consistency ratio. Saaty states that the acceptable consistency ratio (CR) must be less than 0.10. If the CR value exceeds the set value, it must be adjusted to compare the request for a new factor pair. However, acceptable CR values do not confirm the weight factor values. This is to ensure that there are no conflicts that are unacceptable between the factor pair.

3. Collection of data for assessment of suitability of air cargo hub in Southeast Asia

There are two steps to collect data for research

Secondary data on the statistical significance of factors affecting the air cargo hub which collect from government websites and annual report. The factors that can be counted are number will use to assess importance and value expressed as a number in the analytical hierarchical process as shown in Table 2.

Statistics were applied for quantitative criteria by dividing into five levels. To find a range of information on the basis of the data the least and most extremes should be considered for a wide range of information. The width of the class interval is calculated using the equation below;

The range = Max value data – Min value data

The class interval width=the range/number of layer data

Primary data is collected from the field data. Using purposive sampling method, the questionnaires give 200 sets to air cargo agency both Thai and foreigners, who operates in Thailand by e-mail questionnaires. Information from entrepreneurial ventures all 200 according to the information registered with the government.

Table 1: Summary of air cargo hub criteria in past studies

Geographic Criteria	Previous Study	Type of factors
Number of airline flight to and from airport (NUMFLIGHT)	Zhang [08], Scholz [09]	can be counted are number
Airport connect to other mode of transport (AIRPORTCON)	Zhang [08], Zietsman & Vanderschuren [10], Menou et al [11]	can be counted are number
Airport infrastructure (AIRPORTINFRA)	Zhang [8], Gardiner et al [02], Rocha et al [12]	cannot be counted are number
Number of cities pairs (NUMCITY)	O'Connor [13], Bowen [14], Costa et al. [15], Zhang [08]	can be counted are number
Economic Criteria	Previous Study	Type of factors
GDP of airport home country (GDP)	Bowen [14], Zhang [08], Kang & Kim [16], Homsombat et al [17]	can be counted are number
National income (NI)	Scholz [09], Chao & Yu [03]	can be counted are number
Number of labor (NUMLABOR)	Zietsman & Vanderschuren [10], Lai et al [04]	can be counted are number
Annual cargo volumes (NUMCARGO)	Chao & Yu [03], Lai et al [04]	can be counted are number
Number of manufactories (NUMMANU)	Menou et al [11]	can be counted are number
Operational Criteria	Previous Study	Type of factors
Landing fee (LANFEE)	Scholz [09], Ohashi et al [18]	can be counted are number
Airport service quality (AIRQC)	Rocha et al [12], Menou et al [11]	cannot be counted are number
Cargo-handling charges (CARGOCHR)	Wanga et al [19], Kupfer et al [20]	cannot be counted are number
Number of aircraft movement (NUMACM)	Watanabe [21], Costa [15], Nenem and Oz-kan-Gunay [22]	can be counted are number
Number of runway (NUMRUN)	Dennis [23], Lai et al [04]	can be counted are number
Custom clearance time (CUSCL)	Gardiner et al [02], Chao & Yu [03], Rocha et al [12]	can be counted are number
Customs administrations (CUSAD)	Zhang [08], Rocha et al [12]	can be counted are number
Size of cargo terminal (SIZETER)	Ohashi et al [18], Zietsman & Vanderschuren [10], Lai et al [04]	can be counted are number
Open airport hours (AIRPORTHR)	Gardiner et al [02], Chao & Yu [03], Kupfer et al [20]	cannot be counted are number
Cargo handling equipment (CARGOEQ)	Wanga et al[19], Kupfer et al [20]	cannot be counted are number
Other Criteria	Previous Study	Type of factors
Government regulations (GOVREG)	Wanga et al [19]	cannot be counted are number
Open sky agreement (OPENSKY)	Tsai and Su [24], Zhang [8], Lirn [25], Gardiner [2], Songguang [26], Costa et al [15], Wanga et al [19]	cannot be counted are number
Political risk (POL)	Wanga et al [19]	cannot be counted are number
New technology for custom clearance (NEWCUS)	Zhang [08]	cannot be counted are number
Number of airfreight airlines (NUMFRE)	Scholz & Cossel [27]	can be counted are number

Table 2: Level of analysis through Analytic Hierarchy Process

Level	Preference Level	Score
1	Very Poor	1
2	Poor	3
3	Fair	5
4	Good	7
5	Very Good	9

Table 3: Estimation of the annual cargo volumes is a dependent variable

Factors	Models		
	Pooled Model	Fixed-Effects	Random-Effects
Constant	-6.962941 (0.0016)	-6.995267 (0.0320)	-6.962941 (0.0006)
LOG(AIRPORTCON)	-0.176963 (0.7676)	-0.493865 (0.4729)	-0.176963 (0.0426)**
LOG(CUSAD)	-2.009912 (0.0109)**	-2.021027 (0.0268)**	-2.009912 (0.0127)**
LOG(CUSCL)	-0.133524 (0.2919)	-0.141562 (0.3171)	-0.133524 (0.3027)
LOG(GDP)	-0.306204 (0.0010)**	-0.330263 (0.0084)**	-0.306204 (0.0013)**
LOG(LANFEE)	0.576478 (0.0000)**	0.583454 (0.0000)**	0.576478 (0.0000)**
LOG(NUMACM)	0.054997 (0.6321)	0.053881 (0.7025)	0.054997 (0.6397)
LOG(NUMCITY)	0.054997 (0.6397)	1.295898 (0.0000)**	1.229199 (0.0000)**
LOG(NUMMANU)	3.780322 (0.0000)**	3.912202 (0.0000)**	3.780322 (0.0000)**
LOG(NUMRUN)	6.495012 (0.0000)**	6.562470 (0.0000)**	6.495012 (0.0000)**
LOG(SIZETER)	-0.444592 (0.0001)**	-0.430292 (0.0005)**	-0.444592 (0.0001)**
Adjust-R2	0.931606	0.936598	0.932606
F-statistic (Prob)	261.5399 (0.000000)	86.59726 (0.000000)	261.5399 (0.000000)

ANALYSIS AND RESULTS

The results of the research can be divided into three main groups as follows.

1. Selecting factors by multiple regression analysis and Delphi technique

1.1 Multiple regression analysis

1.1.1 Panel data regression model test

The important thing is to explore and experiment and that the model variations are of potential. Pooled model, Fixed Effects and Random Effects therefore test the model by Redundant Fixed Effects Test and Huasman Test.

1.1.1.1 Redundant Fixed Effects Tests

Test cross-section fixed effects

Table 4: The test runs Redundant Fixed Effect Test for the Fixed Effect

Effects Test	Statistic	d.f.	Prob.
Cross-section F	0.563434	(19,170)	0.9274
Cross-section Chi-square	12.213768	19	0.8763

1.1.1.2 Correlated Random Effects – Hausman Test

Test period random effects

Table 5: The test runs Hausman Test for the Random Effect

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Period random	6.260590	10	0.7929

From Table 4 and 5, the results showed that the Hausman Test ChiSq Statistic has only 6.260590 and the P-value equal to 0.7929 which shows the Prob > 0.01 that the random effects model is the most appropriate method to estimate the model used in the study. It can be written in equation as;

Factor affecting of air cargo hub =

-6.962941-0.176963AIRPORTCON-2.009912CUSAD
-0.306204GDP+0.576478LANFEE+1.229199NUMCITY
+3.780322NUMMANU+6.495012NUMRUN
-0.444592SIZETER

1.2 Delphi Technique

The results obtained by Delphi technique were analyzed by 17 experts as shown in Table 6.

The consistency of scale accepted in the research has a median equal to or more than 4.50 and an interquartile range equal to or less than 1.00. So that the results of factors which affect to air cargo hub can be seen as Table 7.

2. Determine the weight factor using the AHP method

Analysis results from calculation is given Figure 2. The highest importance criteria by 36.5 % relative is “Geographical” as can be seen in figure 2. As for the other criteria, “Economic” (0.132) is the lowest points unlike “Economic” criteria. The next criteria is the “Operational” (0.253) which is the second important air cargo hub criteria and followed by “Other” (0.25).

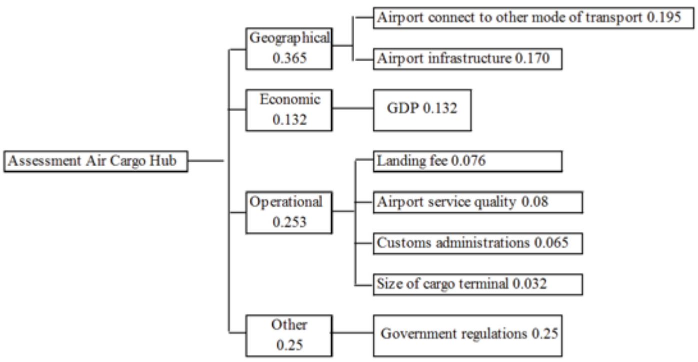

Figure 2: Weights obtained using AHP

3. Assessing the suitability of air cargo hub by AHP and TOPSIS method

Table 8: The result of AHP method

Alternatives	Preference Scale	Preference Score
BKK	0.206	2
SIN	0.622	1
KUL	0.172	3

Table 9: The results using TOPSIS method and ranking the suitable options

Airport	S+	S^-	CC	Ranking
BKK	0.01006	0.00217	0.177351	2
SIN	0.00146	0.01357	0.902861	1
KUL	0.01555	0.00013	0.00848	3

Table 6: Selection of factors affecting the air cargo hub by Delphi techniques

Rank 1	Geographic Criteria	Second round		Third round	
		Mdn	IR	Mdn	IR
1.1	Number of airline flight to and from airport	4	1	4	0.5
1.2	Airport connect to other mode of transport	5	0.5	5	0.5
1.3	Airport infrastructure	5	0.5	5	0.5
1.4	Number of cities pairs	4	0.5	3	1
Rank 2	Economic Criteria	Second round		Third round	
		Mdn	IR	Mdn	IR
2.1	GDP	5	0.5	5	0.5
2.2	National income	3	1	4	1
2.3	Number of labor	3	0.5	4	0.5
2.4	Annual cargo volumes	5	0.5	5	0.5
2.5	Number of manufactories	4	0.5	3	1
Rank 3	Operational Criteria	Second round		Third round	
		Mdn	IR	Mdn	IR
3.1	Landing fee	5	0.5	5	0.5
3.2	Airport service quality	5	0.5	5	0.5
3.3	Cargo-handling charges	4	0.5	3	0.5
3.4	Number of aircraft movement	5	0.5	5	0.5
3.5	Number of runway	4	1	4	1
3.6	Custom clearance time	5	0.5	5	0.5
3.7	Customs administrations	5	0.5	5	0.5
3.8	Size of cargo terminal	5	0.5	5	0.5
3.9	Open airport hours	3	0.5	3	0.5
3.10	Cargo handling equipment	4	0.5	4	0.5
Rank 4	Other Criteria	Second round		Third round	
		Mdn	IR	Mdn	IR
4.1	Government regulations	5	0.5	5	0.5
4.2	Open sky agreement	4	0.5	4	0.5
4.3	Political risk	4	0.5	3	0.5
4.4	New technology for custom clearance	3	0.5	5	0.5
4.5	Number of airfreight airlines	5	0.5	5	0.5

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Table 7: Summary of air cargo hub factor from two methods

Factors Affecting Southeast Asia Air Cargo Hub	Factors that can be counted are numbers		Factors that cannot be counted are numbers	SUM
	Regression	Delphi	Delphi	
1. Number of airline flight to and from airports (per week)	✗	✗	None	✗
2. Airport connect to other mode of transport (LPI index)	✓	✓	None	✓
3. Opinion about airport infrastructure	None	None	✓	✓
4. Number of cities pairs (counts)	✓	✗	None	✗
5. GDP of airport home country (USD)	✓	✓	None	✓
6. National income (USD)	✗	✗	None	✗
7. Number of labor (counts)	✗	✗	None	✗
8. Annual cargo volumes (tons)	✓	✓	None	✓
9. Number of manufactories (counts)	✓	✗	None	✗
10. Landing fee for B747 (USD)	✓	✓	None	✓
11. Opinion about airport service quality	None	None	✓	✓
12. Opinion about cargo-handling charges	None	None	✗	✗
13. Number of aircraft movement (time)	✗	✓	None	✗
14. Number of runway (counts)	✓	✗	None	✗
15. Custom clearance time (day)	✗	✓	None	✗
16. Customs administrations (LPI index)	✓	✓	None	✓
17. Size of cargo terminal (sqm)	✓	✓	None	✓
18. Opinion about open airport hours	None	None	✗	✗
19. Opinion about cargo handling equipment	None	None	✗	✗
20. Opinion about government regulations	None	None	✓	✓
21. Opinion about open sky agreement	None	None	✗	✗
22. Opinion about political risk	None	None	✗	✗
23. Opinion about new technology for custom clearance	None	None	✗	✗
24. Number of airfreight airlines (counts)	✗	✓	None	✗

CONCLUSION

This study has developed a quantitative evaluation model for the competitiveness of air freight hub using the Delphi method, questionnaire survey and AHP method. This measure has been applied in literature and has been selected by experts. Determines the weight of individual measures in different dimensions. Values are calculated using the value function and the competitiveness of each measure, depending on the weight multiplied by the values. The difference in data is better compared to the absolute value of the raw data. Competitive advantage analysis and overall performance on dimensions and measures can serve as useful reference for policy makers in both the government and the air transport industry. A better understanding of the strengths and weaknesses of different airports can help them to define development strategies to increase competitiveness in air cargo. Comparative analysis of airports in Southeast Asia for three airports shows that Changi international airport has a competitive edge overall, follow by Suvarnabhumi international airport and Kuala Lumpur international airport, the AHP method weightings show that factor of government regulation has the highest weight, followed by factor of airport connect to other mode of transport. Future research may consider adding a DEA (Data Envelopment Analysis) model to the AHP model as it will make the results more accurate. At the same time, the factors affecting Southeast Asia's regional hub are used to assess airports in other regions to determine whether they are accurate. Analysis of policy strategies for planning future aviation facilities.

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