# AIRPORT TECHNICAL EFFICIENCY AND BUSINESS MODEL INNOVATIONS: A CASE OF LOCAL AND REGIONAL AIRPORTS IN THAILAND

**Thanavutd Chutiphongdech**

**A Dissertation Submitted in Partial**
**Fulfillment of the Requirements for the Degree of**
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# ABSTRACT


| | |
|---|---|
| **Title of Dissertation** | AIRPORT TECHNICAL EFFICIENCY AND BUSINESS MODEL INNOVATIONS: A CASE OF LOCAL AND REGIONAL AIRPORTS IN THAILAND |
| **Author** | Thanavutd Chutiphongdech |
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| **Year** | 2020 |

The growth in demand for air transport and the budget constraints put the pressure on airports as a service provider in the air transport system. Hence, airports are required not only to develop infrastructure, service quality, and improve performance but also to adapt themselves by performing better business operations and searching for healthier business management. To accomplish such outcomes, airport business models seem to be a strategic tool to improve overall administrations. However, the knowledge in this field is hardly found in the airport literature. To bridge the research gaps, this dissertation aims to design the airport business model and propose the business model innovations to improve airport technical efficiency. Twenty-eight local and regional airports under operations of the Department of Airports (DOA) are used as a case study. To construct the airport business model and propose the innovations of business models, the situation of local and regional airports in Thailand, factors affecting airport technical efficiency, and airport business model analytical framework are investigated to answer the ultimate research question of the dissertation.

To analyze the situation of the local and regional airport industry, the PESTEL-AHP Model which collecting opinions from the key experts reveal that the Air Navigation Act (No.14) BE 2562 is the component that mostly impacting the overall industry and shaping how DOA airports run their businesses as they are public airports. The situation analysis of the firm-level from the BCC-DEA Model confirms that 28 local and regional airports under the operations of DOA are technically inefficient with the average technical efficiency scores during 2009-2018 equal to 0.188. To examine the sources of airport technical efficiency, the econometric model under the Structure-conduct-performance paradigm is specified. By using the Panel Least Square Method, airport ownership patterns are found the most significant factors affecting technical efficiency while the service-relating policies and total airport revenues also significantly play a part in airport efficiency.

For designing the airport business models, Suratthani International Airport, Lampang Airport, and Ubon Ratchathani International are purposively selected as a unit of analysis. The Business Model Canvas (BMC) from Osterwalder and Pigneur (2010) together with the documentary research from the World's Best Airport and the World's Best Regional Airport and the exploratory research approach is integrated to draw the lessons learned and construct the airport business model framework for local and regional airport business model designs. Although the BMC is well-described to the airport business operations, this study adds the new component that is the Sustainability of airports to virtually cover the overall business operations.

After designing the business models for each selected airport, the study finds out that the units of analysis share the common airport business components that are Key Resources, Key Activities, Revenue Streams, Cost Structures and Sustainability of Airport. The reason behind this argument is the impacts of the Air Navigation Act (No.14) BE 2562 shadowing their business administration. However, the individual airport business model is required to customize as they have some diversities in airport operations reflecting from differences in BMC components. The discussion between the best practice airports and the recent airport business models of local and regional airports provides the gap for business model innovations which defined as the strategic options for innovating the airport business models suitable for certain contexts.

To improve the airport technical efficiency of local and regional airports in Thailand, the samples of business model innovations are introduced. The Airport-as-a-tourism Platform Business Model, the Local Partner-and-engagement Business Model, and the Value Proposition-oriented Business Model are proposed as they are regarded as the most feasible, practical, and appropriate to the contexts of local and regional airports under operations of DOA. Policy and managerial implications for relevant government agencies are recommended.

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Thanavutd Chutiphongdech

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# CHAPTER 1

# INTRODUCTION

## 1.1 Rationale of the Study

Airport efficiency improvement is essential to airport authorities in the present time since the industry competitiveness of the nation depends on the positive performance of airports (Barros & Sampaio, 2004; Lam, Low, & Tang, 2009). After the deregulation in the airline industry, it puts the pressure on airports as a service provider in the aviation sector. A growth in demand for air transport causes airports to invest in developing their infrastructure and also service quality (Andrew, 2012; De Neufville & Odoni, 2013; Graham, 2009). Therefore, airports mostly owned and operated by a government tend to shift public enterprise management regime into more profitable and competitive orientation policies (Frank, 2011). They also need to finance a huge amount of fund for airport refurbishing, improving their cost efficiency and also looking for managerial instrument for serving a new business model (Assaf, Gillen, & Tsionas, 2014). For a past thirty years, an ownership and control has played a large part in the sector as a key to improve airport efficiency. The best practice in the industry is the privatization of British Airports Authority (BAA) in 1987 which its main objectives was to decrease financial burden and improve efficiency by commercializing public utility (Humphreys, 1999). This event has spurred many airports around the world to consider an ownership and control approach as a key to adopt to changes (Cahill, Palcic, & Reeves, 2017; Gillen, 2011) despite the fact that empirical evidences of ownership and control patterns toward airport efficiency are yet unclear and inclusive (Assaf & Gillen, 2012; Graham, 2011; Lai, Potter, & Beynon, 2012; Liebert & Niemeier, 2013; Oum, Adler, & Yu, 2006; Oum, Yan, & Yu, 2008). Thus, not surprisingly, scholars in the field are putting an effort to investigate factors affecting airport efficiency, measurement, benchmarking and other relevant issues in order to maintain airport strategic planning, strategy formulation and sustain competitive advantage (Assaf & Josiassen, 2016). Even though there are an array of published papers rising in the literature after the BAA privatization, most of them are still lack of providing managerial implications, collecting information from airport stakeholders or proposing any business models to practitioners (Graham, 2011; Liebert & Niemeier, 2013).

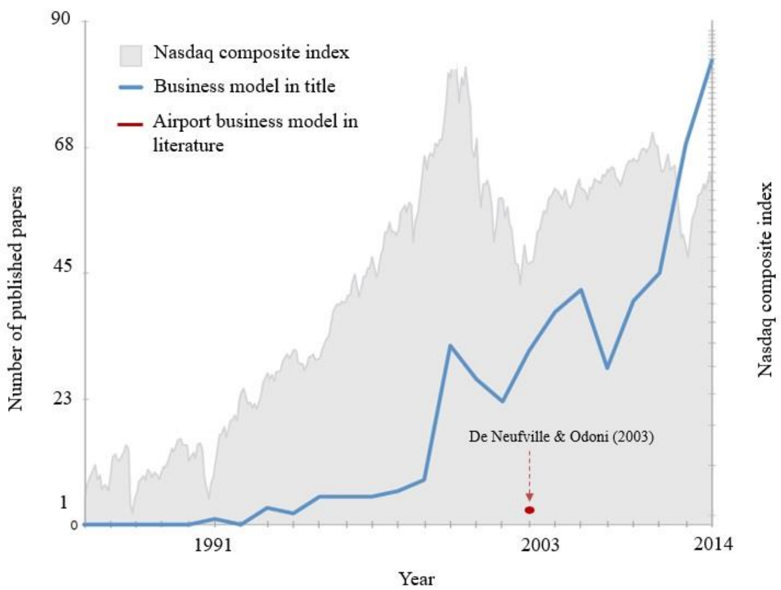



Figure 1.1 Airport Business Model Literature Emergence
Note: Adapted from DaSilva and Trkman (2014); Frank (2011).

Among business model literature, an application to airport sector is rarely appeared (Frank, 2011; Graham, 2018) causing the trend of further research to fulfill literature on the relevant issues. Even the business model terminology, there are various understanding of the term from scholars in different fields (Wirtz, Pistoia, Ullrich, & Göttel, 2016). Although it was raised and emerged in the literature since the work from Bellman et. al in 1957, its definition is still unclear, lack of theoretical background, misused and misinterpretation among scholars, practitioners and business sectors due to technological breakthrough (Baden-Fuller & Morgan, 2010; DaSilva & Trkman, 2014; Osterwalder, Pigneur, & Tucci, 2005; Porter, 2001; Wirtz et al., 2016); accordingly, the clear definition of airport business model, business model theoretical application and relating literature on the issue seems still far from the studies (Figure 1.1) (Frank, 2011; Kalakou & Macário, 2013), especially, the literature working on regional airport contexts either business model or airport efficiency measurement and benchmarking is not widely available (Adler, Ülkü, & Yazhemsky, 2013; Merkert, Odeck, Brathen, & Pagliari, 2012) in spite of the fact that local and regional airports bring economic and social effects such as local economy boosting, facilitating logistics and supply chain through connecting different modes of transportation, promoting educational opportunities, distributing healthcare services, developing tourism at destinations, generating taxation revenue and employment to remote areas due to market accessibility (Ahn & Min, 2014; Button, 2010; Tveter, 2017).

Consequently, many governments around the globe have selected local and regional airport system policy as a tool to subsidize and encourage suburban areas. However, this system has suffered from the inadequate demand for air transport comparing to other hub or airports. The inefficiency from the system incurring from low volume of passenger traffic leads to small operational scale which impacting average costs per unit increment and cutting an opportunity for commercial activities and non-aeronautical revenue management (Adler, Ülkü, et al., 2013).Therefore, it is inevitable for a government to sustain the local and regional airports without financing regional airports.

## 1.2 Research Problem Identification

Similar to other regional airports in the world, Thailand local and regional airports are also subsidized by the government due to their inefficiency. Although they adopt a government-owned airport model (Figure 1.2) which is a most common airport business model in the world (Airport Council International, 2017a; lo Storto, 2018; Qin, 2010; Vogel, 2006b), the Department of Airports (DOA) acting as an authority responsible for airport development, operation and management throughout the country is yet struggling for efficient administration and productivity which is the same as other public airports in many counties (Adler, Liebert, & Yazhemsky, 2013). Since its regime reflects a contradiction to the classical economics of property rights said by Alchian (1965) that public ownership is less efficient than private ownership due to lack of profit incentive from management, DOA still strives for efficiency which can be noted not only from its mission statement mentioned in the DOA

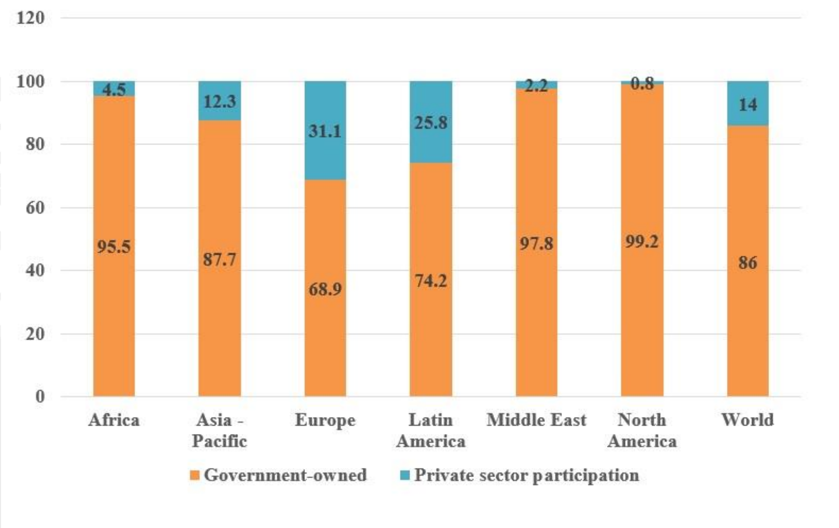



Figure 1.2 Distribution of Airports by Ownership Structure and Region in 2016
Source: Airport Council International (2017a).

Strategic Plan (BE 2560-2564) and also the 5th strategic objective indicated in Thailand Airport Master Plan (BE 2560-2579), launched by the Civil Aviation Authority of Thailand (CAAT). This plan aims to create operational efficiency by allocating resources effectively and generates values to airport stakeholders. However, according to Ministry of Transport (2016a, 2016b), the 22 of 29 local and regional airports under control of DOA are now under performance (Figure 1.3 and Table 1.1) leading to massively financial burden to the government because of efficiency improvement unavailability and budget constraint circumstances (Hanaoka & Phomma, 2004). Consequently, efficiency measurement together with an investigation of factors affecting airport efficiency for designing a business model to upgrade the local and regional airport performance under control of DOA will contribute to the decreasing in financial dependency from a government, financial burden reduction and also avoiding permanent foreclosure.

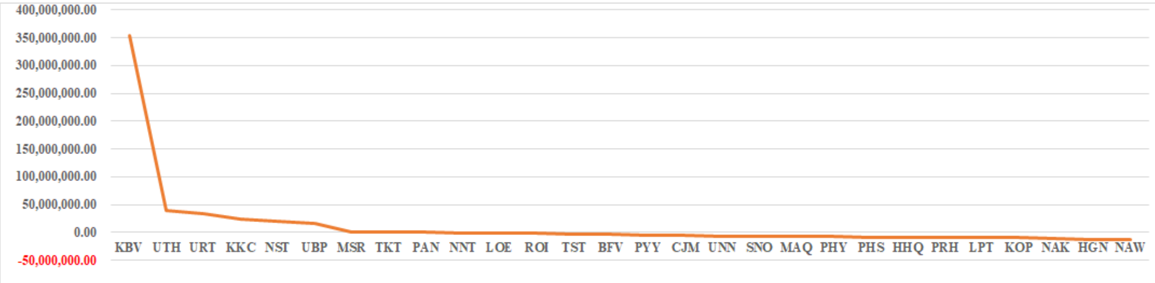



Figure 1.3 Performance of Thailand Local and Regional Airports for 2018 Fiscal Year

Note: Department of Airports (2019); Ministry of Transport (2016a, 2016b).

Table 1.1 DOA Airport Performance for 2018 Fiscal Year

| Local and Regional Airports | Profit-loss (Baht) |
|---|---|
| Krabi International Airport | 354,520,363.75 |
| Udonthani International Airport | 39,642,900.89 |
| Suratthani Airport | 33,667,763.13 |
| Khon Kaen Airport | 23,305,433.50 |
| Nakorn Sri Thammarat Airport | 19,254,501.43 |
| Ubon Ratchathani Airport | 17,161,947.50 |
| Mae Sariang Airport | 2,500.00 |
| Tak Airport | 0.00 |
| Pattani Airport | 0.00 |
| Nannakorn Airport | -459,056.00 |
| Loei Airport | -1,794,044.57 |
| Roiet Airport | -1,920,252.29 |
| Trang Airport | -2,552,507.50 |
| Buriram Airport | -4,018,451.85 |
| Pai Airport | -4,658,238.49 |
| Chumphon Airport | -4,871,298.10 |
| Ranong Airport | -6,841,947.05 |
| Sakonnakhon Airport | -7,054,206.15 |

| Local and Regional Airports | Profit-loss (Baht) |
|---|---|
| Maesot Airport | -7,863,255.67 |
| Petchabun Airport | -8,002,884.09 |
| Phitsanulok Airport | -8,268,957.58 |
| Huahin Airport | -8,286,601.21 |
| Phrae Airport | -8,693,185.36 |
| Lampang Airport | -9,224,174.94 |
| Nakhon Phanom Airport | -9,559,106.74 |
| Nakhon Ratchasima Airport | -11,763,913.32 |
| Phrae Airport | -11,991,868.51 |
| Narathiwat Airport | -13,591,277.70 |

**Source:** Department of Airports (2019).

## 1.3 Research Gaps

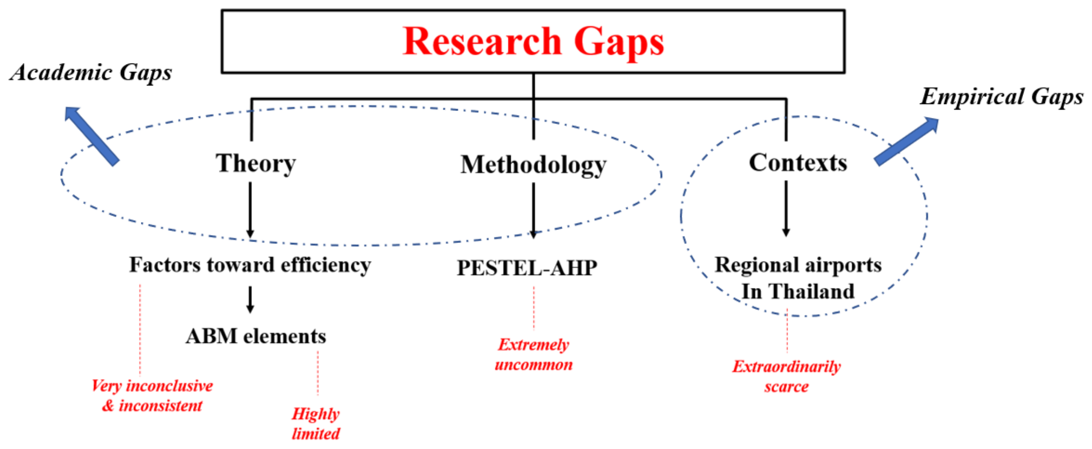



Figure 1.4 Research Gaps from Literature Review

To fulfil the research gaps which dividing into academic and empirical gaps in the literature, this study aims to fulfill those gaps in various dimensions, that is, theoretical, methodological and contextual (Figure 1.4). By analyzing the local and regional airport situation with PESTEL-AHP, the method that is hardly applied in the literature (Oey & Nitihardjo, 2016). It will shed the light on the novel way to describe the airport industry situation. Moreover, using the Second-stage Panel Regression to examine factors affecting airport technical efficiency, this study will reveal and confirm the results relevant to airport technical efficiency which is inclusive and inconsistent from the past until present. (Adler & Liebert, 2014; Adler, Ülkü, et al., 2013; Assaf & Gillen, 2012; Assaf et al., 2014; Barros & Sampaio, 2004; Chi-Lok & Zhang, 2009; Curi, Gitto, & Mancuso, 2010; D'Alfonso, Daraio, & Nastasi, 2015; Ha, Wan, Yoshida, & Zhang, 2013; Kutlu & McCarthy, 2016; lo Storto, 2018; Martín, Rodríguez-Déniz, & Voltes-Dorta, 2013; Martini, Manello, & Scotti, 2013; Merkert & Mangia, 2014; Oum et al., 2008; Oum, Yu, & Fu, 2003; Oum, Zhang, & Zhang, 2004; Sarkis, 2000; Scotti, Malighetti, Martini, & Volta, 2012; Tovar & Martin-Cejas, 2009; Tsekeris, 2011; Vasigh & Haririan, 2003; Vogel, 2006a; Yan & Oum, 2014). Additionally, the stage of airport business model design for local and regional airports in Thailand will uncover the airport business elements which are highly limited and fragmented in the academia (Frank, 2011; Kalakou & Macário, 2013). With the focuses on local and regional airport contexts that are extraordinarily scarce, the study will complete the works and enhance knowledge relating to the airport industry both in academical and practical ways (Adler, Ülkü, et al., 2013; Hanaoka & Phomma, 2004; Merkert et al., 2012).

## 1.4 Research Questions

1.4.1 To what extent, what are the situation and how are the efficiency of local and regional airports in Thailand?

1.4.2 What are the factors driving airport technical efficiency?

1.4.3 How are the business model analytical framework for local and regional airports?

1.4.4 What are the promising Thailand local and regional airport business model innovations suitable for certain contexts?

## 1.5 Research Objectives

1.5.1 To analyze the situation and efficiency of local and regional airports in Thailand

1) To analyze the situation of local and regional airports in Thailand

2) To analyze the efficiency of local and regional airports in Thailand

1.5.2 To examine the factors affecting airport technical efficiency

1.5.3 To investigate the airport business model analytical frameworks in order to make analytical comparison for local and regional airports in Thailand

1.5.4 To design and propose the business model innovations for Thailand local and regional airports suitable for certain contexts

## 1.6 Significance of the Study

Referring to the research problem justification, the study intends to bridge the gaps in the literature in several ways. By providing a better understanding in the topics relating to research objectives and formulating an econometric model, the research methodology and the key findings will signify the research questions and also shed the light on the following issues:

1.6.1 Research contributions to academia

1) An application of the PESTEL model basing on the structure-conduct-performance paradigm – AHP Analysis for the airport industry

2) An econometric model indicating factors affecting airport technical efficiency

3) The business model frameworks for local and regional airports

1.6.2 Research outcomes to airport management practitioners

1) The situation and efficiency of local and regional airports in Thailand

2) Factors affecting airport technical efficiency in Thailand

3) Once the technical efficiency of local and regional airports in Thailand are measured, the efficiency scorers gaining from the second research

objective will be a vital source to classify and conduct the strategic groups. Ultimately, the airport business model design aiming for technical efficiency improvement for each regional airport, selected to represent each strategic group, will be presented to the Department of Airports managements.

4) Business model innovations will be guidelines for airport managements to develop and innovate the present airport business model for future technical efficiency improvement.

## 1.7 Operational Definitions of Terms

1.7.1 A commercial airport means an airport having commercialized-oriented purposes to serve scheduled flights for airlines and passengers. If classifying a commercial airport by using ownership patterns, there are 3 types of commercial airports in Thailand, privatized airports managed by Airports of Thailand (AOT), public airports operated by the Department of Airports (DOA) and private airports owned by Bangkok Airways Plc.

1.7.2 A local and regional airport refer to a typology of commercial airports. It also has commercial objectives and is diversely and dispersedly located in local and regional areas of a country. In particular for the study, the local and regional airports mean the commercial airports run and administered by the Department of Airports (DOA) which controlling over 28 airports located throughout Thailand such as Trang Airport, Pai Airport, Udonthani International Airport and so on.

1.7.3 Technical efficiency means an airport's ability to produce an amount of outputs under given an amount of inputs, and that ability comes from proper production techniques and production process management.

1.7.4 A business model is defined as an organizational template or a comprehensive model representing focal airport operations, transactions creating values and how the local and regional airports in Thailand deliver them to all stakeholders.

1.7.5 Business model innovations refer to the strategic options derived from the development of each conventional airport business model component. They are the novel approach to improve airport business models of local and regional airports in Thailand. Such novel ways include various dimensions - the airport revenue enhancement, key activity development and strategic partnership cooperation - and those business model innovations link with the airport technical efficiency determinants both from quantitative and qualitative analysis.

## 1.8 Scope of the Study

### 1.8.1 Scope of the Content

The focus of the study is to design business models and propose business model innovations for improving technical efficiency of local and regional airports in Thailand.

### 1.8.2 Scope of the Populations and Samples

The scope of the populations and samples is diverse depending on each research objective, that is;

Table 1.2 Summary of Population and Samples

| Research Objectives | Scope of the Population and Samples |
|---|---|
| 1.1 To analyze the situation of local and regional airports in Thailand | 7 opinions from scholars and DOA both from central and regional units are collected to illustrate the factor interacting local and regional airport situation. |
| 1.2 To analyze the efficiency of local and regional airports in Thailand | The 34 commercial airports in Thailand are the unit of analysis for this research objective. It includes 6 airports from the Airports of Thailand (AOT) and 28 airports under control of the Department of Airports. |

| Research Objectives | Scope of the Population and Samples |
|---|---|
| 1.2 To analyze the efficiency of local and regional airports in Thailand | The 34 commercial airports in Thailand are the unit of analysis for this research objective. It includes 6 airports from the Airports of Thailand (AOT) and 28 airports under control of the Department of Airports. |
| 2. To analyze the factors affecting airport technical efficiency | The unit of analysis for this research objective is also 34 commercial airports in Thailand, 6 from the Airports of Thailand (AOT) and 28 from the Department of Airports (DOA). |
| 3. To investigate the airport business model analytical frameworks in order to make analytical comparison for local and regional airports in Thailand | 9 airport management panels from public airports, private airports and privatized airports together with a series of documentary research are explored. |
| 4. To design and propose the business model innovations for Thailand local and regional airports suitable for certain contexts | In-depth interviews from 36 airport stakeholders are performed in order to construct 3 local and regional airport business models from each strategic group that are Lampang Airport, Suratthani International Airport and Ubon Ratchathani International. |

**1.8.3 Scope of the Time**

The scope of time of the study is varied depending on each research objective, that is;

Table 1.3 Summary of Scope of the Time

| Research Objectives | Scope of the Time |
|---|---|
| 1.1 To analyze the situation of local and regional airports in Thailand | The period using for analyzing the situation of local and regional airports in Thailand are framed during 2019-2020. |
| 1.2 To analyze the efficiency of local and regional airports in Thailand | Ten fiscal year time-series data from 2009 to 2018 are collected to calculate the efficiency score for each local and regional airport. |
| 2. To analyze the factors affecting airport technical efficiency | The panel data employed in this step is gathered from 5 fiscal years from 2014 to 2018. |
| 3. To investigate the airport business model analytical frameworks in order to make analytical comparison for local and regional airports in Thailand | The documentary research is started since 2003 onwards when is the first airport business model emerged in the literature. |
| 4. To design and propose the business model innovations for Thailand local and regional airports suitable for certain contexts | Using the outputs from the 3 research objectives, the period of designing airport business models are initiated from 2019 to 2020. |

## 1.9 Organization of the Study

The composition of this dissertation and the abstract of each chapter are outlined as follows:

1) Chapter 1 Introduction

The chapter provided an overview of the research problem identification leading to the rationale of the study and research objectives. It presented the research gaps, possible research contributions and outcomes from the study for academicians, policymakers and airport stakeholders.

2) Chapter 2 Literature Review

This chapter described a structured and systematic review of previous studies relevant to the research questions. The review of the literature and theoretical frameworks for each research objective was comprehensively displayed and critiqued.

3) Chapter 3 Research Methodology

This chapter illustrated the conceptual research framework derived from the literature review. The research designs which including data collection, data analysis, source of data and research approaches implemented to disclose research questions were also clarified.

4) Chapter 4 Situation and Technical Efficiency of Thailand Local and Regional Airports

The chapter produced the key findings obtaining from the situation analysis of local and regional airports in Thailand. The industry-level analysis using PESTEL-AHP and the firm-level analysis using BCC-DEA to measure the technical efficiency were present. The outputs from this chapter shed light on the key trends and forces that impact on business model designs.

5) Chapter 5 Factors Affecting Airport Technical Efficiency

This chapter offered information relating to airport technical efficiency determinants. The econometric model indicated that airport ownership forms, service quality policies and airport revenues were the keys that airport management should pay attention when designing the airport business model to enhance the technical efficiency.

6) Chapter 6 Airport Business Model Analytical Frameworks

This chapter provides a collective set of insightful information on the topic from the documentary research together with the in-depth interview results from the airport management. By integrating the results from both methods, the outputs of the chapter provide business model components leading to the framework for designing the airport business models in chapter 7.

7) Chapter 7 Business Model Designs and Innovations for Local and Regional Airports in Thailand

To design the business models for local and regional airports in Thailand, the outputs from the chapter 4, 5 and 6 were unified. The chapter also discussed the comparison between the best practice airports and the as-is airport business models to show the process of innovating the airport business model components.

8) Chapter 8 Conclusion and Future Research

Finally, the overall summary of the key findings was gathered. This chapter offered policy implementations, managerial suggestions, future research recommendations. The limitations of the study were concluded in this chapter.

# CHAPTER 2

# LITERATURE REVIEW

This chapter provides a comprehensive review of literature relevant to the research objectives and presents theoretical framework behind the research questions. It is divided into 3 main sections; that is, commercial airports in Thailand, airport efficiency and measurement, studies relating to airport business model and summary of significant findings are succinctly discussed in this chapter.

## 2.1 Commercial Airports in Thailand

Civil aviation in Thailand has been seriously developed since 1913 by establishing the Aviation Division under control of Ministry of Defense before shifting authorizations to Ministry of Transport in 1954. Later on, it was upgraded into the Department of Commercial Aviation in 1963 as an agent to promote civil aviation development and airport expansion throughout the country. The aviation in Thailand has been growth steadily, to manage efficiently, some airports under control of the Department of Commercial Aviation such as Bangkok International Airport (DMK), Chiangmai International Airport (CNX), Hadyai Airport (HDY) and Phuket International Airport (HKT) were transferred and run as public enterprises by Airports of Thailand public limited company. In 2002, the Department of Commercial Aviation was changed into the Department of Air Transportation and renamed again to the Department of Civil Aviation in 2009. In 2015, all assets and obligations under the Department of Civil aviation was transferred to the new Department of Airports under the Ministry of Transportation due to International Civil Aviation Organization (ICAO) compliance.

Since Thailand was inspected under the Universal Safety Oversight Audit Program (USOAP) pursued by the International Civil Aviation Organization (ICAO) and was addressed the Significant Safety Concerns (SSC) which had impacts on Thailand civil aviation safety standard. Consequently, to avoid being downgraded by other country aviation authorities, it is necessary to comply with the standards and recommended practices of ICAO. The Department of Air Transportation was separated into the Office of Civil Aviation Authority of Thailand (CAAT) as a regulator under the act of Civil Aviation Authority of Thailand Emergency Decree B.E. 2558 while the Departments of Airports (DOA) was formed as a service provider or operators for local and regional airports in Thailand. Presently, there are three different ownership patterns of commercial airports in Thailand (Figure 2.1), that is, privatized airport managed by Airports of Thailand (AOT), government-owned airports operated by Department of Airports (DOA) and private airports owned by Bangkok Airways Public Limited Company. All types of ownerships are regulated by CAAT responsible for promoting civil aviation activities, continuously monitoring safety and security practices and improving the supporting system.

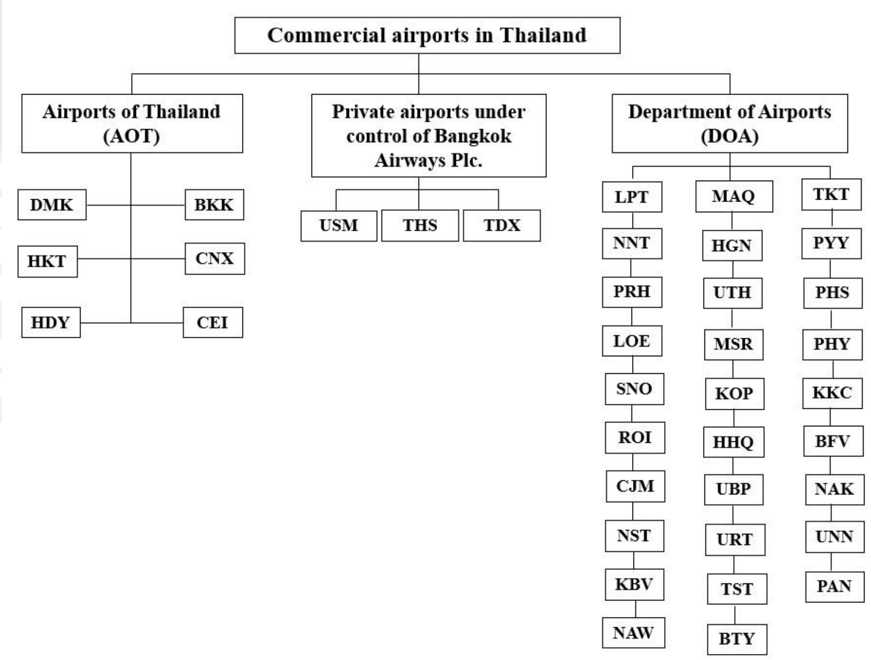



Figure 2.1 Thailand Commercial Airports Distinguished by Ownership and Control Patterns

### 2.1.1 Airports under Control of Airports of Thailand

According to Figure 2.2 and Table 2.1, Airports of Thailand Public Limited Company (AOT) is currently managing 6 privatized airports, Suvarnabhumi Airport (BKK), Donmueang International Airport (DMK), Chiangmai International Airport (CNX), Mah Fae Luang – Chiangrai International Airport (CEI), Phuket International Airports (HKT) and Hat Yai International Airport (HDY), as a holding company after adopting an ownership and control approach by privatizing the airports under control of Airports of Thailand (AOT) in 2002. The privatization regime at that time resulted from the economic crisis in 1997 causing the government had to borrow funds from International Monetary Fund (IMF) and pass the Corporatization Act B.E. 2542 in 1999 to transform public enterprises into a holding company in order to decrease the financial burden and recover the whole economic system (Hanaoka & Phomma, 2004). With majority ownership belongs to Ministry of Finance (70%), AOT sold another 30% shares to public investments in the stock exchange of Thailand (SET).


Figure 2.2 Commercial Airports under Control of Airports of Thailand

Hanaoka and Phomma (2004) explained the advantages from the privatization plan which referring to AOT that is:

1) To give an opportunity to joint ownership with the expert airport businesses

2) To increase efficient performance under globalization and deregulation period

3) To obtain technological advancement from the partnership

4) To decrease financial burden of the government in investing infrastructure for airport business activities

5) To gain money from share selling which will be a part of financing activities which leading to future investment in other airports under control of AOT

6) To achieve transparency by avoiding the political inferences due to autonomy of airport organization

7) To offer ownership of airports to public investment

Table 2.1 AOT Commercial Airports Specification as of 2017

| Location | Name of airports | IATA code | Passenger movement per year | Aircraft movement per year | Immigration formalities |
|---|---|---|---|---|---|
| Central part | Donmuang International Airport | DMK | 40,563,727 | 269,964 | Yes |
| | Suvarnabhumi Airport | BKK | 62,814,644 | 364,047 | Yes |
| Northern part | Chiangmai International Airport | CNX | 10,808,866 | 75,593 | Yes |
| | Mah Fae Luang – Chiangrai International Airport | CEI | 2,804,700 | 19,724 | Yes |

| Location | Name of airports | IATA code | Passenger movement per year | Aircraft movement per year | Immigration formalities |
|---|---|---|---|---|---|
| Southern part | Hat Yai International airport | HDY | 4,265,718 | 29,184 | Yes |
| | Phuket International Airport | HKT | 18,260,833 | 116,487 | Yes |

Source: Airport of Thailand (2019).

### 2.1.2 Private Airports under Control of Bangkok Airways Plc.

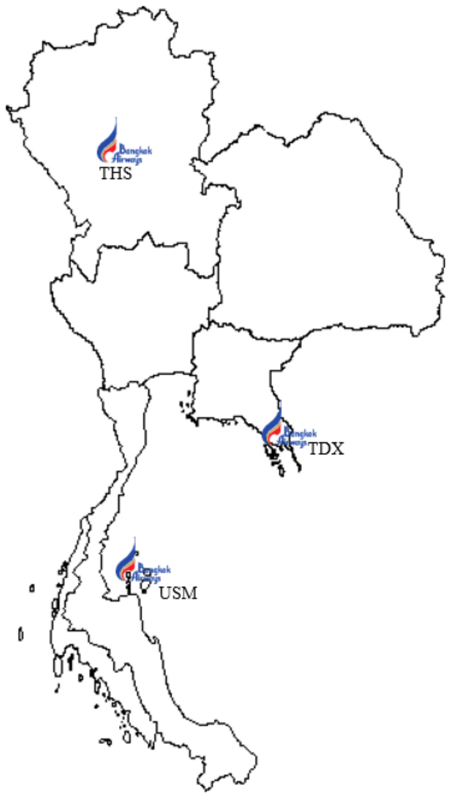



Figure 2.3 Private Airports under Control of Bangkok Airways Plc

There are many flight carriers in Thailand but the only airline running a commercial airport business is Bangkok Airways Public Limited Company (PG). Bangkok Airways had the right to operate the 3 airport businesses since 1989 (Figure 2.3) and was the first private-owned public airport service provider. According to Table 2.2, it commenced its first airport at Samui island (Samui International Airport) which is now carrying 2.6 million passenger per year. In 1998, Bangkok Airways opened the second airport, Sukhothai Airport, where serving approximately 89,000 passengers with more than 2,100 flights per year. Trat Airport is the third airport owned and managed by Bangkok Airways Plc. It provided around 2,200 flights per year serving 98,000 passengers in 2017.

Table 2.2 Thailand Private Airports Specification as of 2017

| **Location** | **Name of airports** | **IATA code** | **Passenger movement per year** | **Aircraft movement per year** | **Immigration formalities** |
|---|---|---|---|---|---|
| Eastern part | Trat Airport | TDX | 98,000 | 2,200 | Yes |
| Northern part | Sukhothai Airport | CNX | 89,000 | 2,100 | Yes |
| Southern part | Samui International Airport | USM | 2,600,000 | 31,000 | Yes |

Source: Bangkok Airways Plc. (2017).

### 2.1.3 Local and Regional Airports under Control of the Department of Airports

Because of economic crisis in 1997, Thai government planned to reduce financial burden incurred from some government agents; therefore, DOA, which was Department of Civil Aviation or DCA at that time, needed to transfer some businesses to private sectors. Some airports that required a huge fund to improve infrastructure were allocated to AOT while Aeronautical Radio of Thailand Limited Company was founded to obtain air traffic businesses from DCA (Hanaoka & Phomma, 2004). After the inspection from ICAO under the Universal Safety Oversight Audit Program (USOAP) in 2015, DOA was established as an airport operator for promoting local and regional air transport.

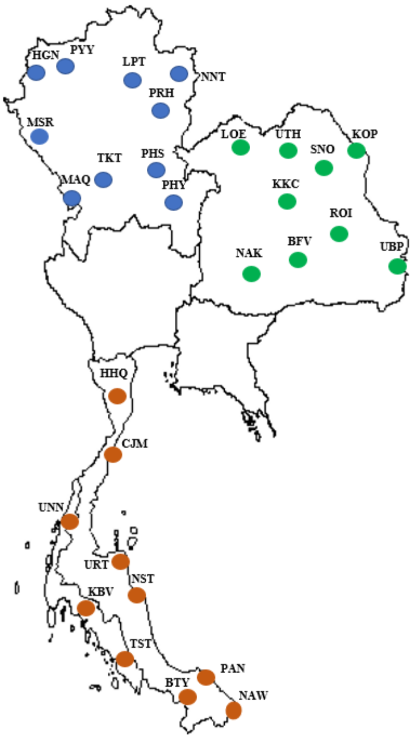



Figure 2.4 Local and Regional Airports under Control of DOA
Note: Adapted from Department of Airports (2019).

According to ministerial regulations No. 132 chapter 96, DOA has its main function by developing airport network to serve the growth of air transport, promoting airport businesses within the country and also achieving efficient organizational management. Presently, there are 29 airports (Figure 2.4) under control. 28 commercial airports (Table 2.3) are now in service while the latest one, Betong International Airport, is now being constructed and expected to be available for services in 2019. Referring to DOA Air Transport Traffic Report 2017 and Table 2.3, 25 regional airports (some of them does not have schedule flights) produced air transport service approximately 150,454 flights, carried passengers 18,671,505 per year. The top three airports that offering the highest proportion of aircraft movements are Krabi International Airport (KBV)19.22%, Nakorn Sri Thammarat Airport (NST) 12.01% and Udonthani International Airport (UTH) 11.89%. While the highest passenger movement airports are Krabi International Airport (KBV) 23.24%, Udonthani International Airport (UTH) 13.8% and Suratthani Airport (URT) 12.03% respectively.

Table 2.3 Thailand Local and Regional Airports in Thailand

| **Location** | **Year founded** | **Name of airports** | **IATA code** |
|---|---|---|---|
| Northern part | 1923 | Nannakorn Airport | NNT |
| | 1939 | Mae Hong Son Airport | HGN |
| | prior to 1929 | Maesot Airport | MAQ |
| | 1923 | Lampang Airport | LPT |
| | prior to 1952 | Pai Airport | PYY |
| | prior to 2000 | Petchabun Airport | PHY |
| | prior to 1952 | Phrae Airport | PRH |
| | 1941 | Phitsanulok Airport | PHS |
| | prior to 1954 | Tak Airport | TKT |
| | | Mae Sariang Airport | MSR |
| North Eastern part | 1942 | Loei Airport | LOE |
| | | Udonthani International Airport | UTH |
| | prior to 1972 | Sakonnakhon Airport | SNO |
| | prior to 1975 | Nakhon Phanom Airport | KOP |
| | prior to 1962 | Khon Kaen Airport | KKC |
| | 1989 | Roiet Airport | ROI |
| | | Ubon Ratchathani International Airport | UBP |

| Location | Year founded | Name of airports | IATA code |
|---|---|---|---|
| | 1985 | Buriram Airport | BFV |
| | prior to 1986 | Nakhon Ratchasima Airport | NAK |
| Southern part | prior to 1954 | Huahin Airport | HHQ |
| | 1990 | Chumphon Airport | CJM |
| | 1989 | Ranong Airport | UNN |
| | prior to 1971 | Suratthani International Airport | URT |
| | 1985 | Nakorn Sri Thammarat Airport | NST |
| | prior to 1983 | Krabi International Airport | KBV |
| | prior to 1954 | Trang Airport | TST |
| | prior to 1963 | Pattani Airport | PAN |
| | | Narathiwat Airport | NAW |
| | 2015 | Betong International Airport | BTY |

Note: Adapted from Department of Airports (2019).

Table 2.4 Thailand Local and Regional Airports Specifications as of 2017

| Name of airports | Passenger movement per year | Aircraft movement per year | Immigration formalities |
|---|---|---|---|
| Nannakorn Airport | 428,202 | 3,976 | Yes |
| Mae Hong Son Airport | 63,328 | 1,940 | No |
| Maesot Airport | 193,329 | 3,038 | Yes |
| Lampang Airport | 4,636 | 268,638 | No |
| Pai Airport | 1,779 | 484 | No |
| Petchabun Airport | 1,082 | 56 | No |
| Phrae Airport | 88,971 | 1,460 | No |
| Phitsanulok Airport | 672,084 | 5,314 | Yes |

| Name of airports | Passenger movement per year | Aircraft movement per year | Immigration formalities |
|---|---|---|---|
| Tak Airport | 0 | 0 | No |
| Mae Sariang Airport | 0 | 0 | Yes |
| Loei Airport | 262,906 | 2,488 | Yes |
| Udonthani International Airport | 2,651,242 | 18,855 | Yes |
| Sakonnakhon Airport | 382,962 | 2,828 | No |
| Nakhon Phanom Airport | 434,128 | 3,400 | Yes |
| Khon Kaen Airport | 1,819,013 | 13,416 | Yes |
| Roiet Airport | 431,785 | 3,713 | |
| Ubon Ratchathani International Airport | 1,832,340 | 11,795 | Yes |
| Buriram Airport | 340,692 | 3,197 | No |
| Nakhon Ratchasima Airport | 10,671 | 190 | Yes |
| Huahin Airport | 34,779 | 458 | Yes |
| Chumphon Airport | 163,815 | 2,059 | Yes |
| Ranong Airport | 214,250 | 2,532 | Yes |
| Suratthani International Airport | 2,108,289 | 14,000 | Yes |
| Nakorn Sri Thammarat Airport | 1,490,773 | 17,004 | No |
| Krabi International Airport | 4,193,099 | 28,639 | Yes |
| Trang Airport | 691,270 | 4,412 | Yes |
| Pattani Airport | 0 | 0 | Yes |
| Narathiwat Airport | 216,856 | 1,486 | Yes |

Note: Adapted from Department of Airports (2019).

## 2.2 Situation Analysis and Its Theoretical Framework


Figure 2.5 The structure-conduct-performance Paradigm
Note: Adapted from Carlton and Perloff (2015).

To illustrate the situation analysis of an industry, the common economic theory refers to the Industrial Organization. Its theoretical framework was initiated by Mason (1939, 1949) and later developed by his student at Harvard University, Bain (1959) intending to explain the actual phenomenon of the overall market leading to policy recommendations. Although the theory was established since 1939, the application of its grounded framework still available until present with various approaches such empirical studies, Game Theory and so on. By analyzing the relationship among the structure, conduct and performance of an industry (the SCP paradigm) which is the core analysis of Industrial Economics, researchers can understand the realistic settlements, compositions, interactions and ultimately, the situation of an industry (Carlton & Perloff, 2015; Deunden Nikomborirak, 2004).

According to the structure, conduct and performance (the SCP paradigm) (Figure 2.5) which is the model giving explanations on the industrial organization, a firm's performance is impacted by its conducts which determined by market structure of an industry while market structure depends on some basic conditions of the market, consumer demand and productive technology, and it implies the competitiveness of a market (Carlton & Perloff, 2015). The market structure variables include number of sellers, barriers to entry, integration and so on. They are treated as an exogeneous variable which can be manipulated by a government policy to improve a firm's conduct and performance; therefore, Wirth and Bloch (1995) claimed them as a structural remedy from policymakers since it can progress a firm's conduct and performance. For conduct definition, Ferguson and Ferguson (1994) explained it as a firm's behavior relevant to pricing, tactics, strategies, ownership form selection etc. While a firm's performance refers to a firm's succession on producing benefits to stakeholders in which reflecting from price, product quality, profitability, allocative efficiency and also technical efficiency. Due to the interactions among the market structure, conduct and performance, the structure, conduct and performance (the SCP paradigm) provides the descriptive analysis framework (Carlton & Perloff, 2015) on how an industry is organized and sheds the light on situation of the market

### 2.2.1 The PESTEL Analysis

To systematically analyze the situation of an industry, there are various tools to implement such as the PEST Model (Aguilar, 1967) and its extensions such as the PESTEL Analysis or the STEER Analysis, the Porter-five forces Model (Porter, 2001), or even the OT Analysis which capturing the external business environments. However, a common tool used by practitioners, academicians and market researchers to analyze the situation and the overall factors for industry is the PESTEL Analysis (Oey & Nitihardjo, 2016). According to Song, Sun, and Jin (2017) and Bell and Rochford (2016), the PESTEL Analysis framework was developed from the PEST

Table 2.5 The PESTEL Components

| Components | Descriptions |
|---|---|
| *P* – Political factors | *P* relates to any political policies affecting industry policies. Such variables include deregulation policies, inter-state community, tax policies, political environments, federal monetary systems, fiscal budgeting, tariff-related policies, institutional strengths and so on. |
| *E* – Economic factors | *E* concerns general economic conditions, inflation rate, policy interest rates, exchange rates, GDP, income per capita, consumer confidence toward economic climate etc. |
| *S* – Sociocultural factors | *S* refers to values, attitude, behaviors of people in the society. Other societal factors involve population size, cultural factors, lifestyles, demographic changes, growth rate and so on. |
| *T* – Technological factors | *T* is inferred as changes in technological advancement or technical development such as digital disruption, nanotechnology, blockchain, big data, cashless society, Internet of Things, technological incubators etc. |
| *E* – Environmental factors | *E* is relevant to environmental and ecological variables such as waste management, water shortage, weather, climate changes etc. |
| *L* – Legal and legislation factors | *L* includes law and legal issues. For instance, legislations relate to corporatization and privatization laws, laws on consumers, producers and labor protection, antitrust regulations, safety standard practices by international agencies. |

Note: Adapted from Thompson, Peteraf, Gamble, and Strickland Iii (2014).

Model by Aguilar (1967). Its abbreviation standing from Politics, Economic, Social, Technology, Environment and Legal factors (Table 2.5). The main purpose of the PESTEL Analysis is to retain effectiveness and efficiency of an industry in responding to changes, analyze the business environment in a systematic approach and be a tool to support practitioners as a method providing a fundamental connection among macro factors. Moreover, the PESTEL Analysis is able to deliver a good information for strategy formulation.

However, the analysis is lack of quantitative and concise information and doesn't systematically prioritize factors derived from the analysis; in addition, it excludes means of analytically indicating the importance among factors which affecting the fit between the factors and decision alternatives. Consequently, the Analytical Hierarchy Process (AHP) is introduced to conduct a new situation analysis hybrid model or the PESTEL-AHP Analysis.

### 2.2.2 The PESTEL– AHP Analysis

To quantitatively systematize the analysis and enhance the power of using PESTEL Analysis to describe the situation of local and regional airport industry, this tool can be integrated with multicriteria decision making technique called Analytic Hierarchy Process (AHP). The Analytical Hierarchy Process (AHP) is introduced by Saaty (1990) to construct the quantified the PESTEL model basing on the structure, conduct and performance (the SCP paradigm) under AHP. According to Saaty (1990), AHP is a multicriteria decision making method which factors are organized in an order structure. It is able to help represent the general decision operation by decomposing and removing complex problems into a multilevel hierarchical objectives, criteria and choices (Görener, Toker, & Ulucay, 2012; Helms & Nixon, 2010). The advantages of the Analytical Hierarchy Process (AHP) are to measure the importance of factors, reflect the logical considerations of factors relevant to decision making circumstances, and quantify those intangible factors into numerical values by weighing selected factors from expert opinions through a series of pairwise comparison (Saaty, 1990, 2008). The Analytical Hierarchy Process method achieves pairwise comparisons among factors or criterions in order for prioritizing them by using the eigenvalue calculation. To illustrate the pairwise comparison on $n$ criterions and eigenvalue computation, the algebraic matrix of pairwise comparison are as follows:

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{a22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix}$$

where $a_{ij}$ is the relative importance for *i* to *j*, $a_{ij} = 1/a_{ji}$ and $a_{ij} = 1$ if $i = j$ and the importance vector value, $\widehat{W}$ is calculated by this formula:

$$\hat{A} \cdot \widehat{W} = \lambda_{max} \cdot \widehat{W}$$

where $\lambda_{max}$ is the largest eigenvalue of $\hat{A}$.

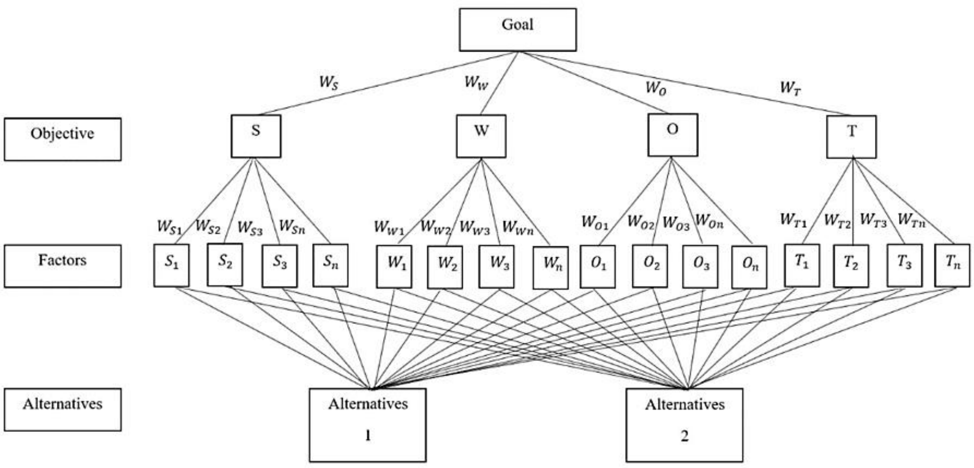



Figure 2.6 SWOT-AHP Construction
Note: Adapted from Lee and Walsh (2011).

However, to the boundary of this approach, literature review using the PESTEL analysis in the aviation industry is highly scarce; especially an adoption of the PESTEL-AHP, it is hardly emerged in the contexts. Traditionally, the weightiness of the factor importance is not common and is used to analyze the situation without quantifying. Additionally, it is mostly used to combined with SWOT analytical method, SWOT-AHP (Figure 2.6). Therefore, to cope with this unavailability, employing PESTEL-AHP to analyze the situation of the local and regional airport industry by converting the framework into a hierarchic structure together with eigenvalue computing method will supplement the richness of the industry-level analytical tool.

## 2.3 Airport Efficiency and Its Theoretical Framework

To evaluate the efficiency which is the firm's performance measurement under the structure, conduct and performance (the SCP paradigm), this section provides an overview of the theoretical framework of airport efficiency which leading to understanding airport efficiency evaluation. Therefore, the Theory of Efficiency, tools for efficiency measurement and relevant literature in airport efficiency assessment are systematically reviewed and discussed.

### 2.3.1 Theory of Efficiency

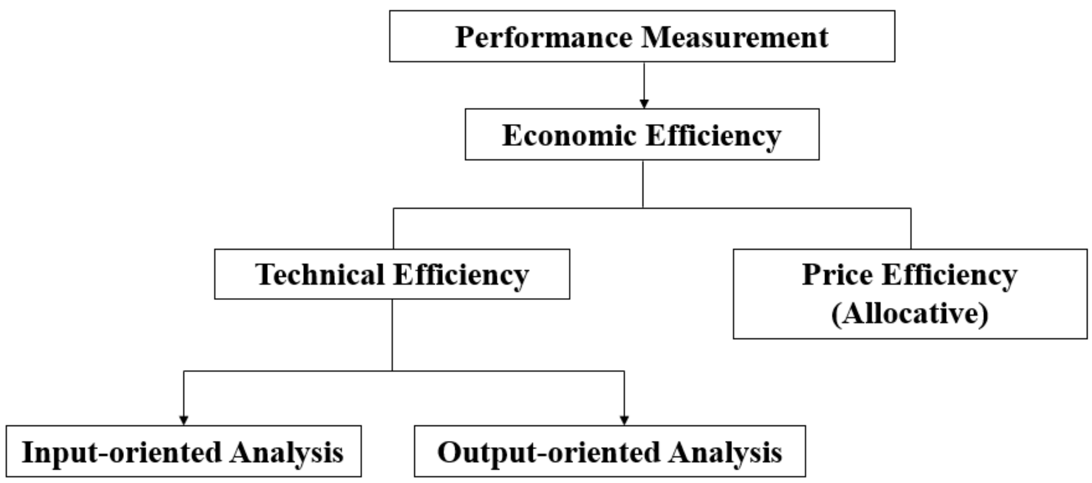



Figure 2.7 Performance Measurement Framework

According to Figure 2.7, efficiency measurement provides a firm or business unit's performance and shows how well it can transform inputs into outputs. Efficiency measurement is a relative concept or it can compare efficiency between firms' performance both in static and dynamic perspectives (Akarapong Untong, 2004). The theoretical framework of efficiency measurement in airport literature was mostly tribute to the Theory of Efficiency developed by Farrell (1957). It was the foundation for efficiency measurement which extensively developed into several approaches until present. Farrell (1957) defined efficiency as a firm's succession in producing outputs from the given factors of production which can elementally be expressed as equation (2.1)

$$Productive\ efficiency = \frac{outputs}{inputs} \qquad (2.1)$$

He said that productive efficiency comprises allocative (price), technical and economic efficiency. To measure efficiency under his concept, supposing that the production function is known and the Constant Return to Scale assumption (CRS) is applied, the simple efficiency measurement can be assessed graphically (Figure 2.8) as follows:

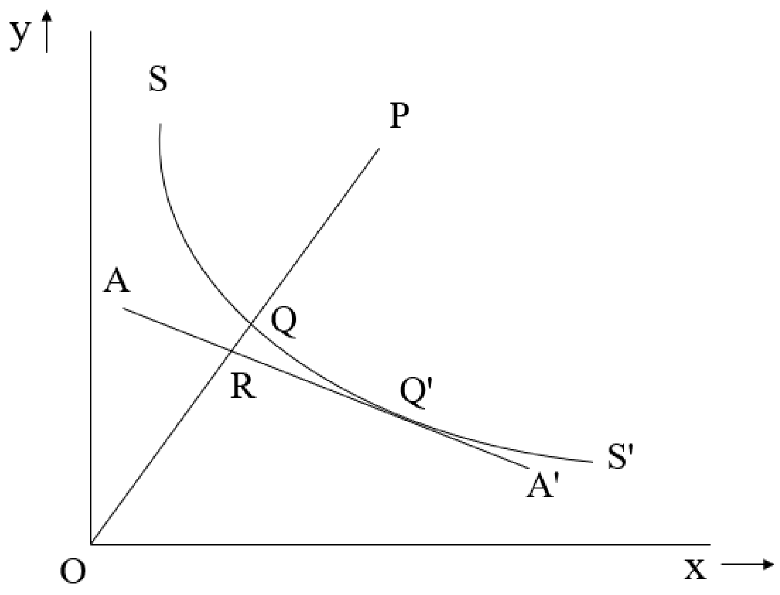



Figure 2.8 Simple Case of Efficiency Measurement
Source: Farrell (1957).

where;

- the point *P* represents the inputs of the two factors (input *X* and *Y*) per output unit;

- the Isoquant *SS'* curve refers to the diverse combinations of the two factors between *X* and *Y* which every point of the curve reflects the equal produced outputs;

- the point *Q* represents an efficient firm using the two factors in the same ratio as *P*;

- and the *AA'* denotes Isocost curve which reflecting the best input proportion in a view of prices.

1) Figure 2.8 shows *AA'* has a slope equal to the ratio of the prices of *X* and *Y*, *Q'* is the optimal mean of production. Then, the cost of production at *Q'* will only be a fraction $\frac{OR}{OQ}$ of those at *Q* and the $\frac{OR}{OQ}$ is called price or allocative efficiency which is the efficiency occurred from selecting suitable input combination under given price constraints.

2) Technical efficiency (TE) is the efficiency reflecting the appropriate production techniques and proper production process management. It can be considered either input orientation (abilities to minimize inputs under given outputs) or output orientation (abilities to maximize outputs under given inputs or to reduce wastages from a production process) which the latter concept has mostly taken part in airport efficiency literature. From Figure 2.7, TE refers to $\frac{OQ}{OP}$ of the firm P because *Q* represents an efficient firm using the two inputs in the same fraction as *P*. It can be considered that it produces similar output to *P* using fraction $\frac{OQ}{OP}$ as much of each input; thus, it produces $\frac{OP}{OQ}$ times as much output from the same inputs.

3) and economic efficiency (EE) is the summation between allocative efficiency and technical efficiency or $\frac{OR}{OP}$ which a firm is perfectly efficient.

However, the efficiency measurement displaying as equation (2.1) is not well-applied for a firm using only a single input to produce a single output (Ahn & Min, 2014); additionally, the measurement under a simple case by Farrell (1957) was conducted under the known production function to calculate the efficient frontier or parametric approach which is not workable to some industries, especially an airport sector, since it is not easily to estimate either the production or cost function from the given inputs, outputs and also price information which are rather subjective and sometimes unavailable (Adler & Liebert, 2014; Kutlu & McCarthy, 2016). As a result, the past 20 years development of efficiency measurement has come to the non-parametric approach, especially in the airport literature. By using a concept presented by Farrell (1957) and some relaxations on the assumptions, the Data Envelopment Analysis is introduced in the industry since 1997 onwards (Perelman & Serebrisky, 2012).

### 2.3.2 Airport Efficiency Measurement

Efficiency measurement and airport benchmarking had never been in an issue until changing in ownership and control of airports has put a pressure and a policy shift on airport business objectives, to be more commercialized and profit-oriented; hence, a better efficient operation needs to be achieved for maximizing shareholder benefits (Graham, 2005; Humphreys & Francis, 2002). Consequently, the efficiency measurement and performance benchmarking are introduced to be a part of strategic planning and strategy formulation. Efficiency measurement is a crucial management instrument for business units in developing and improving their performance among a dynamic of global business environment changes. Through the process of measurement, business units get some information allowing them to investigate areas they are doing well or need improvement and are able to catch up strengths and weaknesses of their operations and production activities (Cook & Zhu, 2008) since it involves with input and output considerations. Assaf and Josiassen (2016) further explained that the measurement will be a key for strategic planning which will be a vital source of sustainably competitive advantage. Additionally, the measurement also benefits business stakeholders. Humphreys and Francis (2002) explained that the performance measurement provide resources to airport stakeholders which having different purposes of using information deriving from efficiency measurement; that is,

1) Government as an airport activity regulator and policy maker
2) Airlines as a key airport customer
3) Airport managers as a strategic planner and financial and operational performance monitor
4) Passengers as a client of airports
5) Owners/shareholders as an airport performance evaluator and return on their investment

Referring to literature on efficiency measurement, there are various methods to evaluate efficiency of business units but most of them are restricted to some constraints and assumptions which not allowing to reality implications in airport business. Although there are some basic efficient measurement using financial indicators, they are able to compare only basic perspectives. Hence, there should be more methods for considering and assessing multidimensional (both inputs and outputs) variables relating to airport activities (Hanaoka & Phomma, 2004). Moreover, some methods does not present a clear understanding of overall performance, so users have to consider employing them with cautions since they are not informative enough which possibly leading to misinterpretations if taking alone such as Partial Factor Productivity Analysis (PFP), Stochastic Frontier Analysis (SFA), Ordinary Least Square Method (OLS), Variable Factor Productivity (VFP) or Total Factor Productivity Analysis (TFP) (Gillen & Lall, 1997; Liebert & Niemeier, 2013; Martín & Roman, 2001; Somchai Pathomsiri, 2006). Liebert and Niemeier (2013) also added that some methods using index numbers to assume efficiency for the collected observations are not applicable to airport industry. Conversely to the Data Envelopment Analysis or DEA, it can be measured the efficiency either physical or financial terms making DEA stand-out from other approaches (Vogel, 2006a). Besides, DEA demands lesser data requirements even financial evaluation data is not available. It can reveal the gap between an actual efficiency and optimal efficiency for which none of the above method can provide (Assaf & Josiassen, 2016; Homburg, 2001). Although DEA permits the relaxation of some assumptions like the distribution of error terms, it is still broadly acceptable and frequently used in wide ranges of contexts due to its flexibility in a process of efficiency calculation (Adler, Liebert, et al., 2013; Charnes, Cooper, & Rhodes, 1978; Lai et al., 2012). Table 2.6 displayed the comparison between non-parametric and parametric approach.

The key idea of DEA is to extend the classical concept of efficiency (equation (1)) to make it proper for the multiple inputs used and multiple outputs produced which are sometimes unable to assess efficiency by other approaches (Cook & Zhu, 2008; Cooper, Seiford, & Zhu, 2004; Homburg, 2001); subsequently, it is widely adopted in the airport literature since airports are considered as a multi-input usage (such as capital, labor and technology) firm to produce multi-products, that is, offering various services such as aircraft movements, passenger transferring, re-fueling, parking and shopping (Ahn & Min, 2014; Curi, Gitto, & Mancuso, 2011; Somchai Pathomsiri, 2006). DEA is a non-parametric approach, or it means DEA is not mandated to specify a functional form for input and output relationship; thus, it does not necessitate some assumptions based on production function that having some parameters underlying in it (Assaf & Josiassen, 2016; Bazargan & Vasigh, 2003). Besides, Cooper, Seiford, and Tone (2006) said that DEA allows some possibilities for using if inputs and outputs are unclearly defined and sometimes they are rigid to measure while Gillen and Lall (1997) added that some data used in the model can be substituted by proxy variables such as gross-ton-miles, available seat miles (ASMs), revenue passenger kilometers (RPKs), available freight ton Kilometer (AFTK), number of aircraft movements (ATM) and so on. Despite small amount of observations which is not qualified for parametric approach, DEA is still applicable (Barros & Sampaio, 2004); thus, this advantage of DEA would not be substituted for efficiency measurements. Additionally, Bazargan and Vasigh (2003) claimed that the most attractive of this method is that it eradicated the weight estimation which is a problematic task as needed by other method like Total Factor Productivity Analysis (TFP). Perelman and Serebrisky (2012) also added that DEA does not require price data for computations, just only physical inputs and outputs are needed to be measured.

Table 2.6 Common Efficiency Measurement Method Comparison

| Issues considered | Non-parametric approach (Data Envelopment Analysis, DEA) | Parametric approach (Stochastic Frontier Analysis, SFA) |
|---|---|---|
| 1. Methodology | Mathematical-based | Statistical-based |
| 2. Production characteristics | Multiple inputs and outputs | Multiple inputs but one output |
| 3. Market price data requirements | No | Yes |
| 4. Sample size | Small | Large |
| 3. Estimation of production or cost function | No | Yes |
| 4. Solutions to multicollinearity | Yes | No |
| 5. Distribution of the random error assumption | No | Yes |
| 6. Outlier sensitivity | Yes | No |
| 7. Growth in airport literature | Mostly applied | Lesser than DEA |

Basing on the efficiency concept and measurement foundation provided by Farrell (1957), the Data Envelopment Analysis (DEA) was further developed and initiated by Charnes et al. (1978) using mathematical method or the linear programming method to convert multiple inputs and multiple outputs into a scalar measure of efficiency by creating a frontier basing on the data to envelope samples (Figure 2.9).

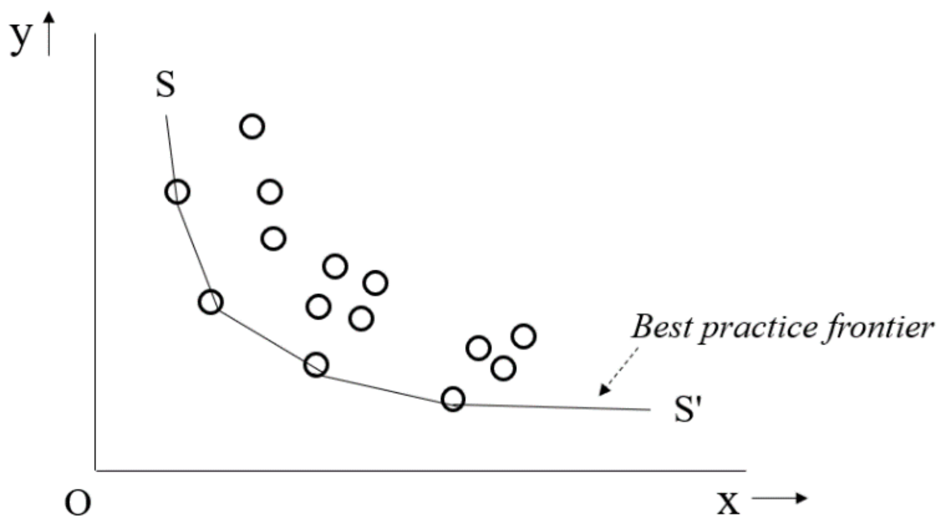



Figure 2.9 Frontier Analysis by Data Enveloping Analysis
Note: Adapted from Farrell (1957).

With this frontier analysis, the ultimate outcomes from DEA for relative efficiency measurement, comparing a weighted output index relative to a weighted input index, are identified into an efficient frontier and an inefficient area or worst practices since efficiency scores $(0 < \theta_k < 1)$ denote the distance between each production unit or the sample and the best practice or the boundary of production frontier which alternately called a Pareto-efficient DMU showing the most suitable input and output combinations (Vogel, 2006b). It can mathematically be shown as equation (2.3), (2.4) and (2.5) (Akarapong Untong, 2004; Assaf & Josiassen, 2016; Cooper et al., 2006; Curi et al., 2011; Walailak Atthirawong & Kanogkan Leerojanaprapa, 2016).

$$relative\ efficiency = \frac{weigthed\ sum\ of\ outputs}{weigthed\ sum\ of\ inputs} \tag{2.3}$$

$$relative\ efficiency = \frac{u_1 y_1 + \ldots + u_s y_s}{v_1 x_1 + \ldots + v_s x_s} \tag{2.4}$$

$$relative\ efficiency = \frac{\sum_{r=1}^{s} u_r\, y_r}{\sum_{i=1}^{m} v_i\, x_i} \;;$$

$$r = 1, \ldots, s, i = 1, \ldots, m \tag{2.5}$$

where; $u_r$ is a weighted output *r*

$y_r$ is an amount of output *r*

$v_i$ is a weighted input *i*

$x_i$ is an amount of input *i*

As mentioned earlier that the concept of technical efficiency measurement was grouped into input-oriented and output-oriented framework. Martín and Roman (2001) suggested that the decision on choosing the technical efficiency measurement framework must base on the real situation for airport circumstances. Referring to some publications in the field, Gillen and Lall (1997), Oum et al. (2006) and Lai, Potter, Beynon, and Beresford (2015) advised that airport efficiency measurement should be output-oriented. It is because once an airport makes an investment such as passenger terminal building, runway construction, parking space structuring and so on, it is impossible to adjust the combination of inputs to save costs of production. To compute the efficiency under those couple frameworks, Charnes et al. (1978) was the pioneer in employing DEA to evaluate each production unit which called the Decision Making Units (DMUs) in their work since they focused on public organization performance which was not profit-oriented. They proposed the input-oriented analysis to evaluate DMUs efficiency under constant return to scale assumption which can be presented as equation (2.6);

$$Min_{\theta,\lambda}\,\theta$$

$$subject\ to \quad -y_{rk} + \sum_{j=1}^{J} y_{rj}\,\lambda_{jk} \geq 0$$

$$\theta x_{ik} - \sum_{j=1}^{J} \lambda_{jk}\,x_{ij} \geq 0$$

$$\lambda_{jk}, i, r \geq 0;$$

$$k > 0;\ j = 1, \ldots, J \qquad (2.6)$$

where; $\theta$ is an efficient score

$x_{ij}$ is an amount of input *i* of a production unit *j*

$y_{rj}$ is an amount of output *r* of a production unit *j*

$\lambda$ is a weighted value of either input or output

$k$ is a production unit that is being considered

$j$ is a number of production unit

In addition to constant return to scale assumption, Charnes et al. (1978) also presented the classic model which focusing on output-orientation and it was later so called the CCR Model. The precise form can be expressed as equation (2.7);

$$Max_{\varphi,\lambda}\,\varphi$$

$$subject\ to \quad -\varphi y_{rk} + \sum_{j=1}^{J} \lambda_{jk}\, y_{rj} \geq 0$$

$$x_{ik} - \sum_{j=1}^{J} \lambda_{jk}\, x_{ij} \geq 0$$

$$\lambda_{jk}, i, r \geq 0;$$

$$k > 0;\ j = 1, \ldots, J \qquad (2.7)$$

where; $\varphi$ is an efficient score

$x_{ij}$ is an amount of input *i* of a production unit *j*

$y_{rj}$ is an amount of output *r* of a production unit *j*

$\lambda$ is a weighted value of either input or output

$k$ is a production unit that is being considered

$j$ is a number of production unit

There are various forms of the Data Development Analysis (DEA) models but the most common ones and suggested to use are the CCR Model which previously explained and the BCC Model which further developed by Banker, Charnes, and Cooper (1984) since they needed to increase the capability of indicating the inefficient units (Ahn & Min, 2014; Barros & Dieke, 2007; Vogel, 2006b). However, prior to select any models, Martín and Roman (2001) suggested that one understand the elementary assumptions of the investigated industry since it determines the model being used for the analysis. To further clarify, the CCR Model assumes Constant Return to Scale (CRS) while the BCC Model relaxes the CCR Model assumption to Variable Return to Scale (VRS) and breaks down the efficiency into pure technical efficiency and scale efficiency (Lin & Hong, 2006). As recommended by many scholars for the BCC Model, Akarapong Untong (2004) said that VRS assumption should be used in case the fact that the competition tends to be imperfect since firms in that market inappropriately produce at the optimal level.  While Lai et al. (2015) suggested that the model by Banker et al. (1984) should be employed in a case of airport industry as its structure is imperfect competition owing to some effects deriving from government regulations and budget constraints. Additionally, Forsyth (1984), Hooper (2002) and Adler and Liebert (2014) proposed that airports are considered as a natural monopoly characteristic due to not only a large scale operations but also an existence of economies of scale because it relates to an enormous sunk cost that allowing a long period of facility utilization. Obviously, there are some empirical studies support that an airport industry is imperfect competition. For example, Vogel (2006a) discovered that small and medium sized airports which having passengers lower than 3 million terminal operated under Increasing Return to Scale while Assaf (2010) tested the scale efficiency of UK airports and reported that they operated under decreasing return to scale and increasing return to scale.

Consequently, choosing the BCC Model seems to be applicable to an airport industry. To calculate the efficiency score under Banker et al. (1984), the equation together with constraint are given as equation (2.7) for input-oriented model;

$$Min_{\theta,\lambda}\, \theta$$

$$subject\ to\ \sum_{j=1}^{J} \lambda_{jk} = 1$$

$$-y_{rk} + \sum_{j=1}^{J} y_{rj}\,\lambda_{jk} \geq 0$$

$$\theta x_{ik} - \sum_{j=1}^{J} \lambda_{jk}\,x_{ij} \geq 0$$

$$\lambda_{jk}, i, r \geq 0;$$

$$k > 0; j = 1, \dots, J \qquad (2.7)$$

while output-oriented model shown as equation (2.8);

$$Max_{\varphi,\lambda}\,\varphi$$

$$subject\ to \sum_{j=1}^{J} \lambda_{jk} = 1$$

$$-\varphi y_{rk} + \sum_{j=1}^{J} \lambda_{jk}\,y_{rj} \geq 0$$

$$x_{ik} - \sum_{j=1}^{J} \lambda_{jk}\,x_{ij} \geq 0$$

$$\lambda_{jk}, i, r \geq 0;$$

$$k > 0; j = 1, \dots, J \qquad (2.8)$$

where; $\varphi, \theta$ is an efficient score

$x_{ij}$ is an amount of input *i* of a production unit *j*

$y_{rj}$ is an amount of output *r* of a production unit *j*

λ is a weighted value of either input or output

*k* is a production unit that is being considered

*j* is a number of production unit

Table 2.7 presents the summary of basic Data Envelopment Analysis models in the literature. However, the Data Envelopment Analysis (DEA) still have some limitations, Lai et al. (2012) reported that due to the lack of statistical properties, it is unable to consider for an error measurement in the efficiency calculation and it does not provide means for hypothetical testing or any statistical inferences on the results of efficiency estimation (Assaf & Josiassen, 2016). While Liebert and Niemeier (2013) added that the measurement can be more challenging in case of outlier availability which possibly deviating the efficiency estimation. Because of considering only inputs and outputs in the model, Gillen and Lall (1997) stated that DEA does not integrate any information relevant to either cost of production or input prices; thus, it is unable to give any comments on cost efficiency issues. Similar to Gillen and Lall (1997) and Homburg (2001) suggested that DEA does not present some essential information to improve business unit activities so it is necessary to analyze them in detail. This discussion was supported by Barros, Liang, and Peypoch (2013), they added that DEA does not present some essential information to improve business unit activities so it is necessary to analyze them in details. This discussion was supported by Barros et al. (2013), they added that DEA does not recognize the source of factor causing an inefficiency. Consequently, additional data analysis techniques like regression method are needed to adopt for gaining more insight information (Vogel, 2006b); also, the qualitative research method could help researcher discovering the grounded source of inefficiency.

### 2.3.3 Data Envelopment Analysis in Airport Sector

There are various methods used to evaluate airport efficiency. Traditionally, some literature relies on accounting-based calculation or financial indicators to examine an overall performance of business units, but those technique are limitative and sensitive to diverse accounting standards between companies (Assaf & Josiassen, 2016; Graham, 2005). Therefore, more intricate approaches are introduced in the airport contexts and it seems that DEA is suggested to use and takes the most parts in the airport efficiency publications due to the characteristics and sources of airport

Table 2.7 Summary of Basic Data Envelopment Models

| **The classic CCR Model by Charnes et al. (1978) (under constant return to scale assumption)** | |
|---|---|
| Input orientation | Output orientation |
| $Min_{\theta,\lambda}\,\theta$ | $Max_{\varphi,\lambda}\,\varphi$ |
| $s.t.\ -y_{rk} + \sum_{j=1}^{J} y_{rj}\,\lambda_{jk} \geq 0$ | $s.t.\ -\varphi y_{rk} + \sum_{j=1}^{J} \lambda_{jk}\,y_{rj} \geq 0$ |
| $\theta x_{ik} - \sum_{j=1}^{J} \lambda_{jk}\,x_{ij} \geq 0$ | $x_{ik} - \sum_{j=1}^{J} \lambda_{jk}\,x_{ij} \geq 0$ |
| $\lambda_{jk}, i, r \geq 0;$ | $\lambda_{jk}, i, r \geq 0;$ |
| $k > 0;\ j = 1,\ldots,J$ | $k > 0;\ j = 1,\ldots,J$ |
| **The BCC Model by Banker et al. (1984) (under variable to scale assumption)** | |
| $Min_{\theta,\lambda}\,\theta$ | $Max_{\varphi,\lambda}\,\varphi$ |
| $s.t.\ \sum_{j=1}^{J} \lambda_{jk} = 1$ | $s.t.\ \sum_{j=1}^{J} \lambda_{jk} = 1$ |
| $-y_{rk} + \sum_{j=1}^{J} y_{rj}\,\lambda_{jk} \geq 0$ | $-\varphi y_{rk} + \sum_{j=1}^{J} \lambda_{jk}\,y_{rj} \geq 0$ |
| $\theta x_{ik} - \sum_{j=1}^{J} \lambda_{jk}\,x_{ij} \geq 0$ | $x_{ik} - \sum_{j=1}^{J} \lambda_{jk}\,x_{ij} \geq 0$ |
| $\lambda_{jk}, i, r \geq 0;$ | $\lambda_{jk}, i, r \geq 0;$ |
| $k > 0; j = 1, \ldots, J$ | $k > 0; j = 1, \ldots, J$ |

datum (Barros et al., 2013; Gillen & Lall, 2001; Merkert & Mangia, 2014; Somchai Pathomsiri, 2006). Discussing by Lai et al. (2012), Perelman and Serebrisky (2012) together with Liebert and Niemeier (2013), the application of DEA in airport sector was firstly introduced by Gillen and Lall (1997). However, before measuring the efficiency of an airport, it is necessary to define input and out variables which are used to compute the efficiency.

Table 2.8 - 2.10 summarized the input and output variables employed in the Data Envelopment Analysis (DEA). Those input variables include number of staffs which is the most common variable used in DEA. The size of passenger terminal and number of runways are another frequently adopted in the analysis. The remaining input variables are number of runways, number of gates, size of aprons, number of aprons, number of check-in counters, number of parking spaces, number of luggage belts and land area of an airport. Apart from the physical input variables, financial input variables can be found in the literature. The operational cost variable is the most frequent used in the model. The rest financial variables are capital costs, labor costs and capital stocks. For an output variable, it is mostly collected from passenger traffic and flight movements while cargo movement variable is also gained to reflect an output of an airport. Financial output variables can be used in the DEA model. Some literature gathered the information relevant to non-aeronautical revenues, aeronautical revenues, operational revenues and also nonoperational revenues which is the least common in the field.

The literature adopted the Data Envelopment Analysis began with Gillen and Lall (1997) setting 2 output-oriented basic DEA models together with Tobit regression analysis, terminal service model and movement model, to examine efficiency of 21 U.S. airports in period of 1989-1993. Input variables such as number of runways, number of gates, terminal area, airport area, runway area, number of employees, number of baggage collection belts and number of parking while number of passengers, number of pound cargo, air carrier movements and commuter movements were gathered for both models. The models showed that having hub airlines and increasing gate capacity would improve airport efficiency.

A few years later, Martín and Roman (2001) implemented the classic DEA-CRS model and DEA-VRS model to evaluate the technical efficiency of Spanish airports system in 1997 which was the period before privatization process initiation. They gathered air traffic movements, number of passengers and number of tons of cargo as an output variable and collected expenditures, labor costs, capital costs and material costs as an input variable. The authors employed output-oriented framework since they considered that airport authorities would like to use facilities within the airports as much as possible under given inputs. The results showed that some airports were in a poor performance position due to public ownership while some of them were performing the efficient frontier. Parker (1999) also investigated airport efficiency in the period of pre-post privatization. He used the basic DEA-BCC and CCR model to assess the efficiency of 32 UK airports during the privatization. The author collected number of staffs, annual rental, operating costs as an input variable and turnover, passenger handled, cargo and mail business for output variable. He discovered that efficiency of the airports after BAA privatization were below than the pre-privatization.

From the above cited studies, it seems that the classical DEA Model so called the CCR Model and BCC Model with output orientation are the most common analysis and encouraged to use in the literature on various parts of the world airports. Such publications, for instance, are Barros and Sampaio (2004) applied constant return to scale assumption to investigate the technical and allocative efficiency of 37 Portuguese airports during 1999-2000. The study concluded that larger airports are operated efficiently than smaller airports; therefore, the regulation policies between large and small airports should be diverged. The authors also recommended that the government implement the privatization policy to the Portuguese airports.

Apart from some basic models, Barros and Dieke (2007) employed additional means of DEA models. The DEA-CCR, DEA-BCC, the cross efficient DEA and the super efficiency DEA together with panel data from 2001 to 2003 were used to examine the technical efficiency of 31 Italian airports. The output variables were measured by number of planes, number of passengers, cargo, aeronautical receipts, handling receipts and commercial receipts while labor costs, capital invested and operation costs (labor costs excluded) were considered as input variables. They assumed that airport authorities objected to gain profit maximization from the given inputs; thus, the output-oriented framework was applied. The analysis reported that most of Italian airports showed the relatively high Variable Return to Scale efficiency. Similar to the papers from Bazargan and Vasigh (2003), Vogel (2006a), Vogel (2006b), Lin and Hong (2006) and Perelman and Serebrisky (2012) were still employed the classic models.

Bazargan and Vasigh (2003) analyzed the financial and operational efficiency of 15 US airports during 1996-2000 by deploying the classic CCR Model. They gathered operating expenses, non-operating expenses, number of runways and number of gates for input variables whereas output variables were measured by number of passengers, number of other operations, aeronautical revenues, non-aeronautical revenues and percentage of on time operations. The result reported that 75% of all samples were efficiently operated and small airports were outperformed the larger airports.

The same as Perelman and Serebrisky (2012), they used an output-oriented framework for airport efficiency evaluation to analyze the technical efficiency of 21 airports between private participation scheme airports and public airports by using DEA from 2000 to 2007. Number of passengers, tons of freight and number of aircraft movements were collected for output calculation while number of employees, number of runways and terminal size was considered as an input variable. Under the output-oriented framework, the analysis concluded that the efficiency of airport operated by private sector had a higher efficiency than public-owned airports.

Also, Lin and Hong (2006) used the basic model together with other models to investigate 20 international airports around the world by considering number of employees, number of check-in counters, number of runways, number of parking spaces, number of baggage collection belts, number of aprons, number of boarding gates and terminal areas as an input variable while using number of passengers and cargo movements as an output factor. By using a variety of DEA Models (the CCR, BCC, SCE, A&P and FDH Model), they found that some airports operated at optimal scale efficiency. They also reported the airports in Europe and North America had gained operational efficiencies than Australia and Asia airports.

Adler, Liebert, et al. (2013) analyzed airport efficiency in different perspectives. They claimed that most of airport literature treated airports as a single DMU due to avoiding the complexity of airport system. They also added that this treatment would be biased to efficiency results. To open the black box and distinguish the sub-process of airports from the whole efficiency, they grouped the variables into input (staff costs, other operating costs, declared runway capacity, terminal capacity), intermediate product (international passengers, domestic passengers, cargo, air transport movements) and output variables (non-aeronautical revenues, aeronautical revenues). By examining 43 European airports located in 13 countries together with employing basic DEA models with 10 years data set covering period from 1998-2007, They found that Lyon airport needed to earn 40% of aeronautical revenues to meet efficient operations.

However, although there are several papers implemented output-oriented analysis due to the fact that airports aim to serve airlines and passengers as much as possible under given invested infrastructure (Tsekeris, 2011) , there are some works using different framework from previous literature review. For example, Vogel (2006a) used the BCC Model with the input-oriented framework to evaluate financial efficiency of 35 European airports during 1999-2000. The author concluded that DEA showed the beneficial instrument to indicate airport relative position within the industry since it revealed that small to medium sized airports were operating under IRS while the larger airports were operating in an area both DRS and CRS. Vogel (2006b) claimed that using input-oriented analysis permits the most productive scale size and can address some concerns that airports facing some constraints or experience difficulties in expanding airports.

As mentioned earlier, there are various forms of DEA Model since they have further been developed by many scholars using different combination methods such as Bootstrapping Econometric Model, Free Disposal Hull Model (FDH), Malmquist Index, MCDM and so on. For example, Lai et al. (2015) presented the new technique to evaluate 24 international airport efficiency by using the multi-criteria decision-making method (MCDM), Analytic Hierarchy Process (AHP), to integrate with DEA and Assurance Region DEA models (DEA-AR) for gaining powerful results comparing to basic DEA models because the authors believed that AHP/DEA-AR method can manage the motive differences among airport stakeholders which supposing to use different tool to measure. They collected number of employees,

Table 2.8 Physical Input Variables Used for Airport Efficiency Measurement

| **Authors** | **Physical inputs** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Number of employees** | **Size of passenger terminal** | **Number of runways** | **Size of runways** | **Number of gates** | **Size of aprons** | **Number of aprons** | **Number of check-in counters** | **Number of parking spaces** | **Number of luggage belts** | **Land area** |
| Gillen and Lall (1997) | ✓ | ✓ | ✓ | ✓ | ✓ | | | | ✓ | ✓ | |
| Murillo-Melchor (1999) | ✓ | | | | | | | | | | |
| Parker (1999) | ✓ | | | | | | | | | | |
| Sarkis (2000) | ✓ | | ✓ | | ✓ | | | | | | |
| Gillen and Lall (2001) | ✓ | | ✓ | | ✓ | | | | ✓ | ✓ | |
| Pels, Nijkamp, and Rietveld (2001) | | ✓ | | | | | ✓ | ✓ | | ✓ | |
| Abbott and Wu (2002) | ✓ | | | ✓ | | | | | | | |
| E. Fernandes and Pacheco (2002) | | ✓ | | | | ✓ | | ✓ | ✓ | | |

| **Authors** | **Physical inputs** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Number of employees** | **Size of passenger terminal** | **Number of runways** | **Size of runways** | **Number of gates** | **Size of aprons** | **Number of aprons** | **Number of check-in counters** | **Number of parking spaces** | **Number of luggage belts** | **Land area** |
| Bazargan and Vasigh (2003) | | | ✓ | | ✓ | | | | | | |
| Pacheco and Fernandes (2003) | | | | | | ✓ | | ✓ | ✓ | | |
| Pels, Nijkamp, and Rietveld (2003) | | ✓ | ✓ | | | | ✓ | ✓ | | | |
| Barros and Sampaio (2004) | ✓ | | | | | | | | | | |
| Sarkis and Talluri (2004) | ✓ | | ✓ | | ✓ | | | | | | |
| Yoshida and Fujimoto (2004) | ✓ | ✓ | | ✓ | | | | | | | |
| Yu (2004) | | ✓ | | | | ✓ | | | | | |
| Lin and Hong (2006) | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ | ✓ | ✓ | |
| Barros (2008) | ✓ | ✓ | ✓ | | | ✓ | | | | | |

| Authors | Physical inputs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Number of employees** | **Size of passenger terminal** | **Number of runways** | **Size of runways** | **Number of gates** | **Size of aprons** | **Number of aprons** | **Number of check-in counters** | **Number of parking spaces** | **Number of luggage belts** | **Land area** |
| Fung, Wan, Van Hui, and Law (2008) | | ✓ | | ✓ | | | | | | | |
| Somchai Pathomsiri, Haghani, Dresner, and Windle (2008) | | | ✓ | | | | | | | | |
| Chi-Lok and Zhang (2009) | | ✓ | | ✓ | | | | | | | |
| Lam et al. (2009) | ✓ | | | | | | | | | | |
| Assaf (2010) | ✓ | | ✓ | | | | | | | | |
| Yang (2010) | ✓ | | ✓ | | | | | | | | |
| Yu (2010) | ✓ | ✓ | | | | ✓ | | | | | |
| Curi et al. (2011) | ✓ | | ✓ | | | ✓ | | | | | |
| Lozano and Gutiérrez (2011) | | | | | ✓ | ✓ | | ✓ | | ✓ | |
| Tsekeris (2011) | | ✓ | ✓ | | | ✓ | | | | | |

| Authors | Physical inputs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Number of employees** | **Size of passenger terminal** | **Number of runways** | **Size of runways** | **Number of gates** | **Size of aprons** | **Number of aprons** | **Number of check-in counters** | **Number of parking spaces** | **Number of luggage belts** | **Land area** |
| Perelman and Serebrisky (2012) | ✓ | ✓ | ✓ | | | | | | | | |
| Adler, Liebert, et al. (2013) | | ✓ | | ✓ | | | | | | | |
| Adler, Ülkü, et al. (2013) | | | | ✓ | | | | | | | |
| Ahn and Min (2014) | | ✓ | ✓ | | | | | | | | ✓ |
| Lai et al. (2015) | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | |
| Gutiérrez and Lozano (2016) | | | | ✓ | ✓ | ✓ | | | | | |
| Keskin and Köksal (2019) | ✓ | ✓ | | ✓ | ✓ | | | | | | |
| **Total** | **17** | **17** | **16** | **10** | **10** | **9** | **3** | **6** | **5** | **5** | **1** |

Table 2.9 Financial Input Variables Used for Airport Efficiency Measurement

| **Authors** | **Financial inputs** | | | |
|---|---|---|---|---|
| | **Operational costs** | **Capital costs** | **Labor costs** | **Capital stocks** |
| Murillo-Melchor (1999) | ✓ | | | ✓ |
| Parker (1999) | ✓ | ✓ | | ✓ |
| Sarkis (2000) | ✓ | | | |
| Martín and Roman (2001) | | ✓ | ✓ | |
| Abbott and Wu (2002) | | | | ✓ |
| Bazargan and Vasigh (2003) | ✓ | ✓ | | |
| Barros and Sampaio (2004) | | ✓ | | |
| Sarkis and Talluri (2004) | ✓ | | | |
| Barros and Dieke (2007) | ✓ | ✓ | ✓ | |
| Barros (2008) | ✓ | ✓ | | |
| Curi et al. (2010) | ✓ | ✓ | ✓ | |
| Curi et al. (2011) | ✓ | | | |
| Yang (2010) | ✓ | | | |
| Adler, Liebert, et al. (2013) | ✓ | | ✓ | |
| Adler, Ülkü, et al. (2013) | ✓ | | ✓ | |
| Ripoll-Zarraga and Lozano (2019) | ✓ | | ✓ | |
| Keskin and Köksal (2019) | ✓ | | | |
| **Total** | **14** | **7** | **6** | **3** |

Table 2.10 Output Variables Used for Airport Efficiency Measurement

| Authors | Physical outputs | | | Financial outputs | | | |
|---|---|---|---|---|---|---|---|
| | Passenger movements | Flight movements | Cargo movements | Nonaeronautical revenues | Aeronautical revenues | Operational revenues | Nonoperational revenues |
| Gillen and Lall (1997) | ✓ | | ✓ | | | | |
| Murillo-Melchor (1999) | ✓ | | | | | | |
| Parker (1999) | ✓ | | ✓ | | | | |
| Sarkis (2000) | ✓ | ✓ | ✓ | | | | |
| Gillen and Lall (2001) | ✓ | | ✓ | | | | |
| Martín and Roman (2001) | ✓ | ✓ | ✓ | | | | |
| Pels et al. (2001) | ✓ | ✓ | | | | | |
| Abbott and Wu (2002) | ✓ | | ✓ | | | | |
| E. Fernandes and Pacheco (2002) | ✓ | | | | | | |
| Bazargan and Vasigh (2003) | ✓ | ✓ | ✓ | ✓ | ✓ | | |
| Pacheco and Fernandes (2003) | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ |
| Pels et al. (2003) | ✓ | ✓ | | | | | |
| Oum et al. (2003) | ✓ | ✓ | ✓ | | | | |

| Authors | Physical outputs | | | Financial outputs | | | |
|---|---|---|---|---|---|---|---|
| | **Passenger movements** | **Flight movements** | **Cargo movements** | **Nonaeronautical revenues** | **Aeronautical revenues** | **Operational revenues** | **Nonoperational revenues** |
| Barros and Sampaio (2004) | ✓ | ✓ | ✓ | | | | |
| Sarkis and Talluri (2004) | ✓ | ✓ | ✓ | | | | |
| Yoshida and Fujimoto (2004) | ✓ | ✓ | ✓ | | | | |
| Yu (2004) | ✓ | ✓ | | | | | |
| Lin and Hong (2006) | ✓ | ✓ | ✓ | | | | |
| Barros and Dieke (2007) | ✓ | ✓ | ✓ | ✓ | ✓ | | |
| Barros (2008) | ✓ | ✓ | ✓ | | | | |
| Fung et al. (2008) | ✓ | ✓ | ✓ | | | | |
| Somchai Pathomsiri et al. (2008) | ✓ | | ✓ | | | | |
| Chi-Lok and Zhang (2009) | ✓ | ✓ | ✓ | | | | |
| Lam et al. (2009) | ✓ | ✓ | ✓ | | | | |
| Assaf (2010) | ✓ | | | | | | |
| Curi et al. (2010) | ✓ | ✓ | ✓ | ✓ | ✓ | | |
| Yang (2010) | | | | | | ✓ | |
| Yu (2010) | ✓ | ✓ | ✓ | | | | |

| Authors | Physical outputs | | | Financial outputs | | | |
|---|---|---|---|---|---|---|---|
| | Passenger movements | Flight movements | Cargo movements | Nonaeronautical revenues | Aeronautical revenues | Operational revenues | Nonoperational revenues |
| Curi et al. (2011) | ✓ | ✓ | ✓ | | | | |
| Lozano and Gutiérrez (2011) | ✓ | ✓ | ✓ | | | | |
| Tsekeris (2011) | ✓ | ✓ | ✓ | | | | |
| Perelman and Serebrisky (2012) | ✓ | ✓ | ✓ | | | | |
| Adler, Liebert, et al. (2013) | ✓ | ✓ | ✓ | ✓ | ✓ | | |
| Adler, Ülkü, et al. (2013) | ✓ | ✓ | ✓ | ✓ | | | |
| Ahn and Min (2014) | ✓ | ✓ | ✓ | | | | |
| Lai et al. (2015) | ✓ | ✓ | ✓ | ✓ | ✓ | | |
| Gutiérrez and Lozano (2016) | ✓ | ✓ | ✓ | | | | |
| Ripoll-Zarraga and Lozano (2019) | ✓ | ✓ | ✓ | | | ✓ | |
| Keskin and Köksal (2019) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| **Total** | **37** | **28** | **31** | **8** | **7** | **4** | **1** |

number of gates, number of runways, terminal area, length of runways and operational expenditure as an input variable while number of passengers, amount of freight and mail, aircraft movements and total revenue are gained as an output variable. The results revealed that AHP approach increased the discriminatory power of analysis and offered not only benchmarking practices but also debating on insight information since it reflected the perceptions from each stakeholder.

Although the advantage of DEA is to ignore the unit input costs, there are some studies using the Malmquist productivity index combining with DEA to capture efficiency and productivity on multi periods. For example, Gillen and Lall (2001) examined 22 of the top 30 United States airports from 1989 to 1993 efficiency and productivity changes between airside (operations referring to aircraft movements) and landside (operations referring to passengers and freights) activities for discovering the source of efficiency. They found that higher TFP did not present a high TFP for airside production. For airports in Austria, Abbott and Wu (2002) assessed efficiency and productivity changes in 12 airports from 1989-2000 after passing the Federal Airports Corporation Act in 1986 by employing the aforementioned index together with Tobit regression. They used number of employees, amount of capital stock and length of runways as an input variable and collected number of passengers and amount of cargo as an output variable. The results showed that 12 main airports improved their efficiency and total factor of productivity. Even though the time passed many years, this method is still available in the airport efficiency literature. Ahn and Min (2014) evaluated 23 international airport efficiencies across the world during 2006-2011 by using DEA together with the Malmquist productivity index to assess the operational efficiencies (technical, scale and mixed efficiencies) over time. Basing on data availability, they used land area, length of runway, passenger terminal area and cargo terminal area as an input variable while number of flights, annual passengers and annual cargo carried are considered as an output variable. The results showed Beijing's Capital Airport was performed as the most efficient airport during 2006-2011. They also specified that Vienna, London Gatwick, Leonardo da Vinci-Fiumicino, Zurich, Los Angeles, Seattle Tacoma, San Francisco, Beijing Capital, Pudong and Hongkong could be regarded as the benchmarking airports.

In addition, bootstrapping method is also put into application with DEA; for example, Assaf (2010) analyzed the scale efficiency of 27 small and large airports in England by using the bootstrapping methodology. He uncovered that the large airports operated under Decreasing Return to Scale (DRS) while the others operated in an area of Increasing Return to Scale (IRS) which both results related to market structure. Also, Curi et al. (2010) used two-stage data envelopment analysis with bootstrapping to examine the effect of government policies (privatization and service enlargement) on efficiency of 36 airports in Italy from 2001 to 2003. They discovered that airports with public holding were more efficiently operated. Later, Curi et al. (2011) further studied the previous work from Barros and Dieke (2007) by applying bootstrapped DEA to investigate the technical efficiency of 18 Italian airports from 2000 to 2004. An additional input variable, apron, was collected to reflect airside activities aiming to monitor the usage of airside infrastructure. For output variables, they pondered aircraft movements, number of passengers and delivered cargo. By assuming an output orientation, they measured the airport efficiency from two managerial perspectives, operational activities and financial return from those activities, they found that operational efficiency gradually lessened since 2001 while the financial efficiency increased possibly owing to a dual-price cap on aeronautic service introductory.

There are also other thousand forms of DEA-based model, for instance, Sarkis (2000) used Simple Cross Efficiency (SXEF), Aggressive Cross-efficiency (AXEF), Ranked Efficiency (RCCR) and Radii Rankings of Classification to calculate operational efficiency scores for 44 major US airports. Additionally, Barros et al. (2013) adopted hybrid DEA model, the inverse B-convex model, to assess the technical efficiency of 27 French regional airports during 2005-2008. The number of passengers, total cargo, planes and commercial sales were collected and regarded as an output variable whereas employees, operational cost and total assets were an input variable. The results revealed that most the airports from the data set were relative efficient while there were some airports were increasing the technical efficiency during the period. While Merkert and Mangia (2014) assessed the cost efficiency of 35 regional airports in Italy and 46 Norwegian airports by employing a two-stage DEA model together with truncated regression to investigate the effect of government management and the level of competition toward efficiency. They found that Italian airports were lesser efficient than small airports in Norway.

As a result of the deregulation in an airline industry, the airport literature has been fulfilled with airport efficiency measurement and benchmarking by adopting DEA methodology which is the most joint technique in efficiency evaluation. It is because airport authorities across the world are seeking for solutions to upgrade their airports' performance to compete with others and serve the steady growth in air transport demand during the globalization period since the outcomes of efficiency measurement can present insight information on the competitive position, internal situation and operational performance in which providing policy implications to develop airport and administrative system. Additionally, to provide more precise managerial implications, studies relevant to factor affecting airport efficiency are also in academic attentions for last decades.

## 2.4 Factors Affecting Airport Efficiency and Their Theoretical Frameworks

In this section, factors affecting airport technical efficiency under the Structure-conduct-performance framework from the literature during 1997-2018 are systematically reviewed. Since the paradigm shift in airport policy and its business orientation due to a growth in demand for global air transport under limitations of national resources and cutbacks has put a pressure on a government to search for managerial instrument to develop airports and also their efficiency (Ahn & Min, 2014; Hooper, 2002). Consequently, many scholars in the field have put many efforts to examine variables regarded as influencing to airport efficiency since airport efficiency determinants relate to many market and business environment factors. Referring to the literature, the collected variables are theoretically shown the relative relationship between inputs and outputs as said by the Theory of Efficiency; in addition, the factors are not only explained by input and output combinations but also other endogenous and exogeneous factors which are sometimes beyond airport authorities' controls. To summarize the factors affecting the airport technical, they are gathered and presented on the Table 2.11 and 2.12.

1) Terminal Size

Most airport literature consider a terminal size as a revenue driver because it reflects the capacity of airports on producing passenger movements and arranging other commercial activities in an area. A sample of those works include lo Storto (2018) claiming that a terminal size is a proxy for a landside airport capacity. Assaf and Gillen (2012) also said that this variable was the representative for aeronautical revenue of an airport, and they used passenger terminal area in square meters to compute the variables while Ha et al. (2013) used the summation between area of passenger terminal and cargo terminal in square meters to reflect an input that generating revenues from 11 airports in Northeast Asia region. Dissimilar to Oum et al. (2004), they used number volume of passenger movements per year (millions) to reflect airport size. They found the size of airport variable statistically significant toward airport efficiency.

However, there is still some studies considered this variable as a cost revenue since it can be regarded as having an effect on airport efficiency basing on the economies of scale concepts (Merkert & Mangia, 2014). For example, Parker (1999) said that scale operation of airports impacts their performance.

2) Airport Revenues

Revenue generation has an impact on airport performance. According to Graham (2018), it can be classified into nonaeronautical (commercial) revenues and aeronautical (aviation) revenues. Non-aeronautical revenues relate to revenues occurred form other commercial activities within an airport such as concession fee, parking fee, rental fee and so on. It has played a bigger part over the years not only in hubbing airports but also in secondary airports since it steadily grows more than a growth of aeronautical revenues (De Neufville & Odoni, 2013). While aeronautical revenues gain from activities relevant to airport core business and activities directly relating to aircraft, air freight services, that is, landing fees, passenger service surcharges (PSC), security charges, terminal area air navigation fee, ground handling charges and so on. Assaf and Gillen (2012) said that non-aeronautical revenue relating to revenue generation from airport resources. This variable becomes more important in airport revenue generation (Graham, 2009; Oum et al., 2008). In addition, Assaf et al. (2014) reported that most of studies ignored this effect of this variable despite the fact that it tends to be a significant source of airport revenue which some cases account for 60% of airport revenues. Yan and Oum (2014) also used this variable as it played a big part in revenue generation. Moreover, lo Storto (2018) claimed that the non-aeronautical revenue had an impact on airport financial sustainability while Tovar and Martin-Cejas (2009) also yielded the same results that non-aeronautical revenues had an impact on Spanish airport system.

3) Airport Location

An airport location is advised to have an influence on airport efficiency in some literature. Lin and Hong (2006) and Sarkis (2000) demonstrated that location of airports had an impact on airport efficiency. Barros and Sampaio (2004) also examined its effect by using a dummy variable to indicate that airport location position while Chi-Lok and Zhang (2009) revealed that airports in the coastal cities had a higher growing rate. Adler, Ülkü, et al. (2013) still discovered that airports in remote area which having less population and mountain area may affect airport efficiency.

4) Airport Managerial Policies

This factor relates to any managerial policies driven by airport authorities such as outsourcing policy, business diversification, contracting-out policy and so on. It is anticipated to have an impact on airport efficiency. For instance, Curi et al. (2010) investigated impact of service enlargement policy toward airport efficiency in Italy. Oum et al. (2003) reported the business diversification policy possibly affecting the revenue of airports either aeronautical or non-aeronautical revenue. Similar to Tovar and Martin-Cejas (2009), they also examined the policy relevant to contracting-out, outsourcing, airport services and diversification to airport efficiency while Martín et al. (2013) revealed that revenue diversification had a positive impact on efficiency. They also found that a high level of outsourcing policy reduced cost significantly.

5) Economic Growth

Economic growth is a good sample of exogeneous factor affecting an airport performance and it is the factor that is out of airport authorities' control. Lin and Hong (2006) said that economic growth and air transportation had a close relationship

Table 2.11 Factors Affecting Airport Technical Efficiency

| **Authors** | **Terminal size** | **Average aircraft size** | **Aircraft movements** | **Economic growth** | **Number of runways** | **Service quality** | **Managerial issues** | **Airport location** | **Non-aeronautical revenue** | **Aeronautical revenue** | **Number of passengers** | **Cargo movement** | **Populations** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Parker (1999) | ✓ | | | | | | | | | | | | |
| Sarkis (2000) | | | ✓ | | ✓ | | | | ✓ | ✓ | ✓ | ✓ | |
| Vasigh and Haririan (2003) | | | | | ✓ | | | | | | ✓ | | |
| Oum et al. (2003) | ✓ | ✓ | ✓ | | | ✓ | ✓ | | | | | | |
| Barros and Sampaio (2004) | | | | | | | | ✓ | | | | | |
| Oum et al. (2004) | ✓ | | | | | | | | | | | | |
| Lin and Hong (2006) | ✓ | | | ✓ | | | | ✓ | | | | | |
| Oum et al. (2006) | ✓ | ✓ | ✓ | | ✓ | | ✓ | | | | | ✓ | |
| Vogel (2006b) | | | | | | | | | | | | | |

| Authors | Terminal size | Average aircraft size | Aircraft movements | Economic growth | Number of runways | Service quality | Managerial issues | Airport location | Non-aeronautical revenue | Aeronautical revenue | Number of passengers | Cargo movement | Populations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chi-Lok and Zhang (2009) | | | | ✓ | | | | | | | | | ✓ |
| Tovar and Martin-Cejas (2009) | | | | | | | ✓ | | ✓ | | | ✓ | |
| Tsekeris (2011) | ✓ | | ✓ | | ✓ | | | | | | ✓ | ✓ | |
| Assaf and Gillen (2012) | ✓ | | ✓ | | ✓ | | | | ✓ | | | | |
| Scotti et al. (2012) | ✓ | | ✓ | | | | | | | | ✓ | ✓ | |
| Adler, Ülkü, et al. (2013) | | | ✓ | | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| Ha et al. (2013) | ✓ | | | ✓ | ✓ | | | | | | | ✓ | ✓ |
| Martini et al. (2013) | | | | | | | | | | | ✓ | | |
| Martín et al. (2013) | | | ✓ | | | | ✓ | | | | | | |

| Authors | Terminal size | Average aircraft size | Aircraft movements | Economic growth | Number of runways | Service quality | Managerial issues | Airport location | Non-aeronautical revenue | Aeronautical revenue | Number of passengers | Cargo movement | Populations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Adler and Liebert (2014) | | ✓ | ✓ | | ✓ | | ✓ | | ✓ | ✓ | ✓ | ✓ | |
| Assaf et al. (2014) | ✓ | | ✓ | | ✓ | | | | ✓ | | ✓ | ✓ | |
| Merkert and Mangia (2014) | ✓ | | | | | | | | | | | | ✓ |
| Yan and Oum (2014) | | | ✓ | | | | | | ✓ | | ✓ | | |
| D’Alfonso et al. (2015) | ✓ | | ✓ | | ✓ | | | | | | ✓ | ✓ | |
| Kutlu and McCarthy (2016) | | | ✓ | | ✓ | | | | | | | | |
| Liu (2016) | | | | | | ✓ | | | ✓ | | | | |
| lo Storto (2018) | ✓ | | ✓ | | ✓ | | | | | | ✓ | ✓ | |
| **Total** | **13** | **3** | **14** | **3** | **12** | **2** | **6** | **3** | **8** | **3** | **11** | **11** | **3** |

Table 2.12 Other Factors Affecting Airport Technical Efficiency

| Authors | Ownership forms | Market structure/ competition | Regulation & government-relating policy | Labor costs | Non-labor costs | Congested airport | Hubbing airport | Profitability |
|---|---|---|---|---|---|---|---|---|
| Sarkis (2000) | | | | | ✓ | | ✓ | |
| Vasigh and Haririan (2003) | ✓ | | | ✓ | ✓ | | | |
| Oum et al. (2003) | ✓ | | ✓ | | | | | |
| Barros and Sampaio (2004) | ✓ | ✓ | | | ✓ | | | |
| Oum et al. (2004) | ✓ | | ✓ | | | | ✓ | |
| Lin and Hong (2006) | ✓ | | | | | | ✓ | |
| Oum et al. (2006) | ✓ | | | | | | | |
| Vogel (2006b) | ✓ | | | | | | | |
| Oum et al. (2008) | | | | | | | | |
| Chi-Lok and Zhang (2009) | ✓ | ✓ | ✓ | | | | ✓ | |
| Tovar and Martin-Cejas (2009) | | | | | | | | |
| Curi et al. (2010) | ✓ | | | ✓ | ✓ | | ✓ | |
| Tsekeris (2011) | | | | | | | | |
| Assaf and Gillen (2012) | ✓ | | ✓ | ✓ | ✓ | | | |

| Authors | Ownership forms | Market structure/ competition | Regulation & government-relating policy | Labor costs | Non-labor costs | Congested airport | Hubbing airport | Profitability |
|---|---|---|---|---|---|---|---|---|
| Scotti et al. (2012) | ✓ | ✓ | | ✓ | | | | |
| Adler, Ülkü, et al. (2013) | | | ✓ | ✓ | ✓ | | | |
| Ha et al. (2013) | ✓ | ✓ | ✓ | | | | ✓ | |
| Martini et al. (2013) | ✓ | | | | | | ✓ | |
| Martín et al. (2013) | ✓ | | | | | | ✓ | |
| Adler and Liebert (2014) | ✓ | | ✓ | | | ✓ | ✓ | |
| Assaf et al. (2014) | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | |
| Merkert and Mangia (2014) | ✓ | ✓ | | | | | | ✓ |
| Yan and Oum (2014) | | | | ✓ | ✓ | | | |
| D’Alfonso et al. (2015) | | ✓ | | ✓ | | | | |
| Kutlu and McCarthy (2016) | ✓ | | | ✓ | ✓ | | ✓ | |
| lo Storto (2018) | ✓ | | | ✓ | ✓ | | | |
| **Total** | **19** | **7** | **8** | **10** | **10** | **1** | **11** | **1** |

with airport performance; thus, this variable was expected to have an impact on airport efficiency. Additionally, some works employed income per capita to represent the economic conditions. For example, Chi-Lok and Zhang (2009) used GDP per capita to reflect the local economy of Chinese airports and they expected that local economy had an impact on the airports.

6) Number of Runways and Aprons

Many studies adopted number of runways and the summation length of runways (Ha et al., 2013) to capture runway utilization. Vasigh and Haririan (2003) and Lin and Hong (2006) said that this variable affected airport efficiency while Assaf and Gillen (2012) and lo Storto (2018) gave an idea that this variable was the proxy for aeronautical activity on airside airport capacity. To show its effect empirically, Adler and Liebert (2014) found that runway utilization had significantly positive effect on efficiency

7) Service Quality

Service quality is another factor that possibly affecting airport efficiency (Oum et al., 2006); however, the impacts of service quality on airport efficiency is still lack of academic attentions (Liu, 2016). To reflect the service quality on airport performance, Oum et al. (2003) said that passenger satisfaction should be used to be a proxy for airport's service quality because passengers were a group of customers using the facilities in an airport; therefore, it was considered as a factor affecting airport efficiency. This result aligned with the study from Liu (2016) who concluding that service quality had a positive impact on airport commercial efficiency.

8) Number of Passengers

Since a group of passengers drives an airport revenue since it is a source of passenger service charges. This variable is commonly selected into the model. For example, Martini et al. (2013) said that passengers is a desirable output for airports as it affects efficiency. Vasigh and Haririan (2003) also found that passengers have an effect on airport efficiency; similarly, Martín et al. (2013) said that passenger traffic has a direct relationship on airport efficiency.

9) Populations

There are some studies using populations in the area as a revenue driver. Ha et al. (2013) claimed that this variable reflected the market size. Merkert and Mangia

(2014) collected information from population living in the area where was able to drive to the airport within 2 hours as a factor affecting to efficiency; similar to Chi-Lok and Zhang (2009), they used the number of populations in the airport location to reflect the market size serviced by an airport.

11) Ownership and Control Patterns

An ownership from is a factor that considered to have an effect on airport efficiency following the Theory of Industrial Organization (Figure 2.8). Since the privatization of BAA in 1987, an array of studies relating to ownership and control patterns have gained an interest from many scholars. However, the literature on the issue has reported ambiguous, inclusive, controversial and inconsistent outcomes which causing a growing body of relevant works from the past until present (Liebert & Niemeier, 2013; lo Storto, 2018). The very first publication was Parker (1999) who investigating the pre and post-performance of BAA airports. He reported no any impacts on efficiency after the change in their ownership form. Lin and Hong (2006) also statistical rejected the influences of ownership forms on airport efficiency while Kutlu and McCarthy (2016) empirically showed this variable has diminutive effect on airport efficiency. The above results are aligned with Oum et al. (2003) who presented that structure of ownership were not statistical insignificance to airport efficiency.

However, there are many papers showing some contradictions on the issue. They claimed that different ownership forms affect airport efficiency differently. For example, Oum et al. (2006) and Oum et al. (2008) found that different types of ownership forms had diverse effects on airport efficiency. They revealed that private ownership form had a positive effect on efficiency over public airport governance; thus, they encouraged governments to lead the privatization-related policies since they could improve overall airport efficiency. Assaf and Gillen (2012) also supported the previous suggestions. They found that fully private ownership had the highest efficiency. Similar to Vogel (2006b), he discovered that privatized and partial privatized 35 European airports were operated more efficiently than public airports.

In addition, there are some literature empirically revealed other outcomes. For instance, Adler and Liebert (2014) found some slightly different results from the past studies, they reported that mixed ownership pattern was the least efficient comparing to other forms. While Curi et al. (2010) demonstrated that major public ownership airports in Italy operate more efficient than other forms. lo Storto (2018) also discovered that ownership heterogeneity impacts Italy airport efficiency; especially, PPPs has a greater effect on technical efficiency than public ownership form while Martín et al. (2013) still insisted that ownership form had an impact on efficiency; especially, public corporatization pattern had a significant impact on cost.

12) Market Structure and Competition Intensity

Referring to the Industrial Organization paradigm (Figure 2.9), a firm's performance is affected by both market structure and conduct or intensity of competition; thus, it is common for airport scholars to consider this variable having an impact on airport efficiency. Assaf et al. (2014) said that airport competition was another factor driving cost efficiency. Barros and Sampaio (2004) used proportional share of airports by adopting Hirschman Herfindahl Index (HHI) to replicate the market structure of the Portuguese airports; similar to Ha et al. (2013), they used HHI calculating from traffic share at each airport from the data to reflect airline concentration.

However, the effect on the efficiency are still inconsistent. For example, Chi-Lok and Zhang (2009) found that airports with competition were operated efficiently than others. Scotti et al. (2012) revealed that competitive intensity had a negative impact on airport efficiency while Merkert and Mangia (2014) reported that the level of competition had a positive impact on airport efficiency owing to the fact that it forced the airports to improve efficiency. On the other hands, Adler and Liebert (2014) found no any impacts of competition toward airport efficiency.

13) Regulation and Government-relating Policy

Government policies are another factor affecting airport efficiency and possibly drive cost of airports because some regulatory environment and policy implementations influence to airport authorities; therefore, Oum et al. (2008) recommended that each airport heterogeneity should be observed since it affected the cost frontier analysis. Such policies from institutions included price-cap regulation (single-till, dual-till and single-till ROR) which reported by Oum et al. (2004); additionally, Chi-Lok and Zhang (2009) investigated the airport localization program policy on airport efficiency and found that it had a positive impact on efficiency while open-skies polices were no statistical significance. Assaf and Gillen (2012) also examined the effect of price regulation on airport efficiency. They suggested that the restrictive environment affected airport efficiency. Adler and Liebert (2014) added that the policy may tremendously impact the revenue generation of airports; thus, it operated inefficiently in a regulated environment. Moreover, Oum et al. (2004) found the negative impact of various forms of regulation on airport efficiency; however, the further examination was needed as this factor was reported statistical insignificance.

14) Labor Costs

This variable captures the input cost which including wages, salary, fringe benefits pension to airport staff and other expenses paid to employees. There are various methods to calculate the variable; for example, Oum et al. (2006) and Assaf and Gillen (2012) used a number of employees to reflect the cost that airports had to pay while Yan and Oum (2014) used number of full-time employees to represent the labor cost. For Ha et al. (2013), they adopted the summation of full-time and part-time staff to represent the cost of the airports.

15) Non-labor Costs

This variable captures the input cost which including other expenditures apart from labor cost such as capital cost, material costs and other operational costs such as general operation fees, maintenance costs, expenditures on supplies, repair costs, contractual services, miscellaneous expense, soft operating costs and so on.. Barros and Sampaio (2004) gathered ratio operational costs to sale as a proxy to overall cost of production of Portuguese airports while Assaf and Gillen (2012) considered other operational cost in USD as a variable affecting airport efficiency. Yan and Oum (2014) combined material and services that were purchased to reflect non-labor variable

16) Congested Airport

This variable may possibly consider as a cost driver for airport since Zhang and Zhang (2006) claimed that congested airports serving to monopolistic or oligopolistic airlines might be deprived on delivering airport surcharges occurred from congestions owing to the air fare internalization of the airlines. Therefore, there are some papers showing that this factor had an impact on airport efficiency. Oum et al. (2004) set it as a dummy variable to reflect its effect on airport efficiency. They revealed that this variable had a positive effect and statistical significance on airport efficiency especially on non-congested airport. While Adler and Liebert (2014) found that airports that were congestive causing high level of delay recorded overestimated the airport efficiency; therefore, this variable had a negative impact on efficiency as it drove the cost of the airports. Additionally, Martín et al. (2013) said that airline dominance had an impact on congested airports since it affected on airport cost.

17) Hubbing Airports

This factor is usually formed as a dummy variable to indicate that an airport was serving major airlines as a hub. Lin and Hong (2006) said that hubbing airports gained benefits from a huge traffic volume; thus, it affected airport cost efficiency due to economies of scale since it reduced transportation cost while Sarkis (2000) also proposed that airports that airlines used as a hub were operating efficiently than others. On the contrary, Oum et al. (2004) reported that being a hub to serve airlines tended to have negative impact and statistical significance on airport efficiency since this variable reflected the overutilization of the airports while Assaf et al. (2014) added that being a hubbing airport would levy costs on airports due to a large number of passengers. However, this variable may be considered as a revenue driver in some papers. Martini et al. (2013) reported that the degree of airline dominance may affect the airport efficiency since airlines stimulated commercial activities in the airports.

18) Other Factors

There are other factors that considered to have an impact airport efficiency such as an operating hours of airports (Tsekeris, 2011), seasonality (Chi-Lok & Zhang, 2009; Tsekeris, 2011), freight movements (Adler & Liebert, 2014; Assaf et al., 2014; Scotti et al., 2012), number of gates (Vasigh & Haririan, 2003), number of parking spaces and number of check-in counters (D'Alfonso et al., 2015; Tsekeris, 2011), aircraft movements (Assaf & Gillen, 2012), average aircraft size (Oum et al., 2006; Oum et al., 2003). Additionally, Merkert and Mangia (2014) suggested that airport profitability had an impact on airport efficiency especially for the regional airport contexts. Since this variable can indicate a business model and management style which leading to airport efficiency.

## 2.5 Business Model Design and Its Theoretical Framework

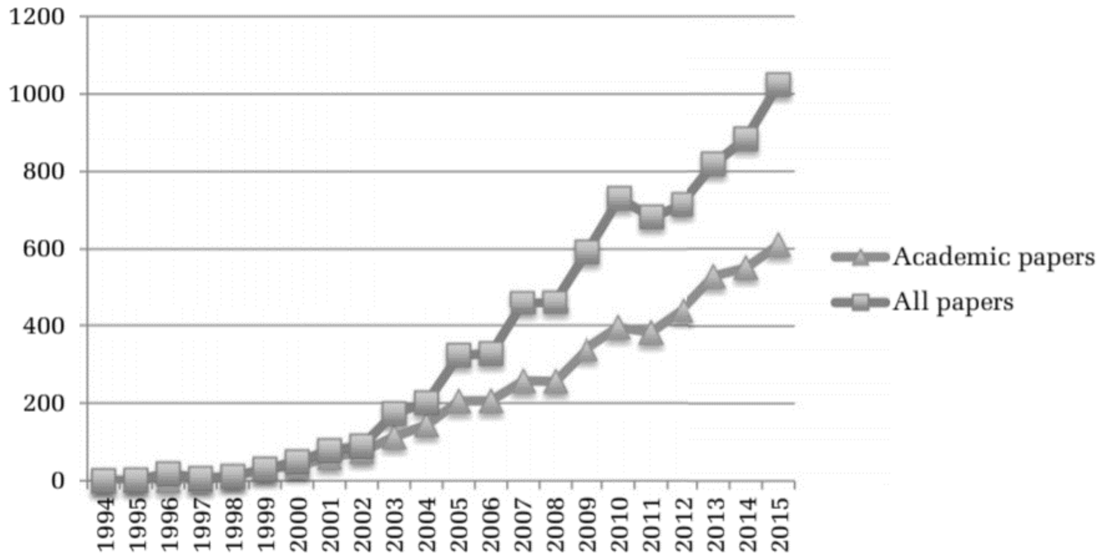



Figure 2.10 The Growth in Business Model Literature Counting from Number of Articles Published per Year
Source: Massa, Tucci, and Afuah (2017).

To design a business model, it is essential to discover its definition since it shows relationship among strategy and a firm (Hedman & Kalling, 2003). However, according to Figurer 2.10 and Table 2.13, a business model terminology is not yet in a consolidation phase due to the growth in business model literature which fragmenting the understandings of the terms from various scholars in different fields of study (Wirtz et al., 2016). Although the term was raised and emerged in the literature since the work from Bellman et al. in 1957, its definition is still unclear, lack of theoretical background, misused and misinterpretation among scholars, practitioners and business sectors in spite of extreme availability in literature (Baden-Fuller & Morgan, 2010; DaSilva & Trkman, 2014; Porter, 2001; Wirtz et al., 2016). It is because most works adopt case studies, especially in information technology businesses, instead of empirical testing and theoretical development. Consequently, the growing body of the empirical testing and theoretical development is very fragmented (Hossain, 2017).

Opposite to business model concepts, the relevant literature for airport industry is scarce and under studied (Graham, 2018; Kalakou & Macário, 2013) in spite of its positive effect and core determinants as explained by Afuah (2019) on a firm's performance (Giesen, Riddleberger, Christner, & Bell, 2010; Huang, Lai, Lin, & Chen, 2013; Zott & Amit, 2007, 2008).

Table 2.13 Some Diverse Selected Conceptualizations of Business Model

| Authors | Definitions |
|---|---|
| Porter (2001) | The definition of a business model, most often, refers to how a firm does business and creates revenue. Simply, a business model is a low bar in order for setting and building a firm. |
| Chesbrough and Rosenbloom (2002) | In the general sense, a business model is the ways of doing business by which a firm can accompany itself – that is generating revenues. It spells out how a firm makes money by indicating where its position in the value chain. |
| Magretta (2002) | A model telling a story how a firm sells its products and deliver value. |
| Hedman and Kalling (2003) | Business models are used to illustrate the key components of a company. |
| Morris, Schindehutte, and Allen (2005) | A business model is the firm's economic model. It involves with profit generations, revenue sources, methods of pricing, cost structures, profit margins, and expected volumes. |
| Osterwalder et al. (2005) | A tool containing elements showing the relationship and presenting the logic of specific business. It describes company values offering to various customer segments. It shows the architecture and networks of partners for delivering values to create and sustain the profits and revenues. |

| Authors | Definitions |
|---|---|
| Chesbrough (2007) | Business models perform two crucial functions. They act as value creators and value captions. They define a series of activities from purchasing to final customers. |
| Zott and Amit (2007) | It explains how a firm is connected with external parties, and how a firm engages in economic exchanges to create values for external parties. |
| Zott and Amit (2008) | A business model is a structural template describing a firm's focal transactions with all stakeholders. |
| Baden-Fuller and Morgan (2010) | A business model is a mean of describing and classifying businesses. It is operated as a site of scientific investigation and acted as a recipe for managers. |
| Amit and Zott (2010) | They defined a business model as the bundle of specific activities conducted to serve the market needs and parties and represented how these activities are linked together. |
| Baden-Fuller and Morgan (2010) | At the same time, business models play many different roles not just only recipes, scientific models, scale models or even role models. They can play different roles in different companies. |
| Demil and Lecocq (2010) | A business model may refer to the articulation between a variety of a company's activities designed to propose value to customers. |
| Giesen et al. (2010) | A business model element relates to these questions:<br>- What value is handed to customers<br>- How the value is delivered to customers<br>- How a firm's revenues is created<br>- How a firm posits itself in the industry |

| Authors | Definitions |
|---|---|
| Chesbrough (2010) | A business model is a model fulfilling these functions:<br>- articulating the value proposition<br>- identifying a market segment and specifying the revenue creation mechanism<br>- defining the structure of the value chain<br>- detailing the revenue mechanisms which a firm offers<br>- estimating the cost structure and profit<br>- describing the position of a firm within the value network connecting between suppliers and customers<br>- formulating the competitive strategies |
| Osterwalder and Pigneur (2010) | A business model is a description of the rationale on how a firm creates, delivers and capture value. |
| Teece (2010) | A business model explains the architecture of value creating and capturing mechanisms it uses. |
| Zott and Amit (2010) | Business models act as a system of interdependent activities transcending the firm pinnacle and its boundaries and that system allows a firm to create and share that value. |
| Cavalcante, Kesting, and Ulhøi (2011) | They posit a business model as a tool to provide some stabilities for the development of a firm's activities and it is flexible to changes. |
| Casadesus-Masanell and Ricart (2011) | They suggested that a business model must contain components allowing managerial choices for management to make on how a firm should operate and the consequences which are results from those managerial choices and they have impacts on a firm's logic of value creation and value capture. |

| Authors | Definitions |
|---|---|
| Zott, Amit, and Massa (2011) | Business models provide the holistic view on how a firm does businesses. They explain how the value created not just how it is captured. |
| Trimi and Berbegal-Mirabent (2012) | A business model explains how a firm deliver value to customers, where to allocate the money for a firm's sustainability and how to run the organization. |
| Boons and Lüdeke-Freund (2013) | A business model is provided as a plan which specifying how new ventures are able to become profitable. |
| Kalakou and Macário (2013) | An attempt of conceptualizing business operations through a model and regarding it as an operational tool for improving the firm's performance and revenues |
| Zott and Amit (2013) | Business models depict the ways a firm doing businesses. They are crafted in order to best meet and fit to customer satisfaction. |
| Bocken, Short, Rana, and Evans (2014) | A business model is defined by 3 elements that is value proposition, value creation and delivery and value capture. |
| Everett Jr (2014) | A business model is a part of business plan. It is schematic model that providing a whole picture of a firm and comprehending than other revenues or operating models. |
| Amit and Zott (2015) | The business model explains the system of interdependent activities done by a firm and its parties and the mechanism linking the activities to each other. |
| Joyce and Paquin (2016) | A business model that has a rationale of how a firm creates, delivers and captures the value. |

| Authors | Definitions |
|---|---|
| Wirtz et al. (2016) | Apart from value creation and market component consideration a business model simplifies and represents the relating activities of a firm in order to secure the competitive advantage. |
| Massa et al. (2017) | A business model is an explanation of a firm telling how that firm runs to achieve its goals such as profitability, growth, society, impacts and so NO. |
| Saebi, Lien, and Foss (2017) | An architecture linking together among a firm's value proposition, market segmentation, value chain structure and value capturing. |
| Geissdoerfer, Vladimirova, and Evans (2018) | Business models are defined as simplified version of value proposition, creation, delivery and capture. They represent the interactions among these elements within a firm's unit. |
| Hahn, Spieth, and Ince (2018) | It is the content, structure and the governance of transactions designed to generate values through business opportunity exploitation. |
| Teece (2018) | A model illustrates an architecture for how a business generates and delivers value to customers. It describes the mechanisms for capturing a share of values. It is a combined set of components among costs, revenues, and profits. |
| Afuah (2019) | A set of activities performing to generate and utilize business resources in order for creating, delivering and monetizing benefits to customers. |

Due to a variety of business model conceptualizations, this study integrated the definitions of Zott and Amit (2008), Osterwalder and Pigneur (2010), Everett Jr (2014) and Afuah (2019) since they stated the effect of business modelling on a firm performance. Consequently, this study defined a business model as an organizational template or comprehensive model representing focal firms' activities, transactions creating values and how a firm delivers them to all relevant stakeholders. In addition, due to a variety of business model terminology; thus, there are many attempts to present theoretical background behind a business model design literature. Such theories include:

1) Resource-based View (RBV)

Since Business models (BMs) relates to value generating and capturing (Magretta, 2002), Resource-based View (RBV) is considered to have crucial roles in Business models (BMs) literature according to Barney (1991) discussing on the links among value, resource rareness, imitability and substitutability to sustain competitive advantage. However, this conceptual framework is insufficient to capture the overall element of business models. It is because the RBV concepts alone are unable to provide a construction of business model components; therefore, it is combined with other theoretical frameworks like Industrial Organization or Transaction Cost Economics (TCE). TCE had been rooted in the business model literature due to the fact that those literature were focusing on the information technology sector. With the application of TCE on business models, the transaction costs for each channel of distributions were diminished (DaSilva & Trkman, 2014). Moreover, the concept basing on Barney (1991) intended to sustain the competitive advantage of a firm. If a firm needed to upgrade its performance and efficiency, employing another framework like Transaction Cost Economics would seem more appropriate and promising.

2) Industrial Organization (IO) and Transaction Cost Economics (TCE)

Hedman and Kalling (2003) believed that Business models (BMs) literature was pinned by the Economics of Industrial Organization as it claimed that a firm's performance depending on the pressure from structure and conduct environments. Similar to Zott and Amit (2013), they argued that BMs can generate value through efficiency deriving from transaction cost economics. Transaction Cost Economics (TCE) was another approach to explain the industrial organization and was pioneered by Coase (1937) and Williamson (1975) basing on the Theory of the Firm and internal organization. According to Ketokivi and Mahoney (2017), even though the Transaction Cost Economics Theory had developed and been extended more than decades, it became the most impacted managerial theory on not only describing corporate governance but also designing an organization as it provided the novelty, counter intuition and provocation thoughts to a firm's phenomenon. Its definition referred to any costs happened in the stage of bargaining between partners and it affected a firm's efficiency (Carlton & Perloff, 2015; Mankiw, 2009; Nicholson & Christopher, 2016). The primary objectives of Transaction Cost Economics (TCE) was to comprehend the individual transaction involving two exchange parties. It also adapted more commonly to circumstances where contractual arrangements relating to several parties with overlapping activities. Ketokivi and Mahoney (2017) added that this theoretical framework laid on the question on how a firm was governed those overlapping and complicated contractual relationship among stakeholders to evade waste and generate transaction value. By reducing this cost to avoid wasting, the efficiency of a firm improves. Most of business model literature were rooted on Transaction Cost Economics (TCE). It is because they were researched relevant to Information Technology sector and such sector was well-developed owing to an attempt to reduce transaction costs among parties (DaSilva & Trkman, 2014; Mahadevan, 2000; Osterwalder et al., 2005). Subsequently, there were some papers used Transaction Cost Economics (TCE) as theoretical background to propose the business model intending to upgrade a firm's efficiency such as Zott and Amit (2007), Zott and Amit (2008) and Zott and Amit (2010). Likewise, this study underpinned the Transaction Cost Economics (TCE) in the airport business model design since it was the framework that was the most compatible with efficiency improvement and also the ability to apply in common contracting issues in an organization (Ketokivi & Mahoney, 2017). In other words, Transaction Cost Economics concepts were consistent and adaptable to the Department of Airports (DOA)'s mission statement.

### 2.5.1 Business Model and Its Consequences on Efficiency

Opposite to business model concepts, the relevant literature on airport industry is scarce and under studied (Graham, 2018; Kalakou & Macário, 2013) in spite of its positive effect and core determinants as explained by Afuah (2019) on a firm's performance (Giesen et al., 2010; Huang et al., 2013; Zott & Amit, 2007, 2008) (Figure 2.11). The aims of a business model design were varied depending on a firm's

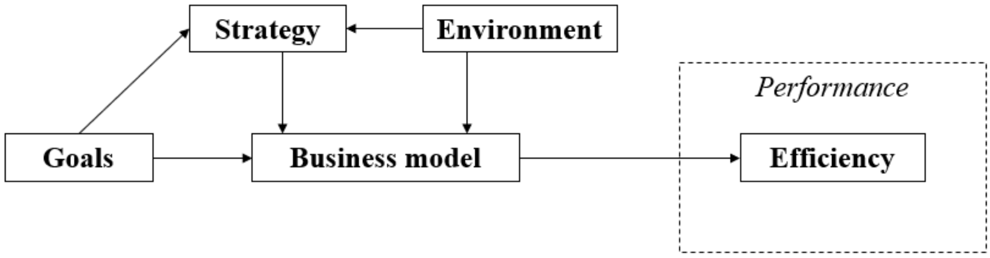



Figure 2.11 Impacts of Business Model on Driving a Firm's Efficiency
Note: Adapted from Afuah (2019).

goal. The business model design was able to be initiated from the way a firm create and capture values, sustainability-oriented to efficiency improvement or even revenue maximation. As the works relating to business model were in transformation era, it allowed freedom for scholars to create the themes for business model design but it was supposed to reflect the holistic view of a company and focal transactions with a firm's stakeholders (Zott & Amit, 2007). For example, Zott and Amit (2007) designed business model themes into efficiency-centered orientation and novelty-centered business model. The first model was constructed to minimize any transaction costs from information symmetry, uncertainty and complexity incurred from stakeholder linkages. By designing such a business model in which enabling to simplify all transaction, reduce switching costs and flow the information among participants, the transaction efficiency was achieved. While the latter one, novelty-centered business model, was proposed to design an activity system and create innovative mechanism to bridge economic exchanges among parties. Following the analytical framework of Zott and Amit (2007), Hahn et al. (2018) used it as the lens for reorganizing firm's activities to reduce the transaction costs which resulting in efficiency enhancement in the context of hybrid, sustainable entrepreneurship business models.

Zott and Amit (2010) also presented other Business models (BMs) in the literature, Lock-in and Complementarities. The Lock-in was designed to attract and retain business stakeholders while the Complementarities was an activity system offering bundle activities for creating more values. In addition, Afuah (2019) explained a various types of generic business model classified basing on a business model attributes – benefit generation, benefit delivery, benefit monetization and building internal resources. Such a business model included; for example, the brokerage business model which focusing on offering a platform interacting between sellers and buyers, the internal development of resource business model that aiming to enhance business resources internally, the freemium business model which its objectives were to monetize the benefits from basic services, the crowdsourcing business model which intending to show user problems in the practice of open calls with no specific contracts to clients, and so on.

### 2.5.2 Analytical Framework of Business Model Design

To design business models, the components adopted in the business model must be consistent with the goals of a firm (Zott & Amit, 2007) and aligned with the employed business model definition. It is because the differences in definitions create the disparities of business model components and designs (Kalakou & Macário, 2013) . For example, if an airport is administered under the orientation of technical efficiency; then, the components should be under the output-oriented framework. There are various solutions to propose business model components. Since each definition provides different BM components which impacting the way firms design BMs such as the BM proposal by Hedman and Kalling (2003). They suggested that BM components should contain customers, competitors, offering, activities and organization, business resources and factors of production. However, there is some works presenting commonly systematic process to design business model archetypes and compatible with the business model definition given in this study; the Business Model Canvas (BMC) published by Osterwalder and Pigneur (2010). Since the Business Model Canvas (BMC) components are classified into the value and efficiency parts; therefore, BMC is adopted as an analytical framework for local and regional airport business models in this study. It is because of the capabilities of capturing business operations and business environments, it has been common in the business model design literature since then (Kalakou & Macário, 2013).

Osterwalder and Pigneur (2010) presented the BMC to illustrate the perception of external participants. It comprises the 9 interconnected elements from the value proposition and efficiency parts. The key partners (KP), key activities (KA), key resources (KR) and cost structure (CS) reflect the efficiency of a firm while the value proposition (VP), customer relationships (CR), channels (CH), customer segments (CS) and revenue streams (RS) are the value part of BMC (Figure 2.12).

To begin designing the business model, Osterwalder and Pigneur (2010) suggested the 9 building blocks visualizing on the Business Model Canvas (BMC) that starting with:

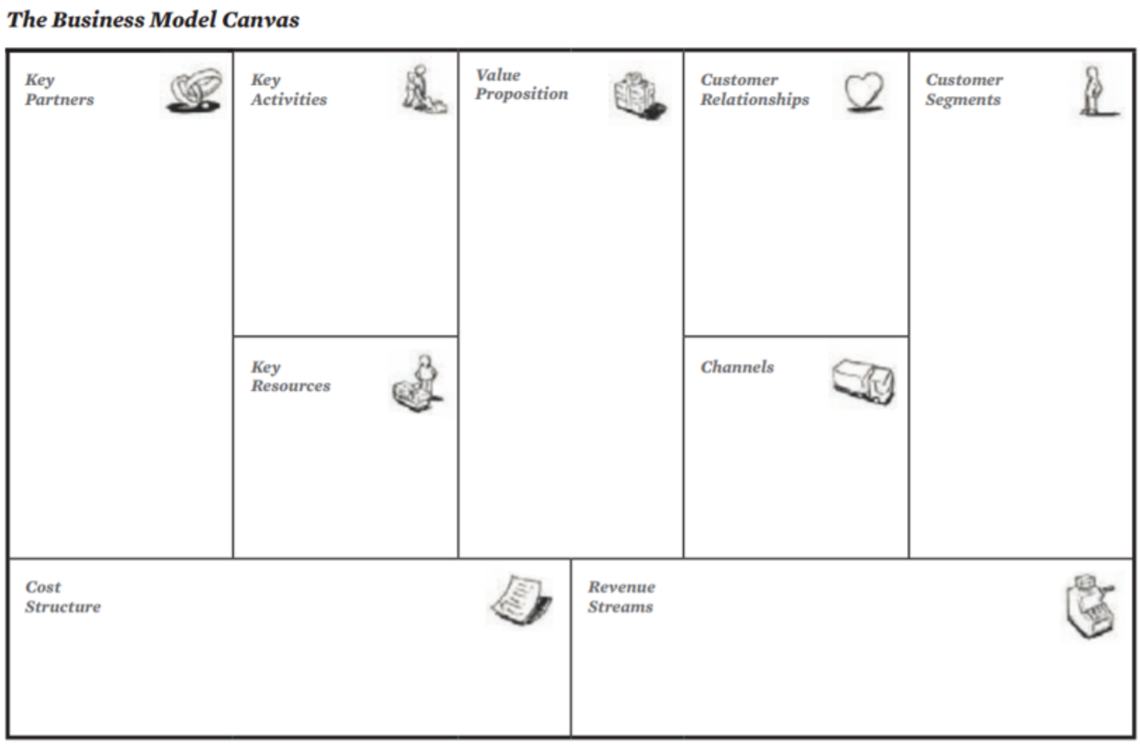



Figure 2.12 The Business Model Canvas
Source: Osterwalder and Pigneur (2010).

1) Customer Segments (CS) - it is the step to consider how many groups of customers they are serving. This block illustrates various groups of customers who are the sources of earning in a business. If a firm offer product and services to various customer segments, it is required to justify and prioritize them in order to deliver the right value to the right groups. The

customer segments can be considered as the mass market, the niche market, the segmented market, the diversified markets and the multi-sided platforms or multi-sided markets which are specifically regarded as the segmentation for airport businesses.

2) Value Propositions (VP) - it is the block describing goods and services that creating values to each customer segment and a firm is going to offer. It also indicates customer pain points and solutions a firm can help to solve. A value proposition can be satisfied with the combination among newness, performance, customization, design, brand, getting the job done, price, cost and risk reduction, accessibility and usability.

3) Channels (CH) - it refers to the selected channels a firm communicate with each segment for proposing values to customers. Finding the right channel helps a company raise awareness among customers about its products and allows a company to assess which channels are the most efficient.

4) Customer Relationships (CS) – it is the block that indicating the interaction forms between a firm and each specific customer segment. The customer relationship can be distinguished in several categories such as personal assistance, dedicated personal assistance, self- service, automated services, communities and co-creation.

5) Revenue Streams (RS) – it is the block showing the revenue stream occurring from each customer segment. It involves two different revenue streams that is the transaction revenues and recurring revenues. The transaction revenue means the payment from one-time customers while the recurring revenue refers to the continuous payment from customers. To generate the revenue streams, a firm may sale assets, collect usage fee, subscription fee, lending, renting, leasing, licensing, brokerage fees or advertising.

6) Key Resources (KR) – this block explains the key resources allowing value propositions to customers, reaching markets, maintaining customer relationship with customer segments and generating revenues. Key

resources can be classified as physical, intellectual, human and financial resources.

7) Key Activities (KA) – it describes a set of activities a firm needs to do to drive its business model. It explains the main activities that a firm supposes to do to deliver value propositions. Such activities include production, problem solving and platform provision or network management.

8) Key Partnerships (KP) – it shows the network between suppliers and a firm's partnership. The aims of networking partnerships are optimization and economies of scale, reduction of risk and uncertainty and acquisition of activities and resources in order to extent a firm's capabilities.

9) Cost Structure (CS) – it reflects important costs occurred from other 8 block operations. Once other blocks are given the details, it is possible to calculate all inherent costs and they are supposed to be minimized. However, it depends on the type of business model that may fall between the cost-driven and value-driven.

### 2.5.3 Airport Business Model Literature

As mentioned earlier, the airport business model literature is not in the attention (Table 2.14). According to Frank (2011), the very first work mentioning the business models was given to De Neufville and Odoni (2013) and Gillen (2009). However, this dissertation argued that the concepts of airport business models were not succinctly presented in De Neufville and Odoni (2013) and Gillen (2009) since the authors just described how airport systems adapted themselves from the impacts of airline business model changing and explained the situation of airport businesses; hence, the literature review on the issues were highly scarce. In other words, the review showed the study containing the airport business model keywords (Table 2.14) were exclusively from Baker and Freestone (2010), Frank (2011), Kalakou and Macário (2013) and Everett Jr (2014).

The very first work mentioning about the business model on an airport context was Baker and Freestone (2010). They explained the concepts of Airport City or Aeropolis that some airports adopted these concepts on their business models in order for adapting to changing environments. The Airport City referred to land utilization and development for airport activities and other commercial business operations. By giving the comparison between Athens Airport and Brisbane Airport, the paper shed the light on how those two airports embracing the Airport City business model to develop their airport area.

Table 2.14 Literature which Entitled Airport Business Model

| Authors | Aspects of Studying |
|---|---|
| Baker and Freestone (2010) | The paper compared how two sample airports from different scales embracing the airport city concept in order for commercially developing their lands in response to business environments. |
| Frank (2011) | The author suggested the structures of airport business models that comprise customer value proposition, break-through rule changing, regulators, key profit formula, stakeholders, governance mix, reform opportunity cost, key resources, key processes, network value, risk and externalities. |
| Kalakou and Macário (2013) | They explored the new framework for airport business model design by adapting the elements from Osterwalder and Pigneur (2010). The authors presented additional building blocks so called the regeneration factor, expected investments and expected returns. They intended to capture and consider the revenues and forthcoming costs. The study concluded that high performance airports shared the same airport business model components. |
| Everett Jr (2014) | Also, the paper presented the framework for developing airport operations in an era of business environment changing. By providing the sample of small airport in USA, the author adopted the components regarding Osterwalder and Pigneur (2010) to illustrate the framework applications. |

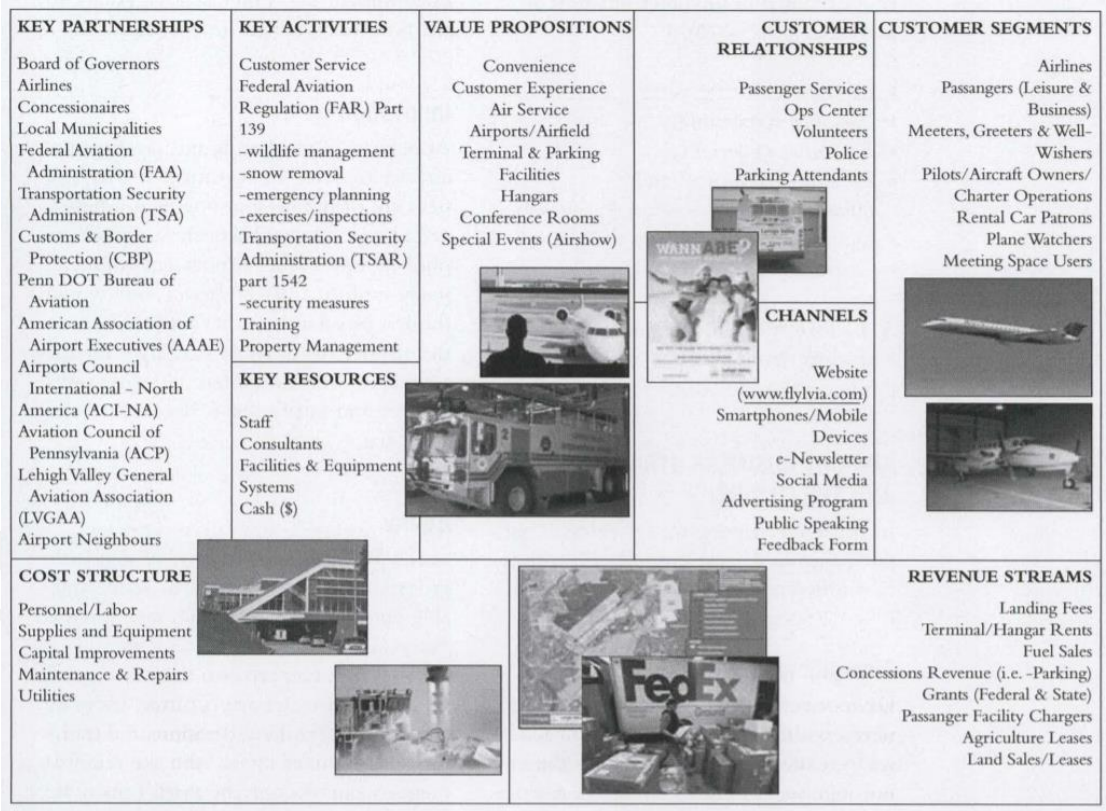



Figure 2.13 Airport Business Model Canvas of Lehigh-Northampton Airport Authority

Source: Everett Jr (2014).

While Frank (2011) employed the exploratory research from in-depth interviews to examine airport business practices in order to propose the different types of airport business models among Talip Airport (TIA), Mills Airport (MIL) and Malik Airport (MAK). The author’s contributions delivered the airport business model matrix which its components included customer value proposition, key profit formula, stakeholder rewards, key resource encompass, key processes, network value and innovation. She concluded that airport business model the design should be heterogenous in essence and the quality of the airport business model should supply the holistic views of airport operations.

For Kalakou and Macário (2013), they used the Business Model Canvas (BMC) to conduct the analysis for 20 airport business models since the authors believed that it captured the overall airport operations and also business environment.

They found that types and traffic volume had a high impact on the business models; in addition, they further developed Osterwalder and Pigneur (2010) by recommending another building blocks that was a regenerator factor reflecting expected investments and returns. the authors suggested ideas similar to Frank (2011) that an airport business model should not be a static fashion. It should reflect present operations for future model development. Moreover, the authors explained that each element of BMC illustrated the innovative process of airport business modelling. It was because all elements of BMC affected the new value proposition; therefore, it created the innovation from current airport operations. Besides the work from Kalakou and Macário (2013), Everett Jr (2014) employed the same framework to explain the small airport operations in Eastern Pennsylvania where operated by Lehigh-Northampton Airport Authority (LNAA). By illustrating the nine element building blocks (Figure 2.3), the author displayed the current operations which relative to airport business environment.

In summary, a piece of airport business model literature is countable. It is because the airport business model literature is still in the age of early development in spite of its strong relationship on a firm’s performance. As noticing from the review, the studies employed both the exploratory approach and the common business model frameworks to explain sample airport operations. Still, the shortage of theoretical background underpinned on the airport business model is leaving the gap for further research. Consequently, to fill the gap in the literature, the exploratory research together with the theoretical background relating to Transaction Cost Economics which is the theory involving with a firm’s performance improvement is adopted in this dissertation in order to create the concrete knowledge the field.

# CHAPTER 3

# RESEARCH METHODOLOGY

This chapter presents the methodologies used to answer the research questions. It is divided into 5 core sections which providing insightful research methodology design for each research objective. The first part of the chapter is the research procedure which demonstrating the summary of the whole process for this study. The second part shows the unit of analysis and key informants for the study and follows with data reliability check which is the third part and the most crucial issue in this chapter. The fourth part presents the research methodological design which including research instrument development, and also the rationale for data analysis technique selection. Lastly, the conceptual research framework drawn to illustrate the overall research objectives and research methodology is presented at the end of the chapter.

## 3.1 Research Procedure

The focus of the study is to design business models for improving technical efficiency of local and regional airports which are under control of the Department of Airports (DOA), operating 28 commercial airports in local and regional parts of Thailand. However, due to the limitations of the time and budget constraints, only 3 regional airports under DOA that is the representative from each strategic group divided by technical efficiency scores are selected to propose the airport business models.

According to Figure 3.1, after reviewing the relevant literature for each research objective, the outputs from research objectives 1, 2, and 3 essential for designing the airport business models, are the situation of local and regional airports in Thailand, factors affecting airport efficiency and the airport business model analytical framework. The outputs from 1st research objective to 3rd research objective were used as the inputs for designing the airport business models for each strategic group and proposing the business model innovations suitable for local and regional airports in Thailand. To illustrate how to obtain the outputs for this study, the upcoming session presents the unit of analysis in which populations, samples and key informants were included.

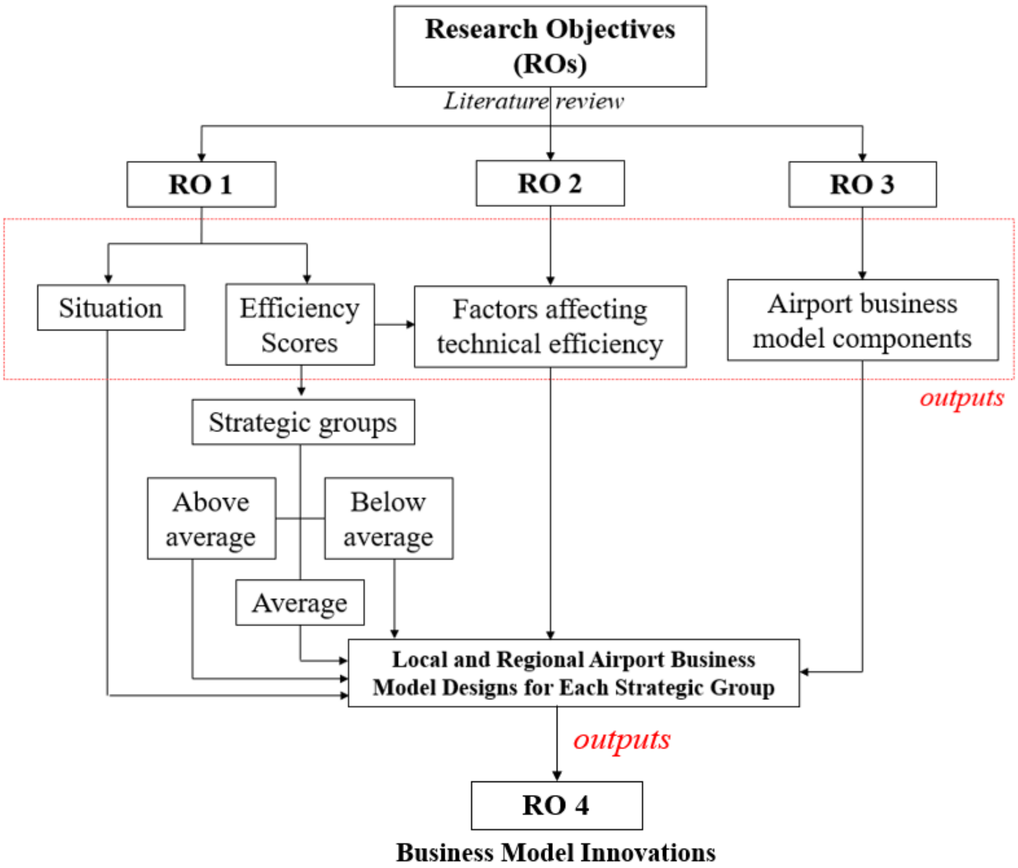



Figure 3.1 Research Procedure of the Study

## 3.2 Unit of Analysis and Key Informants

The summary of unit analysis and key informants considered for each objective can be categorized to quantitative approach and qualitative approach. The criterions for selecting unit of analysis and key informants together with the data collection are as follows:

### 3.2.1 Quantitative Approach

This quantitative methodology is applied to the first research objective, analyzing the local and regional airport situation and measuring the technical efficiency of Thailand local and regional airports, and the second research objective, examining factors affecting the technical efficiency. Table 3.1 summarizes the unit of analysis for research objective 1 and 2. Although there are 3 forms of commercial airport ownership pattern – private, public and privatized airports – as mentioned in the chapter 2, only two latter ownership patterns – public and privatized airports – are included as the unit of analysis due to data availability.

Table 3.1 Unit of Analysis for Research Objectives Applying Quantitative Method

| **Research objectives** | **Unit of analysis** | **Data collection** |
|---|---|---|
| 1.1 To analyze the situation of regional airports in Thailand | 7 opinions toward industry situation were collected from 6 expert panels plus 1 author judgement. | Semi-structured questionnaire |
| 1.2 To analyze the efficiency of regional airports in Thailand | The population included 34 commercial airports in Thailand. It comprised 28 regional airports under the Department of Airports (DOA) and 6 privatized airports under Airports of Thailand (AOT). | 10 fiscal year time-series data from 2009 to 2018 collected from DOA and AOT. |
| 2. To analyze the factors affecting airport technical efficiency | The unit of analysis for the second research objective was also 34 commercial airports in Thailand. It consisted of 28 under control of DOA and 6 privatized airports run by AOT. | 5 fiscal year panel data from 2014 to 2018 collected from DOA and AOT. |

### 3.2.2 Qualitative Approach

This qualitative methodology was adopted to the third research objective, investigating airport business model frameworks, and the fourth research objective, proposing the business models for local and regional airports in Thailand. The number of the key informants depended on the maturity of the collected data. In particular, once the data was repeated or sutured; it reflected the reliability of the interviewing results (Chai Podhisita, 2013; Yothin Sawangdee, 2017). The key informants selecting criterions for research objective 3 and 4 and data collection were presented in Table 3.2.

Table 3.2 Key Informants for Research Objectives Applying Qualitative Method

| Research objectives | Key informants | Data collection |
|---|---|---|
| 3. To investigate the airport business model analytical frameworks in order to make analytical comparison for local and regional airports in Thailand<br>4. To design and propose the business model innovations for Thailand local and regional airports suitable for certain contexts | Since only 3 local and regional airports under DOA that was the representative from each strategic group divided by efficiency scores were selected to propose the business models. The key informants comprise 4 groups:<br>- The group of directors of chosen Thailand regional airports under the Department of Airports (DOA).<br>- The group of airport customers which consisting of the passengers having experiences on the 3 selected regional airports.<br>- Another group of airport users is the airline managements providing commercial flights to the 3 selected regional airports.<br>- The group of key informants includes research scholars having experiences in airport Economic research projects. | Interviewing with semi-structured questionnaire |

## 3.3 Data Reliability Check

This section provided the description for data reliability check both quantitative method and qualitative method. The data reliability check both for quantitative method and qualitative analysis was the most crucial part for the research since it affected not only the accuracy of estimators but also the trustworthiness of results; therefore, cautious data reliability check was highly essential since it removed the possible bias occurred during the data analysis (Hair, Babin, Anderson, & Black, 2019; Paitoon Kraipornsak, 2016; Yothin Sawangdee, 2017).

### 3.1.1 Quantitative Data

For the quantitative method, the pre-analysis data screening was carefully investigated since it affected the accuracy of the collected data. To avoid misunderstanding and misinterpreting from missing data, extreme values or multivariate outliers and some statistical assumptions, the data cleaning should never be neglected (Mertler & Reinhart, 2017). In particular, the classical Ordinary Least Square (OLS) assumptions according to Gauss–Markov Theorem was needed to be considered since if one of the assumptions were violated, the results would yield biasness (Kennedy & Bush, 1985). Consequently, before any data processing, the data used in the regression equation was required to be tested by the following instruments:

1) Normality Test

The first assumption was to test what extent that all observations were normally distributed. It was the test that check the distribution of an error term that was required to distribute normally or $\varepsilon_t \sim N(0, \sigma^2)$. There were various methods to check the normality either using the graphical analysis or statistical method. In this study, the graphical methods were used, that was, the normal probability plot (Q-Q plot). If the observations were distributed normally, the plot should be formed look alike the straight line (Mertler & Reinhart, 2017).

2) Multicollinearity Test

This test evaluated the correlation between the independent variables which they should not have any strong influences toward each other; in other words, it was no perfect multicollinearity. or $Corr\,(x_i, x_j) \neq 1$. The correlation coefficients which exceeding 0.80, they indicated the violation of this assumption and had impacts on the reliability of the estimators.

3) Homoskedasticity Test

According to Tabachnick, Fidell, and Ullman (2007) this assumption was relevant to the normality since the multivariate normality was achieved then those variables must be homoscedastic. Moreover, although the possibility of assumption violation was lesser than the cross section data, this test was also provided in an appendix since it affected the efficiency of the estimators (Akarapong Untong, 2007b). This test proved and showed that the error term computed from the dataset had a constant variance or $Var(\varepsilon_t) = \sigma^2$ ; it was no heteroscedasticity.

4) Non-stochastic Test

The non-stochastic test examined the model that all employed independent variables were uncorrelated with the error term or $Corr\,(x_i, \varepsilon_t) = 0$.

5) Autoregressive Test

Since the study employs 5 fiscal year data, the autoregressive or serial correlation test was necessary for the model that using the time-series or longitudinal dataset since it is possible that the covariance of independent variables $(X_i, X_j;\ i \neq j)$ and error term $(\varepsilon_i, \varepsilon_j;\ i \neq j)$ had some relationship despite the fact that it should not have autocorrelation or $Cov\,(\varepsilon_i, \varepsilon_j) = 0$; therefore, it had impacts on the efficiency of the estimators. There were many methods to check the autoregressive problem such as the correlogram, the Durbin-Watson statistic and Breusch-Godfrey Test.

**3.1.2 Qualitative Data**

To check the reliability of qualitative data before analyzing, the data saturation and the triangulation method were extremely essential. By designing the group of key informants relevant to the research questions $3^{th}$ and $4^{th}$ , the group of key informants could be assigned into 3 groups (Chai Podhisita, 2013; Harding, 2019; Yothin Sawangdee, 2017);

1) Insiders

The insiders were the key informants having the strongest relationship and knowing the information on the research problems by which they were directly affected.

2) The first group of outsiders

The key informants considered as the first order outsider were the group of people having an interaction with the research problems and had some connections with the insiders.

3) The second group of outsiders

The second order outsiders referred to another outsider indirectly participating with insiders and knew some information about the research problems. This group played a role as aviation scholars or airport strategists (Figure 3.2).

With the multiple embedded cases from various groups of key informants, they allowed the triangulation among data collected. If the dataset met the saturation; then, the data would be ready to be analyzed by content analysis. It is because the data Triangulation Method leading to the data saturation or repetition of data collected from 3 groups of key informants both insiders and outsiders, they reflected and represented the reliability of qualitative check (Yothin Sawangdee, 2017).

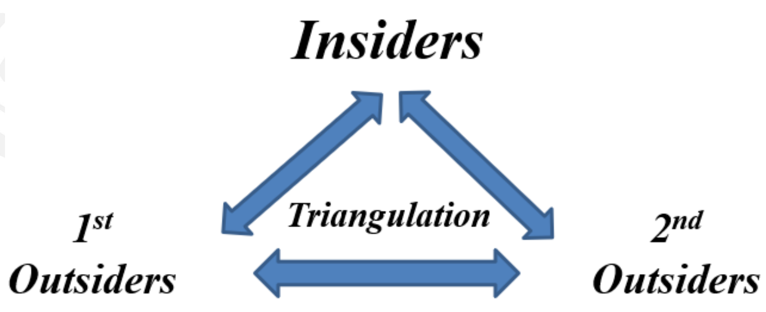



Figure 3.2 Reliability Check for Qualitative Dataset

## 3.4 Research Methodology Designs

The mixed research methodology was applied in this study. Each research objective (RO) was assigned with the specific research methodology which can be either quantitative analysis or qualitative approach. To answer the research questions, the methodological designs are as follows:

### 3.4.1 The Methodology for the 1st Research Objective

To assess the situation of local and regional airports in Thailand, the source of secondary data which referring to business environments affecting local and regional airport industry in Thailand were from Office of the National Economics and Social Development Council, the Ministry of Transport Strategic Plan BE 2560-2564, the Department of Airports Strategic Plan BE 2560-2564, Thailand Aviation Industry Report from the Civil Aviation Authority of Thailand, the information from the DOA Information Center and Library, some economic reports from Airport Council International (ACI), academic journals and in-depth information from the airport expert panels. The collected data was framed under the Structure-conduct-performance in order to illustrate the interactions among the variables so that the whole picture of local and regional airport industry is presented.

Once the data was gained, the PESTEL framework was used as the data analysis technique. To initially construct the PESTEL-AHP, the problem (which factor had an impact on local and regional airport operations the most) was decomposed and the hierarchy was conducted. The prioritization procedure was started in order for determining the relative importance of the criteria from each PESTEL element. Secondly, the questionnaire (see the appendix A) created basing on the elements under the PESTEL Analysis was distributed to 7 expert panels. The opinions from the Departments of Airports (DOA) managements both from central and local and regional units, the aviation scholars and the author's judgement (Görener et al., 2012) was acquired in order to request for variable weighting estimations which measuring the level of factor importance according to Saaty (1990)'s scale (Table 3.3) and capture the pairwise comparison of each PESTEL factor.

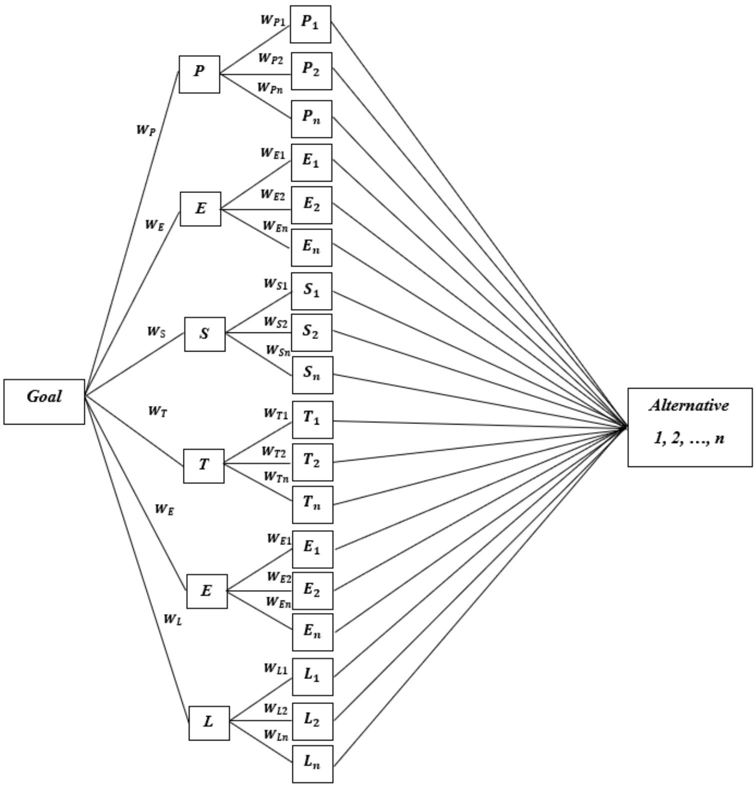



Figure 3.3 Modified PESTEL-AHP Construction

Source: Adapted from Lee and Walsh (2011).

Table 3.3 Level of Factor Importance Weighted by the Department of Airports (DOA) Managements and Expert Panels

| **Intensity of importance** | **Definition** |
|---|---|
| 1 | Equal importance |
| 3 | Somewhat more importance |
| 5 | Much more importance |
| 7 | Very much more importance |
| 9 | Absolutely more importance |
| 2,4,6,8 | Intermediate values |

Source: Saaty (1990).

The model of PESTEL-AHP and weighting estimation was presented as Figure 3.3 and equation 3.1 respectively. The output from this section was a partial source for business model design in the 4th research objective.

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{a22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix}$$

where $a_{ij}$ was the relative importance for $i$ to $j$, $a_{ij} = 1/a_{ji}$ and $a_{ij} = 1$ if $i = j$ and the importance vector value, $\widehat{W}$ was calculated by this formula:

$$\hat{A} \cdot \widehat{W} = \lambda_{max} \cdot \widehat{W} \qquad (3.1)$$

where $\lambda_{max}$ was the largest eigenvalue of $\hat{A}$.

For technical efficiency assessment, the Data Envelopment Model, The Bank-Charnes-Cooper Model (the BCC Model) by Banker et al. (1984) was employed and the variable return to scale (VRS) assumption was applied in this stage (Table 3.5). Although there were thousands of Data Envelopment Models recently, those basic Data Envelopment Model was also suggested to use from past until present (Ahn & Min, 2014; Barros & Dieke, 2007; Gillen & Lall, 1997; Wojcik, Dyckhoff, & Clermont, 2018). It was because the unit of analysis was lying on some authors' assumptions such as Forsyth (1984) Hooper (2002) Adler and Liebert (2014) Lai et al. (2015) and Keskin and Köksal (2019) suggested that the model by Banker et al. (1984) should be employed in a case of airport industry as its structure was imperfect competition owing to some effects deriving from government regulations and budget constraints. Moreover, according to Coelli, Rao, O'Donnell, and Battese (2005) and Attapol Suebpongsakorn (2012), the BCC Model also presented the scale efficiency and the types of returns to scale which was essential for policy implications in the case of resource allocation among Decision Making Units (DMUs).

The output-oriented framework was considered for Thailand local and regional airport efficiency computation. Since the author believed that airports needed to maximize their outputs instead of changing the input combination for cost reduction. It was because the input combination such as number of runways, runway size, apron size, terminal area and number of parking lots was unable to change in the short run period. Therefore, the author followed the assumptions argued by Gillen and Lall (1997), Barros and Dieke (2007), Curi et al. (2011), Tsekeris (2011), Lai et al. (2015) and Keskin and Köksal (2019).

Table 3.4 The Specification of Data Envelopment Model by Banker et al. (1984)

| **Variables** | | **Efficiency score calculation** |
|---|---|---|
| **Input variables** | **Output variables** | **The BCC Model (output orientation)** |
| - number of runways<br>- runway size<br>- apron size<br>- terminal size<br>- number of parking lots | - aircraft movements<br>- passenger traffic<br>- cargo movement | $Max_{\varphi,\lambda}\,\varphi$<br>*subject to*<br>$\sum_{j=1}^{J}\lambda_{jk} = 1$<br>$-\varphi y_{rk} + \sum_{j=1}^{J}\lambda_{jk}\,y_{rj} \geq 0$<br>$x_{ik} - \sum_{j=1}^{J}\lambda_{jk}\,x_{ij} \geq 0$<br>$\lambda_{jk}, i, r \geq 0;$<br>$k > 0; j = 1, \dots, J$ |

To specify the variables for the BCC Model (Table 3.4), number of runways, runway size, apron size, terminal size and number of parking lots were collected as an input variable because it reflected the overall operations both airside and landside. While aircraft movements, passenger traffic and cargo movements were selected as an output variable. The rationale of using the variables because the author regarded Gillen and Lall (2001), Lin and Hong (2006), Somchai Pathomsiri et al. (2008) and Yu (2010) as they said that the selected variables should represent overall airport performance and those specified in the employed model were well-reflected the operations of local and regional airports in Thailand. Additionally, the amount of variables and decision making units (DMUs or local and regional airports) in the model were considered under the assumption of Boussofiane, Dyson, and Thanassoulis (1991), Parker (1999), Somchai Pathomsiri et al. (2008) and Cooper, Seiford, and Zhu (2011) claiming that a number unit of analysis should not be lesser than triple of the summation between input and output variables or the product of the variables specified in the model (formula 3.2).

$$n \geq max\{m \times s, 3(m+s)\} \qquad (3.2)$$

where $n$ was number of airports

$m$ was input variables

$s$ was output variables

Once we substitute the formula 3.2 with the number of variables and which were $m$ = 5, $m$ = 3 and $n$ = 34, then the assumption for DEA model specification according to Boussofiane et al. (1991), Parker (1999), Somchai Pathomsiri et al. (2008) and Cooper et al. (2011) was satisfied.

Additionally, since this study used the data collected from 10 fiscal year (2009-2018); therefore, it was possible to capture the technical efficiency changes during this period by adopting the Malmquist Index together with the BCC Model. According to T. J. Coelli (1996) and Attapol Suebpongsakorn (2012), the Malmquist Index, pioneered by Malmquist (1953), was firstly introduced to measure the productivity changing over time by Caves, Christensen, and Diewert (1982) and developed later on by Fare, Grosskopf, and Lovell (1994). It was appeared in the airport literature first time in the papers from Murillo-Melchor (1999) and Gillen and Lall (2001).

Referring to the basic equation 3.3 which was the two output-based Malmquist efficiency changing index, it was calculated basing on the geometric mean to reflect the change in technical efficiency and technology.

$$m_o(y_{t+1}, x_{t+1}, y_t, x_t) = \left[\frac{d_o^{t+1}(x_{t+1}, y_{t+1})}{d_o^{t+1}(x_t, y_t)} \times \frac{d_o^t(x_{t+1}, y_{t+1})}{d_o^t(x_t, y_t)}\right]^{1/2} \qquad (3.3)$$

where $m_o$ is the Malmquist efficiency changing index
$y$ is a vector of outputs
$x$ is a vector of inputs
$t$ is a period in year $t$

The index was equal to unity. If $m_o$ is greater than 1, it represented the positive change of Decision Making Units (DMUs) from year $t$ to year $t+1$. On the contrary, if $m_o$ was lesser than 1, the DMUs efficiency would get worse considering from year $t$ to year $t+1$.

After running the Malmquist-BCC Model (output-oriented) with DEAP 2.1 invented by T. J. Coelli (1996), the outputs from this section, efficiency scores for each unit of analysis, were used as an independent variable for the second research objective. Moreover, the efficiency scores acted as a criterion to classify the strategic groups for Thailand local and regional airports as mentioned in the research procedure. According to Sarkis and Talluri (2004), the efficiency score grouping could be divided into 3 groups - the units having efficiency score above average efficiency level, the units showing on the average level and the units having efficiency score lower than the average level. With the strategic group classification, 3 local and regional airports, representing each strategic group, each group was purposively be selected to present the local and regional airport business model designs for the 4th research objective.

### 3.4.2 The Methodology for the 2nd Research Objective

The quantitative research method was applied for the 2nd research objective, investigating factors affecting airport technical efficiency, but before processing to the stage of analysis, the data cleaning was needed to be done. The classic OLS assumptions as mentioned earlier – $\varepsilon_t \sim N(0, \sigma^2)$, $Corr\ (x_i, x_j)\ \neq\ 1$, $Var(\varepsilon_t)\ =\ \sigma^2$, $Corr\ (x_i, \varepsilon_t)\ =\ 0$ and $Cov\ (\varepsilon_i, \varepsilon_j)\ =\ 0$ – were required to test for checking the accuracy of the estimators (Hair et al., 2019; Mertler & Reinhart, 2017; Paitoon Kraipornsak, 2016).

Apart from the OLS classical assumption testing, the stationary of dataset was required to be observed since the type of data used in this research objective was longitudinal. Therefore, the dataset must have the conditions as follows (Akarapong Untong, 2007b):

$$E(x_t) = \mu$$
$$Var(x_t) = E(x_t - \mu)^2 = \sigma^2$$
$$E[(x_t - \mu)(x_{t+k} - \mu)] = \gamma^2 \qquad (3.4)$$

With the equitation set 3.4, $x_t$ was the time-series variables that meeting the stationery property.

Once the data cleaning process was completed, the second stage Panel Least Square (PLS) method was chosen to analyze the factors affecting airport technical efficiency. The regressand was derived from efficiency scores calculated by the first stage Data Envelopment Analysis from the 1st research objective while the regressors were collected from the 5 year panel data from various sources of commercial airport ownership patterns – 28 public airports under control of Department of Airports and 6 privatized airports in charge by Airports of Thailand with the total 34 unit of analysis for this research objective. Referring to chapter 2, the variables regressors under the Structure-conduct-performance framework yielding inconsistent and inconclusive results and having an impact on airport technical efficiency such as airport location, airport managerial policies, service quality, ownership patterns, market structure and regulation policies were gathered as in order to fulfil the academic gap in the airport literature.

Following the theoretical framework mentioned earlier, the econometric model can be specified as equation (3.5)

$$\boldsymbol{\theta_t = \beta_0 + \beta_1 OWN_t + \beta_2 MKT_t + \beta_3 SER_t + \beta_4 LOC_t + \beta_5 POL_t + \beta_6 REG_t + \beta_7 REV_t + \varepsilon_t} \qquad (3.5)$$

where; $\boldsymbol{\theta_t}$ was an efficiency score in year *t* calculated from the first stage Data Envelopment Analysis model (the BCC Model) from the 1st research objective

$\boldsymbol{\beta_0}$ was an intercept term

$\boldsymbol{OWN_t}$ was a dummy variable reflecting the ownership patterns (government agencies and privatized) in year *t* since the SCP-paradigm indicates that a conduct of an industry had an impact on a firm's performance. Since there were only 2 forms of ownership patterns; hence, 0 was marked as privatized airports by Airports of Thailand while 1 represented the unit of analysis that having a public ownership form by the Department of Airports (DOA).

$\boldsymbol{MKT_t}$ was a market structure in year *t*. According to the SCP paradigm, the market structure had an impact on a firm's efficiency. The Herfindahl-Hirschman Index ($HHI_t$) represented the airport concentration (Ha et al., 2013) which indicating a market structure. The HHI calculation was as follow:

$$HHI_t = \sum_{i=1}^{N} S_{i,t}^2 \qquad (3.6)$$

where; $S$ was a market share calculating from total flight movements from each airport

$N$ was a number of airports operating in the region

$\boldsymbol{SER_t}$ was the dummy variable reflecting an airport policy that relating to service quality improvement in year *t*. Since the global trend toward airports were commercialized and passenger-oriented; therefore, the customer satisfaction from airport service quality provision played a part of airport performance. The variable was marked 1 if an airport provided the policy, measures or any strategies that linking to passenger orientations. Conversely, it was marked as 0 if the airport had no such a policy relevant to customer satisfaction.

$\boldsymbol{LOC_t}$ was an airport location in year *t*. An airport location was expected to have an effect on airport efficiency according to Chi-Lok and Zhang (2009). The study followed the secondary-tier city classification prepared by the Tourism Authority of Thailand. If the observation was among 55 of the secondary-tier provinces, it will be considered as 1. Conversely, it was regarded as 0 if the unit of analysis was not in the area of secondary city.

$\boldsymbol{POL_t}$ was a dummy variable relevant to managerial policies of an airport in year *t*. Such managerial policies included diversification, outsourcing, contracting out, temporary worker employment and so on. The observation was marked 1 if that airport had at least one policy measures. On the contrary, 0 was given if the airport had no managerial policies.

$\boldsymbol{REG_t}$ was a dummy variable indicating regulatory policies from the Civil Authority of Thailand (CAAT). The samples of regulatory policies are single-till, double-till, passenger service charge etc. This variable also expected to have an influence on airport efficiency. It was because a government interaction played a crucial part on SCP paradigm. The unit of analysis on the model was given 1 if that airport was under the regulatory policies while 0 was marked to an airport that was not under the policy frameworks from CAAT.

$\boldsymbol{REV_t}$ was the airport revenues calculated from the aeronautical and non-aeronautical revenues collected from year *t*. This variable was expected to have an impact on airport efficiency especially non-aeronautical revenues. As Graham (2009) and De Neufville and Odoni (2013) revealed that this revenue plays an important roles in airport performance in present days. However, due to data accessibility from some units of analysis, the airport revenues were collected as the proxy of non-aeronautical revenues.

$\varepsilon_t$ was an error term at year *t* which occurred from the $\theta_t$ estimation by the independent variables in the model.

**3.4.3 The Methodology for the 3rd Research Objective**

To investigate the airport business model analytical framework, the qualitative research methodology was employed. Double qualitative data collections were adopted. Firstly, since the airport business model literature were very scarce; therefore, the exploratory research was introduced in order for examining the airport business model components from the key expert panels. According to Table 3.5, the semi-structured interviewing form (see Appendix A) was distributed and triangulated to triple groups of key informants (Harding, 2019). To select the key informants with inclusive criterions, the insider group consists of the experts working in the managerial position relevant to airport administration in various ownership airport patterns. Specifically, the in-depth interviews were conducted with the airport managements from Airports of Thailand (AOT) and Bangkok Airways Plc. where administered the privatized airports and private airports in Thailand respectively; opinions of the management of the Department of Airports (DOA) from central unit were also acquired. While the 1st outsiders were collected from the key informants working in the local and regional airports; moreover, primary datum from the airport scholars who having experiences on aviation research were collected and regarded as the 2nd outsiders. By using the in-depth interview together with the semi-structured questionnaire and analyzing by the Content Analysis, the results yielded the elementary business model components for designing the local and regional airport business models.

Secondly, the series of document research on airport business models from the emergence of the first publication by De Neufville and Odoni in 2003 (Frank, 2011) and also the information relevant to the best performance of world airport was acquired to examine the components that allowing those airports perform as the most outstanding efficiency airport in the globe. The sources of the World's Best airport data were gained from SKYTRAX, the global and well-known agency providing the World Airport Awards since 1999 and recognized as the quality benchmark for the

Table 3.5 Key Informants Collected for the $3^{rd}$ Research Objective

| **Insiders** | | | **Outsiders** | | **Total key formants collected** |
|---|---|---|---|---|---|
| **Airport management personnel** | | | **$1^{st}$ outsiders** | **$2^{nd}$ outsiders** | |
| **Airports of Thailand (AOT)** | **Bangkok Airways (PG)** | **Department of Airports (central unit)** | **Department of Airports (regional units)** | **Aviation scholars** | |
| 1 | 1 | 1 | 4 | 2 | 9 |

airport industry (Sezgin & Yuncu, 2016). After that, the common business model framework so called Business Model Canvas (BMC) by Osterwalder and Pigneur (2010) was drawn to frame the lessons learned from the World's Best airport and the World's Best regional airport operations. The reason for selecting these two airports because they were chosen as a bench marker due to the ability of continuous performance improvement and prominent airport development for consecutive years. Therefore, the lessons learned gained from those best practice airports would reveal the guidelines for local and regional airport development. Although the scale of the best practice airports was not the same as the local and regional airports in Thailand, studying airport development mechanisms from the frontier airports would illustrate efficiency upgrading solutions to the local and regional airports in Thailand.

For qualitative data analysis, as suggested by Bowen (2009), Corbin & Strauss (2008) and Strauss & Corbin (1998), the reason behind selecting the Content Analysis for both in-depth interviews and documentary research is because this method processed and organized the information derived from both qualitative research and categorized that information to the central research question which allowing meaningful and relevant to the reviewed documents especially for the documentary research. However, it was advised that identification of pertinent documentary analysis should carefully be aware.

Once the data analysis from the exploratory and documentary research were done, the airport business model components and analytical framework was constructed in this stage by employing the Comparative Analysis between the results of exploratory and documentary research. The outputs from aforementioned methods were integrated by using the Comparative Analysis to create the lessons learned for airport business modelling. Ultimately, the airport business model frameworks and were formed and ready for proposing the local and regional airport business models in the 4th research objective.

### 3.4.4 The Methodology for the 4th Research Objective

| *N* | *S* | *N* | *S* | *N* | *S* |
|---|---|---|---|---|---|
| 10 | 10 | 220 | 140 | 1200 | 291 |
| 15 | 14 | 230 | 144 | 1300 | 297 |
| 20 | 19 | 240 | 148 | 1400 | 302 |
| 25 | 24 | 250 | 152 | 1500 | 306 |
| 30 | 28 | 260 | 155 | 1600 | 310 |
| 35 | 32 | 270 | 159 | 1700 | 313 |
| 40 | 36 | 280 | 162 | 1800 | 317 |
| 45 | 40 | 290 | 165 | 1900 | 320 |
| 50 | 44 | 300 | 169 | 2000 | 322 |
| 55 | 48 | 320 | 175 | 2200 | 327 |
| 60 | 52 | 340 | 181 | 2400 | 331 |
| 65 | 56 | 360 | 186 | 2600 | 335 |
| 70 | 59 | 380 | 191 | 2800 | 338 |
| 75 | 63 | 400 | 196 | 3000 | 341 |
| 80 | 66 | 420 | 201 | 3500 | 346 |
| 85 | 70 | 440 | 205 | 4000 | 351 |
| 90 | 73 | 460 | 210 | 4500 | 354 |
| 95 | 76 | 480 | 214 | 5000 | 357 |
| 100 | 80 | 500 | 217 | 6000 | 361 |
| 110 | 86 | 550 | 226 | 7000 | 364 |
| 120 | 92 | 600 | 234 | 8000 | 367 |
| 130 | 97 | 650 | 242 | 9000 | 368 |
| 140 | 103 | 700 | 248 | 10000 | 370 |
| 150 | 108 | 750 | 254 | 15000 | 375 |
| 160 | 113 | 800 | 260 | 20000 | 377 |
| 170 | 118 | 850 | 265 | 30000 | 379 |
| 180 | 123 | 900 | 269 | 40000 | 380 |
| 190 | 127 | 950 | 274 | 50000 | 381 |
| 200 | 132 | 1000 | 278 | 75000 | 382 |
| 210 | 136 | 1100 | 285 | 1000000 | 384 |

Figure 3.4 Determining Sample Size for Small Population

Note: Adapted from Krejcie and Morgan (1970).

In order to provide realistic implication and get in-depth details relating to the issues, the qualitative research was used for confirming the results. The outputs from each research objective – the situation and airport technical efficiency, the strategic groups, the factors affecting the airport technical efficiency and the airport business model framework – were integrated to design the airport business models and propose business model innovations for local and regional airports under the management of the Department of Airports, Thailand. According to Krejcie and Morgan (1970), although the minimum samples from the small population size should be equal or close to its size (Figure 3.4), due to the limitations of times and budget, only 3 of 28 local and regional airports was proposed the airport business models.

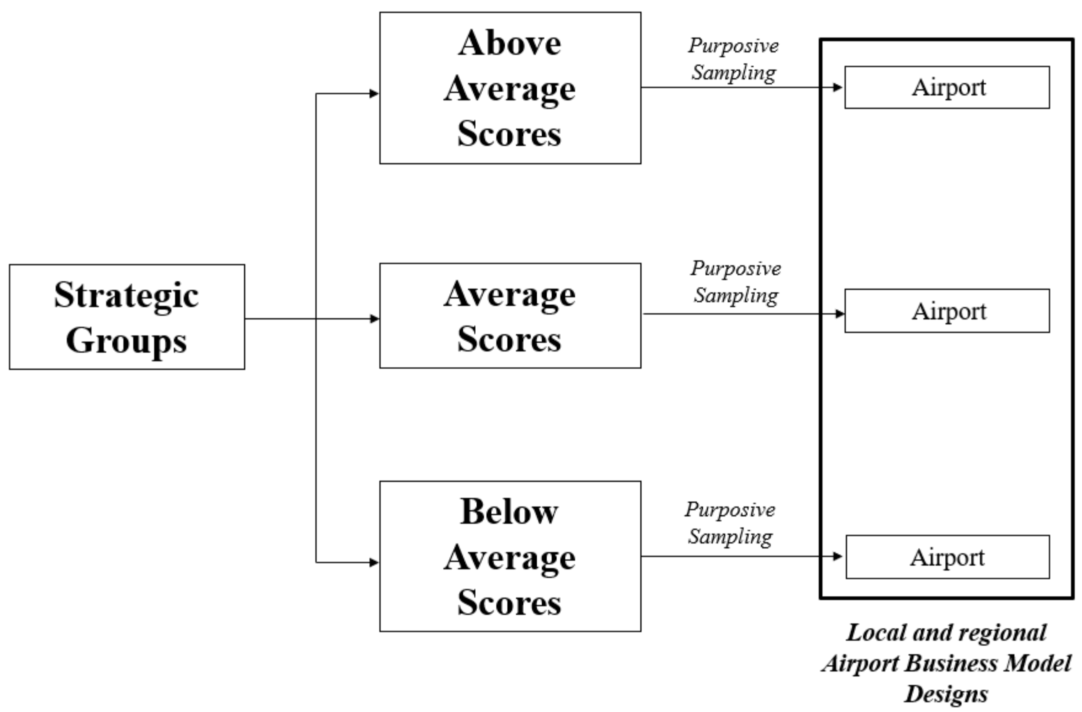



Figure 3.5 Method on Selecting the Local and Regional Airports for Proposing the Business Model and Innovations

To select those 3 local and regional airports, the means of technical efficiency scores were regarded as the criterion to classify the strategic groups. With the means of technical efficiency scores following Sarkis and Talluri (2004) and Lin and Hong (2006), the groups can be clustered into above-average scores, average score level and below-average scores. Each group represented the airport technical efficiency status of local and regional airports. One local and regional airport from each of them will be selected basing on the negative trends of technical efficiency scores and negative trends of productivity changes by means of Malmquist Index.

Table 3.6 Number of Key Informants Collected for the $4^{th}$ Research Objective

| **Insiders** | | **Outsiders** | | | | **Total key formants collected** |
|---|---|---|---|---|---|---|
| **Department of Airports (DOA)** | | **$1^{st}$ outsiders (airport users)** | | | **$2^{nd}$ outsiders** | |
| **Central unit** | **Regional units** | **airlines** | **passengers** | **ramp operators** | | |
| 1 | 3 | 7 | 22 | 1 | 2 | 36 |

Once the airports were chosen, the qualitative approach was designed to answer the last research objective of the study. To collect the data for formulating the local and regional airport business models and triangulate the data before analyzing, key informants from different groups were considered (Harding, 2019). According to Table 3.6, the semi-structured questionnaire (see Appendix A) was distributed to triple groups of key informants. The insider group consisted of the key informants who working in the management positions in the Department of Airports (DOA) both from central and regional units while the $1^{st}$ outsiders were gained from the key informants using services in the local and regional airports that were passengers, airlines and ramp operator company. Lastly, the aviation scholars were interviewed as the $2^{nd}$ group of outsiders in order for providing the insightful information for business modelling.

To design local and regional airport business models from each strategic group and propose business model innovations, the theoretical frameworks were laid on the roots of Industrial Organization (the structure-conduct-performance paradigm), Theory of Efficiency and the business model conceptualizations following Zott and Amit (2008), Osterwalder and Pigneur (2010) and Afuah (2019) since they believed in the effect of business modelling on a firm performance which their details were comprehensively reviewed in the previous chapter. To implement the study into practices, each model was proposed to the groups of airport expert panels or users in the industry in order to verify the models for gaining insightful comments; moreover, the model verification allowed the triangulation method which was necessary for data reliability.

After designing the airport business models for each strategic group, the business model innovations which were the novel ways to improve airport business models of local and regional airports in Thailand were proposed to enhance airport revenues, develop airport key activities, link the strategic partnership among airport stakeholders and ultimately improve airport technical efficiency.

The business model innovations were proposed basing on the innovation development process. By integrating results from situation analysis together with airport technical efficiency determinants both from quantitative and qualitative analysis and comparing the innovation gap analysis between the best airports and the present business model of local and regional airport in Thailand, the novel approach to improve conventional business model were presented.

To summarize the overall pictures relating to research methodology design, Table 3.8 and 3.9 provided the informative sources for all research objectives. The tables included theoretical frameworks used to frame the research methods, unit of analysis and keys informant, data collection, period of data, employed research approach, data analysis, techniques and outputs gained from each research objective.

## 3.5 Research Conceptual Framework

In addition, Figure 3.6 presented the research conceptual framework which illustrating research design for every research objective for this study. It was the result from the literature review from the chapter 2. It presented research methodology, variables used in the models, data analysis techniques in the framework.

Table 3.7 Summary of Research Method Designing

| | Research objectives | Inputs | | | |
|---|---|---|---|---|---|
| | | **Theoretical Frameworks** | **Unit of Analysis / Key informants** | **Data collection** | **Period of data** |
| RO 1 | - To analyze the situation of local and regional airports in Thailand | - Industrial Organization (Bain, 1959; Mason, 1939, 1949) | 6 expert panels plus 1 author opinion | Secondary and primary data collection from semi- structured questionnaire | 2019-2020 |
| | - To analyze the efficiency of local and regional airports in Thailand | - Theory of Efficiency (Farrell, 1957) | 34 commercial airports in Thailand | - DOA<br>- AOT | 2009-2018 (Time-series data) |
| RO 2 | - To analyze the factors affecting airport technical efficiency | - Industrial Organization (Bain, 1959; Mason, 1939, 1949) | 34 commercial airports in Thailand | - DOA<br>- AOT | 2014-2018 (Longitudinal data) |
| RO 3 | To investigate the airport business model analytical frameworks in order to make analytical comparison for local and regional airports in Thailand | - Industrial Organization (Bain, 1959; Mason, 1939, 1949)<br>- Theory of Efficiency (Farrell, 1957) | 9 expert panels including managements from DOA, AOT, PG and airport scholars | In-depth interviews with semi-structured questions | 2019-2020 |
| RO 4 | To design and propose the business model innovations for Thailand local and regional airports suitable for certain contexts | - Industrial Organization (Bain, 1959; Mason, 1939, 1949)<br>- Theory of Efficiency (Farrell, 1957) | 36 key expert panels including DOA managements, passengers, airline, ramp operators and airport scholars | In-depth interviews with semi- structured questionnaire | 2019-2020 |

Table 3.8 Summary of Outputs Derived from Each Research Objective

| | **Research objectives** | **Research Methodology** | **Data analysis techniques** | **Outputs** |
|---|---|---|---|---|
| RO 1 | - To analyze the situation of local and regional airports in Thailand | - Quantitative Analysis<br>- Unit of Analysis: 6 expert panels plus an author judgement | PESTEL-AHP Analysis | The situation of regional airports in Thailand |
| | - To analyze the efficiency of local and regional airports in Thailand | - Quantitative Analysis<br>- Unit of Analysis: 34 commercial airports in Thailand including 28 regional airports (DOA) and 6 privatized airports (AOT) in Thailand | Malmquist-Data Envelopment Analysis (DEA) | The efficiency scores for categorizing strategic groups |
| RO 2 | - To analyze the factors affecting airport technical efficiency | - Quantitative Analysis<br>- Unit of Analysis: 34 commercial airports in Thailand including 28 regional airports (DOA) and 6 privatized airports (AOT) in Thailand | Panel Least Square Method | The factors that affecting airport technical efficiency |
| RO 3 | To investigate the airport business model analytical frameworks in order to make analytical comparison for local and regional airports in Thailand | - Documentary Research<br>- Qualitative Analysis<br>- Key informants: Expert panels from DOA, AOT, PG managements and airport scholars | - Content Analysis<br>- Comparative Analysis | Airport business model analytical frameworks |
| RO 4 | To design and propose the business model innovations for Thailand local and regional airports suitable for certain contexts | - Qualitative Analysis<br>- Key informants: Expert panels from DOA managements, airline managements, passengers, ramp operators and airport scholars | Content Analysis | Airport business models for each strategic group and proposed business model innovations for local and regional airports in Thailand |

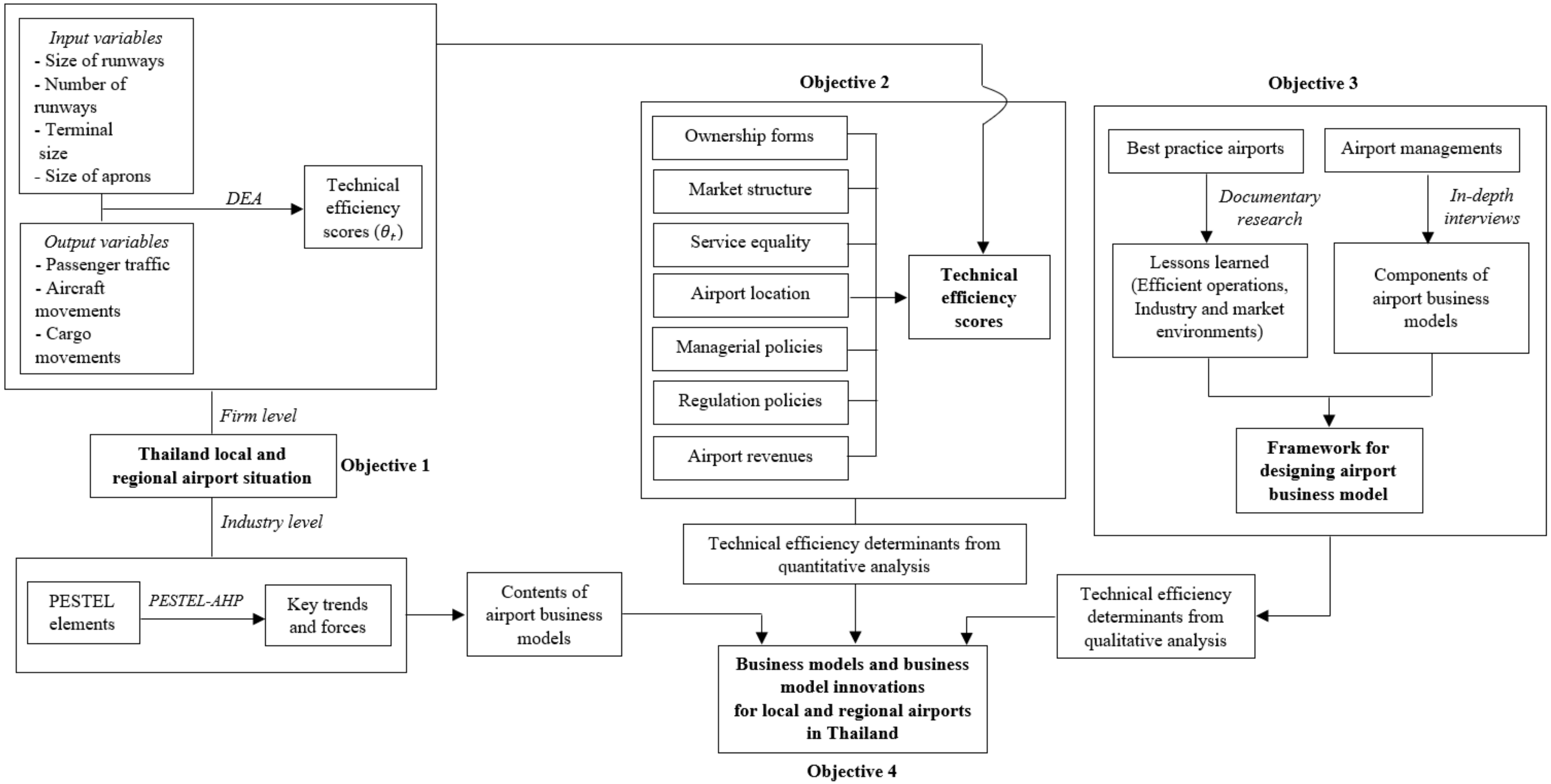



Figure 3.6 Research Conceptual Framework

## 3.6 Academic Integrity and Research Ethical Issues

Since the author has a strong belief that a quality dissertation deriving from a meticulousness on academic integrity and research ethics, plagiarism which referring to practices of stealing other ideas and studies without giving citations and acknowledging them as own's works, and the research ethical issues should cautiously be concerned at every step of research conducting. Due to the fact that the dissertation designs the research method that relevant to collect data from humans such as surveying by questionnaire or in-depth interview with stakeholders; the Belmont Report created by the National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, is applied. In particular, this dissertation is constructed basing on 3 principles:

1) The Respect of Person

This principle refers to the respect for human dignity which is the crucial rule for research in human. The basic guidelines under this rule are the respect for free and informed consent, respect for privacy, respect for confidentiality and respect for vulnerable persons. Therefore, the collected information in the forms of any records are required to ask for written permission from the dissertation participants. All the data are confidentially kept by the computer with password. Once the research is done and the outcomes are academically published, the records will be terminated.

2) The Beneficence

This rule provides benefits and harm assessment for the research participants. The information relating to either possible risk or minimal one, physical and psychological harm and other direct and indirect benefits for the participants and academia are informed with written notices; thus, the participant information sheet, presenting the research project details, is offered.

3) The Justice

The Justice rule offers some guidelines for research participant recruiting. The approach for acquiring the participants should be randomized, clear selecting criterions and not taking vulnerable groups for granted. It is because of avoiding the bias possibly occurred during the process of screening.

To officially manifest the research ethics, this dissertation is reviewed and certified an exemption on human research protection by the Ethics Committee in Human Research at National Institute of Development Administration (NIDA), Protocol ID No. ECNIDA 2019/0008. It is full complied with international guidelines of human research protection such as CIOMS Guidelines, the Declaration of Helsinki and the Belmont Report.

# CHAPTER 4

# SITUATION AND TECHNICAL EFFICIENCY OF THAILAND LOCAL AND REGIONAL AIRPORTS

To answer the first research objective, this chapter uncovers the results from the situation and industry analysis and shows to what extent the regional airport efficiency in Thailand is. The scores computed from the efficiency measurement will signify the strategic groups which being a key of identifying the unit of analysis selected for business model designing. Ultimately, the outputs both from situation analysis and efficiency measurement will be a partial source in order for conducting the airport business models.

## 4.1 The PESTEL Analysis under the Structure-conduct-performance Paradigm

To illustrate the situation of local and regional airport in Thailand, the analysis lays on the adoption of PESTEL under the Structure-conduct-performance framework (Figure 4.1). Each element of PESTEL is drawn and described the interactions among structure, conduct and performance of the local and regional airports in order to reflect the overall situation of the industry. The National Strategy (2018-2037) initiated by the recent Thailand Prime Minister, General Prayut Chan-o-cha, is considered as the political factor (P) affecting the structure of the industry. The New S Curve Policy drawn from Thailand Industry Development Strategy (2017-2036) is the economic factor (E) while the Second-tier City Tourism Policy is selected to represent the sociocultural factor (S). The trend toward digital airport is considered as the technological factor (T) and the climate change according to the study from International Civil Aviation Organization (ICAO) is regarded as environmental factor

(E). Lastly, the revision of Air Navigation Act BE 2562 is chosen to reflect the legal and legislation factor (L). The industry analysis of the following factors are as follows:

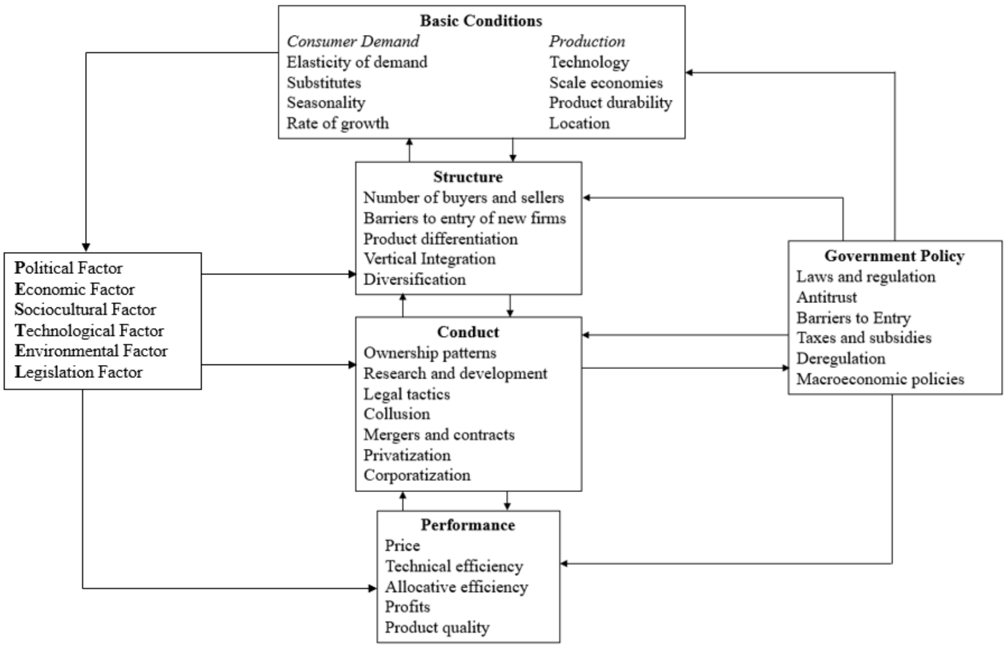



Figure 4.1 Situation Analysis Basing on PESTEL under the Structure-conduct-performance Paradigm

Note: Adapted form Carlton and Perloff (2015).

**4.1.1 Political Factor (P)**

As mentioned, the National Strategy (2018-2037) is the political factor influencing on the regional airport performance due to the fact that the National Strategy's vision - Thailand to become a developed country with security, prosperity and sustainability in accordance with Sufficiency Economy Philosophy - not only shapes the government policies (Figure 4.2) but it frames every aspect of national developments, planning and also air transport infrastructure. Under the National Strategy (2018-2037), it aims to achieve 6 strategic goals which are

1) well-being of Thai society

2) national competitiveness, economic growth and income distribution


Figure 4.2 The National Strategy (2018-2037)

Source: Office of the National Economic and Social Development Council (2018).

3) human capital development

4) social equality and equity

5) sustainability of national biodiversity, environmental quality and natural resources

6) government efficiency and better access to public services

To achieve the goals especially the competitiveness of the nation, 2 of 23 master plans are written. According to Figure 4.3, those 2 plans that relevant to airport industry are the 4$^{th}$ Master Plan for Future Industry and Services and the 7$^{th}$ Master Plan for Basic Infrastructure, Logistic System and Digital.

Due to the global growth of technology and innovation advancement, the 4$^{th}$ Master Plan for Future Industry and Services and the 7$^{th}$ Master Plan for Basic Infrastructure, Logistic System and Digital are prepared to serve the national development. By engaging those two master plans with the 12$^{th}$ National Economic and Social Development Plan (2017-2021), they pursuit to further develop the aviation industry which include airlines, airports, MRO (Maintenance Repair and

Overhaul) sector and other basic infrastructures that supporting the logistic system in the country.

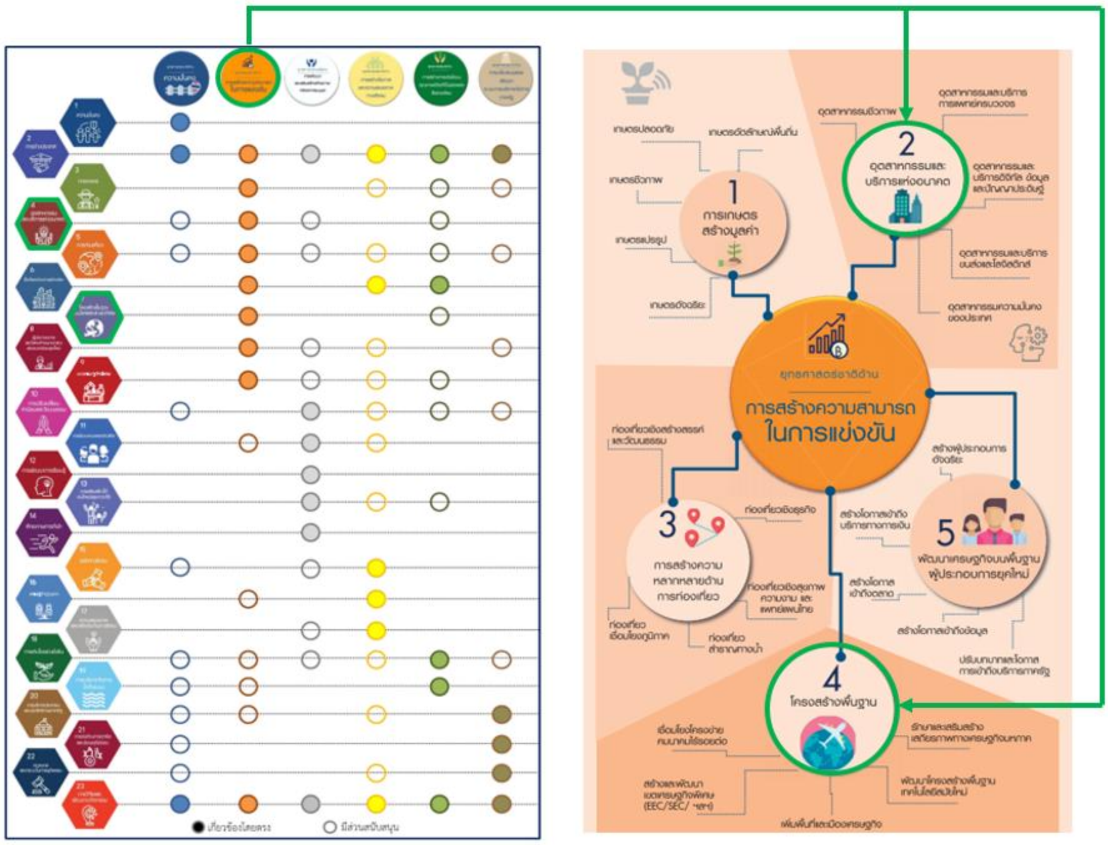



Figure 4.3 The Relationship between The National Strategy and Airport Industry

Note: Adapted from Office of the National Economic and Social Development Council (2018).

Moreover, the plans intend to increase and fully utilize the capacity of airport system and improve the management and technical efficiency of the system as whole in order for ensuring the service quality of passenger and product transportation in accordance with international standards. In addtition, the plans focus on preparing the basic infrastructure to support the potential demand for air transport to avoid the traffic delays and facilitate all stakeholders in the indsutry. Ultimately, the competitivenss of the nation according to the National Strategy is increased.

In summary, the National Strategy (2018-2037) has an impact on the local and regional airports under control of the Department of Airports (DOA) due to the fact that the National Strategy influences the government transport policies which affecting the performance of local and regional airports as explained by the strucure-conduct-performance paradigm.

### 4.1.2 Economic Factors (E)

The New S-curve Policy according to the Thailand 4.0 Industry Development Strategy Plan (2017-2036) has an impact on the structure of the airport industry since the plan shape the guidelines for the industry development which playing an important role as a new engine of growth and economic development mechanism in the country. The new S-curve industry refers to the industry that using an intensive technology and innovation and potentially have high growth rates in the future (Figure 4.4). It includes robotics industry, biofuels and biochemicals industry, digital industry, medical industry and aviation and logistics industry.

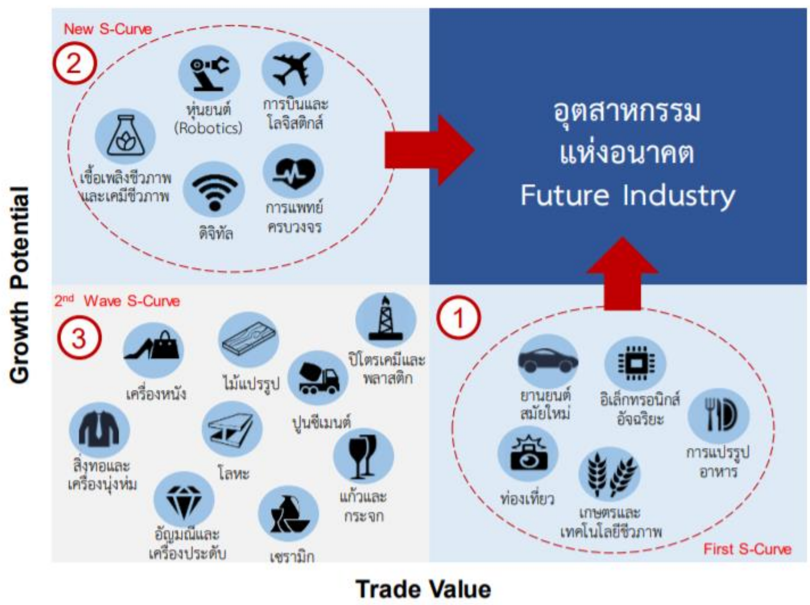



Figure 4.4 The New S-curve Policy
Source: Ministry of Industry (2017a).

The aviation and logistics following The New S-curve Policy prepares the infrastructure servicing for transportation, aircraft maintenance, repair and overhaul (MRO), time sensitive product, drones, software and aviation-relating institutions. With the new S-curve policy frameworks, it allows plenty of integrations among various sectors in the industry to pursuit the concepts of the Aeropolis or the airport city. Consequently, they affect the market structure and performance of local and regional airport system.

In summary, according to the structure-conduct and performance paradigm, It has an effect on the macroeconomic policies which impacting the structure of the industry due to the integration in various dimensions such as vertical, horizontal or even the helix collaboration among various sectors in the aviation industry which finally have an impact on the performance of the local and regional airports operated by the Department of Airports.

#### 4.1.3 Sociocultural Factors (S)

With the intentions of equal income distribution in the suburban areas, local economy stimulation and congestion decrement in main tourism cities, the Second-tier City Tourism Policy has been implemented since 2016. Referring to TAT Interlligence Center (2018), the second-tier city is defined as a province that having visiting tourists lesser than 4 million per year. From the aforementioned criterions, 55 provinces are considered as the second-tier tourism city. (Table 4.1). The biggest areas of second-tier cities are located in the north eastern part and northern of Thailand (18 and 16 provinces) while the smallest areas are assigned to the eastern part cities.

Table 4.1 Second-tier Cities According to Tourism Authority of Thailand Criterion

| Regions | Second-tier provinces | Total |
|---|---|---|
| Northern part | Lampang, Chiang Rai, Lamphun, Mae Hong Son, Nan, Phayao, Uttrradit, Phrae, Kamphaeng Phet, Phichit, Nakhon Sawan, Tak, Phitsanulok, Phetchabun, Uthai Thani, Sukhothai | 16 |

| Regions | Second-tier provinces | Total |
|---|---|---|
| Central part | Chai Nat, Lopburi, Samut Songkhram, Sing Buri, Supphan Buri, Ang Thong, Ratchaburi | 7 |
| North Eastern part | Kalasin, Chaiyaphum, Nakhon Phanom, Bueng Kan, Buriram, Maha Sarakham, Mukdahan, Yasothon, Roiet, Loei, Ubon Ratchathani, Sakon Nakhon, Sisaket, Surin, Nong Khai, Nong Bua Lamphu, Amnat Charoen | 18 |
| Eastern part | Sa Kaeo, Chanthaburi, Trat, Prachinburi, Nakhon Nayok | 5 |
| Southern part | Chumphon, Trang, Nakhon Si Thammarat, Narathiwat, Pattani, Phatthalung, Yala, Ranong, Satun | 9 |
| **Total** | | **55** |

Note: Adapted from TAT Interlligence Center (2018).

Such a tourism policy attempts to transfer tourist from the main tourism cities to second-tier tourism provinces by providing attractive tax deduction packages. Therefore, mega projects linking between those destinations are invested to facilitate tourist accessibility. Therefore, the Second-tier City Tourism Policy has an effect on demand for traveling which later on it may have an impact on demand for air transport. As Thailand regional airports are the part of tourism supply chain (Figure 4.5), the Second-tier City Tourism Policy certainly has an impact on their performance since the policy possibly stimulates the demand for air transport and tourism in the mentioned provinces.

However, there are some other factors that affecting the local and regional airport industry. The lifestyle of tourists that preferring the convenience and time-oriented and also the urbanization can play a part as a driver for demand for air transportation. Hence, they positively impact the overall industry.

According to the structure-conduct-performance paradigm, changes in macroeconomic policies which reflecting from the Second-tier City Tourism Policy together has an impact on demand for traveling which later on possibly stimulating demand for air transport respectively. subsequently, it influences the structure, conduct and performance of local and regional airports under control of the Department of Airports (DOA) eventually.

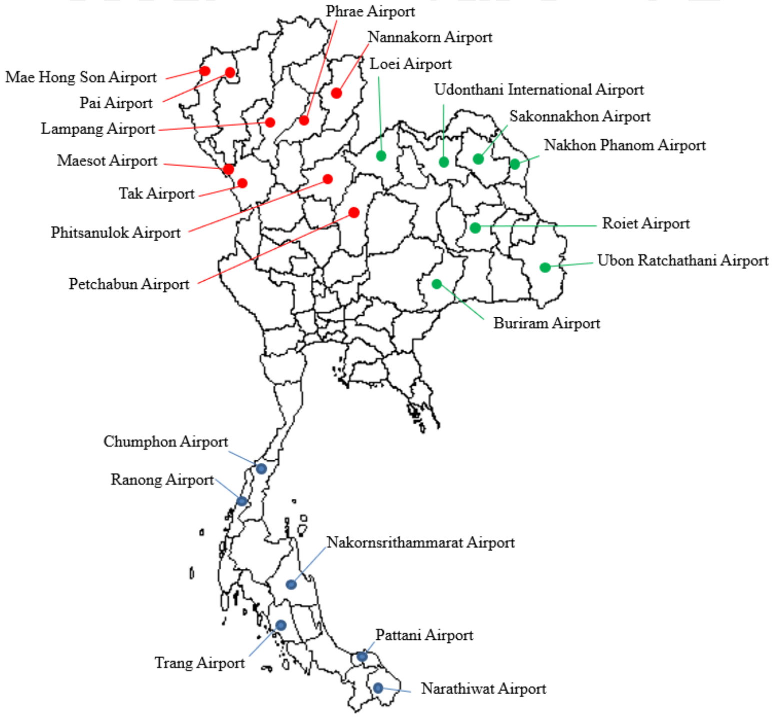



Figure 4.5 Local and Regional DOA Airports Serving Secondary-tier Provinces in Thailand

#### 4.1.4 Technological Factors (T)

Technological adaptation in an airport can be classified in two ways. Firstly, it can help airport operators reduces the cost of production once the technology is replaced in some job functions such as using lesser manpower in the security process and so on. Not only improving the process time of safety and security, the technology can also develop the overall operational efficiency of an airport. Hence, it effects on passengers' satisfaction.

Besides, airport technology is playing a part on creating passengers' experiences as some passengers tends to spend more times on airports and regards them as a destination (Bogicevic, Bujisic, Bilgihan, Yang, & Cobanoglu, 2017). Since the digital transformation is about using technologies in the process of automation, customer comfort facilitation and airport client experience increment (Airport Council International, 2017b; Zaharia & Pietreanu, 2018), this technological factor inevitably has an impact on demand for air transport and tourism as it influences passenger and airline satisfaction. According to Bogicevic et al. (2017), the technologies in an airport can be clustered into the self-service technology and the supporting technologies.

The self-service technology includes check-in kiosks, touch screen information kiosks and self-service baggage dropping while the supporting technologies in an airport consist of a business center, a tour guide application and USB chargers. In addition, Airport Council International (2017b) presents the airport technological features and trend toward becoming the digital airport (Figure 4.6) that beyond Bogicevic et al. (2017) classification. It suggested that airport operators provide basic technology infrastructure starting from IT security, WIFI to the advance components like digitalized touch points or biometric. It is because they are able to be the digital airports that are ready to create user experiences.

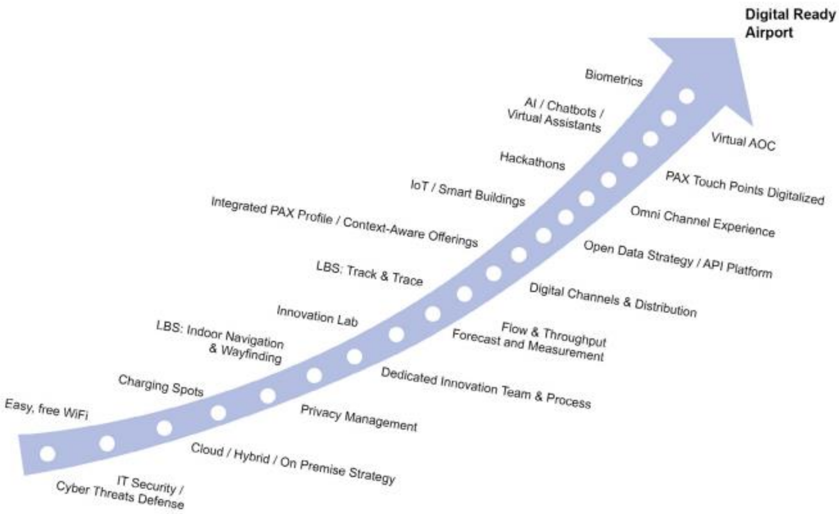



Figure 4.6 Pathways for Digital Airport Transformation
Source: Airport Council International (2017b).

In conclusion, the technological factor affects the basic conditions according to Structure-conduct and Performance Approach. Demand for tourism and air transport and production are impacted by technologies given in the airport. Hence, this factor showing the relationship among structure, conduct and performance of airports.

### 4.1.5 Environmental Factors (E)

Although it is quite sound scientific when talking about impacts of environmental factor like climate changes on every airport performance, it is clear and unable to avoid such impact on airport operations. As suggested by many research from international airport-relating organizations, Baglin (2012), Puempel and Williams (2016) and International Air Transport Association (2019), they explained the risks possibly happening from climate changes on airports. Their works indicated that airports are facing the risks from physical risks, business risks, security risks and financial risks. The physical risks refer to the damage from natural devastations such as storm surges, runway and taxiway flooding, wind pattern shifting and sea level rising (Figure 4.7). The business risks mean the flight disruption and delays, route network changes, legal compliance, supply of utilities, loss of airport capacity, and airport closures while the security risks are regarded as threatening to life and safety. Lastly, the climate change can cause an unplanned expenditure and decease demand for air transport and tourism.

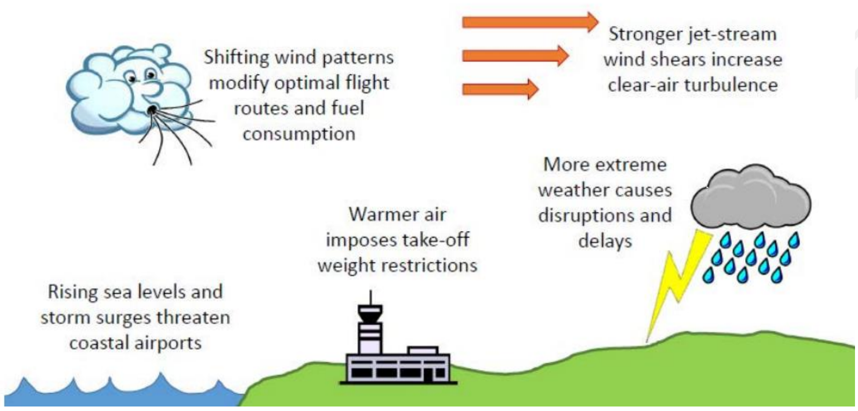



Figure 4.7 Impact of Climate Change on Airport Performance

Source: Puempel and Williams (2016).

In summary, the environmental factor can play a part on airport performance either positively or negatively. Referring to Structure-conduct and Performance Approach, the climate change factor influences the consumer demand for tourism and air transportation; thus, it effects on the numbers of sellers (market structure) and local and regional airport operations eventually (conduct).

### 4.1.6 Legal and Legislation Factors (L)

The revision of Air Navigation Act BE (No.14) 2562 and Ministerial Regulation on the Department of Airports Division BE 2558 issued by the Ministry of Transport seems to be the most crucial factor for Thailand local and regional airport operations since it legally indicated the Department of Airports' mission. Samples of such obligations include how it finance their operations, sources of working capital, department spending on airport investment, regional airport network development, airport business administration and so on.

In essence to the structure-conduct-performance paradigm, the legal and legislation factor has impacts on aviation-relating laws and regulations and macroeconomics policies. Consequently, any policies launched from the department must be complied to the Air Navigation Act BE 2562 (No.14); ultimately, it affects the performance of the regional airports.

## 4.2 The PESTEL-AHP Analysis

To specifically illustrate the overall situation of regional airports under the Department of Airports (DOA) in quantitative way, the Analytical Hierarchy Process (AHP) is constructed to reconfirm the factors and prioritize the virtual effects. By collecting the primary data using the scoring approach in the semi-structured questionnaire form (see Appendix A) through the in-depth interviews from 6 expert panels plus the author judgement. The weightings of factor importance according to Saaty (1990)'s scale are performed by the Department of Airports (DOA) managements, the aviation scholars and author judgement to apply the pairwise comparison among PESTEL elements. Table 4.2 reflects their opinions toward the situation of regional airports under control of the Department of Airports (DOA).

Table 4.2 Level of Factor Importance Scoring from Expert Panels

| Expert NO. | Scorer groups | Level of factor importance | | | | | |
|---|---|---|---|---|---|---|---|
| | | **P** | **E** | **S** | **T** | **E** | **L** |
| 1 | Aviation Scholar | 9 | 4 | 5 | 7 | 4 | 9 |
| 2 | | 7 | 1 | 5 | 8 | 5 | 5 |
| 3 | Department of Airports Managements | 7 | 5 | 4 | 9 | 5 | 8 |
| 4 | | 8 | 2 | 4 | 2 | 5 | 9 |
| 5 | | 8 | 5 | 7 | 9 | 6 | 9 |
| 6 | | 9 | 9 | 9 | 6 | 7 | 8 |
| 7 | Author | 9 | 5 | 5 | 8 | 8 | 9 |

According to the expert panel ideas from Table 4.3 and Figure 4.8, the revision of Air Navigation Act BE 2562 (No.14) plays the most crucial part on local and regional airport environment. By normalizing each PESTEL element by AHP prioritization, the revision of Air Navigation Act BE 2562 (L) effects the regional airport performance 27.5% (see Appendix B for AHP construction). While the National Strategy (2018-2037) and the trend toward airport digitalization are estimated to have an impact on regional airport industry 22.08% and 20.58% respectively. The logic behind these numbers is because the law orientation of DOA. Since the Department of Airports is the government agency, it is governed and directed the missions by the national legislations. The Air Navigation Act BE 2562 indicates the airport business obligations. It also implies the managerial limitations for DOA. The revision of the Air Navigation Act BE 2562 (No.14) provides the financial flexibility to the department since it allows the establishment of the DOA Working Capital Fund (DOA-WCF) which encouraging and facilitating the administrations among 28 regional airports. Still, the DOA Working Capital Fund provides the options for the department to generate its own revenues. It is because DOA is legally authorized not to deliver the partial incomes incurred from 28 regional airports to the Ministry of Finance and the Treasury Department.

Table 4.3 Normalized Average Values of PESTEL Elements

| **PESTEL Analysis** | **P** | **E** | **S** | **T** | **E** | **L** | **Summation** | **Weighted Scores** | **Ranking** |
|---|---|---|---|---|---|---|---|---|---|
| P | 0.07850 | 0.14866 | 0.19616 | 0.26740 | 0.22681 | 0.40749 | 1.32502 | 0.22084 | 2 |
| E | 0.12728 | 0.03357 | 0.10779 | 0.15820 | 0.09465 | 0.00906 | 0.53055 | 0.08842 | 6 |
| S | 0.16869 | 0.16904 | 0.04015 | 0.07378 | 0.12772 | 0.13742 | 0.71681 | 0.11947 | 4 |
| T | 0.21374 | 0.21648 | 0.23899 | 0.05995 | 0.18793 | 0.31747 | 1.23455 | 0.20576 | 3 |
| E | 0.01440 | 0.15893 | 0.13513 | 0.13717 | 0.03969 | 0.05767 | 0.54300 | 0.09050 | 5 |
| L | 0.39739 | 0.27333 | 0.28177 | 0.30349 | 0.32320 | 0.07089 | 1.65008 | 0.27501 | 1 |
| **Summation** | **1.00000** | **1.00000** | **1.00000** | **1.00000** | **1.00000** | **1.00000** | **6.00000** | **1.00000** | |

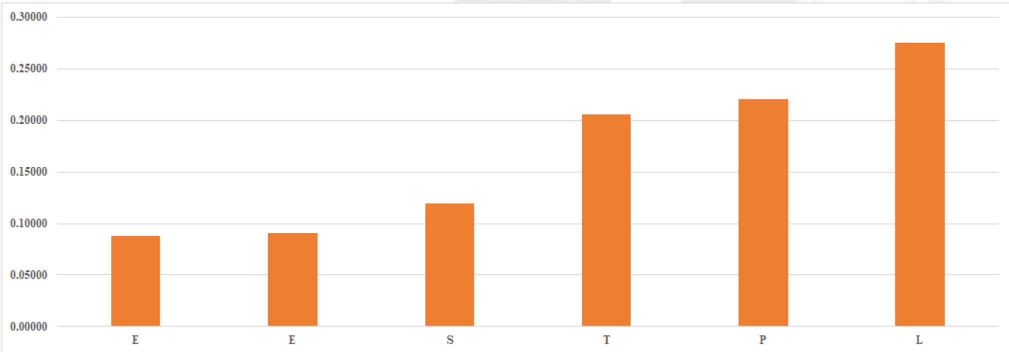



Figure 4.8 PESTEL Element Ranking

For the National Strategy (2018-2037), it is the second element of PESTEL Analysis that playing another part on regional airport situation. Regarding the expert team's opinions, this element affects 22.08% on the regional airports under control of DOA. The reasons behind these considerations shares the common themes as the revision of Air Navigation Act BE 2562. In other words, DOA is one of the government agencies; thus, it is required to follow the policy directly derived from the present prime minister and the cabinet. Since some parts of the National Strategy (2018-2037) focuses on the competitiveness of the country as details said in the previous section, it is strongly impacting on the local and regional airport environments.

The trends toward airport digitalization are considered to influence regional airport industry. Basing on the opinions of the experts, this PESTEL element can affect both demand and supply side of the industry. The digitalization in an airport can decrease the cost of operations, improve comfortability among staff and enhance the accuracy of safety and security which all considering as the supply side. While creating passengers' experiences, conveniences and airline facilities is viewed as the demand side deriving from digitalized airports.

For the effects of the Second-tier City Tourism Policy on local and regional airport industry, they are approximately weighted as 11.95%. There are some contradictions of rationale given by the expert opinions, some experts said that statistics on some local and regional airports recorded insignificant increment of passenger traffic after the policy implementation while some airports do have significance. It is because the main groups of passengers using some local and regional airports are business travelers; the tourism policy then do not have an impact on this groups of passengers. Consequently, the scores computed for this PESTEL element is ranked in $4^{th}$.

The climate changes are another factor influencing the local and regional airport industry. However, as the patterns of climate changes in the country are quite common and not extreme; therefore, the rating scale for this element is ranked as the $5^{th}$. Most of the circumstances relating to climate changes are in the forms of airport flooding, PM 2.5, forest fires and weather conditions which can cause flight delays and cancellations. This factor may have an effect on tourism demand which ultimately influencing the local and regional airport revenues.

The New S-curve Policy and Eastern Economic Corridor Development Project seems to have the least effect on overall local and regional airport situation. To quantify this economic policy on local and regional airports under DOA, only 8.84% is scored from the expert panels. There are two main reasons behind these decisions. Firstly, the content in Thailand 4.0 Industry Development Strategy (BE 2560-2579) by Ministry of Industry (2017b) is lack of the policy directions to DOA. Although it focuses on the aviation and aeronautic development, there is not much information for guiding DOA the objective key results. Secondly, the location of 28 local and regional airports are not in the area of the Eastern Economic Corridor Development Project; hence, it may cause indirect impact to the situation of local and regional airports instead.

## 4.3 Technical Efficiency of Thailand Local and Regional Airports

The technical efficiency (TE) of Thailand local and regional airports operated by the Department of Airports (DOA) is calculated by the DEAP 2.1 developed by Professor Tim Coelli. The results of technical efficiency scores and the efficiency changing over time during 2009-2018 fiscal years computed by the Malmquist Index are presented in Table 4.4 and Table 4.5 respectively. According to Table 4.4, the overall technical efficiency of Thailand local and regional airports during the past 10 fiscal years are averagely 0.188 where considering number of runways, runway size, apron size, passenger terminal size and number of parking lots as an input variable. The top three local and regional airports which achieving the highest technical efficiency scores are Pai Airport (PYY), Nakorn Sri Thammarat Airport (NST) and Trang Airport (TST) with the average scores 1, 0.775 and 0.325 respectively.

Although most of the technical efficiency scores of DOA airports showing a positive trend (Figure 4.9), the score reflects relative inefficiency of local and regional airport operations comparing to the privatized airports managed by Airports of Thailand (AOT) gaining an average mean of technical efficiency scores equal to 0.791 which Suvarnabhumi Airport (BKK) and Phuket International Airport (HKT) are the best practice airports (see Appendix C for the additional results of AOT technical efficiency score output report). The fiscal year of 2015 is the period that all Thailand local and regional airports operated best showing the average technical efficiency score was 0.237 while 2010 fiscal year was the worst with the technical efficiency score of 0.117.

As mentioned above, the local and regional best practice airport yielding the highest average mean of technical efficiency during fiscal year 2009-2018 is Pai Airport (PYY). It is possible this airport is among the smallest scale airport with total summation of input variables of 23,000 $m^2$ comparing to others local and regional airports in Thailand. Although this airport provides only 500 $m^2$ passenger terminal size, 1,800 $m^2$ apron size and 20,700 $m^2$ runway size, it continuously produces passenger and aircraft movements for the past ten years. On the contrary to Udonthani International Airport (UTH), the summation of all input variables is 235,200 $m^2$ where considered as the biggest local and regional airport under control of DOA. Its technical efficiency score is averagely 0.277 when it is able to operate at its best on 2015 (TE = 0.362). While Krabi International Airport (KBV), the second largest local and regional airport in terms of the summation of all input variables (234,505 $m^2$), averagely has the technical efficiency score 0.28 when it is able to operate at its best on 2015 (TE = 0.453).

For the worst practice local and regional airports, they are the group of smallest DOA airports that is Mae Sariang Airport (MSR), Tak Airport (TKT) and Pattani Airport (PAN) which having input variable area only 15,300 $m^2$, 56,120 $m^2$ and 60,130 $m^2$. Conversely to Pai Airport, the technical efficiency scores of those three airports are equal to zero. The reasons behind this number are due to the fact that those airports are producing highly light traffic of passengers, flight and cargo movements; additionally, the outputs are unavailable due to the ceasing operations of schedule airlines on some sample periods.

To examine the productivity changes during the past ten fiscal years, Table 4.5 and Figure 4.10 provides such insightful information. According to the positive trend of technical efficiency among DOA local and regional airports, the mean of Malmquist Index indicates the positive change of productivity from most of regional airports during the past ten fiscal years except Petchabun Airport (PHY), Pai Airport

(PYY) and those DOA airports having zero technical efficiency scores. The top three local and regional airports that achieving the highest mean of productivity changes are Chumphon Airport (CJM), Loei Airport (LOE) and Nakhon Ratchasima Airport (NAK)

Due to the significant jumping growth of aircraft movements at Chumphon Airport (CJM) from 2009 to 2012, the traffic was enormously increased from only 4 flights with 20 passengers to 391 flights with 5,152 passengers. While Loei Airport (LOE) experienced an increase in flight and passenger movements from 10 and 28 to 516 and 15,409 in the same period as Chumphon Airport (CJM). For Nakhon Ratchasima Airport (NAK), the aircraft movements and passenger flows were doubled in 2012. Figure 4.10 is well illustrated the prior explanations.

For the negative productivity change of local and regional airport performance, there are only Petchabun Airport (PHY) and Pai Airport (PYY) in this case. Due to the variances of flight movements in Petchabun Airport (PHY), they have impacts on airport productivity change in the sample periods. For Pai Airport (PYY), although it is the best practice airport of the Department of Airports (DOA) as its technical efficiency score achieves 1, the growth of aircraft movements is quite limited. From 2009 onwards, the traffics within the airport gradually face the diminishing from 1,374 with 10,053 passengers to 230 flights with only 637 passengers in 2018. For Mae Sariang Airport (MSR), Tak Airport (TKT) and Pattani Airport (PAN) which having a zero value of technical efficiency, the Malmquist Index for in this case is unable to compute since it does not reflect any productivity changes during the ten years sample periods.

## 4.4 Thailand Local and Regional Airport Strategic Groups

After the computations of the technical efficiency scores, the means of all unit of analysis during the past ten fiscal years were gathered to calculate the mean that used for clustering Thailand local and regional airport strategic groups. The strategic groups are divided into 3 groups following to Lin 2006. According to Figure 4.11 since the mean of technical efficiency is equal to 0.29, then it constructs the Average Score Group, the Above Average Group and the Below Average Group

Table 4.4 Technical Efficiency (TE) Scores of Thailand Local and Regional Airports during 2009-2018 Fiscal Years

| **Local and regional Airports** | **Airport Code** | **Fiscal years** | | | | | | | | | | **Mean** | **Ranking by mean** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | | |
| Buriram Airport | BFV | 0.054 | 0.027 | 0.048 | 0.026 | 0.041 | 0.035 | 0.086 | 0.145 | 0.143 | 0.077 | 0.077 | 18 |
| Chumphon Airport | CJM | 0.002 | 0 | 0.04 | 0.038 | 0.148 | 0.141 | 0.118 | 0.093 | 0.085 | 0.076 | 0.076 | 19 |
| Mae Hong Son Airport | HGN | 0.223 | 0.19 | 0.181 | 0.242 | 0.284 | 0.198 | 0.124 | 0.111 | 0.103 | 0.172 | 0.172 | 10 |
| Huahin Airport | HHQ | 0.112 | 0.032 | 0.155 | 0.051 | 0.073 | 0.096 | 0.073 | 0.062 | 0.031 | 0.071 | 0.071 | 20 |
| Krabi International Airport | KBV | 0.195 | 0.178 | 0.167 | 0.18 | 0.209 | 0.339 | 0.453 | 0.39 | 0.363 | 0.280 | 0.28 | 6 |

| Local and regional Airports | Airport | Fiscal years | | | | | | | | | | Mean | Ranking by mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | | |
| Khon Kaen Airport | KKC | 0.164 | 0.129 | 0.135 | 0.135 | 0.126 | 0.175 | 0.271 | 0.276 | 0.284 | 0.195 | 0.195 | 9 |
| Nakhon Phanom Airport | KOP | 0.125 | 0.048 | 0.067 | 0.118 | 0.112 | 0.095 | 0.116 | 0.147 | 0.131 | 0.110 | 0.11 | 16 |
| Loei Airport | LOE | 0 | 0.002 | 0.103 | 0.078 | 0.096 | 0.127 | 0.236 | 0.253 | 0.257 | 0.136 | 0.136 | 13 |
| Lampang Airport | LPT | 0.146 | 0.105 | 0.128 | 0.117 | 0.109 | 0.15 | 0.25 | 0.256 | 0.225 | 0.169 | 0.169 | 11 |
| Maesot Airport | MAQ | 0.026 | 0.015 | 0.156 | 0.199 | 0.471 | 0.445 | 0.363 | 0.333 | 0.321 | 0.264 | 0.264 | 8 |
| Mae Sariang Airport | MSR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 |

| Local and regional Airports | Airport | Fiscal years | | | | | | | | | | Mean | Ranking by mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | | |
| Nakhon Ratchasima Airport | NAK | 0.001 | 0.007 | 0.022 | 0.011 | 0.004 | 0.003 | 0.008 | 0.004 | 0.003 | 0.007 | 0.007 | 23 |
| Narathiwat Airport | NAW | 0.098 | 0.111 | 0.092 | 0.067 | 0.054 | 0.053 | 0.085 | 0.105 | 0.102 | 0.084 | 0.084 | 22 |
| Nannakorn Airport | NNT | 0.045 | 0.082 | 0.136 | 0.154 | 0.128 | 0.104 | 0.182 | 0.191 | 0.143 | 0.130 | 0.13 | 14 |
| Nakorn Sri Thammarat Airport | NST | 0.285 | 0.292 | 0.897 | 1 | 1 | 1 | 1 | 0.879 | 0.755 | 0.775 | 0.775 | 2 |
| Pattani Airport | PAN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 |
| Phitsanulok Airport | PHS | 0.093 | 0.078 | 0.073 | 0.119 | 0.148 | 0.185 | 0.146 | 0.099 | 0.11 | 0.116 | 0.116 | 15 |

| Local and regional Airports | Airport | Fiscal years | | | | | | | | | | Mean | Ranking by mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | | |
| Petchabun Airport | PHY | 0 | 0 | 0.005 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0 | 0.001 | 0.001 | 24 |
| Phrae Airport | PRH | 0 | 0 | 0.047 | 0.092 | 0.093 | 0.102 | 0.131 | 0.173 | 0.201 | 0.102 | 0.102 | 17 |
| Pai Airport | PYY | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Roiet Airport | ROI | 0.082 | 0.005 | 0.067 | 0.121 | 0.15 | 0.093 | 0.209 | 0.222 | 0.22 | 0.138 | 0.138 | 12 |
| Sakonnakhon Airport | SNO | 0.102 | 0.039 | 0.068 | 0.082 | 0.069 | 0.052 | 0.176 | 0.12 | 0.119 | 0.093 | 0.093 | 18 |
| Tak Airport | TKT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 |
| Trang Airport | TST | 0.231 | 0.267 | 0.28 | 0.310 | 0.372 | 0.375 | 0.384 | 0.353 | 0.373 | 0.325 | 0.325 | 3 |
| Ubon Ratchathani International Airport | UBP | 0.269 | 0.212 | 0.278 | 0.285 | 0.251 | 0.3 | 0.369 | 0.366 | 0.342 | 0.299 | 0.299 | 4 |

| Local and regional Airports | Airport | Fiscal years | | | | | | | | | | Mean | Ranking by mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | | |
| Ranong Airport | UNN | 0.026 | 0.004 | 0.037 | 0.029 | 0.073 | 0.124 | 0.105 | 0.092 | 0.082 | 0.069 | 0.069 | 21 |
| Suratthani International Airport | URT | 0.195 | 0.227 | 0.219 | 0.241 | 0.283 | 0.318 | 0.385 | 0.352 | 0.357 | 0.289 | 0.289 | 5 |
| Udonthani International Airport | UTH | 0.241 | 0.239 | 0.237 | 0.28 | 0.27 | 0.293 | 0.362 | 0.274 | 0.296 | 0.277 | 0.277 | 7 |
| **Mean** | | **0.133** | **0.117** | **0.166** | **0.178** | **0.199** | **0.207** | **0.237** | **0.225** | **0.216** | **0.2** | **0.188** | **-** |

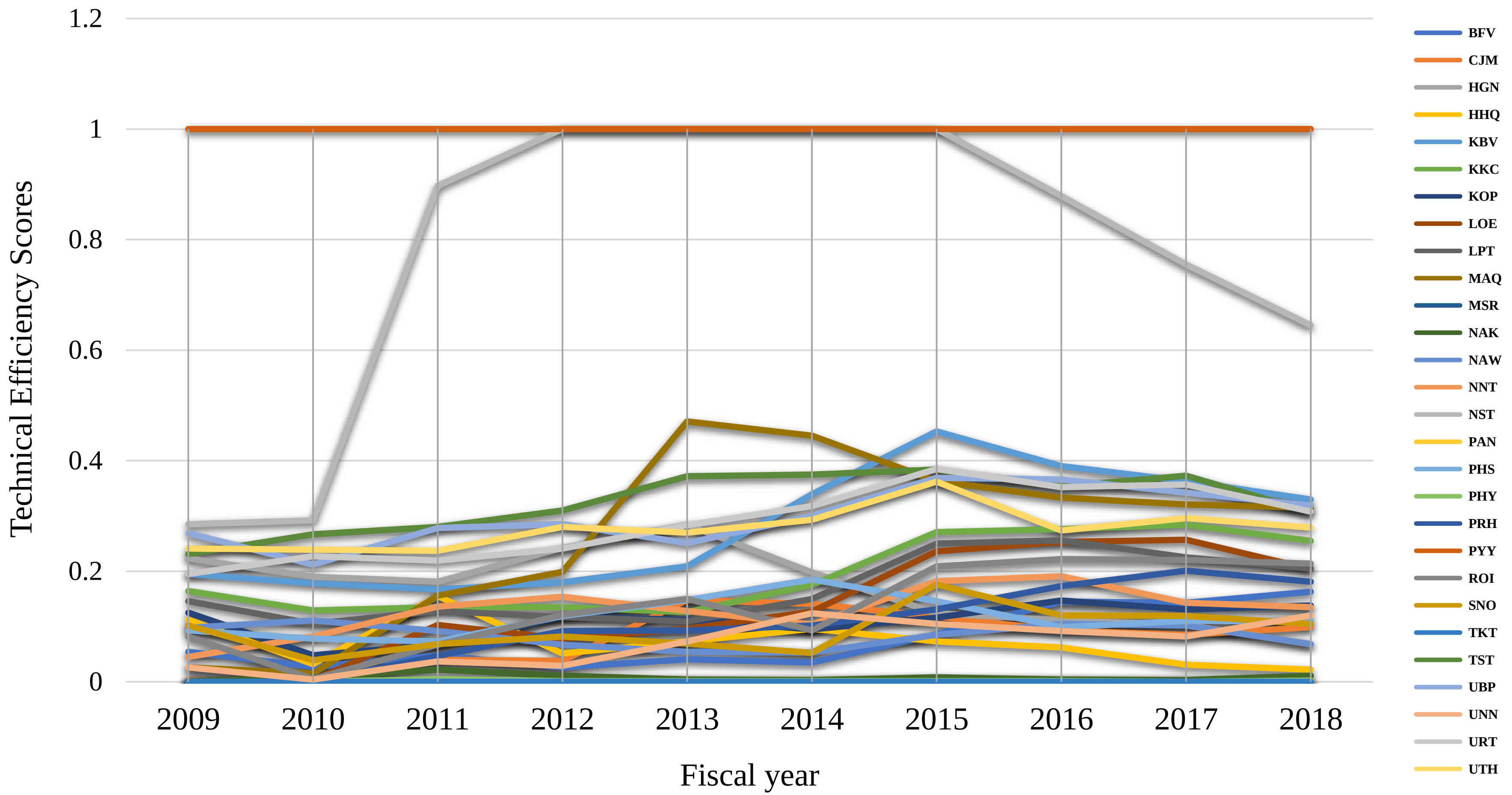



Figure 4.9 Efficiency Scores of Thailand Local and Regional Airports during 2009-2018 Fiscal Years

Table 4.5 Thailand Local and Regional Airport Productivity Changes during 2009-2018 Fiscal Years

| **Local and regional Airports** | **Airport Code** | **Fiscal years** | | | | | | | | | | **Mean** | **Ranking by mean** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | | |
| Buriram Airport | BFV | - | 0.625 | 2.033 | 0.637 | 1.735 | 0.939 | 2.591 | 1.944 | 1.091 | 1.267 | 1.429 | 7 |
| Chumphon Airport | CJM | - | 0.333 | 99.250 | 0.985 | 4.471 | 1.018 | 0.914 | 0.919 | 0.995 | 1.283 | 12.241 | 1 |
| Mae Hong Son Airport | HGN | - | 1.084 | 1.096 | 1.389 | 1.371 | 0.744 | 0.683 | 1.037 | 1.015 | 0.728 | 1.016 | 23 |
| Huahin Airport | HHQ | - | 0.361 | 5.449 | 0.332 | 1.643 | 1.409 | 0.825 | 0.986 | 0.542 | 0.775 | 1.369 | 10 |
| Krabi International Airport | KBV | - | 1.168 | 1.118 | 1.158 | 1.372 | 1.718 | 1.468 | 0.997 | 1.028 | 1.01 | 1.226 | 14 |
| Khon Kaen Airport | KKC | - | 1.043 | 1.115 | 1.161 | 1.088 | 1.587 | 1.698 | 1.182 | 1.133 | 0.993 | 1.222 | 15 |

| Local and regional Airports | Airport Code | Fiscal years | | | | | | | | | | Mean | Ranking by mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | | |
| Nakhon Phanom Airport | KOP | - | 0.491 | 1.615 | 2.071 | 1.067 | 0.916 | 1.329 | 1.468 | 0.981 | 1.171 | 1.234 | 13 |
| Loei Airport | LOE | - | 5 | 60.6 | 0.851 | 1.411 | 1.423 | 2.006 | 1.237 | 1.119 | 0.885 | 8.281 | 2 |
| Lampang Airport | LPT | - | 0.91 | 1.406 | 0.943 | 1.087 | 1.473 | 1.823 | 1.184 | 0.967 | 1.003 | 1.2 | 17 |
| Maesot Airport | MAQ | - | 0.708 | 11.683 | 1.537 | 2.546 | 1.057 | 0.843 | 1.057 | 1.062 | 1.091 | 2.398 | 6 |
| Mae Sariang Airport | MSR | - | * | * | * | * | * | * | * | * | * | * | * |
| Nakhon Ratchasima Airport | NAK | - | 13.333 | 3.525 | 0.56 | 0.443 | 0.743 | 2.846 | 0.601 | 0.809 | 4.097 | 2.995 | 3 |
| Narathiwat Airport | NAW | - | 1.431 | 0.959 | 0.8 | 0.955 | 1.042 | 1.727 | 1.424 | 1.078 | 0.737 | 1.128 | 22 |

| Local and regional Airports | Airport Code | Fiscal years | | | | | | | | | | Mean | Ranking by mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | | |
| Nannakorn Airport | NNT | - | 2.337 | 1.921 | 1.189 | 0.974 | 0.865 | 1.924 | 1.214 | 0.826 | 1.041 | 1.366 | 11 |
| Nakorn Sri Thammarat Airport | NST | - | 1.424 | 3.57 | 1.337 | 1.082 | 1.118 | 1.036 | 1.011 | 0.949 | 0.948 | 1.386 | 9 |
| Pattani Airport | PAN | - | * | * | * | * | * | * | * | * | * | * | * |
| Phitsanulok Airport | PHS | - | 1.066 | 1.117 | 1.725 | 1.462 | 1.332 | 0.864 | 0.786 | 1.222 | 1.094 | 1.185 | 19 |
| Petchabun Airport | PHY | - | * | * | 0.257 | 1 | 1.111 | 1.2 | 0.833 | * | * | 0.88 | 24 |
| Phrae Airport | PRH | - | * | * | 2.329 | 1.094 | 1.22 | 1.331 | 1.518 | 1.286 | 1.001 | 1.397 | 8 |
| Pai Airport | PYY | - | 1.195 | 0.763 | 0.539 | 0.867 | 1.243 | 0.883 | 1.195 | 0.812 | 0.271 | 0.863 | 25 |
| Roiet Airport | ROI | - | 0.081 | 14.579 | 2.171 | 1.334 | 0.69 | 2.358 | 1.225 | 1.095 | 1.078 | 2.735 | 4 |
| Sakonnakhon Airport | SNO | - | 0.482 | 2.033 | 1.318 | 0.988 | 0.799 | 3.723 | 0.789 | 1.092 | 0.979 | 1.356 | 12 |

| Local and regional Airports | Airport Code | Fiscal years | | | | | | | | | | Mean | Ranking by mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | | |
| Tak Airport | TKT | - | * | * | * | * | * | * | * | * | * | * | * |
| Trang Airport | TST | - | 1.453 | 1.194 | 1.222 | 1.402 | 1.073 | 1.124 | 1.063 | 1.166 | 0.922 | 1.18 | 20 |
| Ubon Ratchathani International Airport | UBP | - | 1.207 | 1.537 | 1.082 | 1.035 | 1.273 | 1.347 | 1.15 | 1.027 | 1.033 | 1.188 | 18 |
| Ranong Airport | UNN | - | 0.179 | 11.6 | 0.905 | 2.825 | 1.835 | 0.904 | 1.01 | 0.989 | 1.616 | 2.429 | 5 |
| Suratthani International Airport | URT | - | 1.586 | 1.139 | 1.165 | 1.382 | 1.198 | 1.329 | 1.059 | 1.116 | 0.955 | 1.214 | 16 |
| Udonthani International Airport | UTH | - | 1.268 | 1.179 | 1.264 | 1.134 | 1.155 | 1.357 | 0.879 | 1.19 | 1.046 | 1.164 | 21 |

Note: * Malmquist Index unavailability

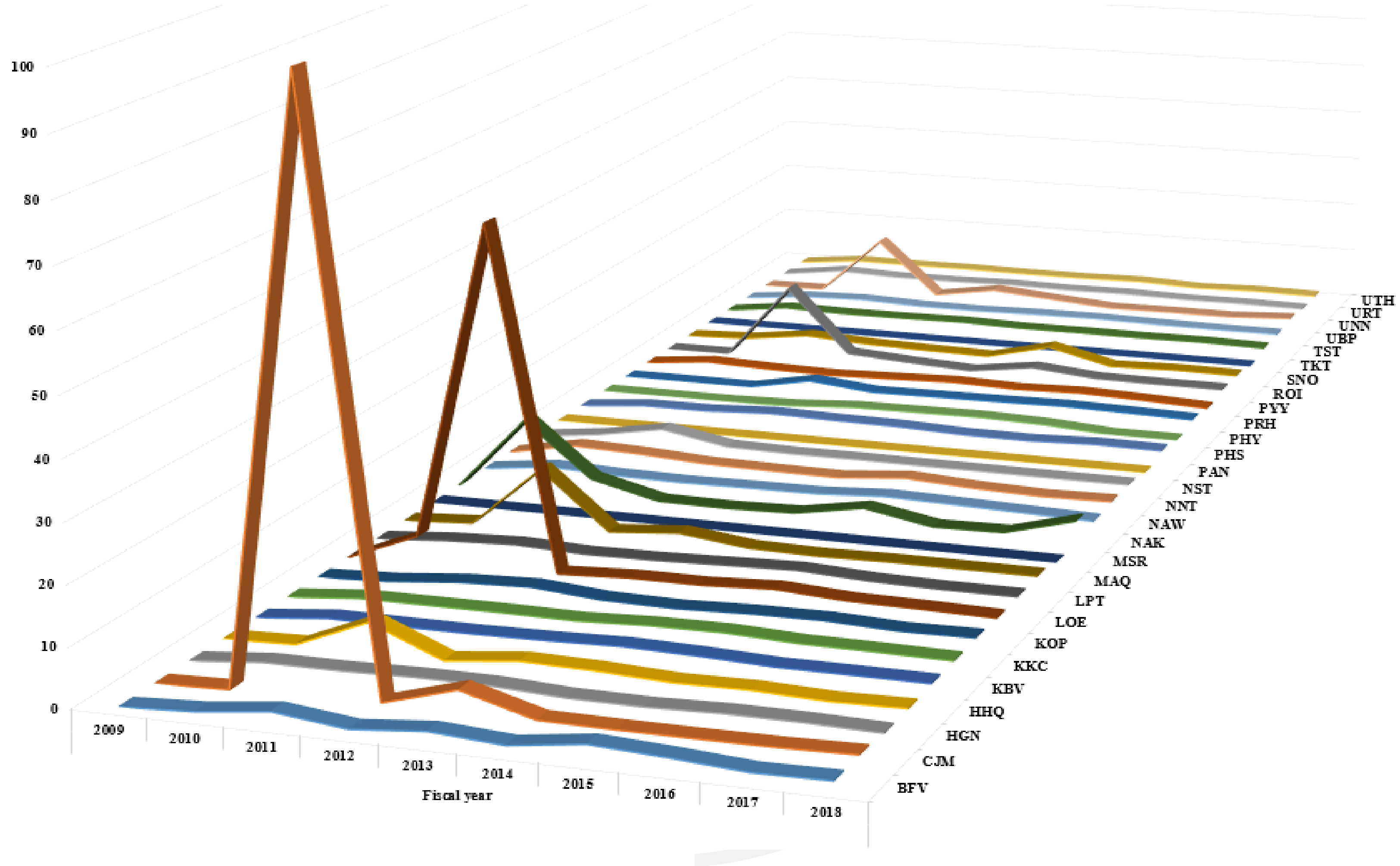



Figure 4.10 The Malmquist Efficiency Changing Index of Thailand Local and Regional Airport during 2009-2018 Fiscal Years

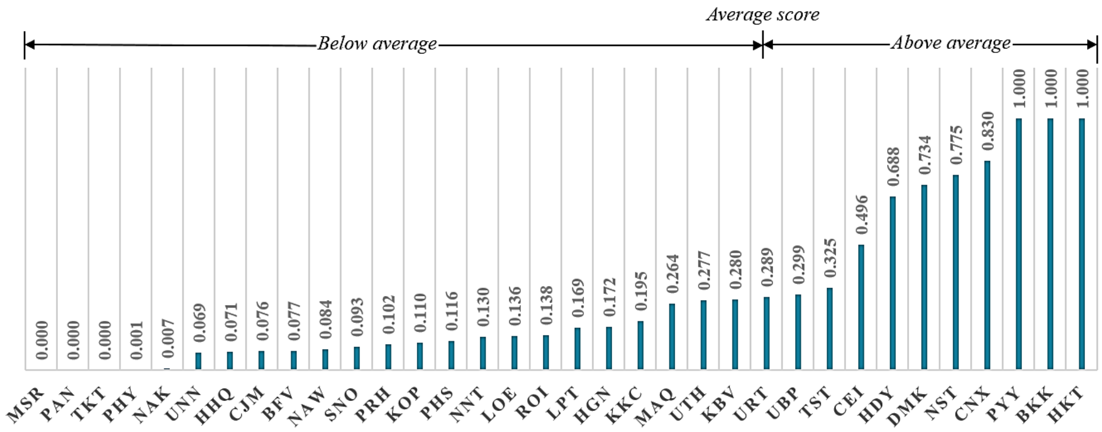



Figure 4.11 Strategic Group Classification Basing on Technical Efficiency Scores

There is only one airport in the Average Score Group that is Suratthani Airport (URT). Table 4.6 showing there are 4 local and regional airports in the Above-average Group that is Ubon Ratchathani International Airport (UBP), Trang Airport (TST) and Nakorn Sri Thammarat Airport (NST) while other 6 airports belong to Airport of Thailand (AOT) which are not included in the unit of analysis since the scope of the study primarily focuses on improving the local and regional airports under control of the Department of Airports (DOA). For the Below-average Group, there are 23 local and regional airports. The members of this group comprise Krabi International Airport (KBV), Udonthani International Airport (UTH), Maesot Airport (MAQ), Khon Kaen Airport (KKC), Mae Hong Son Airport (HGN), Lampang Airport (LPT), Roiet Airport (ROI), Loei Airport (LOE), Nannakorn Airport (NNT), Phitsanulok Airport (PHS), Nakorn Phanom Airport (KOP), Phrae Airport (PRH), Sakonnakhon Airport (SNO), Narathiwat Airport (NAW), Buriram Airport (BFV), Chumphon Airport (CJM), Huahin Airport (HHQ), Ranong Airport (UNN), Nakhon Ratchasima Airport (NAK), Petchabun Airport (PHY), Tak Airport (TKT), Pattani Airport (PAN) and Mae Sariang Airport (MSR).

Once the strategic groups are constructed, the regional airport in each group is selected due to the limitations of budget and time. According to Table 4.6, the study

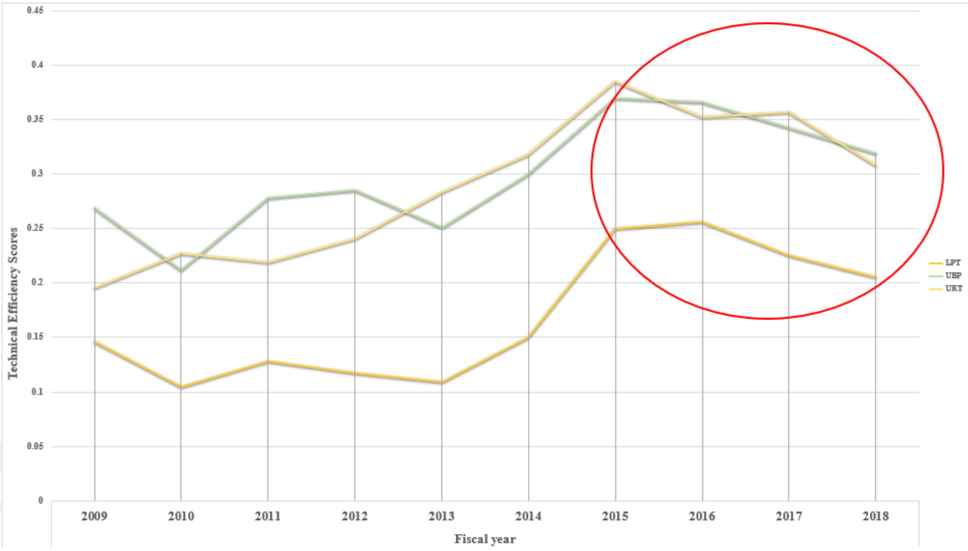



Figure 4.12 Negative Trends of Selected Local and Regional Airports' Technical Efficiency Scores

Table 4.6 Selected Local and Regional Airports for Airport Business Designs

| **Strategic local and regional airport groups** | **Local and regional airports** | **Number of local and regional airports in each group** | **Selected local and regional airport** |
|---|---|---|---|
| Above Average Group | UBP, TST, NST, PYY | 4 | UBP |
| Average Score Group | URT | 1 | URT |
| Below Average Group | MSR, PAN, TKT, PHY, NAK, UNN, HHQ, CJM, BFV, NAW, SNO, PRH, KOP, PHS, NNT, LOE, ROI, LPT, HGN, KKC, MAQ, UTH, KBV | 23 | LPT |
| **Total** | | **28** | **3** |

purposively selects Ubon Ratchathani International Airport (UBP) as the representative of local and regional airports in the Above-average Group. It is because Ubon Ratchathani Airport shows the variant and unstable trend of technical efficiency and productivity changing over time (Figure 4.12); thus, it is gathered as the unit of analysis since the ultimate dissertation research objective is to improve airport technical efficiency. Lampang Airport (LPT) is also chosen as the representative of the Below-average Group due to the negative trend of both technical efficiency and Malmquist index. It is included in the unit of analysis in order for proposing the regional airport business model. Since Suratthani International Airport (URT) is the only local and regional airport in the Average Score Group, it is gained as one of the units of analysis for airport business model design.

## 4.5 Conclusion

To examine the situation of local and regional airport industry in Thailand both industry and firm level, PESTEL Analysis and BCC-DEA Model under the structure-conduct-performance paradigm provides the insight analysis. For PESTEL-AHP, the pairwise comparison is constructed to estimate and prioritize each PESTEL element that playing a large part on local and regional airport industry. The scoring approach from expert panels reports that the revision of Air Navigation ACT BE 2562 (No.14) has the strongest force approximately 28% on the local and regional airports. While other top 2 PESTEL elements are given to the National Strategy (2018-2037) and the trend toward airport digitalization with pairwise estimation 22% and 21% respectively.

For the firm-level analysis, the technical efficiency of 28 local and regional airports in Thailand is calculated under BCC-DEA model, the computation from DEAP 2.1 reveals the inefficiency of those airports with the average score of 0.188. Pai Airport (PYY) is the most efficient local and regional airport with the technical efficiency score of 1 while Pattani Airport (PAN), Tak Airport (TKT) and Mae Sariang Airport (MSR) are the worst efficient airport with the technical efficiency score of 0. Chumphon Airport (CJM) has the highest productivity change calculated by the Malmquist Index; conversely, Pai Airport (PYY) has the lowest productivity change which is compatible with the technical efficiency computation since it is efficient with technical efficiency score of 1 from 2009 to 2018. By using the mean of technical efficiency scores in order for classifying the strategic groups, 3 clusters of Thailand local and regional airports are identified. They are defined as the Average Score Group, the Above-average Group and the Below-average Group. Suratthani International Airport (URT), Ubon Ratchathani International Airport (UBP) and Lampang Airport (LPT) are purposively regarded as the representative of each group respectively. The criterion of selecting each representative is lying on the research objective of the study, to improve the technical efficiency of local and regional airports.

The results of the 1st research objective provide the source for airport business model designs and the proposition of business model innovations. The industry analysis by using the PESTEL-AHP indicates the key trends and macro-economic forces that influencing the overall business operations of local and regional airports. While the firm-analysis by computing the BCC-DEA Model reports how well the local and regional airports can perform. The technical efficiency scores derived from this stage not only functioned as a criterion for constructing the strategic group, but also employed as an independent variable for technical efficiency determinant specification.

# CHAPTER 5

# FACTORS AFFECTING AIRPORT TECHNICAL EFFICIENCY

This chapter examines factors affecting airport technical efficiency. It consists of data cleaning technique section which providing more information and showing the process on how to prepare the dataset for data analysis while the next following part describes the general information on the estimated econometric model. The third section presents the results of the factors affecting airport technical efficiency by using the second stage regression analysis. Lastly, the conclusion is covered to summarize the inputs that will be used in the process of airport business model design for the last research objective.

## 5.1 Data Cleaning Techniques

To make sure the reliability of the results, all dataset collected from the Department of Airports (DOA) and Airports of Thailand (AOT) were carefully screened to ensure the same unit of each variable used in the model. Furthermore, data investigations starting from graphical data, basic descriptive statistics, correlation metric, functional form transformation to advanced statistics are thoroughly covered. Although the type of data used in the econometric model is the panel data using the range from 2014 to 2018 fiscal years, the statistical stationary condition is required to be tested prior to modelling by finding the differences between time-series (Akarapong Untong, 2007b). It is because the panel data has the combined properties between times-series and cross section data (Wooldridge, 2013).

To initiate modeling the equation, the OLS classical assumptions are carefully tested by using EViews®10. The outputs of various tests are presented in Appendix D. Firstly, the multilinearity problem is observed. After performing the Simple

Correlation Matrix, the high multicollinearity among independent variables are identified. The compared variables between $REV_t$ and $MKT_t$and $POL_t$ and $SER_t$ are proved to have highly collinearity property. To explain it in statistical ways, their correlation coefficients are equal to 1 or $Corr\ (x_i, x_j)\ =\ 1$. To solve this problem, the study is choosing to drop $POL_t$ and $MKT_t$ according to the recommendations from Pindyck and Rubinfeld (1998), Akarapong Untong (2007a), Wooldridge (2013), Paitoon Kraipornsak (2016) and Hair et al. (2019). The logic behind this actions is $MKT_t$ can be replaced by $OWN_t$ as it represents the Structure-conduct-performance variable while $POL_t$ can be substituted by other variables reflecting the Department of Airports managerial policies. Consequently, the remaining independent variables for the econometric model are intercept term $(C)$, $OWN_t$, $REV_t$, $REG_t$, $LOC_t$ and $SER_t$.

To further cure the issue and select only the best variable into the model, the Stepwise Least Square (SLP) is recommended to use regarding Hair et al. (2019) and Startz (2019). The SLP is the method of selecting variables for including in the regression model. It is started by choosing the best predictor from the set of independent variables. The independent variable is additionally picked up as the incremental exploratory power. They can be added to the regression model as long as their partial correlation coefficients are statistically significant. However, the independent variable can also be dropped if the predictive power drops to a non-significant level when another independent variable is added to the regression model. With the procedure given by SLP, the efficiency property of the estimator is gained due to the minimizations of errors and variances (Kraipornsak, 2016). Thus, a researcher is able to simulate the efficient econometric model that having the ability of explaining the dependent variable.

To initiate the process of SLP, $OWN_t$ is the only Structure-conduct-performance variable, it is programmed to fit in the model. By processing the Stepwise Least Square Method, it additionally selects $C$, $SER_t$ and $REV_t$ included in the model while $LOC_t$ and $REG_t$ are dropped out of the econometric model. Figure 5.1 illustrates the SLP procedure.

Dependent Variable: TE
Method: Stepwise Regression
Date: 03/03/20 Time: 10:11
Sample: 2014 2018
Included observations: 170
Number of always included regressors: 1
Number of search regressors: 6
Selection method: Stepwise forwards
Stopping criterion: p-value forwards/backwards = 0.5/0.5

| Variable | Coefficient | Std. Error | t-Statistic | Prob.* |
|---|---|---|---|---|
| OWN | -0.464119 | 0.053224 | -8.720143 | 0.0000 |
| C | 0.464185 | 0.077544 | 5.986119 | 0.0000 |
| SER | 0.239596 | 0.059682 | 4.014574 | 0.0001 |
| REV | 1.23E-11 | 3.63E-12 | 3.401457 | 0.0008 |

Selected variables

| | | | |
|---|---|---|---|
| R-squared | 0.555967 | Mean dependent var | 0.318594 |
| Adjusted R-squared | 0.547943 | S.D. dependent var | 0.324847 |
| S.E. of regression | 0.218411 | Akaike info criterion | -0.181624 |
| Sum squared resid | 7.918791 | Schwarz criterion | -0.107841 |
| Log likelihood | 19.43804 | Hannan-Quinn criter. | -0.151684 |
| F-statistic | 69.28210 | Durbin-Watson stat | 2.202169 |
| Prob(F-statistic) | 0.000000 | | |

Selection Summary

Added C
Added SER
Added REV

*Note: p-values and subsequent tests do not account for stepwise selection.

Figure 5.1 Stepwise Regression Procedure

After solving the multicollinearity, the heteroskedasticity problem is examined since it affects the efficiency of the estimator. The White's Heteroskedasticity Test is employed in this case. After running the test, it indicates the rejection of null hypothesis with the confidential level at 99%. It is because the probability value of the estimated observation $R^2$ is lesser than the critical value (see Appendix D); therefore, it shows that the variance of the error term in the model is constant; in other words, the variance of the error term is unable to be influenced by the variables in the model.

Similar to the previous problem that affecting the efficiency of the estimators, the autocorrelation problem or commonly called serial correlation in panel regression can be inspected by observing the Durbin-Watson Statistic (D.W.). Since the value of the Durbin-Watson Statistic (D.W.) is 2.20217 and it is close to 2 (Kraipornsak, 2016); hence, the econometric model containing $C$, $OWN_t$, $SER_t$ and $REV_t$ does not encounter the autocorrelation problem. Therefore, the estimated econometric model is met the requirements of Gauss Markov Theorem and it is ready to make the interpretations and discussion on the results.

For the reason behind the specification of linear functional form econometric model, the relationship between the variables and theoretical framework and the properties of data distribution between independent variables and dependent variable clarified this issue. In particular, since the relationship among independent variables and dependent variable were constant and linear regarding the literature review, the linear functional form of the econometric model was applied. The appendix D displayed the scatter plots between $OWN_t$, $SER_t$ and $REV_t$ and $TE_t$.

## 5.2 General Information on Estimated Econometric Model

To construct the econometric model for estimating the impacts of factors influencing airport technical efficiency, the 34 units of analysis from airports under the operations of the Department of Airports (DOA) and Airports of Thailand (AOT) during 2014-2018 are gathered to create 170 observations. The partial output from the 1st research objective that is the technical efficiency scores ($TE_t$) computed by the 1st stage Data Envelopment Analysis developed by Banker et al. (1984) (BCC-DEA Models) are used in this stage and it is considered as the dependent variable for the estimated econometric model. According to Table 5.1, the mean of the technical efficiency score is 0.31859 with the standard deviation around the regression line of 0.32484. The mean of the technical scores represents the distance between the best practice airport from the set of observation. In other words, most of the observations tend to be technically inefficient. As the technical efficiency scores are theoretically rounded between 0 and 1; hence, the maximum and minimum are 1 and 0 respectively. The maximum technical efficiency score devotes to Pai Airport (PYY), Phuket International Airport (HKT) and Suvarnabhumi Airport (BKK) while the minimum technical efficiency scores are given to Mae Sariang Airport (MSR), Tak Airport (TKT) and Pattani Airport (PAN).

$OWN_t$ is the regressor examining the effect of structure and conduct on regional airport technical efficiency scores which reflecting the performance of the airports. Since $OWN_t$ is conceptualized as the ownership patterns of airport which is the qualitative data; thus, it is assigned as the dummy variable. 1 is given to the observation if the airport is the public airport under control of the Department of Airports (DOA) while 0 is recorded if the observation is from the privatized airports under the operations of Airports of Thailand (AOT). In the same vein, 0 and 1 are the minimum and maximum value of the variable. The mean is equal to 0.82235 which precisely showing the most of observations, 28 of 34 airports, are from the DOA airports as the mean is closer to 1.

Table 5.1 Descriptive Statistic of Included Variables

| **Variables** | **Mean** | **Standard Deviation** | **Maximum** | **Minimum** |
|---|---|---|---|---|
| $TE_t$ | 0.31859 | 0.32484 | 1 | 0 |
| $OWN_t$ | 0.82235 | 0.38235 | 1 | 0 |
| $SER_t$ | 0.91177 | 0.28448 | 1 | 0 |
| $REV_t$ (Unit: THB) | 1.47E+09 | 5.57E+09 | 3.57E+10 | 0 |
| **Observations** | | **170** | | |

For the mean of $SER_t$ which is another dummy variable representing the airport policy relating to user orientation, it is equal to 0.91177 with the standard deviation approximately 0.28448. Since 1 is assigned to the airport that providing such the service quality-relating policy; not surprisingly, the mean of $SER_t$ illustrates the intentions of both airport authorities on passenger satisfaction development during the period of the study. The Department of Airports (DOA) annually surveys the satisfaction from airport users while the Airport of Smiles Strategy by Airports of Thailand (AOT) has been implemented on every airport across the country since 2010. Due to the property of dummy variable, $SER_t$ has the maximum and minimum between 1 and 0.

$REV_t$ is a ratio-scale variable that expecting to have an impact on airport efficiency regarding the literature review. The descriptive statistic of $REV_t$ is shown in the e-notation. It is because the $REV_t$ variable contains the huge values for a whole period of the study; therefore, EViews® 10 converts them into scientific exponent notation. Therefore, this software option allows researchers to conveniently interpret real numbers that are very big and too small in a decimal format. In particular, it is easily to perform arithmetic operations and mathematically express in an understandable way. The mean calculation for $REV_t$ is equal to 1.47E+09 with the standard deviation of 5.57E+09. The maximum airport revenue is from the privatized airport operated by the Airports of Thailand (AOT) while the minimum airport revenue is from Mae Sariang Airport (MSR), Tak Airport (TKT) and Pattani Airport (PAN) where they all obtain the zero technical efficiency scores.

## 5.3 Factors Affecting Airport Technical Efficiency: The Discussion

By estimating the econometric model by using the Second-stage Panel Least Square Method, the econometric model is shown in the equation (5.1) and it is more than 50% able to describe the factors affecting airport technical efficiency. Normally the average range of $R^2$ for the dataset that having cross-section property is from 0.4 to 0.5 (Paitoon Kraipornsak, 2016). While the $R^2$ calculated from the model measures 56% fit of the regression line which reflecting the ability of the right hand-side variables on explaining their effects toward airport technical efficiency. The minimum error from estimating the overall regression coefficients (ser) is equal to 0.21841. It describes the measurement of predictive accuracy and expected variations in the predicted values. Specifically, the standard error of regression portrays the uncertainty measurement of $C$, $OWN_t$, $SER_t$ and $REV_t$ that are 0.07754, 0.05322, 0.05968 and 3.63-E12 respectively.

$$\boldsymbol{TE_t = 0.46419 - 0.46412 \cdot OWN_t + 0.2396 \cdot SER_t + 1.23E - 11 \cdot REV_t}$$

$$\quad\;(0.07754) \qquad\qquad (0.05322) \qquad\qquad (0.05968) \qquad\qquad (3.63\text{-E12})$$

$$R^2 = 0.5597, ser = 0.21841, D.W. = 2.1125, F - statistic = 69.2821\ (Prob = 0.0000)$$

(5.1)

To illustrate the big picture of the estimated equation, the F-statistic, 69.2821, calculated from the model presents that the overall regression coefficients (Table 5.2) do differ from zero with 99% confidential level as the selected size of the test at 99% confidential level creates the smallest critical value which showing the intentions of incorrectly rejecting the null hypothesis. In other words, the regression coefficients except the intercept term which are the explanatory variables accurately explain the casual effects on dependent variable. Once again for D.W. statistic, it closes to 2.0 which consistently shows no serial correlation on the estimated model.

In order to visualize the fitness between the actual and estimated values so called fitted values, Figure 5.2 shows the illustration from EViews®10 processing. The three series of residual, actual and fitted values are displayed. The residuals are mapped on the left vertical axis while the actual and fitted values are plotted against the right vertical axis. The mapping between actual and fitted series is quite good because the estimated series almost cover the actual values on the graphical illustration. For the residual interpretations, the econometric model presents the better fitness of the observations during 2014-2016 than 2017-2018. In other words, the absolute values of residuals become smaller in the earlier period and quite take a distance between the data point and the regression line during 2017-2018.

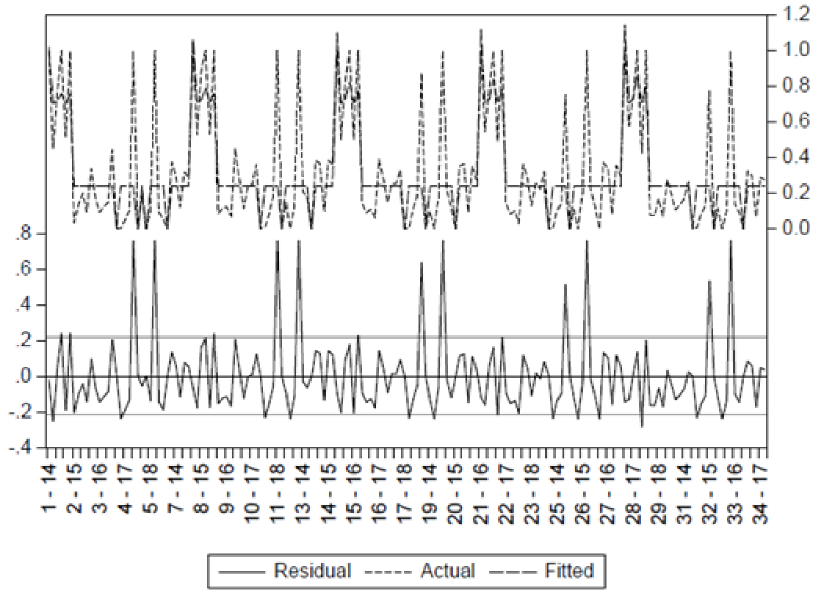



Figure 5.2 The Residual, Actual and Fitted Value Comparison from EViews®10

Table 5.2 Factors Affecting Airport Technical Efficiency

| **Independent variables** | **Estimated regression coefficients (Standard errors)** |
|---|---|
| $C$ | 0.46419 *** |
| | (0.07754) |
| $OWN_t$ | -0.46412 *** |
| | (0.05322) |
| $SER_t$ | 0.2396 *** |
| | (0.05968) |
| $REV_t$ | 1.23E-11 *** |
| | (3.63E-12) |
| $R^2$ | 0.55597 |
| $ser$ | 0.21841 |

Note: *** Statistical significance at 99% confidential level
** Statistical significance at 95% confidential level
* Statistical significance at 90% confidential level

In order for making the statistical interpretations, the econometric model sheds the light on the new several issues (see Appendix D for comprehensive statistic computation). Firstly, the analysis reveals that $OWN_t$has an impact on airport efficiency; therefore, it contrasts with the conclusion from Parker (1999), Oum et al. (2003), Lin and Hong (2006) and Kutlu and McCarthy (2016) whose findings report no significant effects or diminutive impacts of ownership patterns on airport efficiency. Secondly, the result makes the argument with Curi et al. (2010) who presenting that the public airports have greater efficiency than other ownership forms. Thirdly, $OWN_t$ shows that if the ownership pattern is the public airport, the technical efficiency tends to statistically decrease 0.464 ceteris paribus. In other words, the public ownership tends to have lesser technical efficiency than the privatized airports. The result supports the empirical evidences from Vogel (2006b), Oum et al. (2006), Oum et al. (2008), Assaf and Gillen (2012) Martín et al. (2013) and lo Storto (2018) who affirming that the heterogeneous ownership forms do have an impact on airport efficiency which following the structure-conduct-performance paradigm said by Bain (1959).

Due to the global trends toward the airport commercialization, the emergence of service-relating policy within an airport which is considered as one of the airport managerial policies has been taken large parts on airport strategic planning and development. The estimated regression coefficient shows if an airport in the unit of analysis provides managerial policies relating to service quality improvement, substituting $SER_t$ with 1, the technical efficiency score increases approximately 0.2396 with all other being equal. With the statistical significance with 99% confidence, the result aligns with service quality improvement policies implemented by the Department of Airports (DOA) and Airports of Thailand (AOT). More specifically, while DOA annual keeps surveying the users ‘satisfaction in most of its regional airports, AOT have also executed the Airport of Smiles Strategy over its 6 airports since 2010.

However, in spite of the statistical significance of $SER_t$, this variable is hardly specified in the econometric model. Only Oum et al. (2003) and Liu (2016) support this conceptualization. The result of $SER_t$ estimation in this study enriches the relevant literature and confirms with the two mentioned works that service quality influences the airport efficiency.

For the last regressor, $REV_t$, almost literature point out that non-aeronautical revenues which are airport revenues collected from other non-aero commercial activities are the source of competitive advantage. Additionally, although the trend toward airport commercialization has appeared all over the world and non-aeronautical revenues seem to have crucial impacts on airport revenue structure, the study uses airport revenues which are the summation between non-aeronautical revenues and aeronautical revenue as a proxy of non-aeronautical revenues due to the unavailability of the data. The estimation of the model reveals that airport revenue or $REV_t$ does have diminutive impact on technical efficiency. In other words, an increase in every 10,000,000 THB of airport revenue causes the rise of 1.23E-11 or 0.000123 technical efficiency ceteris parisbus. The result rather aligns with the previous literature such as Sarkis (2000), Tovar and Martin-Cejas (2009), Assaf and Gillen

(2012), Adler, Ülkü, et al. (2013), Adler and Liebert (2014), Assaf et al. (2014), Graham (2018) Yan and Oum (2014) and Liu (2016).

## 5.4 Conclusion

To examine the factors affecting airport technical efficiency, the study employs the Second-stage Panel Regression Analysis with 170 observations constructed from the 34 airports for 5 years period from 2014 to 2018 for modelling the panel regression analysis. The econometric model basing on the structure-conduct-performance paradigm is specified. Airport ownership patterns, service-relating policies and total airport revenues dataset are included in the model regarding the Stepwise Least Square method.

The estimations from the econometric model sheds the light on the new knowledge in the airport literature. The study affirms that airport ownership patterns do have an impact on airport technical efficiency. If an airport is a public airport, the technical efficiency tends to somewhat decrease significantly. While holding the implementation either service-relating managerial polices or service quality development strategies can also cause an increment of technical efficiency. Lastly, if the managements would like to upgrade the performance of an airport, most of attentions should be made through airport corporatization and service-relating policies. The results from the second-stage panel regression are statistical significance and meets the Gauss Markov Theorem.

Considering the output from this chapter, the results present the guidelines for airport business model designs and also the business model innovations. The study advises that airport business model designs for local and regional airports in Thailand should carefully notice on airport operations relating to service quality improvement. The operations of the airports may consider the ownership and control approach. Airport corporatizations or the Public-private Partnerships (PPPs) are the samples. Moreover, the prospective airport business model designs and business model innovations should perform as a revenue driver since airport revenues are the source of airport technical efficiency.

# CHAPTER 6

# AIRPORT BUSINESS MODEL ANALYTICAL FRAMEWORKS

This chapter presents the framework for designing the local and regional airport business model. To construct the analytical framework for business model propositions, the documentary research and exploratory research approach are employed in this stage. The first and second section presents the lessons learned from the best practice airport both World's Best and world regional airport reviewed through the documentary research which are the airport literature and the series of annual reports. Then, the in-depth interviews are used to explore the opinions from airport expert panels who are in charge of airport administrating and aviation research scholars. The last section provides the comparative analysis between the findings of lessons learned from the World's Best airports and expert team ideation. The comparison leads to the regional airport business model frameworks which ultimately prepared for regional airport business model design for the 4th research objective.

## 6.1 Lesson Learned from the World's Best Airport

To create the lesson learned from airport business modelling from the World's Best airport, the analytical framework from Osterwalder and Pigneur (2010) is drawn to illustrate how those best world airport do their businesses efficiently. According to SKYTRAX, Changi International Airport (SIN) is selected as the winner for the World's Best Airport in 2019. This is the 10th times with 7th consecutive years since 2000 that Changi International Airport is awarded such a prize (Figure 6.1).

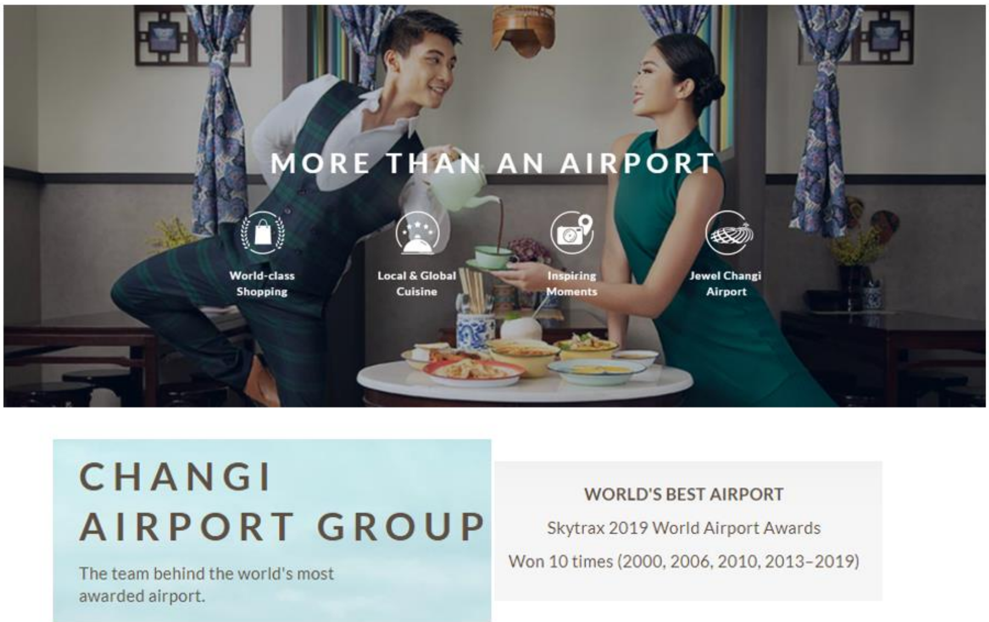



Figure 6.1 The World's Best Airport

Note: Adapted from Changi Airport Group (2020).

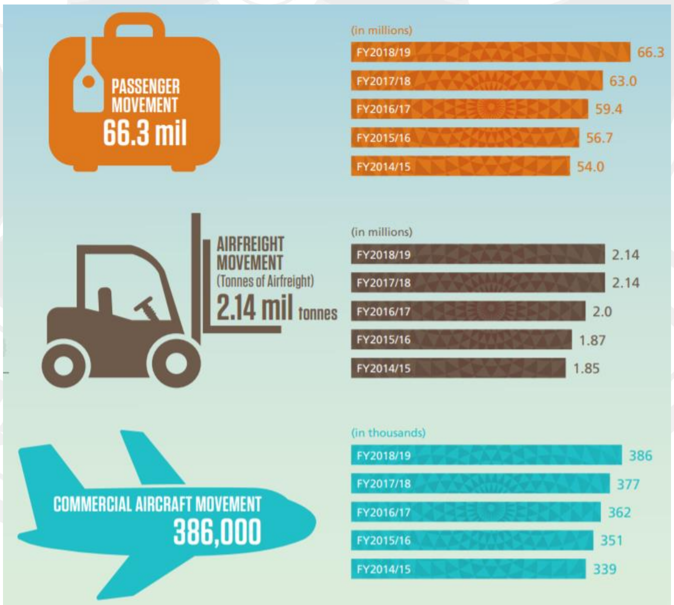



Figure 6.2 Outputs of Singapore Changi International Airport

Source: Changi Airport Group (2020).

The airport did inaugurate the very first commercial flight in 1959. The ownership structure of the airport belongs to Singapore government, but it is managed by Changi Airport Group (Singapore) Pte Ltd (CAG) established in 2009 to prepare for airport corporatization following the Changi Airport Group (CAG) formation in the same year. As CAG acts as the airport company administers Changi International Airport, it undertakes many key activities relevant to airport operations and development. With the vision of airport transformation, CAG not only develops the airport as an aircraft interchanging platform, but it is anticipated to further develop as a destination in Singapore (Changi Airport Group, 2013). According to Changi Airport Group (2020), Singapore International Airport is reported 5.2% growth in passenger movements with respect to 66.3 million passenger as of March 31 in 2019. This number is almost 80% increasing comparing to the period of airport corporatization 10 years ago. The cargo traffic is steady and reported at 2.14 million tons and the commercial flights is steadily rising with the number of 386,000 flights as of the end of March (Figure 6.2).

To illustrate the airport business model of Singapore Changi International Airport, the airport operation template or comprehensive model indicating the focal firm's activities, transactions creating value and value delivering is drawn under the Osterwalder and Pigneur (2010)'s analytical framework. The airport operations are stretched and analyzed with regards to Customer Segments (CS), Value Propositions (VP), Channels (CH), Customer Relationship (CR), Revenue Streams (RS), Key Resources (KR), Key Activities (KA), Key Partnerships (KP) and Cost Structures (CS). Through the series of documentary research relevant to Singapore Changi International Airport, the airport business model is demonstrated as follows:

1) Customer Segments (CS)

There are several customer segments involving in the airport operations (Figure 6.3). They can be classified into the aeronautical customer segments which are airlines, airports and passengers and the non-aeronautical customer segments. Thus, it is contrary to the work said by Gillen (2011) that an airport is the two-sided platform between passengers and airlines, this study argues that an airport should be considered as the multiple-sided platforms instead. The customer segments of Singapore Changi International Airport are illustrated this argument. Since the airport is not only serving the business to passengers and airlines but it also pays attentions to local residents in every age who don't have a flight as a passenger. With the company vision orienting on customers, the airport targets from the youngest children to the largest corporations. Consequently, the facilities in the airport have been in the processes of passenger terminal upgrades with a variety of universal design programs.

Besides the mentioned customer segments, several airports in the world are the customers of Changi International Airport since Changi Airport Group (CAG) also runs the consultation businesses and airport asset management that is the Changi Airport International (CAI). Samples of its customers in the portfolio includes Clark International Airport, Fukuoka International Airport, Vladivostok International Airport, Chongqing Jiangbei International Airport, King Abdulaziz International Airport and so on.

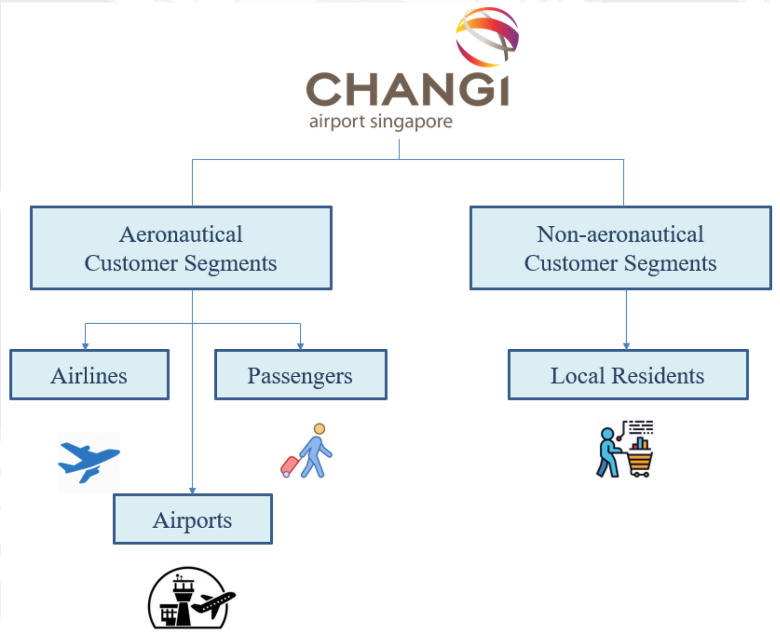



Figure 6.3 Singapore Changi International Airport Customer Segments

2) Value Propositions (VP)

With 8 cargo terminals, 5 passenger terminals and 3 runways ready in 2030, Singapore International Airport offers several value propositions such as newness, airport performance, customization, design and usability to each customer segment.

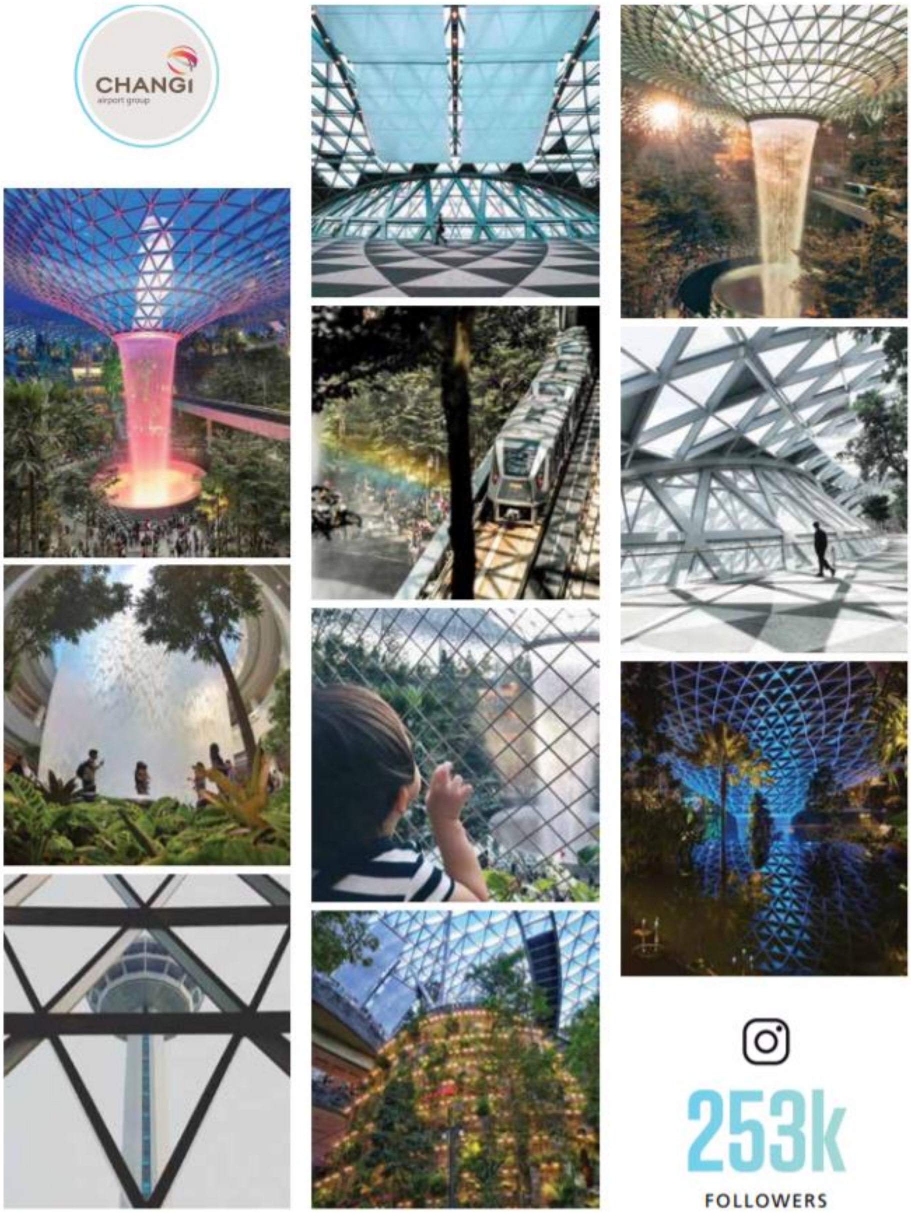



Figure 6.4 Jewel Project in Singapore Changi International Airport
Source: Changi Airport Group (2020).

Daily Airport Operations and Airside Managements safely serve thousands of aircraft taking off and landing. Aprons, taxiways, baggage belts, safety inspections and other tasks relevant in-and-out airport fences are carefully delivered to airlines. Experience Creations is a heart of value proposing to passengers. The airport arranges many attractions for youth to youth at heart passengers and residents which all are set in the greenery and clean settings. They include event spaces where can host multiple activities, indoor garden, community spaces with seating areas, fun-filled activities for family, inflatable playground, entertainment zones, movie theaters, lounges, sesame street exhibitions and so on.

The airport also provides Terminal Operations and Planning tentatively serving the demand of passengers and innovate passenger experiences. Changi International Airport offers the customized and personalized services to enhance passenger experiences in every age. The Changi Lounge provides the fly-ferry and fly-cruise passengers the comfortable and seamless luggage delivery. The baggage transfer services are available from the airport on arrival to the maritime terminals. While waiting for flights or ferries, passengers may enjoy the facilities available in the lounge such as showers, refreshments, seating areas and so on. Furthermore, World-class Retail, Dine Services and to-go Destination are available both in the departure terminals and the very well-known and spectacular Jewel Project within Terminal 1 (Figure 6.4). This project is the man-made destination which combining among gardens, attractions, over 500 retails and more than 260 dining choices across the terminals and Jewel Project, accommodations and aviation facilities to support the airport operations.

Lastly, Engineering and Development provides the safe airport environment for all stakeholders. Sky Train, boarding bridges, airfield lighting, capacity planning and terminal design are the values delivered to airlines, passengers, residents and airport clients. With the recognition of high safety awareness community, the airport has been awarded by the International Federation of Air Line Pilots' Associations (IFALPA) for almost 40 consecutive years. For this reasons, Singapore Changi International Airport offers the storage of baggage during passenger layovers since it applies the Explosive Trace Detector (ETD) to scrutinize luggage for safety and security which virtually increase passenger experiences and satisfaction.

3) Channels (CH)

This component refers to the channels that the Singapore Changi International Airport reaches the customer segments. To propose the values for retail businesses, the airport connects passengers and Singaporean residents and travelers through the highly interactive airport website and iShopChangi (Figure 6.5). It is the e-commerce portal that representing an attempt of the airport to enhance the digital experiences and ecosystem for linking the passenger and resident touchpoints. This platform is also redesigned to tailor and personalize customer preferences through the variety of products and other services. Correspondingly, the Changi Rewards which is the loyalty program has been developed to introduce several member benefits as an after-sale service. The benefits include airport lounge accessibility, free parking lots, other membership privileges and so on. With this user-friendly portal and more than 20,000 products from approximate 800 brands in the store, its customers reach over 100,000 and the Changi Rewards members set the new milestone at 1,000,000 at the end of 2018/2019 financial year (Changi Airport Group, 2016, 2018, 2019, 2020).

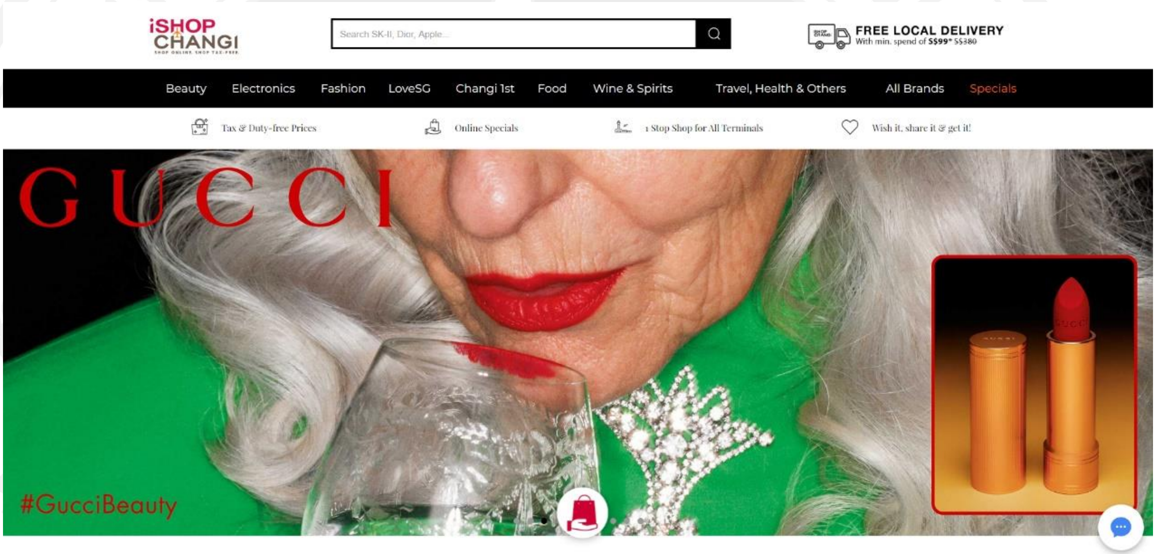



Figure 6.5 iShopChangi Portal for Retail Businesses under Changi Airport Group
Source: Changi Airport Group (2020).

To redeem the points, it is available through iChangi Mobile Application which definitely improving the airport operational efficiency. For this reason, it provides unlimited experiences to airport users with only single username for all transaction relating to Singapore Changi International Airport; for instance, reward redemptions, shops and dine information, flight alerts and attraction reservations.

Moreover, the airport also creates the bond with passengers all over the world with social media (Figure 6.6). With Facebook, Instagram, LinkedIn, WeChat, Weibo, YouTube and Twitter, the airport steadily engages travelers and its residents.

4) Customer Relationships (CR)

There are many types of customer relationship provided in Singapore Changi International Airport. Self-services are available throughout the process of flying. By implementing the full operations of FAST System (Fast and Seamless Travel), its

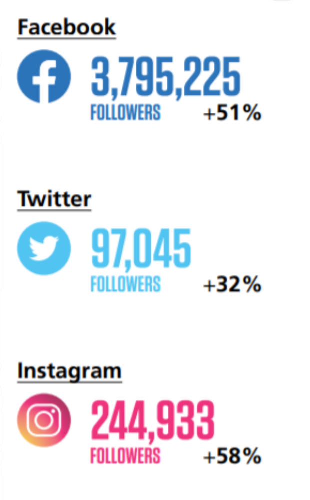



Figure 6.6 Channels for Maintaining Direct Relationship with Airport Users
Source: Changi Airport Group (2020).

automated systems allow passengers to check-in, drop baggage, pass the immigration formalities and go through a boarding gate seamlessly (Figure 6.7). This self-automated service is regarded as the customer relationship in the sense of Osterwalder and Pigneur (2010). Likewise, the airport also establishes the Changi Airport Growth Initiative (CAGi) for the airline customers. It is the program that collaborating airline customers to drive the traffic connectivity to Singapore Changi International Airport and encouraging them to pursue growth especially allowing airlines to strengthen and deepen long haul connections since it is the key for Singapore Changi International Airport success. This program permits the rebates in order for offsetting the increment aeronautical charges.


Figure 6.7 Customer relationships via automated services
Note: Adapted from Changi Airport Group (2020).

Another form of customer relationship in the airport is to use the automated personal assistance via Facebook Messenger and iChangi Mobile Application. MAX powered by IBM Watson and Accenture is the virtual assistant developed under the artificial intelligence technology. It offers on-demand assistances to common enquiries and navigate passengers with necessary information such as flight information, dining places, things to do in the airport and lost and found process. Pepper is another sample of personal automated assistant (Figure 6.8). With the collaborations with various partners, this technological and interactive robot is used to increase the shopping experience for passengers.


Figure 6.8 The Sample of Personal Automated Assistant
Source: Changi Airport Group (2020).

5) Revenue Streams (RS)

This component explains the sources of revenues incurring from each customer segment. The airport revenues can be classified into an aeronautical and non-aeronautical revenue. The aeronautical revenues consist of parking, landing, parking and aerobridge fees and charges for passenger service and security while the non-aeronautical revenues are from the concession revenues and rental incomes which sharply rising from 537 billion in 2009 to 1.17 billion in 2019. According to the annual report as of 2018/2019 financial year, the operating revenues of the airport approximately increased 8.1% due to the strong growth of concession revenues and passenger traffic which leading to an increasing in airport charges for airlines and passengers.

Another source of revenue stream also comes from the Changi Airport International (CAI) which is the 100% subsidiary of Changi Airport Group (CAI). With the airport investments and consultancy services, the consolidation of financial performance indicates 3,040 million Singapore dollars (Figure 6.9).

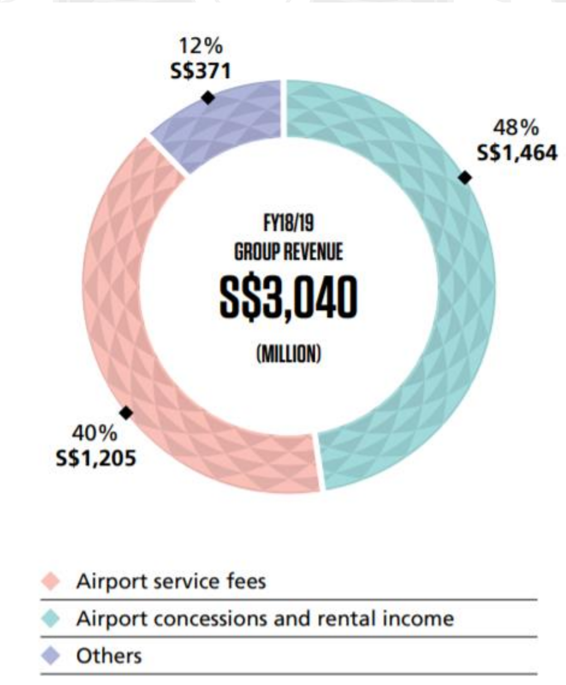



Figure 6.9 Revenue Streams from Airport Operations
Source: Changi Airport Group (2020).

6) Key Resources (KR)

The key resources describe the sources of value propositions. One thing that Singapore Changi International Airport always focuses is how to manage the talents in its organization. The airport values the people development as the key success factor (Figure 6.10). Through a series of talent pools via several engaging and training programs, Changi Airport Group creates the conducive culture, sense of belonging workplace environments through CAG Home Project, internal communications via CAG social networking application and revamped company's intranet, collaborative and open atmosphere through crowdsourcing, personal development and growth, Employee Engagement Survey and skill fulfillment for the fast-changing environments. Moreover, the airport offers scholarship programs by attracting talents from the universities in Singapore. the whole process has been done in order for making sure that the airport draws and retains the best talents.


Figure 6.10 Values of Changi Airport Group
Source: Changi Airport Group (2020).

7) Key Activities (KA)

The airport development in the form of multi-sided platform is the key activities to propose the values for all stakeholders. Such developments include the FAST system as previously mentioned in terminal 4, the completion of 3 runways for sufficient capacity management in the future and also the Jewel Changi Project since 2019 as the destination development. The airport development activities under the Jewel Changi Airport offers the transit and public department mall. With the intentions to create the fresh, green and exciting experiences to passengers and residents, the areas in the Jewel comprises 4 main iconic destinations (Figure 6.11) – the HSBC Rain Vortex, the Shiseido Forest Valley, the Canopy Park and the Changi Experience Studio. In the development areas, the project also provides excellent over 500 dine services and more than 250 food and beverage stores and unexceptional shopping experiences arranged by many unique brands from local to international recognition.


Figure 6.11 Sample of Airport Development – Jewel Project
Source: Changi Airport Group (2020).

In addition, Changi Airport Group also proceeds the Changi East Project (Figure 6.12). It is airport development prepared for serving potential growth and being the aviation hub in the region. Since the airport has the average traffic growth approximately 5.4% per annum, Changi Airport Group initiates this project under the areas of 1,080 hectares. The project includes the 5th terminal, the 3 runway systems, tunnel and underground systems, aviation facilities and Changi Industrial Zone.

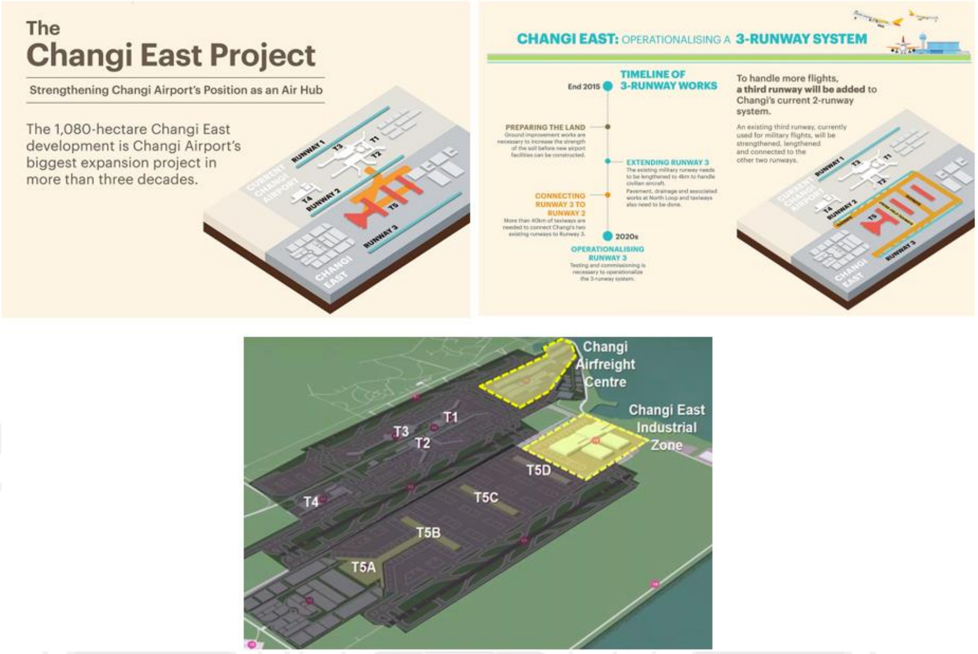



Figure 6.12 Sample of Airport Development – The Changi East Project

Note: Adapted from Changi Airport Group (2020).

8) Key Partnerships (KP)

This business model element explains the key partnerships that allowing the airports to propose the values to its stakeholders. The strategic partnership style is well-described how Changi Airport Group react to its partners; hence, stakeholder hearing from the ONE Changi Project is initiated to allow its partners contribute their ideas on how to improve customer experiences and engage the sense of belongings among the airport partnerships (Changi Airport Group, 2012). For example, the collaborations between the Immigration and Checkpoints Authority (ICA) and Certis Aviation Security is emerged to ease and facilitate passenger experiences during the customs and security check out procedures.

For airline and air cargo partners, the airport maintains the reasonable charges to ensure the airport position as an aviation hub in the region. The airport also facilitates quality inputs to support the needs of growth and future expansion of airline customers. Still, Changi Airport Group cooperates with Singapore Tourism Board (STB) and Costa Cruises to participate in the tripartite partnership in order to develop the Singapore Changi International Airport as a cruise destination in South East Asian.

The cross-industry cooperation and joint venture is another form of key partnerships that can be found in the Jewel Project. The collaboration between Changi Airport Group and CapitaLand reflects the mentioned propositions. With several partnerships and sponsorships such as HSBC, Shiseido, Manulife, DFS Singapore, Temasek Polytechnic and SoftBank Telecom, the experiences uplifting for travelers are possible.

9) Cost Structure (CS)

The cost structure of the airport mostly comes from the depreciation and amortization and service and security-relating fees around 26% and 24% respectively (Figure 6.13). As of the 2018/2019 financial year, the costs incurred from several airport developments such as capacity investments, additional manpower planning, terminal expansion are found to support the various projects whereas the new regulatory measures also contribute to an increase in higher operating costs.

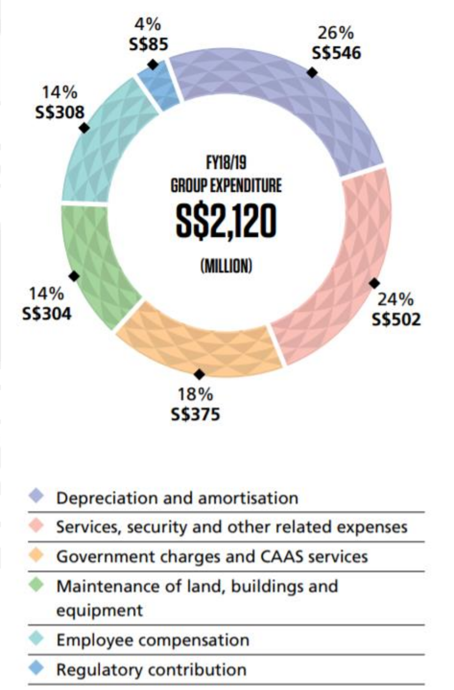



Figure 6.13 Cost Structure of Airport Operations
Source: Changi Airport Group (2020).

10) Sustainability

Apart from the 9 building blocks according to Osterwalder and Pigneur (2010), Singapore Changi International Airport pay it business attentions to the Sustainable Development Goals (SDGs) complying to United Nations. The Sustainability Working Group and Changi Foundation are established to initiate the social responsibility programs across the country. By implementing the CSR projects, the airport engages the local communities by giving students hand-on experiences together with the airport partners. To commit and align with the Singapore Climate Action Plan and Singapore Zero Waste, the airport is working on reducing the carbon emission by the end of 2029/2030 financial year; also, the airport sets the food waste digestors for converting food wastes into the incineration.

To illustrate the whole operation of the airport into the business model as defined in the Chapter 1, the Business Model Canvas (BMC) shows the focal activities creating and delivering values to stakeholders (Figure 6.14).

## 6.2 Lessons Learned from the World's Best Regional Airport

According to the announcement by SKYTRAX, Chubu Centrair International Airport (NGO) in Nagoya, Japan is claimed as the World's Best Regional Airport for 2019. It is not its first prize since the airport has been awarded for 5 consecutive years (Figure 6.15).

Chubu Centrair International Airport or Centrair is the public airport opened in 2005 due to the strong demands for passenger and cargo air transport from numerous private companies located in the central region of Japan. Centrair is designated to operate airport businesses by the Japanese government to Central Japan International Airport Co Ltd (CJIAC) with 50% shareholders are private sectors. CJIAC offers 24-hours airport operational services and provides relating airport services such as airport construction and managements, passenger and cargo terminals, aviation safety and security management and other facilities.

**KP**

**KP1** Strategic Partnerships
**KP2** Joint Ventures
**KP3** Cross-industry Partnership

**KA**

**KA1** Airport Development
**KA2** Jewel Changi Airport
**KA3** Changi East Project
**KA4** Destination Development

**KR**

**KR1** Talent Management
**KR2** Physical Resources (5 terminals and 3 runways)

**VP**

**VP1** Newness
**VP2** Performance
**VP3**Customization
**VP4** Convenience
**VP5** Usability and accessibility

**CR**

**CR1** Automated Self-service
**CR2** FAST System
**CR3** Automated Personal Assistant (Pepper and MAX)

**CH**

**CH1** iShopChangi
**CH2** iChangi Mobile Application
**CH3** Social Media Platforms e.g. Facebook, Instagram, LinkedIn, WeChat, Weibo, YouTube and Twitter
**CH4** Airport website

**CS**

**CS1** Airlines
**CS2** Passengers
**CS3** Residents as a tourist
**CS4** Airports
**CS5** Foodies

**CS**

**CS1** Depreciation and Amortization
**CS2** Services and Security-relating Fees
**CS3** Government Charges
**CS4** Regulatory Contributions
**CS 5** Maintenance of Infrastructures

**RS**

**RS 1** Airport Service Fees
**RS 2** Airport Concessions and Rental Incomes
**RS 3** Consultation Service Fees

Figure 6.14 The Business Model Canvas of Singapore Changi International Airport


Figure 6.15 The World’s Best Regional Airport
Note: Adapted from Centrair Group (2020).

With the strong growth in demand for air transport, the airport is recorded 12,358,026 passengers in the end of Japanese fiscal year 2018 which is increasing more than 18% comparing to the end of 2015 (Figure 6.16). The commercial flights increases around 5.65% or 103,310 comparing between 2015 and 2018 while the cargo movements both from domestic and international transportation are steadily rising approximately 14% from 2015 or around 212,797.

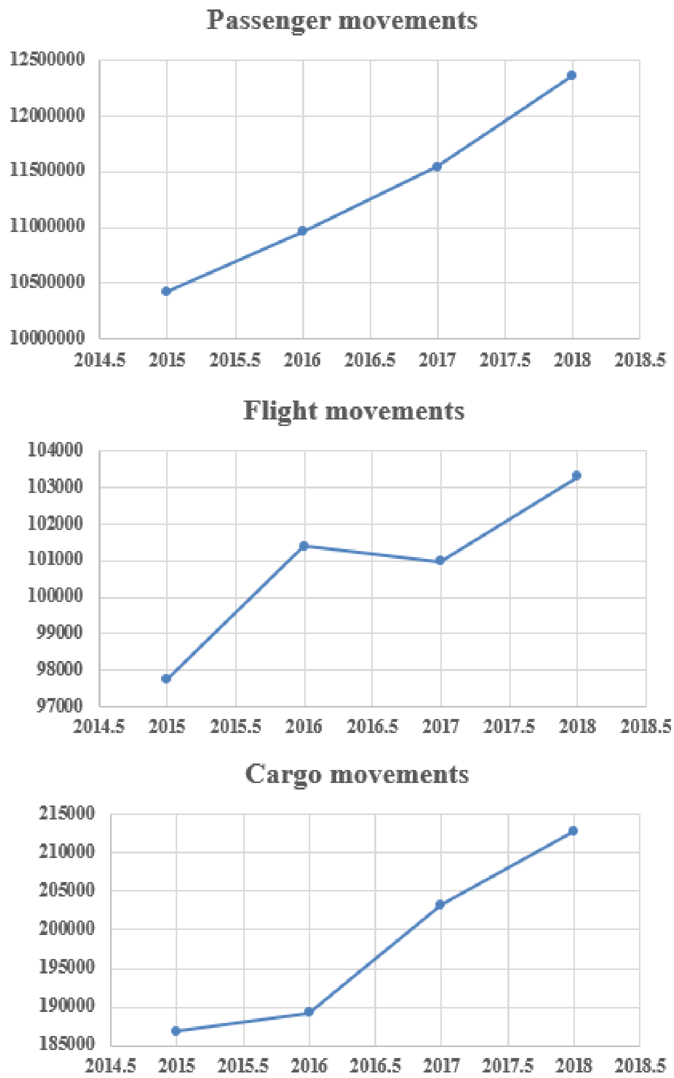



Figure 6.16 Outputs from Chubu Centrair International Airport
Note: Adapted from Centrair Group (2020).

To visualize the airport business model of Chubu Centrair International Airport, the airport operation template or comprehensive model indicating the focal firm's activities, transactions creating value and value delivering is illustrated under some of the Business Model Canvas (BMC) components by Osterwalder and Pigneur (2010). The airport operations are presented and analyzed with regards to Customer Segments (CS), Value Propositions (VP), Channels (CH), Customer Relationship (CR), Key Resources (KR), Key Activities (KA) and Key Partnerships (KP) except Revenues Streams (RS) and Cost Structures (CS) components due to the data unavailability. Through the series of documentary research relevant to Chubu Centrair International Airport, the airport business model is demonstrated as follows:

1) Customer Segments (CS)

This study still insists and argues the work from Gillen (2011) that an airport should be regarded as multi-sided platform instead of two-sided platform. It is because there are lot of customers using services from an airport. Singapore Changi International Airport has already presented the multi-sided platform concept. Similar to Chubu Centrair International Airport, there are several customer segments involving in the airport operations. As usual, the customer segments are passengers and airlines. However, the non-aeronautical customer segments are also present. Considering from the key activities of the airport, Chubu Centrair International Airport offers various relating-tourism activities. Since the airport acts as a host to facilitate many tourism activities, it draws attentions from tourists and athletes who interesting in sport tourism, gastronomy, cultural tourism, regional tourism and so on.

2) Value Propositions (VP)

The value propositions refer to airport newness, design, performance, customization, convenience, usability and accessibility which all reflected on Chubu Centrair International Airport operational services. For example, both passenger terminals are universally designed to serve all groups of passengers. The airport intends to combine the arrival and departure halls in the same terminal but different floors which are easily for passengers to conveniently access and search for their way out to connecting flights. It allows passengers to spend tiny times to aground due to the uncomplexity. The airport is laid out with T-shaped design which shortening walking ways from check-in counters to boarding gates; also, the airport eliminates travelling barriers by providing gentle slopes instead of steps for all terminals (Figure 6.17). Similar to the cargo terminal, the airport facilitates and shorten the shipments among other modes of transportation in the airport. Thus, the airport design reflects its position as the user-friendly airport for all.

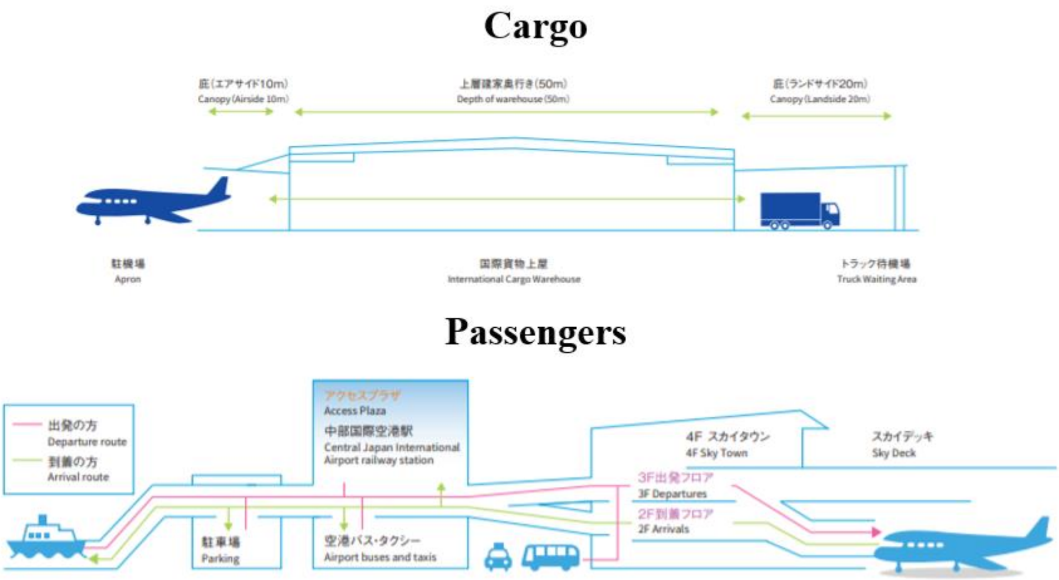



Figure 6.17 Some Samples of User-Friendly Airport Universal Design

Source: Central Japan International Airport (2020).


Figure 6.18 Samples of Yearly Product Events Held in the Terminal Areas

Source: Centrair Group (2020).

Apart from facilities like other common airport business operations such as 70 duty free stores and 66 dining services from global to local cuisines, Chubu Centrair International Airport offers yearly special product events to passengers and tourists. Many local foods, beverages like sake, delicious sweets, famous confectionaries from other central regional parts, fresh vegetables and fruits or even traditional Japanese handicrafts are available in the terminal areas (Figure 6.18).

3) Channels (CH)

Chubu Centrair International Airport engages and reaches its users by using social media platforms such as Facebook (both Japanese and English version), Twitter and Instagram (Figure 6.19). The highly user-friendly airport website is another channel to reach its customer segments. With the provisions of either aeronautical or non-aeronautical information, are fully integrated and available for airport users.


Figure 6.19 Channels for Reaching Airport Users
Source: Central Japan International Airport (2020).

4) Customer Relationships (CS)

Figure 6.20 Personal Assistants within the Airport
Source: Centrair Group (2020).

The personal assistants and self-automated services are the forms of customer relationships available in Chubu Centrair International Airport. The personal assistants in the airport come from various sources. A part of them refers to the regular employment of customer service officers available throughout the airport. Some parts are given to the Volunteer Activities hosted by the airport (Figure 6.20). It is the project allowing senior citizens and other residents playing a part as a passenger assistant. In addition, if passengers or tourists need helps, the airport offers the Accessibility Services through the Centrair Telephone Center to all customers.

Also, the airport arranges many automated facilities for airport users. The automated photo booth is available. Flight check-in Automatic Baggage Drop immigration formalities and security procedures are all automated (Figure 6.21) which reducing the process times and increasing users' conveniences.


Figure 6.21 Automated Services for Airport Users
Source: Centrair Group (2020).

5) Key Resources (KR)

Similar to other conventional airports, Chubu Centrair International Airport arranges a runway, 2 passenger terminals and a cargo terminal to serve airport users. By working under the United Initiatives of Centrair Staff which are another key resource of the airport, the liaison committee founded by several airport stakeholders has the crucial goals to work together by sharing the information on customer satisfaction and exchanging their views toward guaranteeing passenger comfortable experiences. In addition, considering from the airport operations, it seems that the intellectual resources are the key success of Chubu Centrair International Airport, managerial knowledge and partnerships. Since the opening of the airport in 2005, the

Centrair Operation Center (OCC) established from various airport stakeholders play very crucial parts of airport operations. As the Chubu Centrair International Airport is constructed on the artificial island. With 24-hours operations from the Centrair Operation Center, the airport is ready to cope with irregularities, natural disasters, unexpected incidents or even highly recognized events.


Figure 6.22 Collaborations in the Centrair Operation Center (OCC)
Source: Central Japan International Airport (2020).

The Centrair Operation Center strongly collaborates with airport-relating organizations and non-airport agencies. Figure 6.22 illustrates the cooperative chain among the OCC partnership. It includes airport staffs, airlines, Airport Police, Fire Department, West Japan Aviation Bureau, transport companies, Customs, Immigration Agency and Quarantine Station, Tenants, Ministry of Land Infrastructure and Tourism, Chubu Regional Department Bureau, Chubu District Transport Bureau, Bureau of Disaster Prevention, Road Public Corporation, local government agencies and so on.

6) Key Activities (KA)

The airport development in the form of multi-sided platform is the key activities to propose the values for all stakeholders. As Chubu Centrair International Airport offer services not only for aeronautical users but also for tourists and athletes; therefore, the 3 key prominent activities consist of:

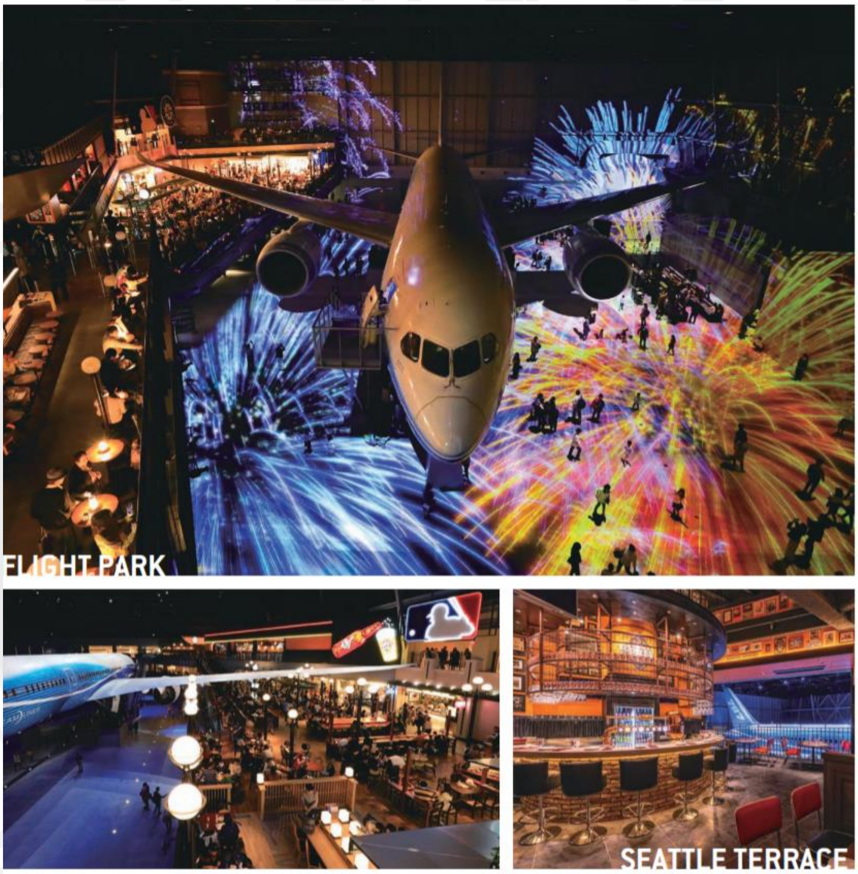



Figure 6.23 Flight of Dreams
Source: Central Japan International Airport (2020).

Destination Developments

The samples of Centrair Group attempt on developing the airport as destinations are the Flight of Dream Project (Figure 6.23). Since the airport aims to transform the terminal into a new gateway where passengers and tourists can enjoy and spend times for attractions and dine services. With the new generation of Boeing 787 theme park, the Flight of Dreams offers the exhibition where this aircraft was born and aviation interactive contents around the Flight Park. This project is emerged due to the collaboration with Boeing. As more than 30% of Boeing 787 aircrafts are built in Chubu; thus, the first testing plane is donated to the airport by Boeing.

The airport structures the area for allowing passengers getting closer to the runway and operating aircrafts (Figure 6.24). With 300-metres distance away from runway, the Sky Deck offers memorable experiences for aviation lovers. Because of positioning its airport as a destination, Chubu Centrair International Airport poses the Segment Guided Tours (Figure 6.25) which passengers and tourists are easily to get access in every allowable area.

Figure 6.24 The Sky Deck of Chubu Centrair International Airport
Source: Centrair Group (2020).

To enhance airport user experiences, it sets the Japan's first bath where passengers and tourists can watch aircrafts during taking off and landing (Figure 2.26). In addition to other attractions, the airport arranges the Art Quilt Museum for all users. It is the exhibition with interchangeable themes where drawing the attractions from passengers worldwide since 2005.

Figure 6.25 Segway Guided Tours around Chubu Centrair International Airport

Source: Centrair Group (2020).

Figure 6.26 Observation Bath Fu no Yu

Source: Centrair Group (2020).

Event Organizing

Apart from the attractions in Chubu Centrair International Airport, Centrair Group offers year-round activities and events in order to utilize the terminal areas. Besides the local food and product festivals such as Okinawan Fair in May, Summertime Winter Wonderland in August and Christmas Market from November to December where furnishing with local authentic food, Japanese beer and global products for shopping, there are several special events such as Bon Festival in the period of summer (Figure 6.27). During 2 days in the event organizations, the number of passengers and residents joining the event are counted more than 6,000 around the Sky Deck area where turned into the place for Bon Festival. The airport also hosts Centrair Airport Music Festival every year. Many music programs throughout the year since 2011 from all music genres such as professional jazz, amateur music, chorus, sky marching bands, live performance, concerts and so on are conducted (Figure 6.28).

Figure 6.27 Bon Festival around the Terminal Areas
Source: Centrair Group (2020).

Also, the airport arranges the Centrair Sky Illumination with the theme Temple of Life. It is the event that using the areas around the Sky Deck to display the amazing lighting during the winter every year (Figure 6.29). An integration of lighting from lanterns and chandelier together with the aircraft scenery, it creates memorable experiences for all airport users.


Figure 6.28 Centrair Airport Music Festival
Source: Central Japan International Airport (2020).


Figure 6.29 Centrair Sky Illumination
Source: Central Japan International Airport (2020); Centrair Group (2020).

Tourism Linkages

Tourism linkages are another key airport activity that supporting airport business development of Chubu Centrair International Airport. With the collaborations among airlines, tourism body agencies, local governments and nearby regions, the Shoryudo Project or the Dragon-rise Regions is emerged (Figure 6.30). The airport acts as a platform providing tourist information to visitors. Such traveling information includes the attractions in Chubu regions where including Shiga Prefecture, Nagano, Toyama, Ishikawa, Fukui, Mie, Gifu, Shizuoka and Aichi.


Figure 6.30 The Shoryudo Project

Source: Central Japan International Airport (2020); Centrair Group (2020).

Moreover, the airport also acts as a tourism platform to bridge the needs of various tourist preferences. For examples, Since the international sport events like Ironman Race held around the airport; therefore, it draws and brings lots of residents and international attendants. Within the airport, Centrair Group arranges and offers various kinds of food from traditional cuisine to global dine services. This activity reflects its roles as gastronomy platform.

As the airport posits itself as the gateway to the central region, it cooperatively works with many stakeholders to create the Samurai×NINJA Airport Project (Figure 6.31) which is the part of tourism linkage activities. Due to the richness of cultural and historical of central Japan where are the birthplace of recognized samurai leaders, the airport puts an effort to internationally promote Ninja and Samurai as a focal figure. Moreover, the airport also combines the project with the Segway Guided Tour by allowing its staffs wearing the ninja costumes (Figure 6.32).


Figure 6.31 Samurai×NINJA Airport Project
Source: Centrair Group (2020).

7) Key Partnerships (KP)

The key partnerships are the most outstanding components of Chubu Centrair International Airport business operations for the reason that the partnerships are


Figure 6.32 Segway Guided Tour in Ninja Uniforms
Source: Centrair Group (2020).

behind many airport development activities. Such cooperative pacts include the working sessions between the airport and the local governments in order to create the Shoryudo Project. Along with 14 local governments, Chubu Transportation Bureau, Chubu Regional Tourism Promotion Council and the Hokuriku Shin-etsu Transportation Bureau, the initiatives and one-day trip campaign among the 14 cities is implemented to promote the airport, domestic network and local attractions. To facilitate the project, the airport offers free car parking services and other tourist information for travelers.

In order for extending the airport network, Centrair Group always visits the international trade shows to promote international flights. This initiative so called *Fly Centrair* allows and encourages the travel agencies and local companies to prioritize the use of flights to Chubu Centrair International Airport when traveling to international destinations either leisure or business purposes. Therefore, it attracts airlines to operate the route network expansion to the airport.

To create more comprehensive partnerships, Centrair Group has implanted the Centrair's Sister Airport Initiatives to adapt to changes in demand for air transport and traveler need diversifications. Centrair Group signs the MOU with various international airports to promote collaborations among partner airport stakeholders such as airlines, travel agencies, trade organizations, investors and local communities. It is to improve service quality, share management knowledge, support businesses to each other, market direct flights, facilitate economic activities and promote tourism and trade activities. The Centrair's Sister Airport Initiatives includes Munich International Airport (MUC) in Germany, Taichung International Airport (RMQ) in Taiwan, Seattle-Tacoma International Airport (SEA) in USA, Paine Field Snohomish County Airport (PAE) in USA and Da Nang International Airport (DAN) in Vietnam. Owing to the Shoryudo Project and Fly Centrair Campaign, the growth of passenger movements is greatest than ever.


Figure 6.33 The East Asia Airports Alliance (EAAA)
Source: Centrair Group (2020).

To cope with changing in the business environment and airport competition, in 2001, Centrair Group additionally joined the East Asia Airports Alliance (EAAA) which is the organization founded to cooperate airport operators from Japan, Korea and China (Figure 6.33). Since the EAAA establishment, Chubu Centrair International Airport has worked closely with the organization to promote air transport services in East Asia, improve passenger service quality, discuss problems relating to airport business operations, standardize airport signage, combine passenger satisfaction campaign, increase cost efficiency, ease passenger transfer flows, mutually market airport members and so on.

For terminal operation partnerships, the airport also collaborates with various partners to create the Flight of Dreams Project as mentioned in the key activity component. With the mutual works with teamLab, Boeing and other partners (Figure 6.34), the amazing theme park in Chubu Centrair International Airport is possible.


Figure 6.34 Flight of Dreams Partnerships
Source: Central Japan International Airport (2020).

8) Sustainability

Beyond the airport operations according to Business Model Canvas (BMC) by Osterwalder and Pigneur (2010), Chubu Centrair International Airport runs its businesses by holding the Universal Design concepts. Positioning itself as the user-friendly airport, Chubu Centrair International Airport provides easy-to-use for everyone and it is opened to public also. To gain the insight information on how to develop the universal design airport, many workshops from stakeholders are conducted. The direct workshop with several varieties of disability groups and specific scholars are publicly heard. Every stage of design from basic planning to the final testing are kept eyes on (Figure 6.35). It is to make sure that the movement routes, deign of traffic flows, restroom accessibility and usability, enough supports and assistances are available and applicable to all groups of airport users.

The airport also cares for its local communities. By creating the Volunteer Activity Project, the airport allows senior citizens to work in the terminal on behalf of the airport personal assistants to passengers. The group of volunteers have a job to provide the airport information, facilities and services; in addition, sometimes they work as the tour guides for taking care of student field trip.

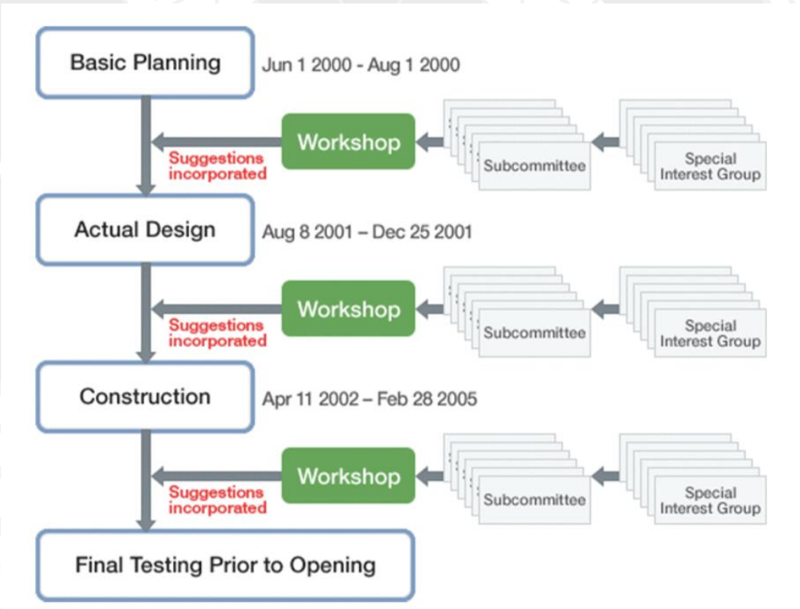



Figure 6.35 The Process of Public Hearing for Universal Design Airport
Source: Centrair Group (2020); Central Japan International Airport (2020).

For the environmental side, the airport implements the Green Initiatives. It is intended to reduce the burden and waste on the environment. Recently, the airport is working on monitoring the stage of environmental surrounding in order to deliver such impact information to the public.

To illustrate the airport business model of Chubu Centrair International Airport, the airport operation template or comprehensive model indicating the focal firm's activities, transactions creating value and value delivering is drawn under the Osterwalder and Pigneur (2010)'s analytical framework. The airport operations are presented with regards to Customer Segments (CS), Value Propositions (VP), Channels (CH), Customer Relationship (CR), Key Resources (KR), Key Activities (KA) and Key Partnerships (KP). Through the series of documentary research relevant to Chubu Centrair International Airport, the airport business model is demonstrated as Figure 6.36.

To summarize and bring the best of documentary research findings, the lessons learned from the World's Best airport and the World's Best regional airport can be presented as follows:

1) The common analytical framework of Osterwalder and Pigneur (2010) well describes the overall airport business operations for both Singapore Changi International Airport and Chubu Centrair International Airport. It is because the Business Model Canvas is able to capture every activity that airport stakeholders taking part in.

2) Both airports are highly connected with their key partnerships (KP); therefore, it allows the synergy among their partners and pools business resources to create several amazing mega projects such as Jewel Changi Project in Singapore Changi International Airport or The Flight of Dreams in Chubu Centrair International Airport. Moreover, strategic partnerships of those two airports also cooperate in proposing values to all stakeholders. For example, Chubu Centrair International Airport acts as a facilitator for providing car parking services to customers during the period of monthly or yearly events.

3) There are always the stages for hearing the strategic partnerships for both airport business operations. Even the cross-industry partnership is possible to create the win-win situations for all parties.

4) A part of strong partnerships among airport stakeholders comes from the sustainability projects of both airports. Since such projects creates surrounding community, university and business sector sense of belongings.

**KP**

**KP1** Strategic partnerships

**KP2** Coopetition in the form of East Asia Airports Alliance (EAAA)

**KA**

**KA1** Airport development

**KA2** Event organizing

**KA3** Destination development

**KA4** Tourism linkages

**KR**

**KR1** Intellectual resources

**KR2** Centrair Operation Center

**KP3** Staffs

**VP**

**VP1** Newness

**VP2** Friendly design

**VP3** Performance

**VP4** Customization

**VP5** Convenience

**VP6** Usability and accessibility

**CR**

**CR1** Personal assistants

**CR2** Automated services

**CH**

**CH1** Social media platforms such as Facebook and Instagram

**CH2** Airport website

**CH3** Call center

**CS**

**CS1** Airlines

**CS2** Passengers

**CS3** Tourists

**CS4** Athletes

**CS5** Foodies

**CS**

**RS**

Figure 6.36 Business Model Canvas of Chubu Centrair International Airport

5) Singapore Changi International Airport and Chubu Centrair International Airport both implement several proactive strategies in enhancing the airport revenues by using e-commerce channels and also many commercial platforms in order for reaching airport stakeholders.

6) Both airports well develop a variety of channels to communicate with their users. Offline and online medium are employed to listen to customers' pain points and expectations in order to allow the airports to serve their needs instantly.

7) Full-area utilizations from airport development through events are significantly found in Singapore Changi International Airport and Chubu Centrair International Airport.

8) In the business operations and development of both best airports, customer segments are beyond the groups of airlines and passengers. The other groups of users such as residents, tourists, athletes or even gastronome are attracted to visit the airports. Those groups of airport users have the potential to increase the non-aeronautical revenues.

9) The airport managements consider their airports as a destination, so they use the concept of destination development and link with the authenticity and originality of local resources; thus, the value propositions are beyond the aeronautical businesses. In particular, they extend the customer segments into the residents, tourists or even athletes who do not have a flight.

10) Those 2 successful airports share the common airport business model components. However, there are some slight differences in airport business operations which leading to the conclusion that an airport business model requires individual and customized designs. The conclusion supported the findings from Frank (2011) who initially found that the airport business model is heterogenous in essence.

11) As presenting in the previous chapter, airport ownership patterns do have an impact on technical efficiency. The best practice both World's Best airport and World's Best regional airport affirm this statement very well since they are the public enterprises but run and operated by the form of corporatization.

12) Table 6.1 compares the business model components between Singapore Changi International Airport and Chubu Centrair International Airport.

Table 6.1 Airport Operations Between Singapore Changi International Airport and Central Japan International Airport

| **Airport** | **Business Model Components according to Osterwalder and Pigneur (2010)** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **CS** | **VP** | **CH** | **CR** | **RS** | **KR** | **KA** | **KP** | **CS** | **Other components** |
| Singapore Changi International Airport (SIN) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | Sustainability |
| Chubu Centrair International Airport (NGO) | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | | Sustainability |

## 6.3 Airport Business Model Components: The Views from Expert Panels

To discover the airport business model components, the exploratory research is applied due to the scarcity of relating literature. The in-depth interviews are conducted with the airport managements from the central unit of Department of Airports (DOA) Airports of Thailand (AOT) and Bangkok Airways Plc. The 3 key experts in this group hold the high-level management positions and have experiences in airport strategic management and development. The primary datum is also gained from 4 DOA airport managements form each strategic group that is Ubon Ratchathani International Airport (UBP), Suratthani International Airport (URT) and Lampang Airport (LPT). In addition, to adopt the triangulation method, the information from the 2nd outsider as aviation scholars are also complement. Once the collected primary data are triangulated and each set of datum shows the data saturation; it is drawn to analyze by using the Content Analysis.

The key informants are asked the questions about their business operations according to Osterwalder and Pigneur (2010) analytical framework. After that, they are asked to give additional opinions about airport technical efficiency improvement - see Appendix A for the semi-structured questionnaire:

*"In your opinions, what kind of business components that your organization should consider in order to improve the technical efficiency of the airports?"*

To present the results from the in-depth interviews, three main keywords are identified and can be discussed as follows (Figure 6.37):

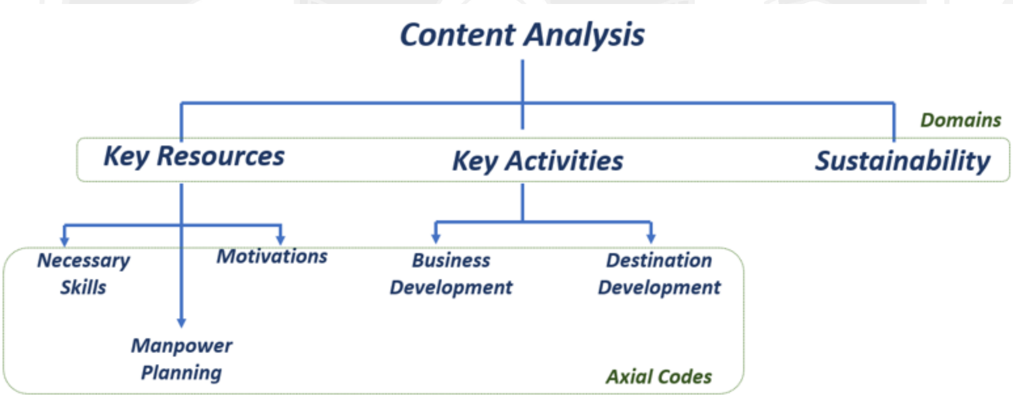



Figure 6.37 The Diagram Representing the Keywords from In-depth Interviews

1) Key Resources

Most of the key informants mentioned about the importance of human resource issues since it plays a part on technical efficiency improvement. The sub-ideas as said by the key experts can be classified into:

(1) Skills Necessary for Airport People

Working in an airport needs specific knowledge for specific job functions. However, most of the workers in an airport are lack of such solid foundation on airport businesses and losing the goals and mindset relating to airport operations. Some of managements are promoted by the political forces which virtually placing from non-airport organizations; therefore, they do not have the solid background and do not realize how important of an airport toward social and local economic development since some of the top management still have their perspectives focusing on infrastructure development despite the fact that the economic aspects are also crucial for efficiency improvement.

In addition to airport business orientation of airport people, they are supposed to have the skills relevant to Business Development and Aero Marketing. It is present that the budgets from the government for public airports are now losing ground; an airport is forced to generate revenues by itself. Hence, skillful airport people who keen on developing the airport businesses and doing the marketing are required as a key resource for airport operations. The sample of interviewing data from key informants is as follows:

"DOA is required to realize how the importance of local and regional airports is. Since DOA was mainly transformed from the Ministry of Transport, the mindset still sticks to the infrastructure development despite the fact that airports have duties and obligations more than that. Therefore, DOA needs to act as agency in the Ministry of Commerce as well. Specifically, DOA must utilize airports into more commercialized platforms and use the concepts of business development and also aero marketing."

(2) Incentives toward their operations

The structure of civil servant system directly has an impact on some of operational airport people. Since the airport budgets are slashed, some of airports are forced to employ the outsourcing policy or hire either a Permanent Employee or a Temporary Employee. As previously mentioned, working in an airport requires specific knowledge especially in the positions relating to safety and security; therefore, the budgeting on training is spread to Temporary Employee positions. However, due to the fact there is no promotion or even salary increment, motivations for employee engagement are somewhat zero. As they lack ambition; hence, operational inefficiency is likely to occur. The sample of interviewing data from key informants is as follows:

"It is clear that young staff are not willing to work in the airport in case they have better choice on career promotion. As there are not any salary adjustments and also other job promotions for temporary staff. Therefore, it makes sense why they do not have any work motivations. This issue is a part of inefficient airport operations."

(3) Manpower planning

The shortage manpower in an airport is another raised issue. Since some of an airport offers only tiny Civilian Servant positions and hire a limited number of Permanent Employees and Temporary Employees; thus, some of them are required to work double shifts. The exhausting occurring from this working regime causes the inefficiency of airport operations. The sample of interviewing data from key informants is as follows:

"Because of the insufficient positions of civil servants in the airport, once the flight is delayed, there are some temporary staff required to work more than their normal operation times and this creates serious exhaustion which literally making the staff are too tried to provide service excellence."

People development is another key resource of airport business operation. Although many job functions are replaced by technological devices, passengers prefer to make conversations with workers to artificial intelligence things. Therefore, some of the key experts insists that forming a team with airport business and goal orientation is the part of efficiency improvement.

2) Key Activities

Airport developments are the key activities for airport business operations. To upgrade the airport technical efficiency, the expert panels link the sub-ideas as follows:

(1) Business Development

Airport managements are required to train the positions that relating to airport business development. It is because the budget cutting puts the pressure on airport operations. Also, an airport needs to proactively attract airlines to operate a flight more than standing still as usual. Since non-aeronautical revenues are now playing a crucial part on airport revenue generation, an airport should develop and convert the available areas into commercial platforms. To efficiently develop airport businesses, an airport needs to hear the stakeholders and also build the key partnerships. The public hearing is not only reducing the chance of airline getting lose but also supplementing the right businesses of airport and other partnership operations. The sample of interviewing data from key informants is as follows:

"Although DOA is the government agency, setting the position relating to business development is essential. Since this position will allow DOA earn the non-aeronautical revenues more. Moreover, DOA should be realized the importance of airport business. It is more than the infrastructure. It acts a mechanism that enable local economic development. Also, it can be used as commercial platforms"

(2) Destination Development

To develop airport businesses together with destination development, an airport needs to search for its originality. Authenticity of destinations nearby an airport should be discovered. In order for linking the attractions with airport businesses, working with the provincial authorities and other key partnerships such as government agencies, communities, airlines, local brands, well-known brands are promising.

3) Sustainability

Airport operators needs to prepare the systematic and good developed plan for issues relating to sustainability. There are several dimensions to consider. Firstly, the plan should be provided to absorb expenditures causing from regulator legal implementations on noise pollution, waste management, carbon footprints and so on. One other thing, the airport development needs to consider any potential effects from airport operations on local communities. For example, if there is an expansion of an airport due to an increase in demand for air transportation, operators are required to concern the impacts causing from the flight frequency increment. The sample of interviewing data from key informants is as follows:

"Airport operators need to focus on sustainability issues. As in the near future, they are significant playing a part on cost incursion to airport operators for sure."

To illustrate the key main airport business components that deriving from the expert panels in order for improving the airport technical efficiency, Table 6.2 compares each component from each key informant groups.

Table 6.2 Summarization of Airport Business Model Components from Key Informants

| | **Data sources** | **Airport Business Model Components** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **CS** | **VP** | **CH** | **CR** | **RS** | **KR** | **KA** | **KP** | **CS** | **Other components** |
| Triangulation | Private airport managements | | | | | | ✓ | ✓ | ✓ | | Sustainability |
| | Privatized airport managements | | | | | ✓ | ✓ | ✓ | ✓ | | Sustainability |
| Triangulation | Public airport managements | | | | | ✓ | ✓ | ✓ | ✓ | | Sustainability |
| | Aviation scholars | | | | | ✓ | ✓ | ✓ | ✓ | | Sustainability |

## 6.4 Local and Regional Airport Business Model Frameworks: The Comparative Analysis

To develop local and regional airport business model framework, the analytical framework for local and regional airport business model designing are retrieved from the Comparative Analysis between the lessons learned gain from the World's Best airport and the World's Best regional airport and the results from the exploratory research collected from airport managements in Thailand.

Table 6.3 Summarization of Comparative Analysis between Documentary and Exploratory Research Approach

| **Methods** | **Data sources** | **Airport Business Model Components** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **CS** | **VP** | **CH** | **CR** | **RS** | **KR** | **KA** | **KP** | **CS** | **Other components** |
| Documentary Research | Singapore Changi International Airport (SIN) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | Sustainability |
| | Chubu Centrair International Airport (NGO) | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | | Sustainability |
| Exploratory Research | Private airport managements | | | | | | ✓ | ✓ | ✓ | | Sustainability |
| | Privatized airport managements | | | | | ✓ | ✓ | ✓ | ✓ | | Sustainability |
| | Public airport managements | | | | | ✓ | ✓ | ✓ | ✓ | | Sustainability |
| | Aviation scholars | | | | | ✓ | ✓ | ✓ | ✓ | | Sustainability |
| Local and regional airport business model components | | ✓ | ✓ | ✓ | ✓ | ✓✓ | ✓✓ | ✓✓ | ✓✓ | ✓ | Sustainability |

Note:

✓ This component is a apart of Osterwalder and Pigneur (2010)'s analytical framework.

✓✓ This component should be emphasized and well-developed.

Table 6.3 represents the Comparative Analysis between airport business model components. The lessons learned gained from the World's Best airport (Singapore Changi International Airport) and the World regional airport (Chubu Centrair International Airport) are compared with business model components drawn from the in-depth interviews from Thailand airport operators. By aligning the analysis basing on the common business model analytical framework of Osterwalder and Pigneur (2010) or Business Model Canvas (BMC), the results from the exploratory research share some common components to the results from the documentary research.

Figure 6.38 displays the analytical framework for designing the local and regional airports in Thailand. Four business model components - the Key Resources (KR), Key Activities (KA), Revenue Streams (RS) and Key Partnerships (KP) – are the airport operations that DOA should be focused. As empirically tested from the 2nd research objective, the Revenue Streams (RS) are the component playing a part on improving the airport technical efficiency. Still, there is another component that is stated during the interviews and it also presents in the airport operations of Singapore

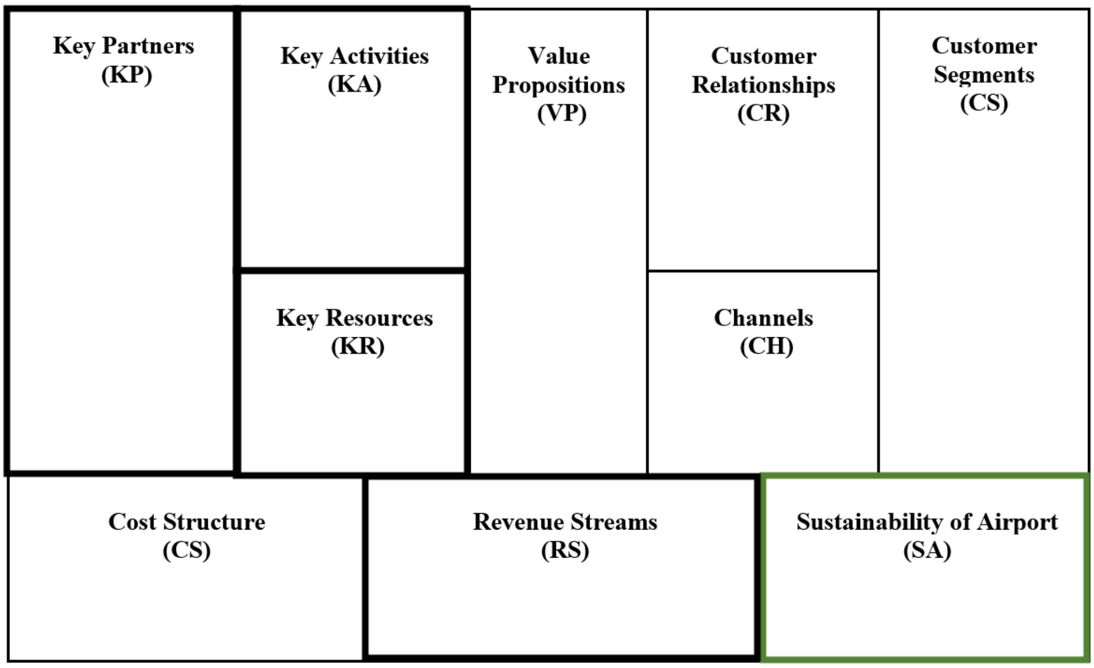



Figure 6.38 Analytical Framework for Designing Local and Regional Airport Business Model

Changi International Airport and Chubu Centrair International Airport. It is the Sustainability of an airport (SA) component. Although this component takes a large part in sustainable business model, it is hardly found in the airport literature (Bocken et al., 2014).

Since the definition of the business model as said in the first chapter is "an organizational template or a comprehensive model representing focal firm activities, transactions creating values and how a firm deliver them to all stakeholders." Therefore, the 9 building blocks – Customer Segments (CS), Value Propositions (VP), Channels (CH), Customer Relationships (CR), Revenue Streams (RS), Key Resources (KR), Key Activities (KA), Key Partnerships (KP) and Cost Structures (CS) – so called the Business Model Canvas (BMC) according to Osterwalder and Pigneur (2010) are constructed as the regional airport business model components. In addition to innovate the conventional BMC framework which emphasizing on the Revenue Streams (RS), Key Resources (KR), Key Activities (KA) and Key Partnerships (KP), the Sustainability of an airport (SA) is added in the local and regional airport business model analytical framework.

## 6.5 Conclusion

To construct the local and regional airport business model analytical framework, 2 qualitative methods are applied. The documentary research derived from analyzing airport operations between Singapore Changi International Airport (SIN) and Chubu Centrair International Airport (NGO) which are the World's Best airport and World's Best regional airport regarding SKYTRAX are investigated to create the lessons learned for holistic airport developments. The study discovers that there are some slight differences in airport business operations though they mostly share the common airport business model components. Hence, the local and regional airport business model designs should be customized for each strategic group regarding the conclusion.

Secondly, the exploratory research approach from Thailand airport managements are employed owing to the scarcity of airport business model literature.

The results reveal that the key expert panels mentioned the same business model components that allowing airports to improve their efficiency. Apart from Revenue Streams (RS), Key Resources (KR), Key Activities (KA) and Key Partnerships (KP), they are all agree that Sustainability of an Airport (SA) should be paid an attention.

By using the Comparative Analysis, it presents the new knowledge on the airport business model components which deriving from the documentary research and the exploratory research. In order to align the definition of business model previously reviewed in the Chapter 1 and 2 to what have found in this chapter, this study still employs the Business Model Canvas which consisting 9 components according to Osterwalder and Pigneur (2010). However, due to the comments from the key expert panels and the airport operations from Singapore Changi International Airport and Chubu Centrair International Airport, this study bridges the gap in the literature by adding the airport business components that is the Sustainability of an airport (SA) to the local and regional airport business model framework.

In summary, the lessons learned from the world best airports not only demonstrating the market and industry forces, but also providing insight information on how these airports run overall businesses to achieve the performance. Although the components of BMC are well-described the holistic airport operations of the world best airports, the information from the in-depth interviews also suggests that the framework for business model designing should consider the airport sustainability. With the 9 building blocks from conventional BMC together with additional building block, the framework for designing business model for Thailand local and regional airports and proposing the business model innovations is illustrated.

# CHAPTER 7

# BUSINESS MODEL DESIGNS AND INNOVATIONS FOR LOCAL AND REGIONAL AIRPORTS IN THAILAND

This chapter integrates all outputs from the 1st, 2nd and 3rd research objective to design and purpose the business models and business model innovations for local and regional airports in Thailand. By using the established strategic groups from Chapter 4, 3 local and regional airports under control of the Department of Airports (DOA) are purposively selected. The first section introduces the summarization of the outputs from the previous research objectives while the following sections design and propose the airport business models for Ubon Ratchathani International Airport (UBP), Suratthani International Airport (URT) and Lampang Airport (LPT) respectively. After that, the airport business model innovations suitable for each certain airport context are proposed and discussed to provide strategic options for airport business model innovating. Lastly, the conclusion is discussed what have been found from each local and regional airport business model.

## 7.1 Introduction

To design the local and regional airport business models, the outputs from each research objective are integrated (Table 7.1). The 1st research objective reveals that the designed business models are supposed to interact under the Air Navigation Act BE 2562. The output also confirms that the local and regional airports in Thailand are technically inefficient. With the effects of ownership patterns, airport revenues and the service-relating policies, they are the sources of such performance. To improve the technical efficiency of the local and regional airports, business model designs and business model innovations for local and regional airports in Thailand are proposed.

A business model for local and regional airports is defined as an organizational template or a comprehensive model representing focal firm activities, transactions creating values and how a firm deliver them to all stakeholders. By designing the business models for local and regional airports, this study develops the components which deriving from a series of documentary research together with airport managements' opinions and key airport stakeholder perspectives. With all above data collection, each component for business model design allows an airport to capture the value propositions and also the factors affecting the value proposition of all stakeholders. The process of airport business model design represents the overall business operations that local and regional airports should be.

Table 7.1 Summarization of Outputs from Each Research Objective

| **1st research objective** | **2nd research objective** | **3rd research objective** |
|---|---|---|
| **Situation of the local and regional airport industry** | **Factors affecting airport technical efficiency** | **Airport business model components** |
| Most of the local and regional airports are technically inefficient. The mean of the technical efficiency score is 0.188. By using the mean, the strategic group is created and divided into Above Average Group, Average Group and Below Average Group. According to the key experts, the Air Navigation Act BE 2562 (NO.14) is the most intensive factor affecting the situation of regional airport industry. | 1) Ownership Patterns (public and private forms)<br>2) Airport Revenues (the summation between aeronautical and non-aeronautical revenues)<br>3) Service-relating Policies | CS, VP, CS, CH, RS, KR, KA, KP, CS, SA |

As previously mentioned, the components of the models are required to discover. By using the documentary research and the exploratory research approach, the common components according to Osterwalder and Pigneur (2010) that are Customer Segments (CS), Value Propositions (VP), Customer Relationships (CS), Key Resources (KR), Key Activities (KA), Key Partnerships (KP), Revenue Streams (RS), Cost Structures (CS) and Channels (CH) are drafted as the local and regional airport components. To cover the whole operation of airport businesses, the Sustainability of an airport (SA) is also added.

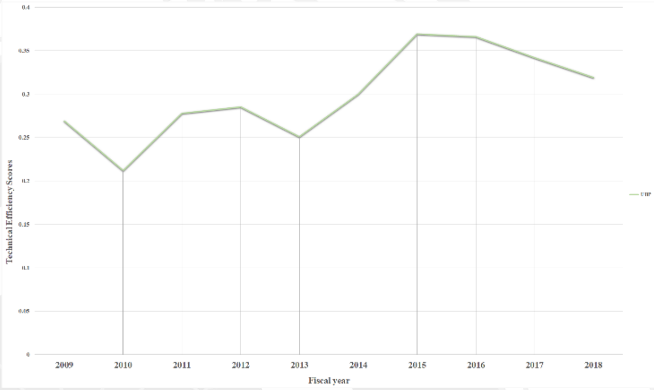
With the aim of technical efficiency improvement, the airport business models for each local and regional airport from each strategic group that was Ubon Ratchathani International Airport (UBP), Lampang Airport (LPT) and Suratthani International Airport (URT) were proposed. The qualitative research method was designed by collecting information from various airport stakeholders in order for capturing the value propositions. The local and regional airport managements from each strategic group, the airport users those were passengers, airlines, and ramp operators and the aviation scholars were surveyed by the in-depth interviews using the semi-structured questionnaire. The proposed airport business models for each strategic group are as follows

## 7.2 Airport Business Model Proposition for Ubon Ratchathani International Airport

### 7.2.1 General Airport Information

Ubon Ratchathani International Airport (UBP) was the representative of 4 local and regional airports purposively sampled from the Above Average Group according to the created Strategic Group. The airport was located in Ubon Ratchathani province, the North Eastern part of Thailand. According to Table 7.2, the information of the airport in 2018 fiscal year reveals that the airport had the traffic growth averagely increasing 3.29% comparing to the 2017 fiscal year. With the aircraft movements approximately 12,923, it produced the 1,884,320 passengers with total airport revenues around 93,130,178.50 Thai baht.

Table 7.2 General Information of Ubon Ratchathani International Airport (UBP)

| Selected local and regional airport information as of 2018 fiscal year | | Technical efficiency scores |
|---|---|---|
| Location | North Eastern part |  |
| Passengers | 1,884,320 | |
| Flights | 12,923 | |
| Aeronautical revenues (THB) | 83,544,386 | |
| Non-aeronautical revenues (THB) | 9,585,792.53 | |
| Traffic growth (2017-2018) | 3.29% | |

Source: Department of Airports (2019).

The mean of technical efficiency scores from 2009 to 2018 was equal to 0.299 which was ranked 4th among the regional airports under control of the Department of Airports (DOA). The technical efficiency score of Ubon Ratchathani International Airport showed the negative trend since 2015 after reaching the highest efficiency in 2016. While The mean of productivity change computed by the Malmquist Index was ranked as 18th among the local and regional airports. It presented the negativity during 2015-2018 with the peak point of technical efficiency productivity change in 2011.

**7.2.2 Proposed Local and Regional Airport Business Model**

To propose the airport business model for Ubon Ratchathani International Airport (Figure 7.1), voices from stakeholders such as airport managements, passengers, airline officers, ramp operators and aviation scholars were collected to provide the advisory for each component. The results are as follows:

1) Customer Segments (CS)

Since the local and regional airport should perform as “the multi-sided tourism platform” that bringing all airport stakeholders to join together. Due to the changing role of the airport that is now beyond only the transportation infrastructure; therefore, the customer segments should consist of passengers, airlines, residents and travelers.

2) Value Propositions (VP)

Due to the fact that the airport jobs are to perform the safety and security; thus, it is the most common way to create the value to airport users. In other words, the linkages between the data collected from passengers and airlines, they reveal that Ubon Ratchathani International Airport is required the measures for safety and security from the very first touch point of airport users. Also, the place around check-in counter should be clear and be ready for the airline staffs to perform their duties.

Accessibility, convenience and usability are other aspects to deliver the value to airport users, information from in-depth interviews indicate that the airport needs to pay more attentions to the terminal cleanliness and neatness. For examples, the seating areas, the trolley stowage and the public transports are not well-arranged. There are not enough money exchange counters, though it is the international airport. Also, Automatic Tell Machines (ATMs) are scarce and not sufficient for airport users. The accessibility to the food terraces is limited and not reflecting the provincial originality. In particular, they are located in the zone that are set outside the terminal. Some of the key informants from the airline customers reported that they are not convenient with the airport collaborations and hardly access the information that they need owing to the characteristics of civil servant styles.

As previously mentioned, the airport should go beyond what it is. The airport should develop the area and renovate in order to create something new but still remain its identity and authenticity to airport users as the newness is another approach to deliver values to stakeholders.

3) Customer Relationships (CR)

Since the service-relating policies plays a big part on airport technical efficiency significantly, the airport managements are recommended to provide the proper customer relationships to users. Personal assistants in the airport available but it should have been located in the area where it would easily be seen and contactable.

4) Channels (CH)

The channels to reach each customer segment are crucial since they allow the airport to deliver the right value propositions to the right groups. According to the in-depth interviews with some key informants, they insist that the airport should hold the public hearing from various airport stakeholders in order to adjust and cure the pain points that airport users are facing.

5) Revenue Streams (RS)

Airport revenues are the sources of airport technical efficiency. Therefore, the key activities should be well-developed to stimulate the revenue streams of the airport especially the revenues from the non-aeronautical businesses such as rental services, retail businesses or even the concessions. Since the ownership patterns also have an impact on airport technical efficiency; thus, allowing the private sectors to take part in business administration in the form of Public-private Partnerships (PPP) is the promising option and is agreeable by the airport management.

6) Key Resources (KR)

Human resources are the hot issue that key experts mentioned them as a key resource influencing the airport performance. Owing to the structure of government manpower planning, it mandates the airport to recruit only the permanent employee and temporary employee positions; therefore, they lack motivations and lose productivity to work for the airport. It is because they don't have the career development or even the job promotions. Moreover, because of these issues, the investments in human resources in the form of on-the-job training or costly training are possibly wasteful. Since if they get a better job, they will absolutely move forward.

The physical resources are also the key advantage of most local and regional airports under control of the Department of Airports (DOA). Due to the fact that they have plenty of airport arenas; thus, it allows the airports to utilize and develop the areas without the limitations relating to the zoning. Moreover, with the implementation of the Air Navigation Act (NO.14) BE 2562, all local and regional airports are qualified for using the Working Capital Fund which permitting Ubon Ratchathani International Airport controls their own revenues and budgeting.

7) Key Activities (KA)

From the best practice airport both from the World's Best airport and the World's Best regional airport, the airport development is required to stimulate activities relating revenue generations. Ubon Ratchathani International Airport should execute the proactive activities for attracting the attention of each customer segment. Such activities include Tourism Linkages, Destination Development and Event Organizations.

8) Key Partnerships (KP)

According to the lessons learned from Singapore Changi International Airport and Chubu Centrair International Airport, the key partnerships are the components behind their success and push the key activities into the amazing mega projects. Therefore, creating the connections and building the mechanism that linking among the provincial agencies, local governments, tourism organizations, local entrepreneurs, local universities and communities helps Ubon Ratchathani International Airport improve its airport business operations.

9) Cost Structures (CS)

Most of the cost structures of Ubon Ratchathani International Airport derive from the salary and compensations paid to the permanent employees, temporary employees and civil servants respectively. In addition, the infrastructure-relating expenditure is another cost immensely occurred from the airport operations.

10) Sustainability (SA)

Sustainability of an airport should be put the airport planning process. Although the part of the issues is mandated by the minimum requirements from international organization, the effects from airport operations should carefully be examined. It is because the impacts from noise pollution, waste management and carbon footprint will possibly cause the money from the regulators. For the case of Ubon Ratchathani International Airport, if the airport needs to expand the terminal due to the growth of traffic, the public hearing should be made as the airport is located in the center of the city.

In the societal and cultural perspectives, Ubon Ratchathani International Airport should interact with communities or even the local institutions. Since it allows the sense of belongings of the local people on the airport as a part of their society.

**KP**

**KP1** Army
**KP2** Local government
**KP3** Provincial agencies
**KP4** Tourism organizations
**KP5** Entrepreneurs
**KP6** Local institutions

**KA**

**KA1** Airport development
**KA2** Event Organization
**KA3** Destination development
**KA4** Tourism linkages
**KA5** Area management

**KR**

**KR1** Working Capital Fund
**KR2** Budgeting
**KR3** Physical resources
**KP4** Human resources

**VP**

**VP1** Convenience and usability
**VP2** Airport performance (safety and security)
**VP3** Newness
**VP4** Accessibility

**SA**

**SA1** Carbon footprint
**SA2** Waste management
**SA3** Noise pollution
**SA4** Community interaction

**CR**

**CR1** Personal assistant

**CH**

**CH1** Information center
**CH2** Public hearing
**CH3** Airport website

**CS**

**CS1** Airlines
**CS2** Passengers
**CS3** Tourists
**CS4** Residents

**CS**

**CS1** Compensation to staffs (permanent employees, temporary employees, civil servants)
**CS2** Operating costs (infrastructure, miscellaneous costs)

**RS**

**RS1** Non-aeronautical revenues (rental fees, retail businesses, concession fees, miscellaneous incomes)
**RS2** Aeronautical revenues (landing fees, parking fees, passenger service charges)

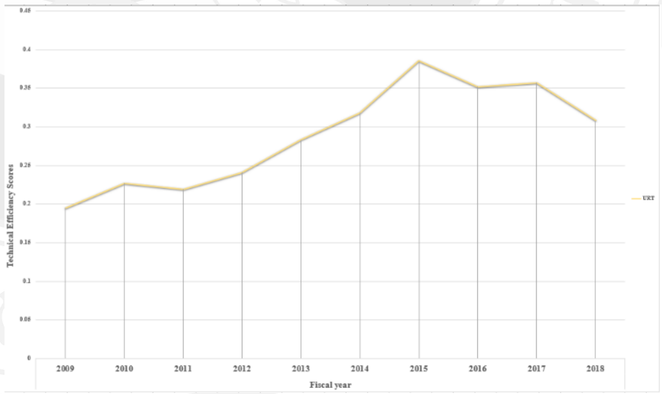
Figure 7.1 Local and Regional Airport Business Model for Ubon Ratchathani International Airport

## 7.3 Airport Business Model Proposition for Suratthani International Airport

### 7.3.1 General Airport Information

Suratthani International Airport (URT) was the only airport in the Average Group according to the created Strategic Group. The airport was located in Suratthani province, the Southern part of Thailand. According to Table 7.3, the information of the airport in 2018 fiscal year reveals that the airport had the traffic growth averagely decreasing 4.47% comparing to the 2017 fiscal year. With the aircraft movements approximately 15,993, it produced the 2,161,209 passengers with total airport revenues around 155,815,533 Thai baht.

Table 7.3 General Information of Suratthani International Airport (URT)

| **Selected local and regional airport information as of 2018 fiscal year** | | **Technical efficiency scores** |
|---|---|---|
| Location | Southern part |  |
| Passengers | 2,161,609 | |
| Flights | 15,933 | |
| Aeronautical revenues (THB) | 135,878,335.23 | |
| Non-aeronautical revenues (THB) | 19,937,198.18 | |
| Traffic growth (2017-2018) | -4.47% | |

Source: Department of Airports (2019).

The mean of technical efficiency scores from 2009 to 2018 was equal to 0.289 which was ranked 5th among the regional airports under control of the Department of Airports (DOA). The technical efficiency score of Suratthani International Airport showed the negative trend since 2015 after reaching the highest efficiency in the same year. While The mean of productivity change computed by the Malmquist Index was ranked as 16th among the regional airports. It presented the negativity during 2015-2018 with the peak point of technical efficiency productivity change in 2010.

**7.2.2 Proposed Local and Regional Airport Business Model**

To propose the airport business model for Suratthani International Airport (Figure 7.2), qualitative data from stakeholders such as airport managements, passengers, airline officers, ramp operators and aviation scholars were collected to provide the advisory for each component. The results were as follows:

1) Customer Segments (CS)

As the local and regional airport should perform as “the multi-sided tourism platform” that joining all airport stakeholders. Due to the changing role of the airport that is now beyond only the transportation infrastructure, therefore, the customer segments should consist of passengers, airlines, residents and travelers.

2) Value Propositions (VP)

Due to the fact that the airport jobs are to perform the safety and security; thus, it is the most common way to create the value to airport users. In other words, the linkages between the data collected from passengers and airlines, they reveal that Suratthani International Airport is required the measures for safety and security especially in the airside zone and car parking areas. Also, the airport should meet the safety and security standards such as the speed limitations on the airside or the procedures in case of airport emergency.

Accessibility, convenience, cost reduction and usability are other aspects to deliver the value to airport users, the repetitive information from in-depth interviews indicate that the airport needs to pay more attentions to the terminal and toilet cleanliness. The convenient stores and additional rental areas and check-in counters should be present also. The airport needs to set the price standard and examine the overprice food and beverages. In addition, some of the key informants reported that the airport should arrange the fair competition of ground transportation since there is only public transport monopolist in the area and it offers uncomfortable route networks.

As previously mentioned, the airport should go beyond what it is. The airport should develop the area and renovate in order create something new but still remain its identity and authenticity to airport users as the newness is another approach to deliver values to stakeholders.

3) Customer Relationships (CR)

Since the service-relating policies plays a big part on airport technical efficiency significantly, the airport managements are recommended to provide the proper customer relationships to users. Personal assistants in the airport available but it should have been placed in the easily accessible areas. Some of the key informants advised that the airport should select the proper personnel to work on this position.

4) Channels (CH)

The channels to reach each customer segment are crucial since they allow the airport to deliver the right value propositions to the right groups. According to the in-depth interviews with some key informants, they suggested that the airport provide the billboard or signs indicating the airport information and also tourist attraction available in the province. The interviewee also recommended that the staff acting as the information giver should be a good service provider.

5) Revenue Streams (RS)

As affirmed in the Chapter 5, airport revenues are the sources of airport technical efficiency. Therefore, the key activities should be well-developed to boost the revenue streams of the airport especially the revenues from the non-aeronautical businesses such as rental services, retail businesses or even the concessions. Since the ownership patterns also have an impact on airport technical efficiency; thus, allowing the private sectors to take part in business administration in the form of Public-private Partnerships (PPP) is the promising option and is agreeable by the airport management.

6) Key Resources (KR)

Human resources are the important issue that key experts mentioned them as a key resource influencing the airport performance in every selected airport. Owing to the structure of government manpower planning, it mandates the airport to recruit only the permanent employee and temporary employee positions; therefore, they lose productivity to work for the airport. It is because they don't have the career development, salary increment or even the job promotions. Moreover, because of these issues, the investments in human resources in the form of on-the-job training or costly training are possibly wasteful. Since if they get a better job, they will absolutely move forward.

The physical resources are also the key advantage of most local and regional airports under control of the Department of Airports (DOA). Due to the fact that they have plenty of airport arenas; thus, it allows the airports to utilize and develop the areas without the limitations relating to the zoning. Moreover, with the implementation of the Air Navigation Act (NO.14) BE 2562, all local and regional airports are qualified for using the Working Capital Fund which permitting Suratthani International Airport to monitor their own revenues and budgeting.

7) Key Activities (KA)

From the best practice airport both from the World's Best airport and the World's Best regional airport, the airport development is required to stimulate activities relating revenue generations. Suratthani International Airport should execute the proactive activities for attracting the attention of each customer segment. Such activities include Tourism Linkages, Destination Development and Event Organizations. Searching for the originality, authenticity, and potential of the province together with having the partnerships allows the airport to promote its role as "the multi-sided tourism platform".

8) Key Partnerships (KP)

According to the lessons learned from Singapore Changi International Airport and Chubu Centrair International Airport, the key partnerships are the components behind their success and push the key activities into the marvelous projects. Therefore, creating the connections and building the mechanism that linking among the provincial agencies, local governments, tourism organizations, local entrepreneurs, local universities and communities helps Suratthani International Airport improve its airport business operations.

9) Cost Structures (CS)

The cost structures of Suratthani International Airport derive from the salary and compensations paid to the permanent employees, temporary employees and civil servants respectively. In addition, the infrastructure-relating expenditure is another cost immensely occurred from the airport operations.

10) Sustainability (SA)

Sustainability of an airport should be put the airport planning process. Although the part of the issues is mandated by the minimum requirements from international organization, the effects from airport operations should carefully be examined. It is because the impacts from noise pollution, waste management and carbon footprint will possibly cause the money from the regulators.

In the societal and cultural perspectives, Suratthani International Airport should interact with communities or even the local institutions. Since it allows the sense of belongings of the local people on the airport as a part of their society.

## 7.4 Airport Business Model Proposition for Lampang Airport

### 7.4.1 General Airport Information

Lampang Airport (LPT) was the representative of 23 local and regional airports purposively sampled from the Below Average Group according to the created Strategic Group. The airport was located in Lampang province, the Northern part of Thailand. According to Table 7.4, the information of the airport in 2018 fiscal year reveals that the airport had the traffic growth averagely increasing 0.26% comparing to the 2017 fiscal year. With the aircraft movements approximately 4,960, it produced the 274,979 passengers with total airport revenues around 14,031,842.40 Thai baht.

The mean of technical efficiency scores from 2009 to 2018 was equal to 0.169 which was ranked 11$^{th}$ among the regional airports under control of the Department of Airports (DOA). The technical efficiency score of Lampang Airport showed the negative trend since 2016 after reaching the highest efficiency in 2016. While The mean of productivity change computed by the Malmquist Index was ranked as 17$^{th}$ among the local and regional airports. It presents the negativity during 2015-2018 with the peak point of technical efficiency productivity change in 2015.

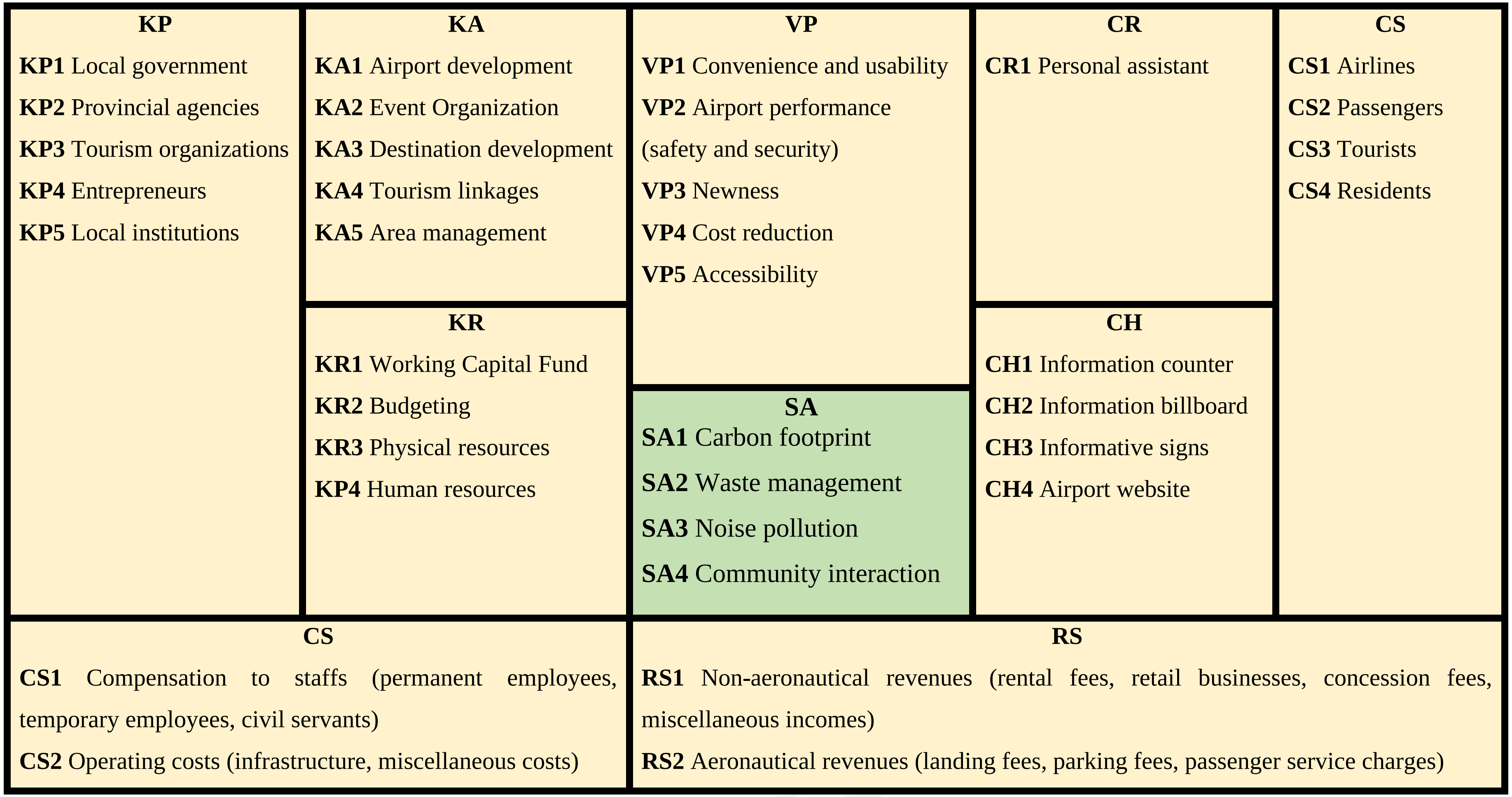
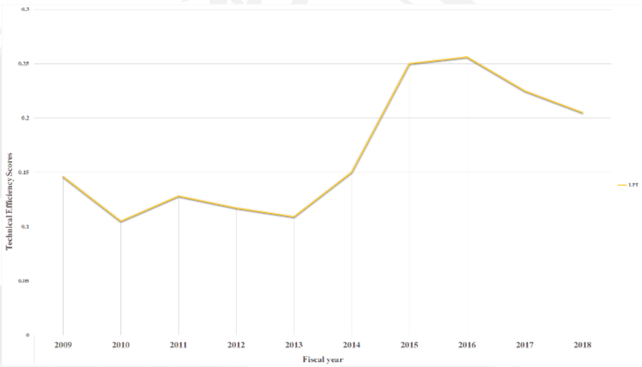



Figure 7.2 Local and Regional Airport Business Model for Suratthani International Airport

Table 7.4 General Information of Lampang Airport (LPT)

| Selected local and regional airport information as of 2018 fiscal year | | Technical efficiency scores |
|---|---|---|
| Location | Northern part |  |
| Passengers | 274,979 | |
| Flights | 4,960 | |
| Aeronautical revenues (THB) | 11,338,542.17 | |
| Non-aeronautical revenues (THB) | 2,693,300.22 | |
| Traffic growth (2017-2018) | 0.26% | |

Source: Department of Airports (2019).

**7.4.2 Proposed Local and Regional Airport Business Model**

To propose the airport business model for Lampang Airport (Figure 7.3), voices from stakeholders such as airport managements, passengers, airline officers, ramp operators and aviation scholars were collected to provide the advisory for each component. The results were as follows:

1) Customer Segments (CS)

Regarding the documentary research, Singapore Changi International Airport and Chubu Centrair International Airport develop their airports as a destination. Therefore, the customer segment should be more groups of passengers and airlines. Since the regional airport should perform as *"the multi-sided tourism platform"* that bringing all airport stakeholders to join together. Therefore, the customer segments should consist of passengers, airlines, residents and travelers.

2) Value Propositions (VP)

To propose the values to each customer segment, accessibility, convenience and usability should be regarded. According the in-depth interviews with passengers, the repetitive data reported that the toilet hygienic, food and beverage selections and zoning, ground public transportation should be serviced and sufficiently arranged.

Some of the key informants from the airline customers reported that they are not convenient with the airport collaborations and hardly access the information that they need owing to the characteristics of civil servant styles. Moreover, the airport should hold the meeting sessions permitting airport stakeholders to join in order for giving the operational feedback.

To effectively propose and deliver the values, the airport should go beyond what it is. The airport should develop the area and renovate in order create something new but still remain its identity and authenticity to airport users as the newness is another approach to deliver values to stakeholders.

3) Customer Relationships (CR)

Since the service-relating policies plays a big part on airport technical efficiency significantly, the airport managements are recommended to provide the proper customer relationships to users. Personal assistants in the airport available but it should have been located in the area where the users could reach.

4) Channels (CH)

The channels to reach each customer segment are crucial since they allow the airport to deliver the right value propositions to the right groups. According to the in-depth interviews with some key informants, they insist that the airport should hold the comprehensive public hearing from various airport stakeholders in order to adjust and cure the pain points that airport users are facing. Moreover, according to the documentary research, connecting the airport and users with the interactive website creates the customer experiences and it is the effective channels to deliver what the airport has.

5) Revenue Streams (RS)

Airport revenues are the sources of airport technical efficiency. Therefore, the key activities should be well-developed to stimulate the revenue streams of the airport especially the revenues from the non-aeronautical businesses such as rental services, retail businesses or even the concessions. Since the ownership patterns also have an impact on airport technical efficiency; thus, allowing the private sectors to take part in business administration in the form of Public-private Partnerships (PPP) is the interesting option and is agreeable by the airport managements.

6) Key Resources (KR)

The employment structure is the frequently mentioned issue that key experts refer to them as a key resource influencing the airport performance. Owing to the structure of government manpower planning, it mandates the airport to recruit only the permanent employee and temporary employee positions; therefore, they lack motivations and lose productivity to work for the airport. It is because they don't have the career development or even the job promotions. Moreover, because of these issues, the investments in human resources in the form of on-the-job training or even costly training courses are tentatively uneconomical. Since if they get a better job that having career development, they will exactly move forward.

The physical resources are also the key advantage of most local and regional airports under control of the Department of Airports (DOA). Due to the fact that they have plenty of airport arenas; thus, it allows the airports to utilize and develop the areas without the limitations relating to the zoning. Moreover, with the implementation of the Air Navigation Act (No.14) BE 2562, all local and regional airports are qualified for using the Working Capital Fund which permitting Lampang Airport to manage their own revenues and budgeting.

7) Key Activities (KA)

From the best practice airport both from the World's Best airport and the World's Best regional airport, the airport development is required to stimulate activities relating revenue generations. Lampang Airport should execute the proactive activities for attracting the attention of each customer segment. Such activities include Tourism Linkages, Destination Development and Event Organizations.

8) Key Partnerships (KP)

According to the lessons learned from Singapore Changi International Airport and Chubu Centrair International Airport, the key partnerships are the components behind their success and push the key activities into the amazing projects. Therefore, creating the connections and building the mechanism that linking among the provincial agencies, local governments, tourism organizations, local entrepreneurs, local universities and communities helps Lampang Airport improve its airport business operations.

9) Cost Structures (CS)

Operating costs of Lampang Airport is mostly structured by the amount of salary and compensations paid to the permanent employees, temporary employees and civil servants respectively. In addition, the infrastructure-relating expenditure is another cost immensely occurred from the airport operations.

10) Sustainability (SA)

Sustainability of an airport should be put the airport planning process. Although the part of the issues is mandated by the minimum requirements from international organization, the effects from airport operations should carefully be examined. It is because the impacts from noise pollution, waste management and carbon footprint will possibly cause the money from the regulators. For the case of Lampang Airport, if the airport needs to expand the terminal due to the growth of traffic, the public hearing should be made as the airport is confronting the PM 2.5 situation.

In the societal and cultural perspectives, Lampang Airport should interact with communities or even the local institutions. Since it allows the sense of belongings of the local people on the airport as a part of their society. Moreover, the future airport development requires to consider for the concepts of universal design, surveying the demands of the disables in the area should be conducted regarding the findings form the documentary research.

## 7.5 Airport Business Model Innovations for Local and Regional Airports in Thailand

The previous sections present the airport business model or what overall airport operations that each Thailand local and regional airport from each strategic group should do and focus on. In this section, the business model innovations which

| KP | KA | VP | CR | CS |
|---|---|---|---|---|
| **KP1** Local government<br>**KP2** Provincial agencies<br>**KP3** Tourism organizations<br>**KP4** Entrepreneurs<br>**KP5** Local institutions | **KA1** Airport development<br>**KA2** Event Organization<br>**KA3** Destination development<br>**KA4** Tourism linkages<br>**KA5** Area management | **VP1** Convenience and usability<br>**VP2** Newness<br>**VP3** Accessibility | **CR1** Personal assistant | **CS1** Airlines<br>**CS2** Passengers<br>**CS3** Tourists<br>**CS4** Residents<br>**CS5** Ramp operators |
| | **KR** | **SA** | **CH** | |
| | **KR1** Working Capital Fund<br>**KR2** Budgeting<br>**KR3** Physical resources<br>**KP4** Human resources | **SA1** Carbon footprint<br>**SA2** Waste management<br>**SA3** Noise pollution<br>**SA4** Community interaction | **CH1** Public hearing<br>**CH2** Airport website | |

| CS | RS |
|---|---|
| **CS1** Compensation to staffs (permanent employees, temporary employees, civil servants)<br>**CS2** Operating costs (infrastructure, miscellaneous costs) | **RS1** Non-aeronautical revenues (rental fees, retail businesses, concession fees, miscellaneous incomes)<br>**RS2** Aeronautical revenues (landing fees, parking fees, passenger service charges) |

Figure 7.3 Local and Regional Airport Business Model for Lampang Airport

are defined as the strategic options for improving technical efficiency by innovating the common airport business models of local and regional airports in Thailand. To achieve the expected outcomes, the present airport business model that is common for local and regional airports in Thailand is firstly demonstrated. After that, the rigorous discussion among results from every research objective especially the lessons learned from the World's Best Airport and World's Best Regional Airport are critiqued with the recent conditions of local and regional airport business models in order to display the innovation gaps. Ultimately, the airport business model innovations suitable for certain contexts are proposed to complete the last research objective of this dissertation.

### 7.5.1 Common Airport Business Models of Local and Regional Airports in Thailand

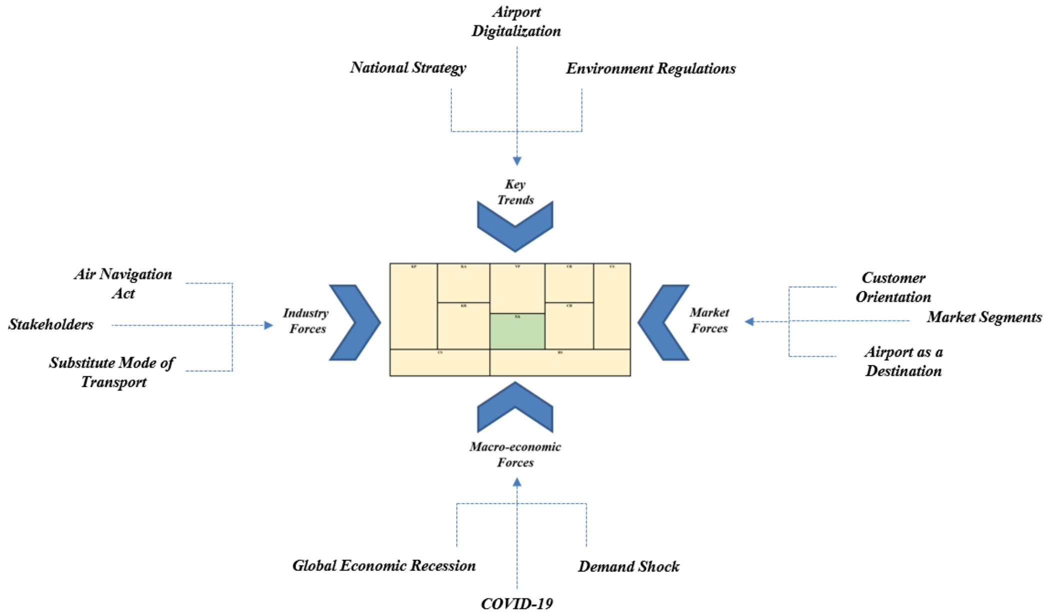



Figure 7.4 Common Airport Business Model for Local and Regional Airports in Thailand

The as-is business models of local and regional airports in Thailand are found to share the same format although the airport business models are from the different strategic group. It is plausible to state that the as-is airport business models of local and regional airports are mainly driven by the Air Navigation Act (No.14) BE 2562 as they are a public agency and such legislation influences overall airport business operations However, the investigations of the situation of local and regional airport industry, factors affecting the airport technical efficiency and lessons learned from the world best airports reflect the truth that the airport business models require individual customization and one-size-fit-all business models should avoid. Consequently, the should-be airport business models of local and regional airports in Thailand are presented in the previous sections.

The common local and regional airport business model can be illustrated as Figure 7.4. The common business model of local and regional airports in Thailand is influenced by several key trends, market forces, industry forces and macro-economic forces. The key trends toward airport business operations include airport digitalization, the national strategy framework and the regulations relating to environmental and sustainability issues.

While the market forces effect the airport business model are the customer orientation that playing a part on airport policy. It is because the airports tend to commercially develop its businesses; hence, good service quality policies are enforced to implement and expected from airport users. Other market forces include how the airports extend their customer segments to serve airport development policies and how to utilize the airports as a tourism platform where bringing a variety of customer segments together.

For industry forces, airport stakeholders mainly influence on overall business operations. Therefore, identifications of main stakeholders are essential. The Air Navigation Act (No.14) BE 2562 is another industry force shaping the local and regional airport businesses while the substitution mode of transport is potentially forcing the airport operations since the high speed train mega project is in the progress throughout the country.

Table 7.5 The Comparative Analysis between the Best Airports and the as-is Business Model of Local and Regional Airport in Thailand

| Airport business model framework | Best practice airports | | Local and regional airports in Thailand | | | Gaps for business model innovations |
|---|---|---|---|---|---|---|
| | SIN | NGO | UBP | URT | LPT | |
| CS | Airlines, airports, passengers, tourists, residents and foodie | Airlines, passengers, tourists, residents, athletes and foodie | Airlines and passengers | Airlines and passengers | Airlines and passengers | Airports, tourists, residents, athletes and foodie |
| VP | Newness, performance, customization, convenience, usability and accessibility | Newness, friendly design, performance, customization, convenience, usability and accessibility | Performance and convenience | Performance and convenience | Performance and convenience | Newness, friendly design, customization, usability and accessibility |

| Airport business model framework | Best practice airports | | Local and regional airports in Thailand | | | Gaps for business model innovations |
|---|---|---|---|---|---|---|
| | SIN | NGO | UBP | URT | LPT | |
| KA | Airport development, Jewel Changi Airport, Changi East Project and destination development | Airport development, local event organizing, destination development, tourism linkages | Airport infrastructure development and area development | Airport infrastructure development and area development | Airport infrastructure development and area development | Local event organizing, destination development, tourism linkages |
| KR | Talent management and physical resources | Intellectual resources, Centrair Operation Center, Staff | Physical resources such as runway, taxi way, apron, terminal, parking lots etc. | Physical resources such as runway, taxi way, apron, terminal, parking lots etc. | Physical resources such as runway, taxi way, apron, terminal, parking lots etc. | Talent management and other physical resources |
| KP | Strategic partnership, joint ventures and cross-industry partnership | Strategic partnerships and Cooperation of EAAA | Slight partnership with private sectors | Slight partnership with private sectors | Slight partnership with private sectors | Strategic partnership, joint ventures and cross-industry partnership |

| **Airport business model framework** | **Best practice airports** | | **Local and regional airports in Thailand** | | | **Gaps for business model innovations** |
|---|---|---|---|---|---|---|
| | **SIN** | **NGO** | **UBP** | **URT** | **LPT** | |
| CR | Automated self-service, FAST system and Automated personal assistant | Personal assistants and automated services | - | - | - | Personal assistants and automated services |
| CH | iShopChangi, iChangi Mobile Application, Social media platforms and airport website | Social media platforms, airport website and call center | Telephone | Telephone | Telephone | Social media platforms, airport website and call center |
| RS | Airport service fees, concession and rental fees | - | Aero and non-aero nautical revenues | Aero and non-aero nautical revenues | Aero and non-aero nautical revenues | Focusing on more concession and rental fees |

| Airport business model framework | Best practice airports | | Local and regional airports in Thailand | | | Gaps for business model innovations |
|---|---|---|---|---|---|---|
| | **SIN** | **NGO** | **UBP** | **URT** | **LPT** | |
| CS | depreciation, amortization, services, security-relating fees, government charges, regulatory fees and maintenance fees | - | High proportions are from staff and other operating costs | High proportions are from staff and other operating costs | High proportions are from staff and other operating costs | - |
| SA | The Sustainability Working Group, Changi Foundation, CSR projects, Singapore Zero Waste and Singapore Climate Action Plan | Airport universal design, volunteer activity project and Green Initiatives | - | - | - | CSR projects, universal design airports and environmental plans |

Lastly, the macro-economic factors are the additional forces driving the local and regional airport business model in Thailand. Due to the COVID-19 pandemic, it effects the demand for tourism and transportation. The aftershock from the pandemic possibly creates the global economic recession which ultimately having an impact on common business model.

In summary, although the one-size-fit-all business models are not workable for airports from each strategic group under the same business environments, the business model innovations for developing each BMC components should be observed. To accomplish such objective, the discussion between the as-is airport business model and the best practice airports are discussed in the next section.

### 7.5.2 Discussion and Gap Analysis between Best Practice Airports and Thailand Local and Regional Airports

To discuss and illustrate the gap between what have learned from the World's Best and World's Regional Best airport and the common airport business models of local and regional airports in Thailand, Table 7.5 displays the comparative analysis that showing the discussion between the best model and the present model of local and regional airports. By using the airport business model analytical framework developed from the 3rd research objective, the gaps used for proposing and developing the airport business model innovations are as follows:

It is clear that the customer segments (CS) between the world best airports and the local and regional airports under DOA are different. Although airports, tourists, residents, athletes and foodie are identified as the group of customer segments for recent airport operations, except the airport customer segments should be neglected. It is because the feasibility of customer segmentation for DOA should consider only tourists, residents, athletes and foodie; hence, they all should be clearly identify in order to create the right value proposition to each group of customers. The Value Proposition-oriented Business Model is presented as a business model innovation.

Newness, friendly design, customization, usability and accessibility should be offered to airport users as a value proposition. It is the availability of several customer segments in the local and regional airports in Thailand. Apart from identifying the right customer segments as previously mentioned, Managements from each DOA airport should carefully select the right value proposing to the right group. The business model innovation from this gap is provided in the next section as the Value Proposition-oriented Business Model.

As discussed, the airport is the multi-sided platform bringing several customer segments together, diverse key activities within the airports should be occurred to create specific values. Such activities include local event organizing, destination development and tourism linkages around airports. To offer various key activities to create values for each diverse customer segment in the airports, strong partnerships and cross-industry partners among airport stakeholders which is another innovation gap is also needed. Therefore, the Local Partner-and-engagement Business Model is proposed as a business model innovation in the next section. By integrating partnership though sustainability projects and development plans such as CSR projects, universal design projects and environmental and community development projects, the engagement among stakeholders is possible.

To utilize and implement all development plans, key resources such as airport talent and other physical resources should be well-defined. The proper human resource management polies that attracting and creating motivations among workers should be formulated under the hearing both expectations and pain points from airport staff.

Channels to reach each customer segments are also important. The local and regional airport websites and interactive social media platforms should be well-developed. Since they provide the source of information which users can easily search for what they want; additionally, they can convey the messages and values to each segment. Moreover, the personal assistants around the airport arenas should be properly located in the visible zone so that users can experience and easily access the airport information and other relevant procedures.

Lastly, the local and regional airports in Thailand should look for non-aeronautical revenue sources due to the trend toward budget slashing. Hence, revenue resources from rental and concession fees should additionally be collected. Moreover, the revenues arising from the destination development basing on airport development should be pain an attention. The next section presents another business model innovation so called the Airport-as-a-tourism Destination Business Model. It is intended to transform the local and regional airports to another destination in the province where bring together tourism activities and so on.

In summary, the comparison between the world best practice airports and the as-is airport business models displays the significant choice to innovate the airport business model components. The next section explains the novel way to improve the airport business model of local and regional airports in Thailand.

### 7.5.3 Airport Business Model Innovations for Local and Regional Airports in Thailand

As discussed in Table 7.5, business model innovations refer to the strategic options derived from the development of each conventional airport business model component. The objectives are to properly segment the group of airport users which leading to right value propositions, initially link the strategic partnership network, develop and utilize the airports as destination. Such airport business model innovations are expected to enhance airport revenues and ultimately improve airport technical efficiency of local and regional airports in Thailand. The innovating choices of some BMC components are suggested as follows:

1) The Value Proposition-oriented Business Model

The lessons learned from the world best airports both from Singapore Changi International Airport (SIN) and Chubu Centrair International Airport (NGO) indicate that airport users are beyond conventional groups of airlines and passengers. Therefore, to draw more non-aeronautical revenues from other groups of users, identifications of each customer segment in order to propose the right values are important. It is because the variety of customer segments affect the diverse value propositions.

To offer the solution for this circumstance, this type of airport business model innovation is proposed with an intension to capture the value for each customer segment that local and regional airport in Thailand should focus on in order to achieve higher technical efficiency. Therefore, each local and regional airport need to specify the right group of customer segments so that the management can develop the managerial policy to serve the right group with the right value propositions (Figure 7.5).

| Airport business model framework | UBP | | | URT | | | LPT | | |
|---|---|---|---|---|---|---|---|---|---|
| | CS 1 | CS 2 | CS 3 | CS 1 | CS 2 | CS 3 | CS 1 | CS 2 | CS 3 |
| VP for each CS | ? | ? | ? | ? | ? | ? | ? | ? | ? |

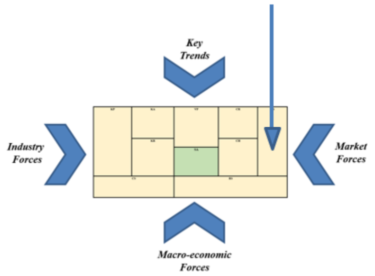



Figure 7.5 Sample of Airport Business Model Innovation – the Value Proposition-oriented Business Model

2) The Local Partner-and-engagement Business Model

As key partnership is a part of business model, the Local Partner-and-engagement Business Model (Figure 7.6) is proposed to illustrate the airport partners of local and regional airports of Thailand. They should comprise various groups of stakeholders. Since the airport is the huge platform bringing economic activities along within its location, entrepreneurs, tourism authorities, provincial agency, local government agency, communities and local higher education should be engaged and synchronized as mechanism to develop the airports. It is because strong partnership can synergy business resources and create mutual benefits among airport stakeholders. Collaborative mechanisms that linking the local and regional airport stakeholders should be well-established. Identifications the right stakeholders and arranging the public hearing for collecting expectations and pain points from each group should be performed. To facilitate this mechanism and collaborations, DOA should act as a host to conduct the regular meetings.

With the cooperation among stakeholders, key activities for airport development are possible.

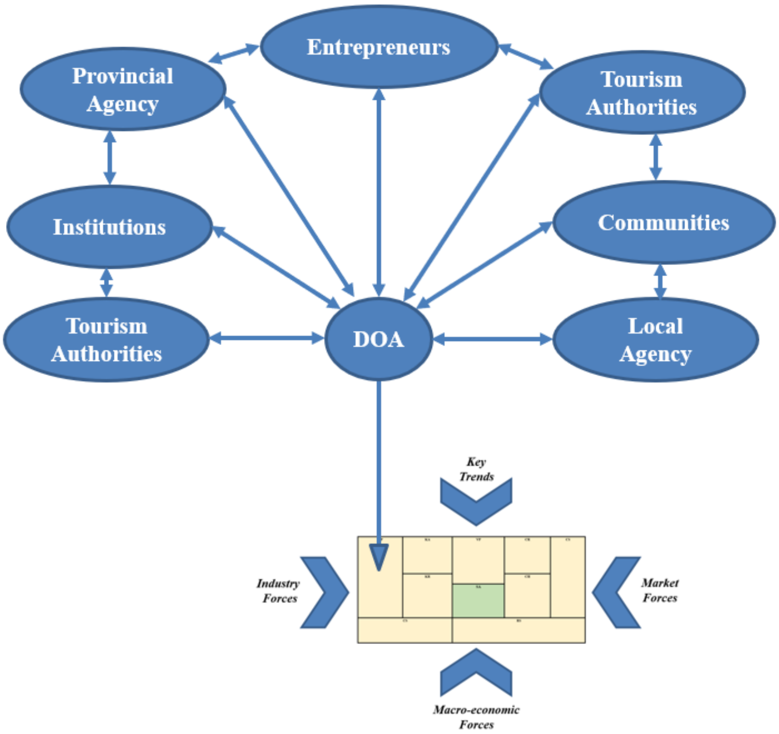



Figure 7.6 Sample of Airport Business Model Innovation – the Local Partner-and-engagement Business Model

3) The Airport-as-a-tourism Platform Business Model

Since the airport contains several groups of customer segments, variety of activities to create diverse value propositions should be available. As the airport should act as a multi-sided platform, tourism components should be integrated in order to create non-aeronautical revenues to local and regional airports. Therefore, the concept of destination development should be applied to airport development to increase airport revenues as they are a part of technical efficiency drivers.

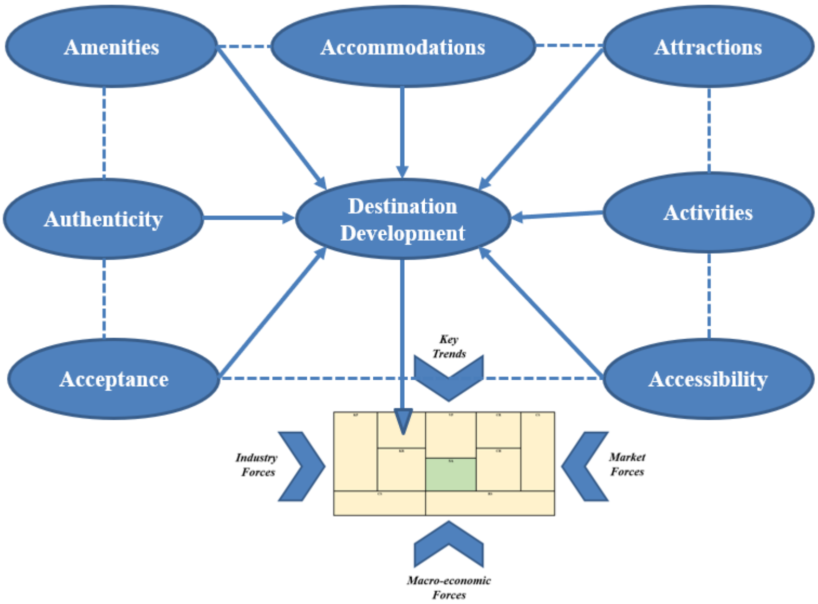



Figure 7.7 Sample of Airport Business Model Innovation – the Airport-as-a-tourism Platform Business Model

Figure 7.7 represents the Airport-as-a-tourism Platform Business Model. This airport business model innovation is linked by the concept of destination development as a key activity for local and regional airport development. In particular, the concept of 7As – Attractions, Accommodations, Amenities, Activities, Accessibilities, Authenticity and Acceptance – is employed to transform the airport as an infrastructure to a platform used for tourism purposes.

The local and regional airport from each location should represent the sense of place of each province (Authenticity). The originality of culture should tangibly be displayed around the airports. The ground transportation (Accessibility) should be easily to accessed and affordable. This is how the sample of stakeholders in the part of local tourism agency, provincial transport bureau should play a part on this provision. The activities in airport should be well-arranged. The regular shops, monthly fairs and annual events showing the local products and identity of the area should be provided with the collaboration among the partners. Amenities within the airports should be present with neat, clean and serve the right customer segments. Information relating to accommodations should be easily reached. To implement the business model innovations, the strong partnerships and acceptance from airport stakeholders are required.

## 7.6 Conclusion

The as-is airport business models of local and regional airports in Thailand presently share the same BMC components although they have different details in each component in nature. Therefore, this chapter proposes the should-be business models for local and regional airports in Thailand. The local and regional airport business models from each strategic group mostly share the common airport business components. Still, there are 5 of 10 that showing the same airport operations that are Key Resources (KR), Key Activities (KA), Revenue Streams (RS), Cost Structures (CS) and Sustainability of Airport (SA). It is because the effects of the Air Navigation Act (No.14) BE 2562 shadowing their business administration. Therefore, the airport business model design for each airport also needs an individual customization and should not be one-size-fit-all designs since there have different Customer Segments (CS) which leading to the diversity in Value Propositions (VP), Customer Relationships (CR), Channels (CH) and Key Partnerships (KP) among the selected local and regional airports in Thailand. The airport business model designs from each strategic group supports the findings from Frank (2011) who reported that the airport business model have the heterogenous characteristics and need specific designs. It is because each selected local and regional airport have diverse contexts especially their originality and authenticity. For example, if an airport has the potential to hold sport events, then the customer segment relating to athletes or sport tourists should be considered. Once the Customer Segment component (CS) is different, it created the diversity among Value Propositions (VP), Customer Relationships (CR), Channels (CH) and Key Partnerships (KP)

This chapter also answer the ultimate research objective that is to propose the business model innovations suitable for certain contexts. With the gap arising from the discussion between the best airports and the common business model of local and regional airport in Thailand, the samples of business model innovations are introduced in order to improve the technical efficiency of local and regional airports in Thailand. The Airport-as-a-tourism Platform Business Model, the Local Partner-and-engagement Business Model and the Value Proposition-oriented Business Model are introduced as they are the most feasible and suitable to the contexts of local and regional airports under operations of the Department of Airports.

# CHAPTER 8

# CONCLUSION AND FUTURE RESEARCH

This chapter illustrates the whole picture of this dissertation. It divides into triple main sections. The first part is the summary of the study. It provides the brief conclusions and answers to all research objectives examined in this dissertation. A series of policy recommendations, airport business model implications and business model innovations are also given. The second section follows with the limitations of the study which the author confronting along the research processes. Basing on the previous part, the third section describes the future research recommendations. In order to allow the further applications for airport authorities, all sections are carefully presented in jargon-free writing.

## 8.1 Summary of the Dissertation

The outputs from the 1st research objective indicated that the interactions among structure, conduct and performance, which affected by the political, economic, societal, technological, environmental and legal factors, represented the situation of the local and regional airport industry in Thailand. By surveying the opinions from the key experts using the PESTEL-AHP approach which is the scarcity methods employed in the airport and industry analysis literature, they mostly agreed to weigh the Air Navigation Act (No.14) BE 2562 as the crucial factor having the most intensive impacts on the industry. Since the Air Navigation Act BE 2562 had limit the number of airport operators (Structure); it enforces how a local and regional airport ran its own businesses; the Act then indicates the performance of a local and regional airport respectively.

To evaluate the performance of the local and regional airports in Thailand which represented by the technical efficiency scores, the Banker et al. (1984)'s Data Envelopment Model processed by DEAP 2.1 revealed that the technical efficiency of local and regional airports tends to be inefficiency as the scores computed by the model yielded the average score of 0.188. With the mean computation, the strategic groups were created to separate the local and regional airports into the Average Score Group, the Below Average Group and the Above Average Group. The representative of each group was Suratthani International Airport (URT), Lampang Airport (LPT) and Ubon Ratchathani International (UBP). They were purposively sampled by considering the negative trend of technical efficiency scores and the productivity change toward airport technical efficiency. These findings supplemented the small airport literature which were under studied due to the limitations of data availability.

To search for the sources of technical inefficiency, the econometric model was specified under the structure-conduct and Performance paradigm. The second-stage panel regression was employed to examine the factors affecting the airport technical efficiency. After achieving the Gauss-Markov Theorem assumptions and processing the model by EViews® 10, this new econometric model shed the light that the ownership patterns, airport revenues and service-relating policies of an airport play statistically significant parts on local and regional airport performance with 99% confidential levels. This finding ceased the inconsistent and inconclusive results of ownership patterns on airport performance; thus, the gap in the literature was filled.

To improve the airport technical efficiency, the revisions of a business model were introduced as it had the capability of efficiency upgrading according to Zott and Amit (2007), Zott and Amit (2008) and Afuah (2019). However, due to the scarcity of airport business model literature, the components for designing were required to rely on the exploratory research. By collecting the qualitative data from Thailand airport managements together with the documentary research gathered from the World's Best airport (Singapore Changi International Airport) and the World's Best regional airport (Chubu Centrair International Airport), the study complied the business model analytical framework by Osterwalder and Pigneur (2010) which the study found out that the framework is well-described the overall airport operations of the world best airports. However, to virtually cover the airport business model components deriving from the Comparative Analysis between the in-depth interview results and the outputs from the documentary investigation, the Sustainability of Airport (SA) component was added in order for bridging the academic gap and supplementing the analytical framework for business model designs in the literature.

The business models, which defined as the organizational template or a comprehensive model representing focal firm activities, transactions creating values and how a firm delivers them to all stakeholders, were constructed by collecting qualitative data from all airport stakeholders. They were proposed to improve the local and regional airport technical efficiency. After designing the airport business models for Suratthani International Airport (URT), Lampang Airport (LPT) and Ubon Ratchathani International (UBP), the study discovered that the selected local and regional airport business models shared the common airport business components. The Key Resources (KR), Key Activities (KA), Revenue Streams (RS), Cost Structures (CS) and Sustainability of Airport (SA) reflected the arguments. It was because of the impacts of the Air Navigation Act (No.14) BE 2562 shadowing their business administration. The result aligned with the weight estimation from the PESTEL-AHP process. Therefore, the airport business model design for each airport needed the customization since there had different Customer Segments (CS) which leading to the diversity in Value Propositions (VP), Customer Relationships (CR), Channels (CH) and Key Partnerships (KP) among the selected local and regional airports.

Apart from the airport business model designs, business model innovations which defined as the strategic options for innovating the airport business models suitable for certain contexts of local and regional airports in Thailand were also purposed in order to improve airport technical efficiency, the Airport-as-a-tourism Platform Business Model, the Local Partner-and-engagement Business Model and the Value Proposition-oriented Business Model were introduced as they were the most feasible, practical and appropriate to the contexts of local and regional airports under operations of the Department of Airports.

## 8.2 Policy Recommendations and Managerial Implications

The overall findings provide several policies and managerial implications for the DOA as an airport operator. The recommendations are as follows:

### 8.2.1 Policy Recommendations

1) DOA should consider the possibilities of adopting an ownership and control approach to airport administration since the ownership forms were reported as the most significant effect on airport technical efficiency and this result aligned with the lessons learned from the documentary research. Thus, corporatization form or Public-private Partnerships (PPPs) should be considered to achieve preferable airport performance.

2) To facilitate the ownership and control approach, the recent Air Navigation Act should be revised. Since the airport business models of local and regional airports are enforced by the Air Navigation Act (No.14) BE 2562, the revision of the relevant legislation should be amended by using the participatory process from airport stakeholders. According to rapid changes, agile airport business operations in various aspects such as revenue enhancement, airport development, area utilization and so on should be emerged to improve airport technical efficiency.

3) DOA should focus on implementing service-quality policies. For example, serious customer satisfaction surveys or monthly meetings among airport users such as airlines, ramp operators and other ground service supporting companies should be held to listen to their pain points. Since the local and regional airports aim to commercialize their resources to enhance airport revenues; therefore, the quality of services offers to customers should never be neglected.

### 8.2.2 Managerial Implications

1) In order to increase both aeronautical revenues and nonaeronautical revenues, as proposed by the business model innovations, DOA should pay attention to other customer segments not only passengers and airlines but also other potential groups of airport users. It is because a variety of customer segments mean diverse sources of airport revenues. Once an airport defines the right segments of airport users, other

business model components such as resources, channels, value propositions, customer relationships will be delivered and developed in the right direction.

2) DOA should develop key activities to serve and match each customer segment. To serve several customer segments, many airport key activities from the supports of strategic partnerships are highly important. As lessons learned from the Word's Best Airport and the World's Best Regional Airport provide several guidelines to DOA, especially to follow how they connected to their partnerships. Therefore, DOA should establish the connections and practical mechanism among airport stakeholders to play a part in airport development. Such partnerships include airlines, local government agencies, provincial authorities, regional tourism organizations, local entrepreneurs, traders, communities and scholars since the airport is considered as *"the multi-sided tourism platform."* Although the scale of those best practice airports is quite different from local and regional airports in Thailand, the lessons learned also present the guidelines and mechanisms for airport development.

3) Local and regional airports should perform themselves as a destination. As an airport plays a part in local and regional economic development, commercial activities such as tourism events can be held regarding to the contexts of each location. Yearly events, monthly activities, local product exhibition regarding the seasonality and other tourism should be considered basing on the collaboration among partnerships.

4) DOA should consider tourism management, business development together with airport development. The integration of such academic fields can assist DOA for further strategic airport planning and development.

5) Results from several research objectives lead to the formation of the business model innovations. Such strategic options provide a novel approach for policymakers to further develop airport business administration. The options for customer segmenting in each airport, the choices for elaborating the cooperative network among airport stakeholders and the trends toward airport development as a destination option should be considered for further implementations.

Working together to integrate the synergy among the airport's business resources, tourism products, and provincial authenticity and originality, the airport will truly perform as a tool for economic and social development not only acting as the infrastructure or transportation platform but also the national competitiveness driver.

## 8.3 Limitations of the Study

8.3.1 Besides airport technical efficiency, allocative efficiency is another performance measurement for airport benchmarking. However, due to the price information which is essential for conducting the allocative efficiency computation is not available, technical efficiency is applied in several airport literatures and also this study.

8.3.2 Data accessibility was a significant source of studying barriers. Since some of the airports that this study aiming to investigate were listed in the Stock Exchange of Thailand (SET), some parts of the data were restricted. For example, the dataset from the private airport operators was not reachable; therefore, the data used for the ownership patterns are available from the public airports and privatized airports only. In sum up, the private airport was excluded from the unit of the analysis. Another example was the unavailability of non-aeronautical revenues. Since the trend toward non-aeronautical revenue generation has been rising; then, using this set of variables would provide unaccountable academic outcomes. However, as mentioned earlier, the privatized airport company was listed in the stock exchange of Thailand; thus, this non-aeronautical revenue dataset was not opened publicly. In order to substitute that dataset, the airport revenues which were the summation between non-aeronautical revenues and aeronautical revenues were in place.

8.3.3 For the part of documentary research, although the in-depth interviews from the World's Best airport and World's Best regional airport management seemed to be a proper research design, due to the time and budget constraints, the documentary research approach was employed. However, some documents relating to the World's Best regional airport used their native language that was Japanese. Therefore, the study may unintentionally miss some parts of important information. To readjust the language barrier, other sources of data such as airport website, social medium and video clips in English version were achieved. Another issue for documentary research was the mismatch between the definition of local and regional airports in Thailand and the globe. Therefore, the scale of selected World regional airport and the regional airports in Thailand were quite different.

8.3.4 Lastly, due to the COVID-19 situation emerging in the world since December 2019, there was some key informants rejected to provide the in-depth information on the issues. It was because some of them were in a busy and hard time circumstance. However, the qualitative data used for content analyzing was theoretically saturated and shows the repetition which also reflecting the reliability of data.

## 8.4 Future Research Recommendations

In order to bring the best outcomes of this dissertation, further studies are needed to complete the practical implications of the airport business models:

8.4.1 Since the business models for local and regional airports represent the only focal firm activities, transactions that creating values and showing how a firm delivers them to all stakeholders, in-depth details and further studies for each business model components should be extended in order to accomplish the full application from the result of this study.

8.4.2 Each local and regional airport is required individual airport business model design. It is because they have different contexts and environments. Therefore, studies relating to the revision of the Air Navigation Act BE 2562 is interesting. In particular, the part of the legislation that allows and facilitate each local and regional airport to run and develop its own businesses; in other words, the decentralization policy should be delegated to the local and regional airports.

8.4.3 If it is possible, data relating to non-aeronautical revenues should be used in airport strategic planning. It is because there are various sources from airport revenues. Getting the right information on revenue generation sources will lead airport management to the right directions.

8.4.4 Data Envelopment Analysis is a very useful tool for airport performance measurement. However, the researcher should use it carefully as it has some limitations that possibly affect the interpretations.

8.4.5 The studies relating to the establishment of the effective network and collaborative mechanisms among airport stakeholders such as airlines, passengers, local tourism authorities, provincial authorities, local institutions, communities, local businesses are recommended. Since such networks play huge parts on terrific airport development and allow the airport utilization as an economic platform to local businesses and communities.

8.4.6 To gain insightful information on airport business models of the World's Best airport and the World's Best regional airport, the in-depth interviews from the airport management from airport visiting should be done.

8.4.7 The future research may review the small-scale airport that achieving the successful airport business operations so that the results could provide promising guidelines for small airport development.

8.4.8 The study argues that the airport is not just the two-sided platform but acting as the multi-sided platform instead; thus, data collection should be covered all airport stakeholders having the interactions on the platform in case future research conducting studies relating to local and regional airport development.

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# APPENDICES

# APPENDIX A

## Semi-Structured Questionnaires for Key Informants

This appendix presents the 3 sets of semi-structured questionnaire distributed to the various groups of key informants. The first semi-structured interviewing forms is given to airport managements and aviation academicians while the second set of semi-structured interviewing forms is given to airport users. Lastly, the third set of the form is used for airport management businesses.

*แบบสัมภาษณ์ชุดที่ 1 สำหรับผู้บริหารกรมท่าอากาศยาน และนักวิจัยด้านการบิน*

**แบบสัมภาษณ์แบบกึ่งโครงสร้าง**

**ดุษฎีนิพนธ์เรื่อง ประสิทธิภาพทางเทคนิคของสนามบิน และแบบจำลองธุรกิจ:**

**กรณีศึกษาสนามบินภูมิภาคของประเทศไทย**

**<u>คำชี้แจงสำหรับผู้เข้าร่วมโครงการ</u>**

1. การวิจัยในครั้งนี้มีวัตถุประสงค์สำคัญในทางวิชาการ ไม่เป็นคุณ หรือโทษแก่ผู้เข้าร่วมการวิจัย ซึ่งผลจากการศึกษาจะเป็นประโยชน์กับหน่วยงานของผู้เข้าร่วมโครงการวิจัย ข้อมูลที่ได้รับจากการสัมภาษณ์จะถูกบันทึกเสียง ถอดเทป และมีการจัดเก็บเป็นความลับในคอมพิวเตอร์ที่มีการใส่รหัส (password) ไม่มีการเปิดเผยชื่อผู้เข้าร่วมโครงการวิจัย ตำแหน่ง ในรายงานผลการวิจัย รวมถึงในผลงานเผยแพร่ในวารสารวิชาการ โดยตลอดการสัมภาษณ์หากมีข้อคำถามใดที่ผู้เข้าร่วมโครงการรู้สึกอัดอัดใจในการตอบคำถาม ผู้เข้าร่วมโครงการมีสิทธิปฏิเสธการตอบคำถาม และสามารถถอนตัวในการเข้าร่วมโครงการวิจัยได้ทันที

2. การศึกษาในครั้งนี้มีวัตถุประสงค์สำคัญในการนำเสนอแบบจำลองทางธุรกิจ เพื่อช่วยยกระดับประสิทธิภาพทางเทคนิคของสนามบินภายใต้การดำเนินงานของกรมท่าอากาศยาน

**ข้อคำถามที่ 1** ท่านคิดว่าปัจจัยทางด้าน **การกำหนดยุทธศาสตร์ชาติ** มีผลต่อการดำเนินงานของสนามบินอย่างไร และปัจจัยดังกล่าวมีผลกระทบในระดับใด (1 น้อยที่สุด 9 มากที่สุด)

**ข้อคำถามที่ 2** ท่านคิดว่าปัจจัยทางด้าน **การดำเนินนโยบาย New S-curve หรือ Eastern Economic Corridors (EEC)** มีผลต่อการดำเนินงานของสนามบินอย่างไร และปัจจัยดังกล่าวมีผลกระทบในระดับใด (1 น้อยที่สุด 9 มากที่สุด)

**ข้อคำถามที่ 3** ท่านคิดว่าปัจจัยทางด้าน **นโยบายการท่องเที่ยวเมืองรอง** มีมีผลต่อการดำเนินงานของสนามบินอย่างไร และปัจจัยดังกล่าวมีผลกระทบในระดับใด (1 น้อยที่สุด 9 มากที่สุด)

**ข้อคำถามที่ 4** ท่านคิดว่าปัจจัยทางด้าน **การพัฒนาเทคโนโลยีในสนามบิน** มีผลต่อการดำเนินงานของสนามบินอย่างไร และปัจจัยดังกล่าวมีผลกระทบในระดับใด (1 น้อยที่สุด 9 มากที่สุด)

**ข้อคำถามที่ 5** ท่านคิดว่าปัจจัยทางด้าน **การเปลี่ยนแปลงสภาพอากาศ** มีผลต่อการดำเนินงานของสนามบินอย่างไร และปัจจัยดังกล่าวมีผลกระทบในระดับใด (1 น้อยที่สุด 9 มากที่สุด)

**ข้อคำถามที่ 6** ท่านคิดว่าปัจจัยทางด้าน **พระราชบัญญัติการเดินอากาศ (ฉบับที่ 14) พ.ศ. 2562** มีผลต่อการดำเนินงานของสนามบินอย่างไร และปัจจัยดังกล่าวมีผลกระทบในระดับใด (1 น้อยที่สุด 9 มากที่สุด)

**ข้อคำถามที่ 7** ท่านคิดว่าปัจจัยนอกเหนือจากที่ได้กล่าวมา มีปัจจัยอื่นๆบ้างที่มีผลต่อประสิทธิภาพของสนามบิน และปัจจัยดังกล่าวมีผลกระทบในระดับใด (1 น้อยที่สุด 9 มากที่สุด)

**ข้อคำถามที่ 8** ในการเพิ่มประสิทธิภาพการดำเนินงานของสนามบิน กรมท่าอากาศยานควรให้ความสำคัญกับประเด็นใดบ้าง

*แบบสัมภาษณ์ชุดที่ 2 สำหรับผู้ใช้บริการกรมท่าอากาศยาน (ผู้โดยสารและสายการบิน)*

**แบบสัมภาษณ์แบบกึ่งโครงสร้าง**

**โครงการวิจัยเรื่อง ประสิทธิภาพทางเทคนิคของสนามบิน และแบบจำลองธุรกิจ:**

**กรณีศึกษาสนามบินภูมิภาคของประเทศไทย**

คำชี้แจงสำหรับผู้เข้าร่วมโครงการ

การวิจัยในครั้งนี้มีวัตถุประสงค์สำคัญในทางวิชาการ ไม่เป็นคุณ หรือโทษแก่ผู้เข้าร่วมการวิจัย ซึ่งผลจากการศึกษาจะเป็นประโยชน์กับหน่วยงาน หรือตัวของผู้เข้าร่วมโครงการวิจัย ข้อมูลที่ได้รับจากการสัมภาษณ์จะถูกบันทึกเสียง ถอดเทป และมีการจัดเก็บเป็นความลับในคอมพิวเตอร์ที่มีการใส่รหัส (password) ไม่มีการเปิดเผยชื่อผู้เข้าร่วมโครงการวิจัย ตำแหน่ง ในรายงานผลการวิจัย รวมถึงในผลงานเผยแพร่ในวารสารวิชาการ โดยตลอดการสัมภาษณ์หากมีข้อคำถามใดที่ผู้เข้าร่วมโครงการ รู้สึกอัดอัดใจในการตอบคำถาม ผู้เข้าร่วมโครงการมีสิทธิปฏิเสธการตอบคำถาม และสามารถถอนตัวในการเข้าร่วมโครงการวิจัยได้ทันที

**ข้อคำถามที่ 1** ในฐานะของการเป็นผู้ใช้บริการ ท่านได้รับบริการ หรือสนามบินนำเสนออะไรบ้างให้แก่ท่าน

**ข้อคำถามที่ 2** ท่านให้ความสำคัญ คาดหวัง หรือต้องการเห็นสนามบินนำเสนออะไรให้กับท่าน

**ข้อคำถามที่ 3** ท่านไม่ชอบใจอะไร หรือไม่ต้องการเห็นสนามบินนำเสนออะไรให้กับท่าน

**ข้อคำถามที่ 4** เพื่อให้การดำเนินงานของสนามบินมีประสิทธิภาพที่ดีขึ้น ท่านคิดว่า ปัจจัยใดบ้างที่สนามบินควรคำนึงถึง หรือพัฒนาเพิ่มเติมเพื่อให้ประสิทธิภาพของสนามบินดีขึ้น

*แบบสัมภาษณ์ชุดที่ 3 สำหรับ ผู้บริหาร หน่วยงาน องค์กรที่ดูแลท่าอากาศยาน*

**แบบสัมภาษณ์แบบกึ่งโครงสร้าง**

**ดุษฎีนิพนธ์เรื่อง ประสิทธิภาพทางเทคนิคของสนามบิน และแบบจำลองธุรกิจ: กรณีศึกษาสนามบินภูมิภาคของประเทศไทย**

**<u>คำชี้แจงสำหรับผู้เข้าร่วมโครงการ</u>**

1. การวิจัยในครั้งนี้มีวัตถุประสงค์สำคัญในทางวิชาการ ไม่เป็นคุณ หรือโทษแก่ผู้เข้าร่วมการวิจัย ซึ่งผลจากการศึกษาจะเป็นประโยชน์กับหน่วยงานของผู้เข้าร่วมโครงการวิจัย ข้อมูลที่ได้รับจากการสัมภาษณ์จะถูกบันทึกเสียง ถอดเทป และมีการจัดเก็บเป็นความลับในคอมพิวเตอร์ที่มีการใส่รหัส (password) ไม่มีการเปิดเผยชื่อผู้เข้าร่วมโครงการวิจัย ตำแหน่ง ในรายงานผลการวิจัย รวมถึงในผลงานเผยแพร่ในวารสารวิชาการ โดยตลอดการสัมภาษณ์หากมีข้อคำถามใดที่ผู้เข้าร่วมโครงการรู้สึกอัดอัดใจในการตอบคำถาม ผู้เข้าร่วมโครงการมีสิทธิปฏิเสธการตอบคำถาม และสามารถถอนตัวในการเข้าร่วมโครงการวิจัยได้ทันที

2. การศึกษาในครั้งนี้มีวัตถุประสงค์สำคัญในการนำเสนอแบบจำลองทางธุรกิจ เพื่อช่วยยกระดับประสิทธิภาพทางเทคนิคของสนามบินภายใต้การดำเนินงานของกรมท่าอากาศยาน

**ข้อคำถามที่ 1** ท่านคิดว่าปัจจัยใดบ้างที่มีผลต่อการดำเนินงานของสนามบิน และปัจจัยที่กล่าวมามีผลกระทบในระดับใด (1 น้อยที่สุด 9 มากที่สุด)

**ข้อคำถามที่ 2** ท่านคิดว่าในการบริหารงานท่าอากาศยานที่ผ่านมา มีปัญหา อุปสรรค หรือข้อติดขัดประการใด และท่านมีแนวทางในแก้ปัญหาดังกล่าวอย่างไร

**ข้อคำถามที่ 3** ในการบริหารงานสนามบินของหน่วยงาน ท่านคิดว่า องค์กรท่านให้ความสำคัญ กับประเด็นใด เพื่อให้การดำเนินงานของสนามบินเป็นไปอย่างมีประสิทธิภาพ

# APPENDIX B

## PESTEL-AHP Construction

To clarify the procedure of constructing the Analytical Hierarchy Process under the PESTEL Analysis (PESTEL-AHP), this appendix provides the method for constructing the PESTEL-AHP by using Microsoft Excel. The process can be organized into these following steps:

**Step 1: Pairwise Comparison**

In this step, each element of PESTEL were scored by 6 expert panels plus an opinion from author according to Saaty (1990)'s scale. The author prepared the dataset by using Microsoft Excel in order for creating the Pairwise Comparison between each element of PESTEL.

| EXPERT NO. 1 | | | | | | |
|---|---|---|---|---|---|---|
| PESTEL Analysis | P | E | S | T | E | L |
| P | 1.00000 | 4.00000 | 5.00000 | 7.00000 | 4.00000 | 9.00000 |
| E | 0.25000 | 1.00000 | 0.20000 | 7.00000 | 4.00000 | 0.11111 |
| S | 0.20000 | 5.00000 | 1.00000 | 0.14286 | 4.00000 | 0.11111 |
| T | 0.14286 | 0.14286 | 7.00000 | 1.00000 | 4.00000 | 0.11111 |
| E | 0.25000 | 4.00000 | 0.25000 | 0.25000 | 1.00000 | 0.11111 |
| L | 9.00000 | 9.00000 | 9.00000 | 9.00000 | 9.00000 | 1.00000 |

| EXPERT NO. 2 | | | | | | |
|---|---|---|---|---|---|---|
| PESTEL Analysis | P | E | S | T | E | L |
| P | 1.00000 | 1.00000 | 0.20000 | 8.00000 | 5.00000 | 5.00000 |
| E | 1.00000 | 1.00000 | 0.20000 | 0.12500 | 0.20000 | 0.20000 |
| S | 5.00000 | 5.00000 | 1.00000 | 0.12500 | 5.00000 | 5.00000 |
| T | 0.12500 | 8.00000 | 8.00000 | 1.00000 | 5.00000 | 5.00000 |
| E | 0.20000 | 5.00000 | 5.00000 | 0.20000 | 1.00000 | 5.00000 |
| L | 0.20000 | 5.00000 | 5.00000 | 0.20000 | 5.00000 | 1.00000 |

| EXPERT NO. 3 | | | | | | |
|---|---|---|---|---|---|---|
| PESTEL Analysis | P | E | S | T | E | L |
| P | 1.00000 | 5.00000 | 4.00000 | 0.11111 | 5.00000 | 0.12500 |
| E | 0.20000 | 1.00000 | 4.00000 | 0.11111 | 5.00000 | 0.12500 |
| S | 0.25000 | 0.25000 | 1.00000 | 0.11111 | 0.20000 | 0.12500 |
| T | 9.00000 | 9.00000 | 9.00000 | 1.00000 | 5.00000 | 8.00000 |
| E | 0.20000 | 5.00000 | 5.00000 | 0.20000 | 1.00000 | 0.12500 |
| L | 8.00000 | 8.00000 | 8.00000 | 0.12500 | 8.00000 | 1.00000 |

**EXPERT NO. 4**

| PESTEL Analysis | P | E | S | T | E | L |
|---|---|---|---|---|---|---|
| P | 1.00000 | 2.00000 | 4.00000 | 2.00000 | 5.00000 | 9.00000 |
| E | 0.50000 | 1.00000 | 0.25000 | 2.00000 | 0.20000 | 0.11111 |
| S | 0.25000 | 4.00000 | 1.00000 | 2.00000 | 0.20000 | 0.11111 |
| T | 0.50000 | 2.00000 | 0.50000 | 1.00000 | 5.00000 | 9.00000 |
| E | 0.20000 | 5.00000 | 5.00000 | 0.20000 | 1.00000 | 0.11111 |
| L | 0.11111 | 9.00000 | 9.00000 | 0.11111 | 9.00000 | 1.00000 |

**EXPERT NO. 5**

| PESTEL Analysis | P | E | S | T | E | L |
|---|---|---|---|---|---|---|
| P | 1.00000 | 5.00000 | 7.00000 | 0.11111 | 6.00000 | 0.11111 |
| E | 0.20000 | 1.00000 | 0.14286 | 0.11111 | 0.16667 | 0.11111 |
| S | 0.14286 | 7.00000 | 1.00000 | 0.11111 | 6.00000 | 0.11111 |
| T | 9.00000 | 9.00000 | 9.00000 | 1.00000 | 6.00000 | 9.00000 |
| E | 0.16667 | 6.00000 | 0.16667 | 0.16667 | 1.00000 | 0.11111 |
| L | 9.00000 | 9.00000 | 9.00000 | 9.00000 | 9.00000 | 1.00000 |

**EXPERT NO. 6**

| PESTEL Analysis | P | E | S | T | E | L |
|---|---|---|---|---|---|---|
| P | 1.00000 | 9.00000 | 9.00000 | 6.00000 | 7.00000 | 8.00000 |
| E | 9.00000 | 1.00000 | 9.00000 | 9.00000 | 7.00000 | 0.12500 |
| S | 9.00000 | 9.00000 | 1.00000 | 6.00000 | 7.00000 | 8.00000 |
| T | 0.16667 | 9.00000 | 0.16667 | 1.00000 | 0.14286 | 0.12500 |
| E | 0.14286 | 0.14286 | 0.14286 | 7.00000 | 1.00000 | 0.12500 |
| L | 0.12500 | 8.00000 | 0.12500 | 8.00000 | 8.00000 | 1.00000 |

**EXPERT NO. 7**

| PESTEL Analysis | P | E | S | T | E | L |
|---|---|---|---|---|---|---|
| P | 1.00000 | 5.00000 | 5.00000 | 8.00000 | 8.00000 | 9.00000 |
| E | 0.20000 | 1.00000 | 5.00000 | 0.12500 | 0.12500 | 0.11111 |
| S | 0.20000 | 5.00000 | 1.00000 | 0.12500 | 0.12500 | 0.11111 |
| T | 0.12500 | 8.00000 | 8.00000 | 1.00000 | 8.00000 | 0.11111 |
| E | 0.12500 | 8.00000 | 8.00000 | 8.00000 | 1.00000 | 0.11111 |
| L | 9.00000 | 9.00000 | 9.00000 | 9.00000 | 9.00000 | 1.00000 |

**Step 2: Normalization**

Once the scores of each PESTEL element are compared, the normalization method is adopted to adjust the values computed from the step 1 into the value between 0-1 since it is easier to prioritize each PESTEL element on the normalized matrix.

| EXPERT NO. 1 | | | | | | |
|---|---|---|---|---|---|---|
| PESTEL Analysis | P | E | S | T | E | L |
| P | 1.00000 | 4.00000 | 5.00000 | 7.00000 | 4.00000 | 9.00000 |
| E | 0.25000 | 1.00000 | 0.20000 | 7.00000 | 4.00000 | 0.11111 |
| S | 0.20000 | 5.00000 | 1.00000 | 0.14286 | 4.00000 | 0.11111 |
| T | 0.14286 | 0.14286 | 7.00000 | 1.00000 | 4.00000 | 0.11111 |
| E | 0.25000 | 4.00000 | 0.25000 | 0.25000 | 1.00000 | 0.11111 |
| L | 9.00000 | 9.00000 | 9.00000 | 9.00000 | 9.00000 | 1.00000 |
| SUM | 10.84286 | 23.14286 | 22.45000 | 24.39286 | 26.00000 | 10.44444 |

| EXPERT NO. 2 | | | | | | |
|---|---|---|---|---|---|---|
| PESTEL Analysis | P | E | S | T | E | L |
| P | 1.00000 | 1.00000 | 0.20000 | 8.00000 | 5.00000 | 5.00000 |
| E | 1.00000 | 1.00000 | 0.20000 | 0.12500 | 0.20000 | 0.20000 |
| S | 5.00000 | 5.00000 | 1.00000 | 0.12500 | 5.00000 | 5.00000 |
| T | 0.12500 | 8.00000 | 8.00000 | 1.00000 | 5.00000 | 5.00000 |
| E | 0.20000 | 5.00000 | 5.00000 | 0.20000 | 1.00000 | 5.00000 |
| L | 0.20000 | 5.00000 | 5.00000 | 0.20000 | 5.00000 | 1.00000 |
| SUM | 7.52500 | 25.00000 | 19.40000 | 9.65000 | 21.20000 | 21.20000 |

| EXPERT NO. 3 | | | | | | |
|---|---|---|---|---|---|---|
| PESTEL Analysis | P | E | S | T | E | L |
| P | 1.00000 | 5.00000 | 4.00000 | 0.11111 | 5.00000 | 0.12500 |
| E | 0.20000 | 1.00000 | 4.00000 | 0.11111 | 5.00000 | 0.12500 |
| S | 0.25000 | 0.25000 | 1.00000 | 0.11111 | 0.20000 | 0.12500 |
| T | 9.00000 | 9.00000 | 9.00000 | 1.00000 | 5.00000 | 8.00000 |
| E | 0.20000 | 5.00000 | 5.00000 | 0.20000 | 1.00000 | 0.12500 |
| L | 8.00000 | 8.00000 | 8.00000 | 0.12500 | 8.00000 | 1.00000 |
| SUM | 18.65000 | 28.25000 | 31.00000 | 1.65833 | 24.20000 | 9.50000 |

| EXPERT NO. 4 | | | | | | |
|---|---|---|---|---|---|---|
| PESTEL Analysis | P | E | S | T | E | L |
| P | 1.00000 | 2.00000 | 4.00000 | 2.00000 | 5.00000 | 9.00000 |
| E | 0.50000 | 1.00000 | 0.25000 | 2.00000 | 0.20000 | 0.11111 |
| S | 0.25000 | 4.00000 | 1.00000 | 2.00000 | 0.20000 | 0.11111 |
| T | 0.50000 | 2.00000 | 0.50000 | 1.00000 | 5.00000 | 9.00000 |
| E | 0.20000 | 5.00000 | 5.00000 | 0.20000 | 1.00000 | 0.11111 |
| L | 0.11111 | 9.00000 | 9.00000 | 0.11111 | 9.00000 | 1.00000 |
| SUM | 2.56111 | 23.00000 | 19.75000 | 7.31111 | 20.40000 | 19.33333 |

| EXPERT NO. 5 | | | | | | |
|---|---|---|---|---|---|---|
| PESTEL Analysis | P | E | S | T | E | L |
| P | 1.00000 | 5.00000 | 7.00000 | 0.11111 | 6.00000 | 0.11111 |
| E | 0.20000 | 1.00000 | 0.14286 | 0.11111 | 0.16667 | 0.11111 |
| S | 0.14286 | 7.00000 | 1.00000 | 0.11111 | 6.00000 | 0.11111 |
| T | 9.00000 | 9.00000 | 9.00000 | 1.00000 | 6.00000 | 9.00000 |
| E | 0.16667 | 6.00000 | 0.16667 | 0.16667 | 1.00000 | 0.11111 |
| L | 9.00000 | 9.00000 | 9.00000 | 9.00000 | 9.00000 | 1.00000 |
| SUM | 19.50952 | 37.00000 | 26.30952 | 10.50000 | 28.16667 | 10.44444 |

| EXPERT NO. 6 | | | | | | |
|---|---|---|---|---|---|---|
| PESTEL Analysis | P | E | S | T | E | L |
| P | 1.00000 | 9.00000 | 9.00000 | 6.00000 | 7.00000 | 8.00000 |
| E | 9.00000 | 1.00000 | 9.00000 | 9.00000 | 7.00000 | 0.12500 |
| S | 9.00000 | 9.00000 | 1.00000 | 6.00000 | 7.00000 | 8.00000 |
| T | 0.16667 | 9.00000 | 0.16667 | 1.00000 | 0.14286 | 0.12500 |
| E | 0.14286 | 0.14286 | 0.14286 | 7.00000 | 1.00000 | 0.12500 |
| L | 0.12500 | 8.00000 | 0.12500 | 8.00000 | 8.00000 | 1.00000 |
| SUM | 19.43452 | 36.14286 | 19.43452 | 37.00000 | 30.14286 | 17.37500 |

| EXPERT NO. 7 | | | | | | |
|---|---|---|---|---|---|---|
| PESTEL Analysis | P | E | S | T | E | L |
| P | 1.00000 | 5.00000 | 5.00000 | 8.00000 | 8.00000 | 9.00000 |
| E | 0.20000 | 1.00000 | 5.00000 | 0.12500 | 0.12500 | 0.11111 |
| S | 0.20000 | 5.00000 | 1.00000 | 0.12500 | 0.12500 | 0.11111 |
| T | 0.12500 | 8.00000 | 8.00000 | 1.00000 | 8.00000 | 0.11111 |
| E | 0.12500 | 8.00000 | 8.00000 | 8.00000 | 1.00000 | 0.11111 |
| L | 9.00000 | 9.00000 | 9.00000 | 9.00000 | 9.00000 | 1.00000 |
| SUM | 10.65000 | 36.00000 | 36.00000 | 26.25000 | 26.25000 | 10.44444 |

**Step 3: Weighted score estimation**

Once the normalized matrix is done, the summation of each PESTEL element is applied. After that, the scores of each element is weighted to estimate the numeric effect of each PESTEL element on regional airport industry.

| EXPERT NO. 1 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| PESTEL Analysis | P | E | S | T | E | L | SUM | Weighted |
| P | 0.09223 | 0.17284 | 0.22272 | 0.28697 | 0.15385 | 0.86170 | 1.79030 | 0.29838 |
| E | 0.02306 | 0.04321 | 0.00891 | 0.28697 | 0.15385 | 0.01064 | 0.52663 | 0.08777 |
| S | 0.01845 | 0.21605 | 0.04454 | 0.00586 | 0.15385 | 0.01064 | 0.44938 | 0.07490 |
| T | 0.01318 | 0.00617 | 0.31180 | 0.04100 | 0.15385 | 0.01064 | 0.53663 | 0.08944 |
| E | 0.02306 | 0.17284 | 0.01114 | 0.01025 | 0.03846 | 0.01064 | 0.26638 | 0.04440 |
| L | 0.83004 | 0.38889 | 0.40089 | 0.36896 | 0.34615 | 0.09574 | 2.43068 | 0.40511 |
| SUM | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 6.00000 | 1.00000 |

| EXPERT NO. 2 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| PESTEL Analysis | P | E | S | T | E | L | SUM | Weighted |
| P | 0.13289 | 0.04000 | 0.01031 | 0.82902 | 0.23585 | 0.23585 | 1.48391 | 0.24732 |
| E | 0.13289 | 0.04000 | 0.01031 | 0.01295 | 0.00943 | 0.00943 | 0.21502 | 0.03584 |
| S | 0.66445 | 0.20000 | 0.05155 | 0.01295 | 0.23585 | 0.23585 | 1.40065 | 0.23344 |
| T | 0.01661 | 0.32000 | 0.41237 | 0.10363 | 0.23585 | 0.23585 | 1.32431 | 0.22072 |
| E | 0.02658 | 0.20000 | 0.25773 | 0.02073 | 0.04717 | 0.23585 | 0.78805 | 0.13134 |
| L | 0.02658 | 0.20000 | 0.25773 | 0.02073 | 0.23585 | 0.04717 | 0.78805 | 0.13134 |
| SUM | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 6.00000 | 1.00000 |

| EXPERT NO. 3 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| PESTEL Analysis | P | E | S | T | E | L | SUM | Weighted |
| P | 0.05362 | 0.17699 | 0.12903 | 0.06700 | 0.20661 | 0.01316 | 0.64641 | 0.10774 |
| E | 0.01072 | 0.03540 | 0.12903 | 0.06700 | 0.20661 | 0.01316 | 0.46193 | 0.07699 |
| S | 0.01340 | 0.00885 | 0.03226 | 0.06700 | 0.00826 | 0.01316 | 0.14294 | 0.02382 |
| T | 0.48257 | 0.31858 | 0.29032 | 0.60302 | 0.20661 | 0.84211 | 2.74321 | 0.45720 |
| E | 0.01072 | 0.17699 | 0.16129 | 0.12060 | 0.04132 | 0.01316 | 0.52409 | 0.08735 |
| L | 0.42895 | 0.28319 | 0.25806 | 0.07538 | 0.33058 | 0.10526 | 1.48142 | 0.24690 |
| SUM | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 6.00000 | 1.00000 |

| EXPERT NO. 4 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| PESTEL Analysis | P | E | S | T | E | L | SUM | Weighted |
| P | 0.39046 | 0.08696 | 0.20253 | 0.27356 | 0.24510 | 0.46552 | 1.66412 | 0.27735 |
| E | 0.19523 | 0.04348 | 0.01266 | 0.27356 | 0.00980 | 0.00575 | 0.54047 | 0.09008 |
| S | 0.09761 | 0.17391 | 0.05063 | 0.27356 | 0.00980 | 0.00575 | 0.61127 | 0.10188 |
| T | 0.19523 | 0.08696 | 0.02532 | 0.13678 | 0.24510 | 0.46552 | 1.15489 | 0.19248 |
| E | 0.07809 | 0.21739 | 0.25316 | 0.02736 | 0.04902 | 0.00575 | 0.63077 | 0.10513 |
| L | 0.04338 | 0.39130 | 0.45570 | 0.01520 | 0.44118 | 0.05172 | 1.39848 | 0.23308 |
| SUM | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 6.00000 | 1.00000 |

| EXPERT NO. 5 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| PESTEL Analysis | P | E | S | T | E | L | SUM | Weighted |
| P | 0.05126 | 0.13514 | 0.26606 | 0.01058 | 0.21302 | 0.01064 | 0.68669 | 0.11445 |
| E | 0.01025 | 0.02703 | 0.00543 | 0.01058 | 0.00592 | 0.01064 | 0.06985 | 0.01164 |
| S | 0.00732 | 0.18919 | 0.03801 | 0.01058 | 0.21302 | 0.01064 | 0.46876 | 0.07813 |
| T | 0.46131 | 0.24324 | 0.34208 | 0.09524 | 0.21302 | 0.86170 | 2.21660 | 0.36943 |
| E | 0.00854 | 0.16216 | 0.00633 | 0.01587 | 0.03550 | 0.01064 | 0.23905 | 0.03984 |
| L | 0.46131 | 0.24324 | 0.34208 | 0.85714 | 0.31953 | 0.09574 | 2.31905 | 0.38651 |
| SUM | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 6.00000 | 1.00000 |

| EXPERT NO. 6 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| PESTEL Analysis | P | E | S | T | E | L | SUM | Weighted |
| P | 0.05145 | 0.24901 | 0.46309 | 0.16216 | 0.23223 | 0.46043 | 1.61838 | 0.26973 |
| E | 0.46309 | 0.02767 | 0.46309 | 0.24324 | 0.23223 | 0.00719 | 1.43652 | 0.23942 |
| S | 0.46309 | 0.24901 | 0.05145 | 0.16216 | 0.23223 | 0.46043 | 1.61838 | 0.26973 |
| T | 0.00858 | 0.24901 | 0.00858 | 0.02703 | 0.00474 | 0.00719 | 0.30512 | 0.05085 |
| E | 0.00735 | 0.00395 | 0.00735 | 0.18919 | 0.03318 | 0.00719 | 0.24821 | 0.04137 |
| L | 0.00643 | 0.22134 | 0.00643 | 0.21622 | 0.26540 | 0.05755 | 0.77338 | 0.12890 |
| SUM | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 6.00000 | 1.00000 |

| EXPERT NO. 7 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| PESTEL Analysis | P | E | S | T | E | L | SUM | Weighted |
| P | 0.09390 | 0.13889 | 0.13889 | 0.30476 | 0.30476 | 0.86170 | 1.84290 | 0.30715 |
| E | 0.01878 | 0.02778 | 0.13889 | 0.00476 | 0.00476 | 0.01064 | 0.20561 | 0.03427 |
| S | 0.01878 | 0.13889 | 0.02778 | 0.00476 | 0.00476 | 0.01064 | 0.20561 | 0.03427 |
| T | 0.01174 | 0.22222 | 0.22222 | 0.03810 | 0.30476 | 0.01064 | 0.80968 | 0.13495 |
| E | 0.01174 | 0.22222 | 0.22222 | 0.30476 | 0.03810 | 0.01064 | 0.80968 | 0.13495 |
| L | 0.84507 | 0.25000 | 0.25000 | 0.34286 | 0.34286 | 0.09574 | 2.12653 | 0.35442 |
| SUM | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 6.00000 | 1.00000 |

**Step 4: Ranking the PESTEL elements**

The last step is to summarize the scores from each expert panel calculated from the Step 2. Then, redoing the Step 3 to create the normalized value in order for ranking the PESTEL elements.

| EXPERT PANELS | | | | | | |
|---|---|---|---|---|---|---|
| PESTEL Analysis | P | E | S | T | E | L |
| P | 7.00000 | 31.00000 | 34.20000 | 31.22222 | 40.00000 | 40.23611 |
| E | 11.35000 | 7.00000 | 18.79286 | 18.47222 | 16.69167 | 0.89444 |
| S | 15.04286 | 35.25000 | 7.00000 | 8.61508 | 22.52500 | 13.56944 |
| T | 19.05952 | 45.14286 | 41.66667 | 7.00000 | 33.14286 | 31.34722 |
| E | 1.28452 | 33.14286 | 23.55952 | 16.01667 | 7.00000 | 5.69444 |
| L | 35.43611 | 57.00000 | 49.12500 | 35.43611 | 57.00000 | 7.00000 |
| SUM | 89.17302 | 208.53571 | 174.34405 | 116.76230 | 176.35952 | 98.74167 |

| EXPERT PANELS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| PESTEL Analysis | P | E | S | T | E | L | SUM | Weighted | Ranking |
| P | 0.07850 | 0.14866 | 0.19616 | 0.26740 | 0.22681 | 0.40749 | 1.32502 | 0.22084 | 2 |
| E | 0.12728 | 0.03357 | 0.10779 | 0.15820 | 0.09465 | 0.00906 | 0.53055 | 0.08842 | 6 |
| S | 0.16869 | 0.16904 | 0.04015 | 0.07378 | 0.12772 | 0.13742 | 0.71681 | 0.11947 | 4 |
| T | 0.21374 | 0.21648 | 0.23899 | 0.05995 | 0.18793 | 0.31747 | 1.23455 | 0.20576 | 3 |
| E | 0.01440 | 0.15893 | 0.13513 | 0.13717 | 0.03969 | 0.05767 | 0.54300 | 0.09050 | 5 |
| L | 0.39739 | 0.27333 | 0.28177 | 0.30349 | 0.32320 | 0.07089 | 1.65008 | 0.27501 | 1 |
| SUM | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 6.00000 | 1.00000 | |

# APPENDIX C

## Outputs of Technical Efficiency Scores

This appendix provides more information on the results from employing the DEAP 2.1 software by T. Coelli (1996) to compute the technical efficiency scores for regional airports in Thailand during 10 past fiscal years (2009-2018) are in the first section. The first section shows the technical efficiency scores calculated for 28 regional airports under control of the Department of Airports (DOA). While the next coming table represents the technical efficiency scores computed by the input and output variables of 6 commercial airports operated by Airports Authority of Thailand (AOT). The productivity change by Malmquist Index also presents in this section.

| | |
|---|---|
| eg1-dta.txt | DATA FILE NAME |
| eg1-out.txt | OUTPUT FILE NAME |
| 34 | NUMBER OF FIRMS |
| 10 | NUMBER OF TIME PERIODS |
| 3 | NUMBER OF OUTPUTS |
| 5 | NUMBER OF INPUTS |
| 1 | 0=INPUT AND 1=OUTPUT ORIENTATED |
| 1 | 0=CRS AND 1=VRS |
| 2 | 0=DEA(MULTI-STAGE), 1=COST-DEA, 2=MALMQUIST-DEA, 3=DEA(1-STAGE), 4=DEA(2- STAGE) |

Results from DEAP Version 2.1

---------

Instruction file = eg1-ins.txt

Data file = eg1-dta.txt

---------

Output orientated Malmquist DEA

DISTANCES SUMMARY

year = 1

| firm no. | crs te rel to tech in yr *********************** t-1 | t | t+1 | vrs te |
|---|---|---|---|---|
| 1 | 0.000 | 1.000 | 0.924 | 1.000 |
| 2 | 0.000 | 0.490 | 0.385 | 0.490 |
| 3 | 0.000 | 0.963 | 0.694 | 1.000 |
| 4 | 0.000 | 0.274 | 0.232 | 0.339 |
| 5 | 0.000 | 0.477 | 0.376 | 1.000 |
| 6 | 0.000 | 1.000 | 0.801 | 1.000 |
| 7 | 0.000 | 0.054 | 0.043 | 0.054 |
| 8 | 0.000 | 0.002 | 0.001 | 0.002 |
| 9 | 0.000 | 0.223 | 0.176 | 0.223 |
| 10 | 0.000 | 0.112 | 0.089 | 0.112 |
| 11 | 0.000 | 0.195 | 0.153 | 0.195 |
| 12 | 0.000 | 0.154 | 0.122 | 0.164 |
| 13 | 0.000 | 0.125 | 0.098 | 0.125 |
| 14 | 0.000 | 0.000 | 0.000 | 0.000 |
| 15 | 0.000 | 0.146 | 0.115 | 0.146 |
| 16 | 0.000 | 0.026 | 0.021 | 0.026 |
| 17 | 0.000 | 0.000 | 0.000 | 0.000 |
| 18 | 0.000 | 0.001 | 0.001 | 0.001 |
| 19 | 0.000 | 0.098 | 0.078 | 0.098 |
| 20 | 0.000 | 0.045 | 0.035 | 0.045 |
| 21 | 0.000 | 0.261 | 0.205 | 0.285 |
| 22 | 0.000 | 0.000 | 0.000 | 0.000 |
| 23 | 0.000 | 0.093 | 0.073 | 0.093 |
| 24 | 0.000 | 0.000 | 0.000 | 0.000 |
| 25 | 0.000 | 0.000 | 0.000 | 0.000 |
| 26 | 0.000 | 1.000 | 0.861 | 1.000 |
| 27 | 0.000 | 0.082 | 0.065 | 0.082 |
| 28 | 0.000 | 0.102 | 0.081 | 0.102 |
| 29 | 0.000 | 0.000 | 0.000 | 0.000 |
| 30 | 0.000 | 0.231 | 0.184 | 0.231 |
| 31 | 0.000 | 0.226 | 0.174 | 0.269 |
| 32 | 0.000 | 0.026 | 0.020 | 0.026 |
| 33 | 0.000 | 0.192 | 0.136 | 0.195 |
| 34 | 0.000 | 0.241 | 0.188 | 0.241 |
| mean | 0.000 | 0.230 | 0.186 | 0.251 |

---------

year = 2

| firm no. | crs te rel to tech in yr ************************ t-1 | t | t+1 | vrs te |
|---|---|---|---|---|
| 1 | 1.302 | 1.000 | 0.954 | 1.000 |
| 2 | 0.509 | 0.397 | 0.339 | 0.397 |
| 3 | 1.140 | 0.820 | 0.745 | 0.926 |
| 4 | 0.296 | 0.251 | 0.218 | 0.321 |
| 5 | 0.584 | 0.460 | 0.404 | 0.884 |
| 6 | 1.422 | 1.000 | 0.896 | 1.000 |
| 7 | 0.034 | 0.027 | 0.023 | 0.027 |
| 8 | 0.001 | 0.000 | 0.000 | 0.000 |
| 9 | 0.241 | 0.190 | 0.165 | 0.190 |
| 10 | 0.040 | 0.032 | 0.028 | 0.032 |
| 11 | 0.228 | 0.178 | 0.150 | 0.178 |
| 12 | 0.162 | 0.127 | 0.106 | 0.129 |
| 13 | 0.061 | 0.048 | 0.042 | 0.048 |
| 14 | 0.002 | 0.002 | 0.002 | 0.002 |
| 15 | 0.133 | 0.105 | 0.091 | 0.105 |
| 16 | 0.018 | 0.015 | 0.013 | 0.015 |
| 17 | 0.000 | 0.000 | 0.000 | 0.000 |
| 18 | 0.009 | 0.007 | 0.006 | 0.007 |
| 19 | 0.141 | 0.111 | 0.096 | 0.111 |
| 20 | 0.104 | 0.082 | 0.071 | 0.082 |
| 21 | 0.370 | 0.292 | 0.251 | 0.292 |
| 22 | 0.000 | 0.000 | 0.000 | 0.000 |
| 23 | 0.099 | 0.078 | 0.066 | 0.078 |
| 24 | 0.000 | 0.000 | 0.000 | 0.000 |
| 25 | 0.000 | 0.000 | 0.000 | 0.000 |
| 26 | 1.230 | 1.000 | 1.414 | 1.000 |
| 27 | 0.007 | 0.005 | 0.005 | 0.005 |
| 28 | 0.049 | 0.039 | 0.033 | 0.039 |
| 29 | 0.000 | 0.000 | 0.000 | 0.000 |
| 30 | 0.335 | 0.267 | 0.236 | 0.267 |
| 31 | 0.270 | 0.212 | 0.181 | 0.212 |
| 32 | 0.005 | 0.004 | 0.003 | 0.004 |
| 33 | 0.289 | 0.227 | 0.192 | 0.227 |
| 34 | 0.305 | 0.239 | 0.201 | 0.239 |
| mean | 0.276 | 0.212 | 0.204 | 0.230 |

---------

year = 3

firm crs te rel to tech in yr vrs

no. ************************ te

t-1 t t+1

| firm no. | t-1 | t | t+1 | vrs te |
|---|---|---|---|---|
| 1 | 1.125 | 1.000 | 0.983 | 1.000 |
| 2 | 0.415 | 0.360 | 0.331 | 0.470 |
| 3 | 0.855 | 0.772 | 0.701 | 0.866 |
| 4 | 0.355 | 0.309 | 0.280 | 0.401 |
| 5 | 0.552 | 0.483 | 0.446 | 0.914 |
| 6 | 1.207 | 1.000 | 0.928 | 1.000 |
| 7 | 0.055 | 0.048 | 0.041 | 0.048 |
| 8 | 0.046 | 0.040 | 0.037 | 0.040 |
| 9 | 0.209 | 0.181 | 0.168 | 0.181 |
| 10 | 0.175 | 0.155 | 0.145 | 0.155 |
| 11 | 0.199 | 0.167 | 0.155 | 0.167 |
| 12 | 0.141 | 0.119 | 0.106 | 0.135 |
| 13 | 0.078 | 0.067 | 0.056 | 0.067 |
| 14 | 0.115 | 0.103 | 0.089 | 0.103 |
| 15 | 0.147 | 0.128 | 0.124 | 0.128 |
| 16 | 0.171 | 0.156 | 0.130 | 0.156 |
| 17 | 0.000 | 0.000 | 0.000 | 0.000 |
| 18 | 0.025 | 0.022 | 0.019 | 0.022 |
| 19 | 0.107 | 0.092 | 0.083 | 0.092 |
| 20 | 0.158 | 0.135 | 0.125 | 0.136 |
| 21 | 1.042 | 0.897 | 0.751 | 0.897 |
| 22 | 0.000 | 0.000 | 0.000 | 0.000 |
| 23 | 0.087 | 0.073 | 0.068 | 0.073 |
| 24 | 0.006 | 0.005 | 0.005 | 0.005 |
| 25 | 0.050 | 0.047 | 0.039 | 0.047 |
| 26 | 0.824 | 1.000 | 2.011 | 1.000 |
| 27 | 0.076 | 0.067 | 0.056 | 0.067 |
| 28 | 0.079 | 0.068 | 0.061 | 0.068 |
| 29 | 0.000 | 0.000 | 0.000 | 0.000 |
| 30 | 0.321 | 0.280 | 0.253 | 0.280 |
| 31 | 0.326 | 0.278 | 0.258 | 0.278 |
| 32 | 0.042 | 0.037 | 0.032 | 0.037 |
| 33 | 0.258 | 0.219 | 0.206 | 0.219 |
| 34 | 0.281 | 0.237 | 0.222 | 0.237 |
| mean | 0.280 | 0.251 | 0.262 | 0.273 |

---------

year = 4

| firm no. | crs te rel to tech in yr t-1 | t | t+1 | vrs te |
|---|---|---|---|---|
| 1 | 1.133 | 1.000 | 1.135 | 1.000 |
| 2 | 0.423 | 0.389 | 0.350 | 0.530 |
| 3 | 0.838 | 0.756 | 0.707 | 0.787 |
| 4 | 0.241 | 0.219 | 0.210 | 0.282 |
| 5 | 0.518 | 0.479 | 0.447 | 0.869 |
| 6 | 1.136 | 1.000 | 0.916 | 1.000 |
| 7 | 0.030 | 0.026 | 0.024 | 0.026 |
| 8 | 0.039 | 0.037 | 0.031 | 0.038 |
| 9 | 0.251 | 0.234 | 0.198 | 0.242 |
| 10 | 0.051 | 0.048 | 0.041 | 0.051 |
| 11 | 0.194 | 0.180 | 0.152 | 0.180 |
| 12 | 0.138 | 0.123 | 0.106 | 0.135 |
| 13 | 0.138 | 0.118 | 0.107 | 0.118 |
| 14 | 0.088 | 0.076 | 0.068 | 0.078 |
| 15 | 0.120 | 0.117 | 0.100 | 0.117 |
| 16 | 0.240 | 0.199 | 0.185 | 0.199 |
| 17 | 0.000 | 0.000 | 0.000 | 0.000 |
| 18 | 0.012 | 0.011 | 0.009 | 0.011 |
| 19 | 0.073 | 0.067 | 0.057 | 0.067 |
| 20 | 0.161 | 0.149 | 0.126 | 0.154 |
| 21 | 1.204 | 1.000 | 0.928 | 1.000 |
| 22 | 0.000 | 0.000 | 0.000 | 0.000 |
| 23 | 0.126 | 0.118 | 0.099 | 0.119 |
| 24 | 0.001 | 0.001 | 0.001 | 0.001 |
| 25 | 0.110 | 0.092 | 0.085 | 0.092 |
| 26 | 0.583 | 1.000 | 1.277 | 1.000 |
| 27 | 0.146 | 0.121 | 0.112 | 0.121 |
| 28 | 0.090 | 0.081 | 0.070 | 0.082 |
| 29 | 0.000 | 0.000 | 0.000 | 0.000 |
| 30 | 0.341 | 0.310 | 0.267 | 0.310 |
| 31 | 0.300 | 0.280 | 0.237 | 0.285 |
| 32 | 0.033 | 0.029 | 0.026 | 0.029 |
| 33 | 0.255 | 0.241 | 0.205 | 0.241 |
| 34 | 0.300 | 0.280 | 0.238 | 0.280 |
| mean | 0.274 | 0.258 | 0.250 | 0.278 |

---------

year = 5

| firm no. | crs te rel to tech in yr t-1 | t | t+1 | vrs te |
|---|---|---|---|---|
| 1 | 0.972 | 1.000 | 1.095 | 1.000 |
| 2 | 0.394 | 0.348 | 0.325 | 0.461 |
| 3 | 0.807 | 0.684 | 0.644 | 0.684 |
| 4 | 0.801 | 0.770 | 0.738 | 1.000 |
| 5 | 0.527 | 0.478 | 0.448 | 0.739 |
| 6 | 1.199 | 1.000 | 0.974 | 1.000 |
| 7 | 0.045 | 0.041 | 0.037 | 0.041 |
| 8 | 0.164 | 0.139 | 0.131 | 0.148 |
| 9 | 0.321 | 0.271 | 0.256 | 0.284 |
| 10 | 0.079 | 0.067 | 0.063 | 0.073 |
| 11 | 0.247 | 0.209 | 0.197 | 0.209 |
| 12 | 0.135 | 0.115 | 0.109 | 0.126 |
| 13 | 0.128 | 0.112 | 0.103 | 0.112 |
| 14 | 0.107 | 0.096 | 0.088 | 0.096 |
| 15 | 0.127 | 0.109 | 0.102 | 0.109 |
| 16 | 0.507 | 0.471 | 0.421 | 0.471 |
| 17 | 0.000 | 0.000 | 0.000 | 0.000 |
| 18 | 0.005 | 0.004 | 0.004 | 0.004 |
| 19 | 0.064 | 0.054 | 0.051 | 0.054 |
| 20 | 0.145 | 0.123 | 0.116 | 0.128 |
| 21 | 1.088 | 1.000 | 0.895 | 1.000 |
| 22 | 0.000 | 0.000 | 0.000 | 0.000 |
| 23 | 0.172 | 0.145 | 0.137 | 0.148 |
| 24 | 0.001 | 0.001 | 0.001 | 0.001 |
| 25 | 0.100 | 0.093 | 0.083 | 0.093 |
| 26 | 0.960 | 1.000 | 0.822 | 1.000 |
| 27 | 0.161 | 0.150 | 0.134 | 0.150 |
| 28 | 0.080 | 0.069 | 0.064 | 0.069 |
| 29 | 0.000 | 0.000 | 0.000 | 0.000 |
| 30 | 0.436 | 0.372 | 0.350 | 0.372 |
| 31 | 0.289 | 0.245 | 0.231 | 0.251 |
| 32 | 0.082 | 0.073 | 0.067 | 0.073 |
| 33 | 0.332 | 0.283 | 0.266 | 0.283 |
| 34 | 0.318 | 0.270 | 0.254 | 0.270 |
| mean | 0.317 | 0.288 | 0.271 | 0.307 |

---------

year = 6

| firm no. | crs te rel to tech in yr t-1 | t | t+1 | vrs te |
|---|---|---|---|---|
| 1 | 1.017 | 1.000 | 0.992 | 1.000 |
| 2 | 0.469 | 0.442 | 0.401 | 0.454 |
| 3 | 0.822 | 0.775 | 0.704 | 0.775 |
| 4 | 0.917 | 0.878 | 0.753 | 1.000 |
| 5 | 0.522 | 0.483 | 0.457 | 0.519 |
| 6 | 1.145 | 1.000 | 1.043 | 1.000 |
| 7 | 0.038 | 0.035 | 0.033 | 0.035 |
| 8 | 0.141 | 0.133 | 0.121 | 0.141 |
| 9 | 0.202 | 0.190 | 0.173 | 0.198 |
| 10 | 0.095 | 0.089 | 0.081 | 0.096 |
| 11 | 0.359 | 0.338 | 0.307 | 0.339 |
| 12 | 0.183 | 0.173 | 0.157 | 0.175 |
| 13 | 0.101 | 0.095 | 0.087 | 0.095 |
| 14 | 0.136 | 0.125 | 0.118 | 0.127 |
| 15 | 0.160 | 0.150 | 0.137 | 0.150 |
| 16 | 0.498 | 0.445 | 0.431 | 0.445 |
| 17 | 0.000 | 0.000 | 0.000 | 0.000 |
| 18 | 0.003 | 0.003 | 0.003 | 0.003 |
| 19 | 0.057 | 0.053 | 0.049 | 0.053 |
| 20 | 0.106 | 0.100 | 0.091 | 0.104 |
| 21 | 1.118 | 1.000 | 0.967 | 1.000 |
| 22 | 0.000 | 0.000 | 0.000 | 0.000 |
| 23 | 0.194 | 0.183 | 0.166 | 0.185 |
| 24 | 0.001 | 0.001 | 0.001 | 0.001 |
| 25 | 0.113 | 0.102 | 0.098 | 0.102 |
| 26 | 1.270 | 1.000 | 1.207 | 1.000 |
| 27 | 0.103 | 0.093 | 0.089 | 0.093 |
| 28 | 0.055 | 0.052 | 0.047 | 0.052 |
| 29 | 0.000 | 0.000 | 0.000 | 0.000 |
| 30 | 0.400 | 0.375 | 0.343 | 0.375 |
| 31 | 0.312 | 0.294 | 0.267 | 0.300 |
| 32 | 0.134 | 0.123 | 0.116 | 0.124 |
| 33 | 0.339 | 0.318 | 0.290 | 0.318 |
| 34 | 0.311 | 0.293 | 0.267 | 0.293 |
| mean | 0.333 | 0.304 | 0.294 | 0.310 |

---------

year = 7

| firm no. | crs te rel to tech in yr t-1 | t | t+1 | vrs te |
|---|---|---|---|---|
| 1 | 1.127 | 1.000 | 0.944 | 1.000 |
| 2 | 0.564 | 0.512 | 0.442 | 0.529 |
| 3 | 0.977 | 0.888 | 0.766 | 0.888 |
| 4 | 1.166 | 1.000 | 0.893 | 1.000 |
| 5 | 0.547 | 0.505 | 0.441 | 0.536 |
| 6 | 1.112 | 1.000 | 0.894 | 1.000 |
| 7 | 0.090 | 0.086 | 0.074 | 0.086 |
| 8 | 0.122 | 0.111 | 0.095 | 0.118 |
| 9 | 0.130 | 0.118 | 0.102 | 0.124 |
| 10 | 0.073 | 0.067 | 0.058 | 0.073 |
| 11 | 0.496 | 0.451 | 0.389 | 0.453 |
| 12 | 0.293 | 0.266 | 0.230 | 0.271 |
| 13 | 0.126 | 0.116 | 0.100 | 0.116 |
| 14 | 0.250 | 0.236 | 0.204 | 0.236 |
| 15 | 0.273 | 0.250 | 0.216 | 0.250 |
| 16 | 0.375 | 0.363 | 0.316 | 0.363 |
| 17 | 0.000 | 0.000 | 0.000 | 0.000 |
| 18 | 0.008 | 0.008 | 0.007 | 0.008 |
| 19 | 0.091 | 0.085 | 0.074 | 0.085 |
| 20 | 0.193 | 0.175 | 0.151 | 0.182 |
| 21 | 1.037 | 1.000 | 0.870 | 1.000 |
| 22 | 0.000 | 0.000 | 0.000 | 0.000 |
| 23 | 0.158 | 0.143 | 0.124 | 0.146 |
| 24 | 0.001 | 0.001 | 0.001 | 0.001 |
| 25 | 0.135 | 0.131 | 0.114 | 0.131 |
| 26 | 0.941 | 1.000 | 0.841 | 1.000 |
| 27 | 0.220 | 0.209 | 0.181 | 0.209 |
| 28 | 0.191 | 0.176 | 0.152 | 0.176 |
| 29 | 0.000 | 0.000 | 0.000 | 0.000 |
| 30 | 0.422 | 0.384 | 0.332 | 0.384 |
| 31 | 0.395 | 0.359 | 0.310 | 0.369 |
| 32 | 0.111 | 0.105 | 0.091 | 0.105 |
| 33 | 0.423 | 0.385 | 0.333 | 0.385 |
| 34 | 0.398 | 0.362 | 0.312 | 0.362 |
| mean | 0.366 | 0.338 | 0.296 | 0.341 |

year = 8

| firm no. | crs te rel to tech in yr t-1 | t | t+1 | vrs te |
|---|---|---|---|---|
| 1 | 1.072 | 1.000 | 0.964 | 1.000 |
| 2 | 0.563 | 0.486 | 0.441 | 0.502 |
| 3 | 0.952 | 0.821 | 0.744 | 0.821 |
| 4 | 1.156 | 1.000 | 0.949 | 1.000 |
| 5 | 0.551 | 0.480 | 0.430 | 0.502 |
| 6 | 1.174 | 1.000 | 0.907 | 1.000 |
| 7 | 0.166 | 0.145 | 0.131 | 0.145 |
| 8 | 0.102 | 0.088 | 0.079 | 0.093 |
| 9 | 0.122 | 0.106 | 0.096 | 0.111 |
| 10 | 0.066 | 0.057 | 0.051 | 0.062 |
| 11 | 0.450 | 0.388 | 0.352 | 0.390 |
| 12 | 0.315 | 0.272 | 0.246 | 0.276 |
| 13 | 0.170 | 0.147 | 0.133 | 0.147 |
| 14 | 0.292 | 0.253 | 0.229 | 0.253 |
| 15 | 0.296 | 0.256 | 0.233 | 0.256 |
| 16 | 0.383 | 0.333 | 0.302 | 0.333 |
| 17 | 0.000 | 0.000 | 0.000 | 0.000 |
| 18 | 0.005 | 0.004 | 0.004 | 0.004 |
| 19 | 0.121 | 0.105 | 0.095 | 0.105 |
| 20 | 0.213 | 0.184 | 0.166 | 0.191 |
| 21 | 1.011 | 0.879 | 0.796 | 0.879 |
| 22 | 0.000 | 0.000 | 0.000 | 0.000 |
| 23 | 0.113 | 0.097 | 0.088 | 0.099 |
| 24 | 0.001 | 0.001 | 0.001 | 0.001 |
| 25 | 0.198 | 0.173 | 0.156 | 0.173 |
| 26 | 1.201 | 1.000 | 1.242 | 1.000 |
| 27 | 0.256 | 0.222 | 0.201 | 0.222 |
| 28 | 0.139 | 0.120 | 0.109 | 0.120 |
| 29 | 0.000 | 0.000 | 0.000 | 0.000 |
| 30 | 0.409 | 0.353 | 0.320 | 0.353 |
| 31 | 0.413 | 0.357 | 0.323 | 0.366 |
| 32 | 0.106 | 0.092 | 0.083 | 0.092 |
| 33 | 0.408 | 0.352 | 0.320 | 0.352 |
| 34 | 0.318 | 0.274 | 0.249 | 0.274 |
| mean | 0.375 | 0.325 | 0.307 | 0.327 |

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year = 9

| firm no. | crs te rel to tech in yr t-1 | t | t+1 | vrs te |
|---|---|---|---|---|
| 1 | 1.069 | 1.000 | 0.950 | 1.000 |
| 2 | 0.584 | 0.529 | 0.476 | 0.548 |
| 3 | 0.881 | 0.799 | 0.719 | 0.799 |
| 4 | 1.066 | 1.000 | 0.940 | 1.000 |
| 5 | 0.539 | 0.488 | 0.439 | 0.493 |
| 6 | 1.154 | 1.000 | 0.900 | 1.000 |
| 7 | 0.158 | 0.143 | 0.129 | 0.143 |
| 8 | 0.087 | 0.079 | 0.071 | 0.085 |
| 9 | 0.107 | 0.097 | 0.087 | 0.103 |
| 10 | 0.031 | 0.028 | 0.025 | 0.031 |
| 11 | 0.399 | 0.362 | 0.325 | 0.363 |
| 12 | 0.308 | 0.279 | 0.251 | 0.284 |
| 13 | 0.144 | 0.131 | 0.118 | 0.131 |
| 14 | 0.283 | 0.257 | 0.231 | 0.257 |
| 15 | 0.247 | 0.225 | 0.205 | 0.225 |
| 16 | 0.354 | 0.321 | 0.289 | 0.321 |
| 17 | 0.000 | 0.000 | 0.000 | 0.000 |
| 18 | 0.003 | 0.003 | 0.003 | 0.003 |
| 19 | 0.113 | 0.102 | 0.092 | 0.102 |
| 20 | 0.152 | 0.137 | 0.124 | 0.143 |
| 21 | 0.834 | 0.755 | 0.680 | 0.755 |
| 22 | 0.000 | 0.000 | 0.000 | 0.000 |
| 23 | 0.119 | 0.108 | 0.097 | 0.110 |
| 24 | 0.000 | 0.000 | 0.000 | 0.000 |
| 25 | 0.222 | 0.201 | 0.181 | 0.201 |
| 26 | 0.819 | 1.000 | 6.925 | 1.000 |
| 27 | 0.243 | 0.220 | 0.198 | 0.220 |
| 28 | 0.131 | 0.119 | 0.107 | 0.119 |
| 29 | 0.000 | 0.000 | 0.000 | 0.000 |
| 30 | 0.411 | 0.373 | 0.335 | 0.373 |
| 31 | 0.366 | 0.332 | 0.299 | 0.342 |
| 32 | 0.091 | 0.082 | 0.074 | 0.082 |
| 33 | 0.393 | 0.357 | 0.322 | 0.357 |
| 34 | 0.326 | 0.296 | 0.267 | 0.296 |
| mean | 0.342 | 0.318 | 0.466 | 0.320 |

year = 10

| firm no. | crs te rel to tech in yr t-1 | t | t+1 | vrs te |
|---|---|---|---|---|
| 1 | 1.063 | 1.000 | 0.000 | 1.000 |
| 2 | 0.618 | 0.556 | 0.000 | 0.579 |
| 3 | 0.838 | 0.755 | 0.000 | 0.755 |
| 4 | 1.077 | 1.000 | 0.000 | 1.000 |
| 5 | 0.467 | 0.421 | 0.000 | 0.426 |
| 6 | 1.273 | 1.000 | 0.000 | 1.000 |
| 7 | 0.181 | 0.163 | 0.000 | 0.163 |
| 8 | 0.101 | 0.091 | 0.000 | 0.099 |
| 9 | 0.071 | 0.064 | 0.000 | 0.068 |
| 10 | 0.022 | 0.019 | 0.000 | 0.022 |
| 11 | 0.365 | 0.329 | 0.000 | 0.330 |
| 12 | 0.277 | 0.249 | 0.000 | 0.255 |
| 13 | 0.153 | 0.138 | 0.000 | 0.138 |
| 14 | 0.227 | 0.204 | 0.000 | 0.204 |
| 15 | 0.226 | 0.205 | 0.000 | 0.205 |
| 16 | 0.350 | 0.315 | 0.000 | 0.315 |
| 17 | 0.000 | 0.000 | 0.000 | 0.000 |
| 18 | 0.012 | 0.011 | 0.000 | 0.011 |
| 19 | 0.075 | 0.068 | 0.000 | 0.068 |
| 20 | 0.143 | 0.129 | 0.000 | 0.135 |
| 21 | 0.716 | 0.645 | 0.000 | 0.645 |
| 22 | 0.000 | 0.000 | 0.000 | 0.000 |
| 23 | 0.118 | 0.106 | 0.000 | 0.109 |
| 24 | 0.002 | 0.002 | 0.000 | 0.002 |
| 25 | 0.201 | 0.181 | 0.000 | 0.181 |
| 26 | 0.509 | 1.000 | 0.000 | 1.000 |
| 27 | 0.237 | 0.214 | 0.000 | 0.214 |
| 28 | 0.117 | 0.105 | 0.000 | 0.105 |
| 29 | 0.000 | 0.000 | 0.000 | 0.000 |
| 30 | 0.346 | 0.307 | 0.000 | 0.307 |
| 31 | 0.343 | 0.309 | 0.000 | 0.319 |
| 32 | 0.133 | 0.120 | 0.000 | 0.120 |
| 33 | 0.341 | 0.308 | 0.000 | 0.308 |
| 34 | 0.309 | 0.279 | 0.000 | 0.279 |
| mean | 0.321 | 0.303 | 0.000 | 0.305 |

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**Technical efficiency scores of commercial airports under control of Airports of Thailand**

| Airports | Airport Code | Fiscal year | | | | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | |
| Suvarnabhumi Airport | BKK | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Mae Fah Luang – Chiang Rai International Airport | CEI | 0.49 | 0.397 | 0.47 | 0.53 | 0.461 | 0.454 | 0.529 | 0.502 | 0.548 | 0.579 | 0.496 |
| Chiang Mai International Airport | CNX | 1 | 0.926 | 0.866 | 0.787 | 0.684 | 0.775 | 0.888 | 0.821 | 0.799 | 0.755 | 0.83 |
| Don Mueang International Airport | DMK | 0.339 | 0.321 | 0.401 | 0.282 | 1 | 1 | 1 | 1 | 1 | 1 | 0.734 |
| Hat Yai International Airport | HDY | 1 | 0.884 | 0.914 | 0.869 | 0.739 | 0.519 | 0.536 | 0.502 | 0.493 | 0.426 | 0.688 |

**Technical efficiency scores of commercial airports under control of Airports of Thailand**

| Airports | Airport Code | Fiscal year | | | | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | |
| Phuket International Airport | HKT | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Mean | | 0.805 | 0.755 | 0.775 | 0.745 | 0.814 | 0.791 | 0.826 | 0.804 | 0.807 | 0.793 | 0.791 |

**Malmquist Index of commercial airports under control of Airports of Thailand**

| Airports | Airport Code | Fiscal year | | | | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | |
| Suvarnabhumi Airport | BKK | - | 1.187 | 1.086 | 1.074 | 0.925 | 0.964 | 1.065 | 1.065 | 1.053 | 1.058 | 1.053 |
| Mae Fah Luang – Chiang Rai International Airport | CEI | - | 1.035 | 1.053 | 1.175 | 1.003 | 1.354 | 1.276 | 1.1 | 1.201 | 1.167 | 1.152 |
| Chiang Mai | CNX | - | 1.183 | 1.04 | 1.082 | 1.016 | 1.203 | 1.261 | 1.072 | 1.073 | 1.049 | 1.109 |

**Malmquist Index of commercial airports under control of Airports of Thailand**

| **Airports** | **Airport Code** | **Fiscal year** | | | | | | | | | | **Mean** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | |
| International Airport | | | | | | | | | | | | |
| Don Mueang International Airport | DMK | - | 1.08 | 1.414 | 0.782 | 3.661 | 1.19 | 1.327 | 1.138 | 1.06 | 1.07 | 1.414 |
| Hat Yai International Airport | HDY | -- | 1.225 | 1.198 | 1.073 | 1.085 | 1.085 | 1.118 | 1.09 | 1.128 | 0.958 | 1.107 |
| Phuket International Airport | HKT | - | 1.333 | 1.161 | 1.106 | 1.144 | 1.085 | 1.033 | 1.146 | 1.128 | 1.189 | 1.147 |
| **Mean** | | **-** | **1.174** | **1.159** | **1.049** | **1.472** | **1.147** | **1.180** | **1.102** | **1.107** | **1.082** | **1.163** |

# APPENDIX D

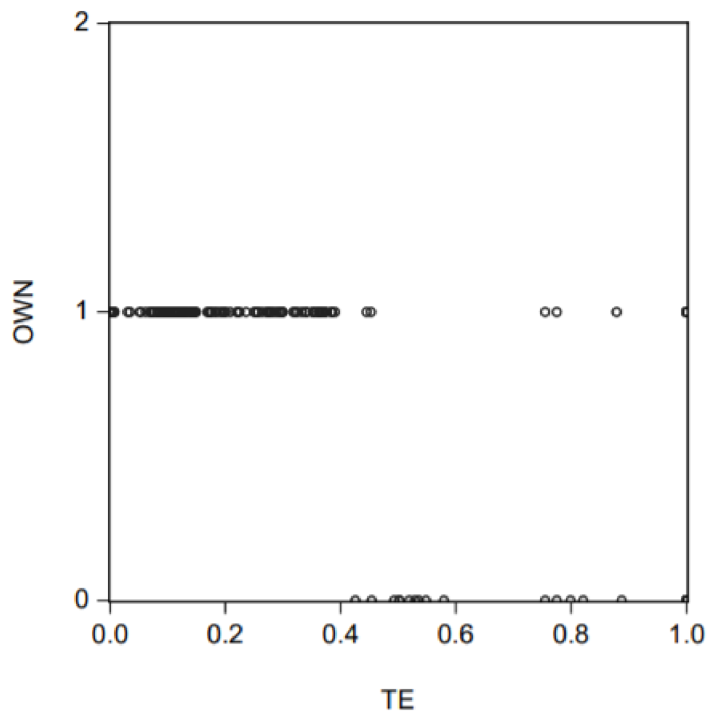
## Outputs of Factors Affecting Airport Technical Efficiency

This appendix shows the outputs of factor affecting airport efficiency produced by EViews® 10 software package. It not only presents the mentioned outputs, but it also provides outputs deriving from classical ordinary least square methods checking and data cleaning preparation. The details of each test are as follows:

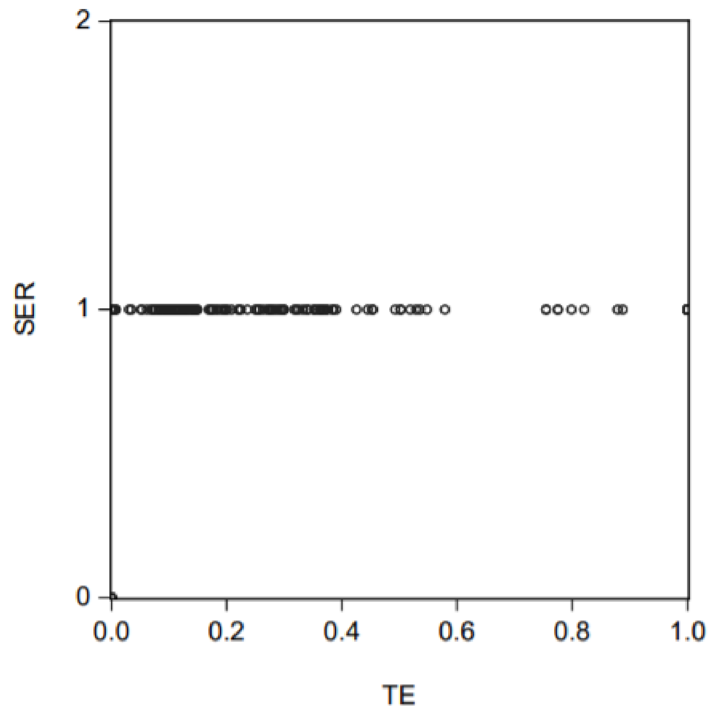
1) The Scatter Plots

These diagrams display the relationship between the independent variable and dependent variable. Since the relationship shows the constant and linear property, the linear functional form is applied to construct the econometric model.

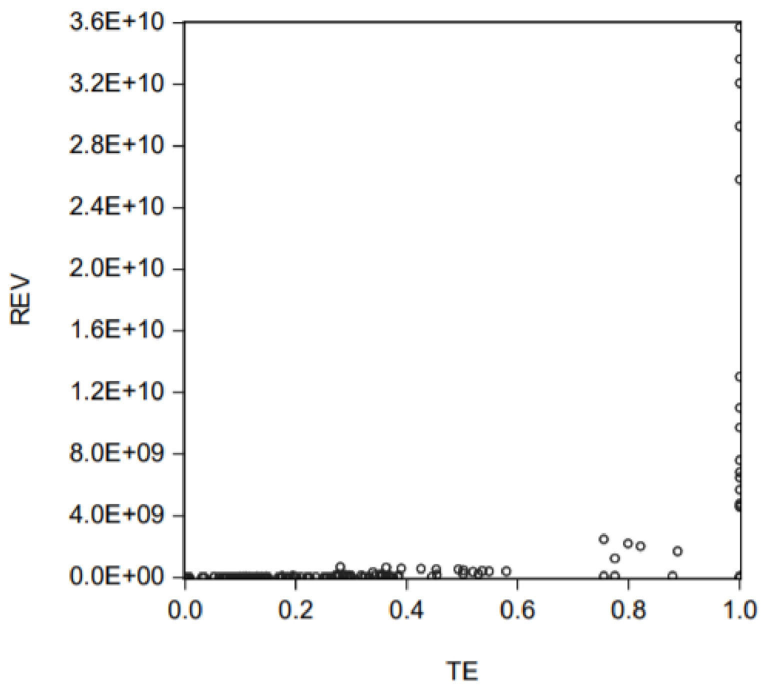
1.1) Scatter plot between airport ownership forms and technical efficiency scores:



1.2) Scatter plot between service quality and technical efficiency scores:




1.3) Scatter plot between airport revenues and technical efficiency scores:



2) The Covariance and Correlation Matrix

To test the correlation among independent variables in the econometric model, the covariance and simple correlation matrix are performed.

Covariance Analysis: Ordinary
Date: 03/02/20 Time: 20:45
Sample: 2014 2018
Included observations: 170

| Covariance<br>Correlation | LOC | MKT | OWN | POL | REG | REV | SER |
|---|---|---|---|---|---|---|---|
| LOC | 0.242215 | | | | | | |
| | 1.000000 | | | | | | |
| MKT | -0.002662 | 0.000647 | | | | | |
| | -0.212753 | 1.000000 | | | | | |
| OWN | 0.055017 | -0.005293 | 0.145329 | | | | |
| | 0.293240 | -0.546092 | 1.000000 | | | | |
| POL | -0.008304 | 0.000613 | -0.016609 | 0.085260 | | | |
| | -0.057789 | 0.082550 | -0.149209 | 1.000000 | | | |
| REG | -19.25606 | 1.852664 | -50.86505 | 5.813149 | 17802.77 | | |
| | -0.293240 | 0.546092 | -1.000000 | 0.149209 | 1.000000 | | |
| REV | -5.93E+08 | 1.35E+08 | -1.18E+09 | 1.39E+08 | 4.12E+11 | 3.08E+19 | |
| | -0.216911 | 0.957480 | -0.555588 | 0.085456 | 0.555588 | 1.000000 | |
| SER | -0.010727 | 0.000575 | -0.015571 | 0.074048 | 5.449827 | 1.30E+08 | 0.080450 |
| | -0.076842 | 0.079670 | -0.144005 | 0.894091 | 0.144005 | 0.082476 | 1.000000 |

3) White's Heteroskedasticity Test

Heteroskedasticity Test: White
Null hypothesis: Homoskedasticity

| | | | |
|---|---|---|---|
| F-statistic | 1.243836 | Prob. F(3,166) | 0.2956 |
| Obs*R-squared | 3.737412 | Prob. Chi-Square(3) | 0.2913 |
| Scaled explained SS | 11.54922 | Prob. Chi-Square(3) | 0.0091 |

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 03/03/20 Time: 10:20
Sample: 2014 2018
Included observations: 170

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | -0.020148 | 0.040494 | -0.497561 | 0.6195 |
| OWN^2 | 0.020148 | 0.026470 | 0.761167 | 0.4476 |
| SER^2 | 0.055839 | 0.032431 | 1.721774 | 0.0870 |
| REV^2 | -2.35E-23 | 5.82E-23 | -0.403674 | 0.6870 |

| | | | |
|---|---|---|---|
| R-squared | 0.021985 | Mean dependent var | 0.046581 |
| Adjusted R-squared | 0.004310 | S.D. dependent var | 0.118943 |
| S.E. of regression | 0.118686 | Akaike info criterion | -1.401421 |
| Sum squared resid | 2.338340 | Schwarz criterion | -1.327638 |
| Log likelihood | 123.1208 | Hannan-Quinn criter. | -1.371481 |
| F-statistic | 1.243836 | Durbin-Watson stat | 2.169288 |
| Prob(F-statistic) | 0.295583 | | |

4) The output from Panel Least Square Method

Dependent Variable: TE
Method: Panel Least Squares
Date: 03/03/20 Time: 10:22
Sample: 2014 2018
Periods included: 5
Cross-sections included: 34
Total panel (balanced) observations: 170

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 0.464185 | 0.077544 | 5.986119 | 0.0000 |
| OWN | -0.464119 | 0.053224 | -8.720143 | 0.0000 |
| SER | 0.239596 | 0.059682 | 4.014574 | 0.0001 |
| REV | 1.23E-11 | 3.63E-12 | 3.401457 | 0.0008 |

| | | | |
|---|---|---|---|
| Root MSE | 0.215827 | R-squared | 0.555967 |
| Mean dependent var | 0.318594 | Adjusted R-squared | 0.547943 |
| S.D. dependent var | 0.324847 | S.E. of regression | 0.218411 |
| Akaike info criterion | -0.181624 | Sum squared resid | 7.918791 |
| Schwarz criterion | -0.107841 | Log likelihood | 19.43804 |
| Hannan-Quinn criter. | -0.151684 | F-statistic | 69.28210 |
| Durbin-Watson stat | 2.112493 | Prob(F-statistic) | 0.000000 |

# BIOGRAPHY

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|---|---|
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| **ACADEMIC BACKGROUND** | Bachelor of Science (Cooperative Economics)<br>Kasetsart University in 2007<br><br>Bachelor of Economics (Labor and Industrial Economics)<br>Ramkhamhaeng University in 2007<br><br>Master of Economics (Business Economics)<br>National Institute of Development Administration in 2014<br>Thesis Title: International Airline Alliance: Its Effects on Trans Pacific Interhub Airfare and Revenue<br>(Excellent Award) |
| **EXPERIENCES** | 2007 - 2008<br>Banking Custodian<br>Department of Capital Market<br>Siam City Bank Plc.<br><br>2008 - 2015<br>Cabin Crew<br>Department of Cabin Operations<br>Bangkok Airways Plc.<br><br>2016 - 2019<br>Part-time Lecturer<br>School of Humanities and Tourism Management<br>Bangkok University<br><br>2017 - 2019<br>Research Assistant<br>Research Center, National Institute of Development Administration<br><br>2019 - present<br>Full-time Lecturer<br>International College for Sustainability Studies<br>Srinakharinwirot University |