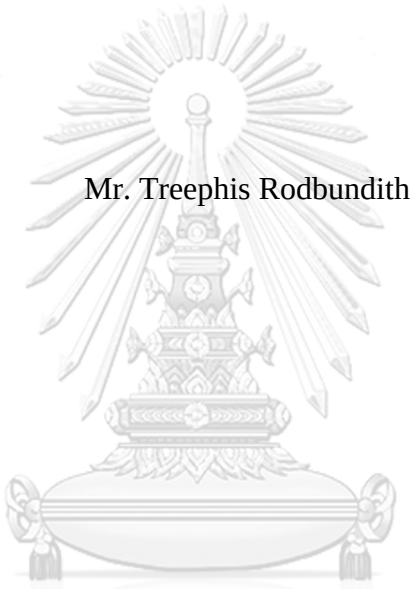
A Study of Criteria for Air Cargo Terminal Classification Model

Mr. Treephis Rodbundith



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นายตรีพิศ รอดบัณฑิต

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรดุษฎีบัณฑิต
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Thesis Title	A Study of Criteria for Air Cargo Terminal Classification Model
By	Mr. Treephis Rodbundith
Field of Study	Logistics Management and Supply Chain Management
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ตรีพิศ รอดบัณฑิต : การศึกษาปัจจัยสำหรับตัวแบบการจัดประเภทคลังสินค้าการขนส่งทางอากาศ (A Study of Criteria for Air Cargo Terminal Classification Model) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: ศ. ดร.กมลชนก สุทธิวาทนฤพุฒิ, อ.ที่ปรึกษาวิทยานิพนธ์ร่วม: รศ. ดร.พงศา พรชัยวิเศษกุล, 187 หน้า.

การขนส่งทางอากาศมีบทบาทสำคัญสำหรับการขนส่งสินค้ามานานหลายสิบปีไปยังทวีปต่างๆ ทั่วโลก โดยสายการบินที่เป็นผู้ขนส่งสินค้าประมาณ 51.3 ล้านบาทตัน หรือมากกว่า 1 ใน 3 ของมูลค่าการค้าทั่วโลก หรือประมาณ 6.8 ล้านเหรียญสหรัฐต่อปี อนึ่ง คลังสินค้าการขนส่งทางอากาศเป็นหนึ่งในปัจจัยแห่งความสำเร็จหลักของสายการบินที่ให้บริการขนส่งสินค้าที่อยู่ในระบบห่วงโซ่อุปทานในพื้นที่สนามบิน การศึกษางานวิจัยนี้มีจุดประสงค์ที่จะสำรวจและวิเคราะห์ความสำคัญของปัจจัยทั้งหลายที่เกี่ยวข้องกับคลังสินค้าการขนส่งทางอากาศจากปัจจัยทั้งหมด 63 ปัจจัยจากงานวิจัยต่างๆ และมาตรฐานการบริการขององค์กร International Air Transport Association โดยผ่านการตรวจสอบความสำคัญจากผู้ให้บริการคลังสินค้าการขนส่งทางอากาศที่มีคลังสินค้าจำนวน 474 คลังใน 6 ทวีปทั่วโลกยกเว้นในประเทศไทย ทั้งนี้ การศึกษางานวิจัยนี้ได้นำการวิเคราะห์ปัจจัยและนำวิธีการศึกษา Factor Analysis โดยวิธี Principal Component Analysis ที่สามารถหาจำนวนตัวแปรที่สามารถนำมาใช้แทนปัจจัยทั้งหมดทุกตัวได้เพื่อลดจำนวนปัจจัยลง โดยปัจจัยที่ได้มาทั้งหมด 9 ปัจจัยหลักโดยมี 44 ปัจจัยรองพร้อมกับคะแนน Factor Loading ของแต่ละปัจจัยที่ผู้เชี่ยวชาญทางการขนส่งทางอากาศ นักวิชาการ หน่วยงานรัฐบาล ผู้ขนส่งสินค้าทางอากาศ และสายการบิน ในอุตสาหกรรมที่เกี่ยวข้อง ยังคงให้ความสำคัญกับปัจจัยนั้นๆ และได้นำปัจจัยดังกล่าวมาทดสอบกับผู้ให้บริการคลังสินค้าการขนส่งทางอากาศที่เป็นกลุ่มตัวอย่างจำนวน 5 ใน 7 ผู้ให้บริการคลังสินค้าการขนส่งทางอากาศ ณ สนามบินนานาชาติสุวรรณภูมิ เชียงใหม่และภูเก็ต โดยมีผู้ให้บริการคลังสินค้าการขนส่งทางอากาศ 2 รายที่ไม่เข้าร่วม ในการทดสอบปัจจัยทั้ง 9 ปัจจัยหลักที่มี 44 ปัจจัยรอง โดยผ่านวิธีการจัดกลุ่มปัจจัยด้วยเทคนิค Hierarchical Cluster Analysis ที่จัดกลุ่มผู้ให้บริการคลังสินค้าการขนส่งทางอากาศ ทั้ง 5 ให้อยู่ในการแบ่งกลุ่มแบบ 2, 3 และ 4 กลุ่ม ที่มีความสัมพันธ์ใกล้เคียงกันไว้ด้วยกัน บริษัท การบินไทย จำกัด (มหาชน) ณ สนามบินนานาชาติสุวรรณภูมิ เป็นผู้ให้บริการคลังสินค้าการขนส่งทางอากาศที่มีความโดดเด่นอย่างชัดเจนโดยถูกแบ่งกลุ่มให้อยู่ใน 1 กลุ่ม และไม่ถูกจัดกลุ่มร่วมกับผู้ให้บริการรายอื่นและได้แสดงการจัดประเภทคลังสินค้าการขนส่งทางอากาศต่างๆ อีกทั้ง มีศึกษาข้อได้เปรียบและข้อเสียเปรียบของ บริษัท การบินไทย จำกัด (มหาชน) ทั้งการจัดกลุ่มในแต่ละปัจจัยและการจัดกลุ่มแบบรวมปัจจัยทั้ง 9 ปัจจัยหลัก และนำมาเปรียบเทียบกับสนามบินนานาชาติฮ่องกง ที่ถือว่าเป็นสนามบินสำหรับการขนส่งสินค้าทางอากาศที่ดีที่สุดในโลก โดยปัจจัยทั้ง 9 ปัจจัยหลักได้ถูกตรวจสอบและพบว่าเป็นปัจจัยที่สามารถนำมาใช้ได้จริงสำหรับแม่แบบการจัดประเภทคลังสินค้าการขนส่งทางอากาศ ซึ่งถือว่าเป็นงานทางด้านการวิจัยที่ค้นพบใหม่ ต่อมาได้นำปัจจัยทั้ง 9 ปัจจัยหลักและ 44 ปัจจัยรอง พร้อมทั้งคะแนน Factor Loading มาทำรายการตรวจสอบตามปัจจัยจากการศึกษานี้ให้สำหรับนักวิชาการ ผู้ให้บริการคลังสินค้าการขนส่งทางอากาศ หน่วยงานรัฐบาล หน่วยงานผู้ที่สนใจอื่นทั่วโลกเพื่อนำไปอ้างอิงและนำไปใช้เพื่อเตรียมความพร้อมสำหรับการทำธุรกิจที่เกี่ยวข้อง และการศึกษาทางด้านงานวิจัยอื่นๆ ต่อไป

สาขาวิชา การจัดการโลจิสติกส์และโซ่อุปทาน ลายมือชื่อนิสิต .....

ปีการศึกษา 2560 ลายมือชื่อ อ.ที่ปรึกษาหลัก .....

ลายมือชื่อ อ.ที่ปรึกษาร่วม .....

5887771720 : MAJOR LOGISTICS MANAGEMENT AND SUPPLY CHAIN MANAGEMENT
KEYWORDS: AIR CARGO TERMINAL / AIR CARGO TERMINAL CLASSIFICATION MODEL / CLUSTER ANALYSIS / CRITERIA / INTERNATIONAL AIR TRANSPORT ASSOCIATION / PRINCIPAL COMPONENT ANALYSIS

TREEPHIS RODBUNDITH: A Study of Criteria for Air Cargo Terminal Classification Model. ADVISOR: PROF. KAMONCHANOK SUTHIWARTNARUEPUT, Ph.D., CO-ADVISOR: ASSOC. PROF. PONGSA PORNCHAIWISESKUL, Ph.D., 187 pp.

Global air cargo transportation has performed a significant role to the trade industry over the past decades for goods delivery. Airlines transport approximately 51.3 million metric tons of goods, or more than one third of worldwide trade or USD 6.8 trillion by value annually. Air cargo terminal is a key success of airlines in the supply chain network at airports. This study is aimed to explore and analyze important criteria of air cargo terminals on the integration of 63 criteria from previous researches of practical operations and International Air Transport Association regulated standard services. To examine reviewed criteria, this paper investigates the criteria significance by 57 of 75 air cargo terminal operators around the world except in Thailand covering 474 air cargo terminals in 6 continents. Also, this research cooperatively evaluates the criteria and employs Factor Analysis by using Principal Component Analysis program for criteria reduction with the similarity. The result of final validation from aviation experts, academicians, government bodies, air cargo logistics service providers and airlines in air cargo related industries reveal that 9 integrated criteria with 44 sub-criteria and factors loading scores are remained important. The significant criteria are studied with air cargo terminal operators in Suvarnabhumi, Chiang Mai, Don Muang and Phuket international airports as a sampling to testify the criteria and model from the first phase finding. There are 5 of 7 operators who participate this assessment only in Suvarnabhumi, Chiang Mai and Phuket international airports. Raw data is given and input in Hierarchical Cluster Analysis program to cluster all 5 air cargo terminal operators into 2, 3 and 4 classifications homogenously. Thai Airways as an air cargo terminal operator in Suvarnabhumi international airport is clustered separately in one classification and obviously outstanding from the other 4 air cargo terminal operators and all classification are presented. Still, strength and weakness of Thai Airways in each criteria and all 9 main criteria are analyzed as results from second phase finding of this research and compared with the best practice of air cargo airport namely Hong Kong international airport. Also, this is proven that the significant criteria are workable and practical for air cargo terminal classification model as a new body of knowledge for third phase finding. Later, the 9 main criteria with 44 sub-criteria and factor loading scores are constructed into the guideline and check list that are available for academicians, air cargo terminal operators, government bodies and interested stake holders around the world to prepare and apply to their business and academic purposes.

Field of Study:	Logistics Management and Supply Chain Management	Student's Signature	.....
		Advisor's Signature	.....
Academic Year:	2017	Co-Advisor's Signature	.....

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Moreover, with professional assistance and advice from Professor Dr. Kamonchanok Suthiwartnarueput as Thesis Advisor and Associate Professor Dr. Pongsa Pornchaiwiseskul as Thesis Co-Advisor, this thesis is completely achieved and valued to the aviation and air cargo industry. Treephis is highly appreciated and thankful to Professor Dr. Kamonchanok Suthiwartnarueput and Associate Professor Dr. Pongsa Pornchaiwiseskul. Treephis is also thankful to Thesis Committee with Associate Professor Dr. Chackrit Dangphastra as Chairman, Associate Professor Dr. Rahuth Rodjanapradied as Examiner, Assistant Professor Dr. Tartat Mokkhamakkul as Examiner, Dr. Chula Sukmanop as External Examiner and Dean of the Graduate School, Associate Professor Dr. Thumnoon Nhujak for great support.

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Chapter 1

1. Introduction

1.1 Air Cargo Trade Industries, Key Regions and Airports

…The global air cargo system is a complex, multifaceted network for transporting vast amounts of freight, packages and mail on both passenger and all-cargo aircrafts. The world's airlines transport more than 50 million tons of freight and mail annually and more than a third of the value of world trade relies directly on air transport and related trade volumes are expected to grow over the long term. The sheer size and economic significance of all this activity underscore the scale of the challenges before us and highlight the need for greater cooperation…

Raymond Benjamin, Secretary General of International Civil Aviation Organization (ICAO) stated in Moving Air Cargo Globally, First Edition

Global air cargo has changed considerably over the past decade. The industry aims to deliver their goods through air cargo transportation. In 2014, airlines transported 51.3 million metric tons of goods, representing more than 35% of global trade by value but less than 1% of world trade by volume by International Air Transport Association (IATA, 2016c). That is equivalent to USD 6.8 trillion worth of goods annually, or USD18.6 billion worth of goods every day (IATA, 2015). According to International Air Transport Association (IATA, 2015) and Raymond Benjamin, Secretary of ICAO above, the trade value represented that air cargo has been one third of the world's economic: even though, the volume was less than 1% of the total volume. The trade industry relies on air cargo transportation to rather deliver the industry's valuable goods via air cargo than other modes.

Table 1 shows that air cargo transportation has significantly become important throughout the world in accordance to Mr. Raymond Benjamin statement and IATA Cargo Strategy report in August 2015. In addition, Airports Council International (ACI, 2017) presented that Asia Pacific region played the major role of global air cargo throughput in Year 2015 comparing to Year 2014 with the greatest number of cargo

volume and its change in percent while the region position has remained unchanged among the seven regions of the world. The Middle East region looked outstanding in change in percent whereas its cargo volume was still far behind Asia Pacific region or North America and Europe.

Regions	Million Metric Tons	% Change from 2014
Asia-Pacific	41.10	2.3%
North America	30.00	0.5%
Europe	18.90	0.5%
Middle East	8.50	9.9%
Latin America, Caribbean	4.90	-1.3%
Africa	2.10	3.5%

Table 1: Airports in Regions with the Largest Amount of Air Cargo during 2015 (ACI, 2017)

ACI (2017) reported the worldwide airport cargo increased by 2.6% in 2015 to 106 million metric tons, with mixed levels of growth across all six regions. Hong Kong (HKG) and Memphis (MEM) took the first and second ranks respectively for the busiest air cargo airports with 4.5 and 4.3 million metric tons in 2015 as shown in Table 2. This Top 10 total cargo airport 2015 was for both domestic and international cargo trade. The numbers were exhibited in huge records annually. Nevertheless, most import and export cargo were from international traffic. See Table 3.

Ranks	Cities, Countries	Codes	Total Cargo (tons)	% Change from 2014
1	Hong Kong, China	HKG	4,460,065	0.4%
2	Memphis TN, USA	MEM	4,290,638	0.8%
3	Shanghai, China	PVG	3,275,231	2.9%
4	Anchorage AK,USA	ANC	2,630,701	5.5%
5	Incheon, South Korea	ICN	2,595,678	1.5%
6	Dubai, United Arab Emirates	DXB	2,506,092	3.4%

Ranks	Cities, Countries	Codes	Total Cargo (tons)	% Change from 2014
7	Louisville KY,USA	SOF	2,350,656	2.5%
8	Tokyo, Japan	NRT	2,122,314	-0.6%
9	Paris, France	CDG	2,090,795	0.2%
10	Frankfurt, Germany	FRA	2,076,734	-2.6%

Table 2: Top 10 Total Cargo Airports 2015 (ACI, 2017)

According to 2015 tonnage data submitted by more than 2,200 commercial airports in 160 countries, ACI (2017) has ranked the world's largest-capacity cargo airports and divided them into three categories: Total airfreight handled as described in Table 2, domestic airfreight handled and international airfreight handled. Below are the top listings for international cargo traffic in 2015. The difference between international and domestic cargo was much lower cargo volumes in domestic side. The international cargo has taken an important part for cargo traffic in the world. See Table 3. Looking at Thailand where Suvarnabhumi international airport was only one airport from Thailand listed on Top 40 airport ranking for international cargo volume in 2015 comparing with the surrounding countries such as Japan, China, Dubai and Abu Dhabi in U.A.E. and India, etc. There were at least two airports ranked in the Top 40 from each country. On the other side of the world in Europe, Germany and Belgium were with two airports each country ranked in the Top 40. Suvarnabhumi international airport was equivalently not completing Hong Kong, Incheon, Taipei or even Singapore international airports in term of international cargo volumes.

Ranks	Cities, Countries	Codes	International Freight (Tons)	% Change from 2014
1	Hong Kong	HKG	4,380,139	0.1
2	Dubai, U.A.E	DXB	2,506,092	3.4
3	Incheon, South Korea	ICN	2,489,539	0.6
4	Shanghai, China	PVG	2,395,496	2.6
5	Tokyo, Japan	NRT	2,035,968	-0.4
6	Taipei, Taiwan	TPE	2,005,277	-3.2

Ranks	Cities, Countries	Codes	International Freight (Tons)	% Change
7	Anchorage, U.S	ANC	1,956,776	9.5
8	Frankfurt, Germany	FRA	1,950,726	-2.8
9	Paris, France	CDG	1,861,311	0.2
10	Singapore	SIN	1,853,100	0.5
11	Miami, U.S.	MIA	1,737,618	-0.1
12	Amsterdam, Netherlands	AMS	1,620,970	-0.7
13	London, U.K	LHR	1,494,886	-0.2
14	Doha, Qatar	DOH	1,443,532	47.3
15	Bangkok, Thailand	BKK	1,189,105	-0.2
16	Chicago, U.S.	ORD	1,176,906	21.0
17	Los Angeles, U.S.	LAX	1,141,981	9.0
18	New York, U.S.	JFK	993,312	-0.5
19	Leipzig, Germany	LEJ	915,308	8.8
20	Dubai, U.A.E.	DWC	890,912	8.0
21	Abu Dhabi, U.A.E	AUH	827,459	3.8
22	Guangzhou, China	CAN	752,759	9.4
23	Istanbul, Turkey	IST	746,981	9.4
24	Beijing, China	PEK	738,953	-0.2
25	Luxembourg, Luxembourg	LUX	736,485	4.2
26	Cologne, Germany	CGN	724,155	0.2
27	Osaka, Japan	KIX	697,374	-0.4
28	Liege, Belgium	LGG	650,254	10.1
29	Kuala Lumpur, Malaysia	KUL	639,908	-4.8
30	Jeddah, Saudi Arabia	JED	615,160	38.8
31	Bogota, Colombia	BOG	521,768	4.1
32	Milan, Italy	MXP	498,108	8.9
33	Mumbai, India	BOM	491,953	2.0
34	New Delhi, India	DEL	469,346	11.5
35	Brussels, Belgium	BRU	462,989	8.2

Ranks	Cities, Countries	Codes	International Freight (Tons)	% Change
36	Louisville, U.S.	SDF	416,622	-2.8
37	Mexico City, Mexico	MEX	364,471	10.0
38	Atlanta, U.S.	ATL	353,497	7.6
39	Madrid, Spain	MAD	343,958	6.0
40	Hanoi, Vietnam	HAN	329,358	21.2

Table 3: Top 40 Airport Rankings: International Cargo in 2015 (ACI, 2017)

Table 3 shows that 12 of 40 airports are located in China, Japan, Malaysia, Singapore, South Korea, Taiwan, Thailand and Vietnam. Also, it is more than half of the list of Top 10 airports are from Asia Pacific region. By cargo value and volume, both statistics imply that the region plays important role to the world's cargo transportation and operations.

1.2 Aircraft Manufacture Trends

As the world's emerging markets continue to grow, airplane manufacturers are seeing greater diversity in their customer base (Boeing, 2017). As reported by (Boeing, 2017), they stated that in over the next 20 years which is year 2034, there will be the need for 38,050 airplanes valued at more than US$5.6 trillion with approximately 40 percent of all the new aircrafts being delivered to based airlines in Asia Pacific region as shown in Table 4. From the number represented below, Asia Pacific region are in the top rank for the new aircraft demanding. The numbers show that air cargo capacity is still growing to accommodate air cargo movement. The airlines foresee that aviation industry has continued to grow for passenger travel and air cargo delivery in accordance to place orders for many more aircrafts from the manufacturers. Airbus also reported in Global Market Forecast, Mapping Demand 2016/2035 that new passenger aircrafts and freighter deliveries during 2016 – 2035 would reach 33,070 units and Asia Pacific region takes the major share of 13,239 deliveries or 40% of new aircraft demand in the world while freighters share of 646 deliveries or 2% in Table 5. The forecast reports from both Boeing and Airbus are in line to predict the increasing growth of aircraft demand for airlines' industry. This statistic represents the air cargo transportation is

still an important role to move all cargo around the globe: especially, in Asia Pacific region. Therefore, this region is the major player of air cargo business for the next two decades.

Demand by sizes (2015 to 2034)			Demand by regions (2015 to 2034)		
New Airplanes		Values ($B)*	Regions	New Airplanes	Value ($B)*
Large wide body	540	230	Asia Pacific	14,330	2,200
Medium wide body	3,520	1,220	Europe	7,310	1,050
Small wide body	4,770	1,250	North America	7,890	940
Single aisle	26,730	2,770	Middle East	3,180	730
Regional jets	2,490	100	Latin America	3,020	350
Total	38,050	5,570	CIS	1,150	140
*$values throughout the current market outlook are catalog price			Africa	1,170	160
			Total	38,050	5,570

Table 4: The Demand by Size and Region from 2015 to 2034 (Boeing, 2017)

Regions	2016 - 2025	2026 - 2035	2016 - 2035	Shares of 2016 – 2035 new deliveries
Africa	447	544	991	3%
Asia-Pacific	5,157	8,082	13,239	40%
CIS	448	753	1,201	3%
Europe	3,108	3,400	6,508	20%
Latin America	1,319	1,226	2,545	8%
Middle East	1,170	1,195	2,365	7%
North America	2,381	3,198	5,579	17%
Freighters	364	282	646	2%
World	14,394	18,680	33,074	100%

Table 5: New Aircraft Demand for Passenger and Freighters during 2016 – 2035(Airbus, 2017)

1.3 Airlines Perspectives

Regarding to air cargo and supply chain management, air cargo commodities: basically, are high-value commodities such as valuable cargo, luxury automobiles, electronic parts/appliances, pharmaceutical products, or the perishable goods and the one that needs the time sensitive and reliable logistics. Passenger aircrafts and dedicated cargo aircrafts or freighters both are operated to carry the air cargo product. By the record from Boeing (2017) in Table 4, with the industry's growth requirements, the air cargo will create the demand for 8,830 wide body aircraft deliveries over the next 20 years. These numbers show the significant demand for aircrafts to enter airline fleets to carry products by air transportation in the future.

In order to support cargo demand, the country and industry should be continuing to innovate products and the sustainability for reliability and speed. For Northern part of Thailand as a secondary aviation hub besides Suvarnabhumi and Phuket international airports, based on Vinit Amorndettawin, Director of Air Cargo Terminal Operation department, Thai Airways International, air cargo market growth is influenced by air cargo demand to be shipped and received by shippers and consignees respectively. The key motivated success for the air cargo demand would be the air traffic itself and the growing trends in the world economic; also in the country. In majority, air cargo will be loaded on passenger aircrafts as scheduled by airlines. The product is in the cargo belly of passenger aircrafts. If there is a flight to the destination, the airlines have to find air cargo demands to fill up their capacity. The passenger airlines would focus on passengers at first and air cargo transportation is additional revenue. Otherwise, airlines will lose revenue from cargo transport. The shipper/consignee would prefer to ship their cargo to/from the nearest customs airports, in order to save trucking transportation cost. Dumrongchai Sawangchareon Managing Director of Cargo and Mail Commercial Department, Thai Airways International advised that nowadays, Chinese airlines and some other ASEAN plus 3 airlines, which are currently operating in Thailand, have available or even empty cargo capacity to facilitate cargo demand in the future. It would be the opportunity for Thailand to expand the cargo capability deliver to the surrounding countries. By the result, cargo operations would be also expanded to handle cargo for all import, export and transit cargo in according to the increasing demand.

1.4 Air Cargo Terminals

The degree of competition is based on delivery times to meet the expectation in scheduled times among air cargo carriers. Air cargo operations costs at an airport include airport charges and fees, terminal and ground-handling costs, and other operating costs of the logistics facilities (Zhang, 2003).

A critical air transport operations bringing the aviation into being, is the aviation ground handling services consisting mainly passenger handling, baggage handling, cargo and mail handling, fueling and catering apart from aircraft cleaning, ramp loading and unloading, marshalling, security, general administration and supervision. Out of these, fueling, catering, loading and security are very specialized services and there is a prominent limitation on competition in general agreement on trades in services and aviation ground handling services at airports. These are services which are noticeably apart from the core ground handling services, which are provided by the ground handling agents and consist the rest of activities like passenger handling, baggage handling, and representation, administration and supervision and ramp services (Narendra, 2014). In this circumstance, ground handling's logistics are one of the biggest challenges and a main factor that determines sustainable success. Efficient and customized processes in the field of passenger, baggage and cargo and mail handling are consequently gaining dominant significance for airports and other logistics service providers (Gonnord & Lawson, 2000; Wyld, Jones, & Totten, 2005).

There are many performance factors provided by ground handling agents including air cargo terminals that affect and indicate airline performance to its customers. Also, the studies of researches have analyzed on performance measurement and management related to aviation operations sector in airlines, airports, service providers by using several techniques.

1.5 Air Cargo Terminal Performances Impact to Airline Industry

Air cargo terminal service is an important part of aviation sectors in order to ensure a smooth completion of cargo transportation and airline performance. Moorman (2010) stated that an important part of air cargo service quality occurs on the ground. Managing

the export cargo acceptance, import cargo delivery, and timely transfer of millions of single shipments each year is an operations challenge. Cargo handling and aircraft handling are ways for airlines to differentiate their services. For example, after a period of outsourcing, Delta Airlines announced in 2008 that it would once again begin to manage its own handling processes as a part of a strategic push to grow its cargo revenue share. This leads to all airlines that air cargo terminal service is a part of business success for stabilizing cargo operations to meet revenue target.

Cargo handling or warehouse handling refers to the handling processes in air cargo terminal where cargo on the outbound side are accepted from shipping freight forwarders, weighed, screened and measured, and built-up into containers or on pallets. Enhancing these processes is a major operational challenge. Service quality management and continuous process management techniques are often engaged by airlines (or their selected subcontractors) to reduce the incident rate (loss of freight due to damage or pilferage), optimize throughput in the warehouse, and limit costs. Security screening has recently added complication. Warehousing technologies such as electronic transfer vehicles and automated stacker systems are often employed to optimize the workflow (Moorman, 2010).

Zhang (2003) used Hong Kong's Chek Lap Kok international airport as a study model for China and East Asia, specifically its status as an international air cargo hub. Chek Lap Kok magnificently participates both combination of air freight transportation and air cargo terminal operations, while at the same time complying the conditions for international air traffic rights. Forster and Regan (2001) investigated the US cargo freight industry and highlighted the need for better electronic integration between shippers and freight forwarders in order to increase efficiency. Other related studies have been conducted in Taiwan, such as those of previous scholarships, which focused on a point of view of the passenger transportation and the others were similar to many other studies looking at logistics and courier express services.

1.6 Government Requirements

Each country has its own local practice even from authorities: for instance, EU claims itself as European Union with 27 state members, however, each country sets its own standard such as customs regulations (Ale et al., 2006). Difference in operating standards, safety management systems and difference in external circumstances such as weather and working culture should be reflected in the incident statistics and therefore should be foreseeable by the model.

Electronic systems, which allow the exchange of information between interested parties (called cargo community systems), have been established at airports by stakeholders in logistics transport chain. Customs are usually applicants in such systems in order to access and monitor data required for risk assessment. Modern customs organizations use automated data control systems to manage security risks and seek to avoid the burden of different sets of requirements to secure and facilitate commerce. Also, where possible, the systems are to recognize other international standards and do not duplicate or contradict other intergovernmental requirements (ICAO, 2017b).

There was an impact to all logistics transportation including air cargo terminal process after 9/11 incident. The impact has forced all parties in cargo logistics industry by government agencies to be changed with more handling process and security: certainly, it is costly to transporters and involved parties (ICAO, 2017b).

1.7 Research Gaps

The list of several reviewed variables from existing researches of academic researchers those who studied in a related air cargo field of airports, air cargo regulations, air cargo, air cargo logistics provider, air cargo hub, express cargo and carriers, etc. Some parts of their researches were connected to air cargo service. Furthermore, the most trustworthy source to any air cargo sector related to airline operations' practices and standard services namely IATA is compulsory to refer as new variables to the academic researches. Some researchers refer to IATA but not in deep details for air cargo terminal operations. In order to integration of separated variables from both sources for this research to fill the gaps completely, the study will become more fulfillment with

variables from academic field based on actual practices and regulated standard parts from IATA and combine them together for an overall point of view and establish criteria for air cargo terminal classification model.

1.8 Research Questions

As mentioned above from the stated conditions and constraints, this would lead to the research questions which there would be any analysis of criteria to classification for air cargo terminals and provide recommendations for improvement and development to the operators. Consequently, the primary research question developed in this research is as established. Also, to support the main research question, the question is too board and there are many informational and functional processes to evaluate for the results of air cargo terminal service and capability. The sufficient mathematical techniques will be applied and help the evaluation. It is a significant step that will be attributed to evaluate the efficiency of current air cargo terminal service at the four airports in Thailand by using the criteria. There are also sub-questions to support the research question as following details:

1.8.1 Main Research Question 1 to Research Objective 1

"What are the relevant and important criteria for air cargo terminal classification?"

1.8.1.1 What are the current perspectives of air cargo terminal operators located in airports outside Thailand on the reviewed variables from academic literatures and International Air Transport Association (IATA) standards for air cargo terminal classification?

1.8.1.2 What and which reviewed variables are relevant and important criteria to classify air cargo terminals by the participating operators and the methodology?

1.8.1.3 Are the selected variables analyzed by the participating air cargo terminal operators and Principal Component Analysis method differently perceived and validated for air cargo

terminal classification by aviation authority, air cargo industrial and academic experts and users?

1.8.2 Main Research Question 2 to Research Objective 2

"What are the significant criteria and classification to classify air cargo terminals differently?"

1.8.2.1 Do the relevant and significant criteria evaluated by experts and academic methodology make the classification of air cargo terminals differently?

1.8.2.2 What are the classifications of air cargo terminals in Suvarnabhumi (BKK), Don Muang (DMK), Phuket (HKT) and Chiang Mai (CNX) airports in Thailand as a sampling to test the significant criteria and what are the criteria that affect the motivation of Suvarnabhumi (BKK), Don Muang (DMK), Phuket (HKT) and Chiang Mai (CNX) airports to improve and develop their air cargo service and infrastructure in the future?

1.8.2.3 What are significant air cargo terminal criteria and classification examined by Cluster Analysis method to classify air cargo terminals?

1.8.3 Main Research Question 3 to Research Objective 3

"What are the relevant and important guideline and check list to major air cargo terminal classification for air cargo terminal operators?"

1.8.3.1 What are the criteria that influence the guideline to air cargo terminal operators and related practitioners around the world to follow for their bidding and business proposes?

1.8.3.2 What are the check list of necessary service requirements and arrangements on major air cargo terminal classification?

1.9 Research Objectives

In order to achieve the research objectives, this study would develop the analysis in details of the below objectives to review, analyze and classify air cargo terminals in the location of study successfully. Hence, the objectives are as follows:

1.9.1 Research Objective 1

To review and analyze the existing criteria listed from reviewed researches and International Air Transport Association standards by the participating air cargo operators outside Thailand around the world, Principal Component Analysis method, aviation experts and air cargo terminal users for air cargo terminal classification.

1.9.2 Research Objective 2

To classify air cargo terminals at Suvarnabhumi (BKK), Don Muang (DMK), Phuket (HKT) and Chiang Mai (CNX) airports in Thailand and prepare the criteria and classification that affect the motivation of the four airports in Thailand to improve and develop their air cargo service requirements and arrangements in the future.

1.9.3 Research Objective 3

To establish the relevant and important guideline and check list to air cargo terminal operators around the world for bidding and business purposes.

1.10 Scopes of Works

The study of air cargo terminal classification is very board and there are many air cargo terminals around the world with several involved conditions and availability. Therefore, the study needs to be scoped down to ensure that this research concentrates on the interested area only and meet the research objectives. In order to accomplish this study, the research scope is based on these following area and details:

1.10.1 Experts from the aviation industries such as International Air Transport Association, International Civil Aviation Organization, Civil Aviation Authority of Thailand (CAAT), Airports Council International, World Bank, aviation government bodies, air cargo terminal operators outside Thailand, aviation academic institute and airport authorities may be contacted via any available channel such as website, e-mail, tele-conference or in-depth interview for providing support information and clarification.

1.10.2 This research is scoped down to study only in all air cargo terminals at Top 4 highest cargo volumes' international airports in Thailand controlled by Airports of Thailand namely Suvarnabhumi (BKK), Don Muang (DMK), Phuket (HKT) and Chiang Mai (CNX) airports as a location of case study. The airports are considered as the best practice airports in the country in term of cargo tonnages respectively.

1.10.3 All air cargo terminal operators as experts at Suvarnabhumi (BKK), Don Muang (DMK), Phuket (HKT) and Chiang Mai (CNX) airports will be conducted surveys and interviewed in person, e-mail or telephone conference.

1.10.4 Air cargo terminal services and activities are mainly based on International Air Transport Association Standard Ground Handling Agreement version 2013 and other IATA related information only.

1.10.5 IATA as international standards would be the main reference to this research.

1.10.6 The only selected variables listed in the research gap validated by experts and methods would be applied for air cargo terminal classification for Suvarnabhumi (BKK), Don Muang (DMK), Phuket (HKT) and Chiang Mai (CNX) airports and measured any significance to analyze relevant criteria of the four airports.

1.10.7 Users of the air cargo terminal service would be invited to validate criteria and air cargo terminal classification to ensure the model is practically useful to academic and trade sections.

1.11 Research Methods

This research is aimed to study criteria importance to classify air cargo terminals for the current classification of air cargo terminals in the four airports of Thailand. In addition, the important variables and criteria that affect the motivation of BKK, DMK, HKT and CNX airports to improve and develop their air cargo operations' preparation based on service requirements and arrangements in the future are reviewed and analyzed. Therefore, recommendations are available to participating air cargo terminals around the world, airports of Thailand, Government of Thailand and air cargo terminal operators for their acknowledgement and implementation.

The examination is to analyze variables from reviews of literature and IATA standard service and gather variables from several aspects for both direct variables to air cargo terminals in airports and indirect relation to air cargo terminals but variables involved with selected parties in contacting air cargo terminals in Figure 1 (Phase I). Mostly, variables from literature reviews are indirect to air cargo terminals whereas variables from IATA are directly for air cargo terminals. Then, all selected variables from literature and IATA standard service reviews will be validated by experts so called air cargo terminal operators located at airports outside Thailand due to the location of study is at BKK, DMK, HKT and CNX airports as stated in Figure 1 (Phase II). The first round questionnaire survey would be designed and distributed to air cargo terminal operators to fill out the relevance and importance of each selected variable from literature and IATA reviews. The questionnaire design is based on a study of "Quantitative evaluation model of air cargo competitiveness and comparative analysis of major Asia-Pacific airports" (Chao & Yu, 2013). The result will be manually analyzed and viewed for important variables. Moreover, to ensure such important and observed variables are properly screened and validated, the important variables are examined by Factor Analysis using Principal Component Analysis method and re-validated by CAAT, IATA, FIATA and users of air cargo terminal operators namely airlines and air cargo logistics service providers. Factor Analysis using Principal Component Analysis is used to analyze the fundamental relationships for a large number of variables and to reduce the number of observed variables to a smaller group of principal components which is for most of variance of the observed variables.

Principal Component Analysis as a variable reduction technique is also used for highly correlated variables (Suhr, 2005; R.-T. Wang, 2007). Consequently, the relevant and important variables are validated and available for second phase of questionnaire survey to air cargo terminal operators at BKK, CNX, DMK and HKT airports. The variables will lead to questions for air cargo terminal operators to fill out information based on evaluated criteria and related questions in the second round questionnaire.

The data for first round questionnaire survey is drawn from air cargo terminal operators around the world outside Thailand to validate the questionnaire and mark only relevant and important variables at the same time to ensure that second round questionnaire survey is properly designed with suitable criteria for air cargo terminal operators at BKK, CNX, DMK and HKT airports. However, the unavailable data is frequently a problem in air cargo research (Kalakou & Macário, 2013; Mayer, 2016). The participating air cargo terminal operators are requested to fill out first round questionnaire in Appendix 1 for relevant and important variables for air cargo terminal classification in airports around the world. Thailand is located in Asia Pacific region and BKK airport is one of the Top 40 cargo airports in the area (ACI, 2017). The participants are necessary to indicate whether the criteria listed are relevant and then rate a score (1, 3, 5, 7 or 9) to specify the importance of the relevant criteria. The higher the score, the more important the criteria (Weighing scores: 1 = Unimportant, 3 = Somewhat important, 5 = Quite important, 7 = Very important, 9 = Extremely important). Otherwise, the selected variables are not relevant, the participants mark “No” for irrelevant variables and skip the process of rating to next variables. The result is from a sample of 75 air cargo terminal operators around the globe. Only 57 operators or respondents filled out the questionnaires and provided data with 61 filled questionnaires that can be analyzed in Principal Component Analysis. The 57 respondents cover 474 air cargo terminals or at 474 airports in 6 continents. Even though, the sample consists around 13.38% of the estimated global air cargo terminals of 3,542 which are estimated from 1,389 customs airport (IATA, 2016a), the number is sufficient to analyze relevant and important variables due to there are 4 respondents providing global air cargo terminal services as shown in Table 6. The 4 respondents have an overall perspectives on global air cargo terminal operations.

In addition, the rest of respondents are servicing airlines with their home base in each country as single terminal or with available branches in regional or global territories. 26 of 57 air cargo terminal operators provide their own indicators to classify air cargo terminals. Classifications by cargo commodities, services, locations, cargo terminal sizes and cargo volumes are eminent from the 26 participants. This shows additional support to this research that air cargo terminal operators look at these sections. A few global service providers mainly heed for only cargo volumes as the more cargo the more revenue generated to them.

Companies	**Networks**
Worldwide Flight Services	141 terminals in 5 Continents except Oceania
Swissport Cargo Services	102 terminals in 5 Continents except Oceania
DNATA	41 terminals in 6 Continents
Menzies Aviation	35 terminals in 6 Continents

Remark: Each terminal is located in one airport.

Table 6: Big Four Global Air Cargo Terminal Operators (DNATA, Menzies Aviation, Swissport Cargo Services and Worldwide Flight Services)

The second round questionnaire is sent to air cargo terminal operators at BKK, CNX, DMK and HKT airports for their information. There are also many tools to classify important variables for air cargo terminal classification after Principal Component Analysis into closely related group or classification. However, Cluster Analysis is found in many papers in general classification. For air cargo related studies for grouping variables and airports into the similarity, Cluster Analysis is popular among the studies which are published in well-known academic journals stated in Chapter 3. Figure 1 is to show the flow chart of all phases of this research.

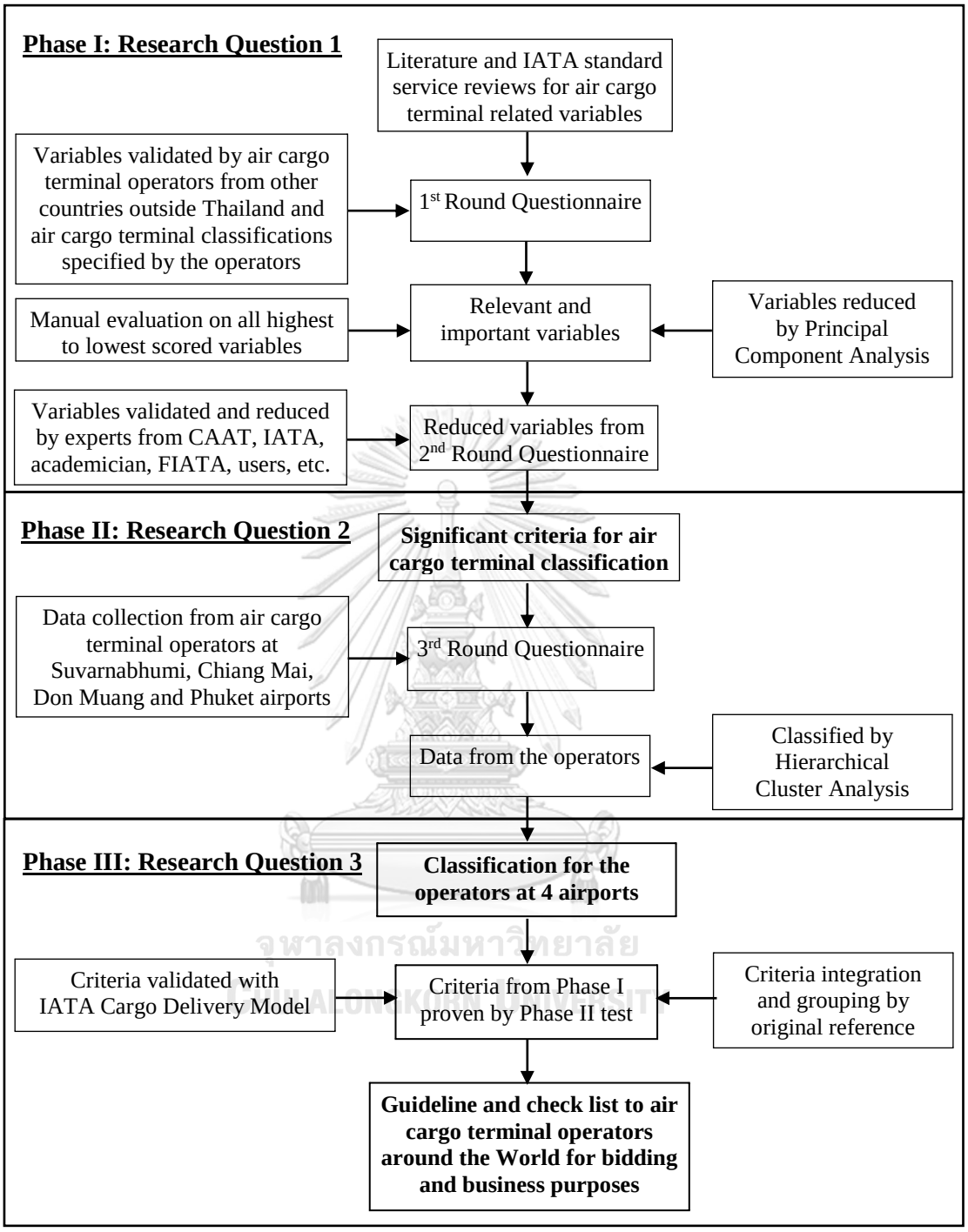


Figure 1: Flowchart of Research Methods

1.12 Research Contributions

The original contribution on this research is mainly obtained the analysis of the evaluation on important criteria and a model for classification of air cargo terminals at BKK, CNX, DMK and HKT airports and the finding would also be able to air cargo terminal operators around the world to use such criteria and model. The finding will also be accessible by academic and business sectors for referring these significant criteria and model to their future researches and business blueprint. Moreover, this research would provide the several contributions to the existing researchers and business stake holders from newly integrated criteria between theories and practical operations as following details:

1.12.1 Contributions to academic sectors

1.12.1.1 Theoretically, the research finding will explore the existing criteria from academic literature and IATA standards and services from several sources as the principal components from air cargo industry for relevance and importance to air cargo terminal classification.

1.12.1.2 The research finding will be integrated variables from existing and different researches of airport, airlines, cargo market, air cargo logistics service, air cargo express, air cargo transshipment, cargo hub fields and IATA standards and services. The integrated variables will be analyzed and validated for the significant criteria.

1.12.1.3 The academic methods and tools those used in published researches separately for aviation section but indirectly to air cargo terminal operations would be modified and jointly integrated onto new integrated variables in this study. In addition, such methods will be validated by air cargo industrial related experts to ensure the practical correctness in accordance to the industry. This study will prove that the current and modified methods together with validation by

related experts are suitable and applicable to a study of criteria for air cargo terminal classification.

1.12.1.4 The new and significant criteria will be constructed and invented as the new body of knowledge for air cargo terminal classification model.

1.12.2 Contributions to business sectors

1.12.2.1 The research finding is expected to enable Airports of Thailand to understand the current performance of air cargo terminals at BKK, CNX, DMK and HKT airports in different perspectives and to improve its air cargo service and capability. In addition, BKK, CNX, DMK and HKT airports are given recommendation to enhance its current capacity & capability to be specialized in a particular cargo characteristics rather than multipurpose airports in order to compete with other competitive major airports in Asia Pacific region.

1.12.2.2 The research finding is to support investors and current air cargo terminal operators who plan to build or renovate their air cargo terminals in any airport or related area such as customs free trade zones or air cargo logistics parks.

1.12.2.3 The guideline and check list for significant criteria are generated in order to provide air cargo terminal operators around the world to acknowledge and apply the criteria importance to their business and gain any future business on bidding purposes.

1.12.2.4 Air cargo terminal operators and related business sectors around the world are able to use the model of air cargo terminal classification for preparation, analysis and audit on any of their investment and strategic planning into air cargo terminal business.

1.13 Results

The criteria listed from reviewed researches and International Air Transport Association are integrated, analyzed and recognized for relevance, importance and air cargo terminal classification by the participating air cargo terminal operators at airports in 6 continents around the world, academic methods and air cargo related experts. The listed significant criteria are selected by the participating air cargo terminal operators, measured into popular methodologies and validated by the experts on significant criteria for air cargo terminal classification and establish different classifications for air cargo terminals. The air cargo terminals in the four airports in Thailand are classified based on their current operations and facilities. In addition, the criteria that affect the motivation of BKK, CNX, DMK and HKT airports are introduced to participating air cargo terminal operators and airports of Thailand to prepare for any future improvement and development in addition to their present air cargo terminal activities. The expected result is also established the guideline and check list for air cargo terminal operators and related practitioners around the world to follow the model in order to invest or gain the bidding-business achievement properly.

Chapter 2

2. Literature Reviews

The logistics of air cargo movement is more complex than the moving of passengers (Ohashi, Kim, Oum, & Yu, 2005). The statement is emphasized on the complication of air cargo operations. The typical air cargo terminal has four major activities of transit, sorting, storage and cargo information handling process (Hu & Huang, 2011). Also, according to academic studies retrieved from reality and regulated standards, there is a limited study to emphasize on air cargo terminal operations for handling cargo for airlines. Most studies were based on cargo airlines, airports, cargo hub, express cargo, cargo market, cargo airport performance and so on. While, in the present practice, IATA (2010), IATA (2016a), IATA (2016d), and IATA (2016b) focus on safety, security and ground handling operations not only for passenger, ramp, technical services but also cargo and mail service. There is no absolute matching between two reliable sources. On the other hand, experienced experts have differently several points of views at their own industries. The perfect combination between academic sources and operations regulators are still not integrated into one. Starting with previous studies which are slightly relevant to air cargo terminal operations but still indirect to the field of actual operations. It seems that the two sides are with partial gaps. The academic researchers studied in their ways to provide related factors for air cargo operations under mathematical methodology. The difference is still on for daily air cargo terminal activities at the airports. These are significant variables collected from researches and international standards mainly stipulated by (IATA, 2010, 2016a, 2016b, 2016d) and perspectives from experts in the business.

2.1 Airports for Air Cargo

In addition to the above factors and studies, Khan (2000) studied “Business process reengineering (BPR) of an air cargo handling process” that was about the preparation of “process flow diagram”, “process analysis work sheets” and “data summary charts” to frame the BPR efforts. Although, efficient air cargo terminal operations are critical for improved performance to users, few studies have efforts on air cargo terminal

performance (Lin, Ling, & Han, 2005). According to all factors raised in the above concerned parties from various industries related to air cargo movement, other complexities impact to air cargo transportation which require more handling processes to comply with governmental regulations and traders at the same time to meet their main objectives to deliver products by airlines. The cargo should be flown as booked, traceability and zero irregularity. The operations issues are distressed by airlines and its subcontracted handlers: otherwise, operations are self-handling by airlines. From "Cargo market competition among Asia Pacific's major airports" by Wong et al. (2016), in terms of cargo value and volume, airport management, the value and volume are deliberated on external factors inclusively trade between countries including global supply chain so called demand, location, freedom and liberalization while airport management is from internal factors. Both external and internal factors on the rest of trade between countries are as a demand point to "supply" stated as airline operations and network development. Equally, demand and supply are keen to impulse on enlightening airline operations and network development. The competitiveness of airport cargo operations is a key accomplishment to airport management and economic. This evidence shows that airline operations for cargo transportation is very significant to support airport and cargo market competiveness. Therefore, each airport must have well-equipped infrastructure to handle cargo sent from trade industry. The infrastructure will be "air cargo terminal operator".

Air cargo has been studied at minor stage in airport researches and some papers put air cargo as a secondary part: especially, in air cargo terminal services. Mayer (2016) studied airport classification based on cargo characteristics, total cargo throughput (metric tons) per annum (p.a.), cargo work load unit as a percentage of the total WLUs, freighter aircraft movement as a percentage of all commercial aircraft movements and international cargo as percentage of the total cargo volume. The result showed eight clusters were marked and explained the definition. The attention of researches are on passenger side while air cargo is by product and concentrate on cargo volume. The other characteristics were also identified at airport level exclusively.

Sarkis and Talluri (2004) considered “Performance based clustering for benchmarking of US airports to view the performance measurement of 44 airports across the US with multi-criteria to identify the main efficiency measures. The input measures were airport operational costs, numbers of airport employees, gates and runways. The result was with five output measures of operational revenue, passenger flow, commercial and general aviation movement and total cargo transportation. This shows that cargo section is one of the key success of airport performance from this study. From Singapore and Hong Kong statistics, cargo tonnage and traffic at the airports were influenced by operating characteristics and the performance from airfreight and supporting industries and the economic function. Cargo traffic (tons) was selected as one of indicators on the importance of the Singapore and Hong Kong air cargo industries (Yuan, Low, & Ching Tang, 2010). Rodríguez-Déniz, Suau-Sanchez, and Voltes-Dorta (2013) classified airports in “A frontier-based hierarchical clustering for airport efficiency benchmarking” and applied cargo tonnages apart from other criteria to the methodology. The study was for overall airport performance for all activities including passenger, cargo and aircraft operations. Adler and Liebert (2014) reviewed airport performance and pricing from the competition, ownership form and economic regulation. The result demonstrated that public and fully private airports operate equivalently in a competitive set up while private airports provides much higher aeronautical charges. The researchers used variables in the first stage efficiency analysis of staff costs, other operating costs, declared runway capacity, passengers, cargo from metric tons per year (trucking excluded), air transport movements as annual number of commercial movements and non-aeronautical revenues. The cargo part was with tonnages and aircraft movements. The second stage was for analyzing airport level of competition.

Behnen (2004) presented that new airports attempted to enter the market: besides, economic and political constraints, increasing numbers of cargo and passenger affect the lack of airport capacity in European countries. Airport capacity faced the trend of larger aircrafts from aircraft manufacturers in everywhere. The shortage of airport capacity started at the UK and continued to other European countries. The operation of regular air transport to serve larger aircrafts need to have more specific equipment but

the key support are runway length. The larger aircraft no matter passenger or cargo aircrafts require longer runways. Runway with unlimited operation including cargo operation is with 3,800 meter length, 3,600 meter for unlimited intercontinental operation for passenger aircrafts, 2,500 meter for medium range jets such as Boeing 737 and Airbus 320. The other shorter runways are for small operations.

Vogel and Graham (2013) devised airports grouping for financial and economic benchmarking. 73 airports from around the world and operators were studied. Five factors were broadly applied to airport classification; airport location, volume of traffic, nature of traffic and role of airport, congestion, utilization & technical characteristic and ownership, organization and regulations. This study included cargo on top of passenger aspects. Work load unit (WLU), serving country capital, ownership type (public, majority public, majority private and private) and cargo tonnages were for cargo cluster profiles of such airports. Park (2003) studied an analysis for the competitive strength of Asian major airports. The necessity of around the clock airport operational time led to meet demand. Tokyo Narita and Taipei Chiang Kai Shek airports are with curfew from 23:00 to 06:00. All cargo operations at that time would be held temporarily and resumed again after 06:00 a.m. The other factors are types of airport operation, the management of the airport prefers to generate productivity depending on ownership. Singapore Changi airport run by the governmental organization has achieved highest efficiency and output. The finding was public sector run airport receive lower productivity.

2.2 Air Cargo Hubs

The air cargo connecting time was able to reduce operating costs in airports (Ohashi et al., 2005). The importance of air cargo hub tended to have high degree of centrality and intermediate location. A location was between significant origins and destinations (Bowen, 2004; Fleming & Hayuth, 1994). The international production especially in Asia had been in place in regional rather than a global (Bowen, 2004; Rimmer, 1994; Yeung, 2001). The selection of air cargo transit or transfer hub was sensitive to time more than the handling expense costs such as landing, parking, and ground handling prices. While direct flights were not available, freight forwarders had

to choose connecting point to minimize the transportation cost in total. There were two cost factors as time cost and monetary cost. Time cost indicated flight time correlated to distance, loading and unloading times on ground, customs clearance and other handling times at the transit airport for next available flights. Monetary cost was both airport charges and cargo processing cost. Capacity (kt per year), length of runways (m), cargo terminal area (sq.m.), throughputs (tons) and averaged hours for loading/unloading and customs process were characteristics to specify major airports. Scholz and von Cossel (2011) also emphasized on minimum and maximum connecting time and freight tonnage of incoming flights of each airports to assess the significance of airport hub status for cargo airlines and airport management as air cargo became increasing revenue sources to airport. Therefore, it was commercially critical to airports to know airline operations network for better airport management and investment. Neiberger (2008) divided cargo airport into hub categories by cargo tonnages per annum with more than 1 million tons.

2.3 Airports for Cargo Airlines

Three types of carriers were cargo airlines, combination airlines and integrators such as Cargolux and Nippon Cargo airlines were first category for purely cargo carried from airport to airport, the combination airlines were carrying passenger and cargo with a few freighter aircrafts. Lastly, integrators were door to door service combining airlines, freight forwarders, truckers (Bowen, 2004). Most of low cost carriers would not move cargo or with a small share from cargo revenue to passenger revenue (Barbot, Costa, & Sochirca, 2008). Factor influencing cargo airlines' choice of airport: an international survey researched by Gardiner, Ison, and Humphreys (2005), freighter operating airlines with a schedule operation as non-integrator selected airports by these following factors: night curfews, influence of freight forwarders and airport charges, were influencing the decision. While other examined factors of trucking time to main markets, local origin and destinations demand, airport road access and customs clearance time were the most important factors. Gardiner and Ison (2008) surveyed on which factors were identified by airlines to select airports. The 15 factors were related to geography, return (cost and demand) or certainty (the desire to economic risk). Non-integrated carriers indicated their interest in preferring gateway airports.

The pull factors affecting to airlines' decision on airport locations were origin and destination demand and freight forwarder presence and push factors of night operations capability for cargo perspectives. The 24 hours operations was really important to Asian markets: although not seem important for European locations as a result of day flights. Apart from airlines, air cargo logistics providers offered outsourcing services to large scale enterprises toward multinational production.

2.4 Air Cargo Services and Air Logistics Service Providers

The study of Meng, Liang, Lin, and Chen (2010) found the four key factors for client satisfaction of reliability, agility, customization and flexibility including the relationship between the outsourcing service providers and manufacturers also critical. Both parties were decision makers to ship cargo on which airlines to deliver cargo to their destinations. Wen, Tsai, and Lin (2011) also concentrated on air cargo logistics providers for high technology cargo in Taiwan. The high technology manufacturers classified service performance when appointing third logistics service providers to air transport logistics. The service performance elements and factors of air cargo logistics service providers on information section were tracking and tracing service and electronic data interchange or EDI capability. The air cargo logistics service providers could take advantage to high technology firms to transport goods including lower logistics investment and improve logistics performance (Bask, 2001; Craig, 1996; Lieb & Bentz, 2004; Sink, Langley, & Gibson, 1996; Tsai, Wen, & Chen, 2007; Van Laarhoven, Berglund, & Peters, 2000).

2.5 Express Cargo Services

Schwieterman (1994) stated in Transportation Research Record that express cargo airlines so called integrators proposed shippers guaranteed overnight and door to door service. The Asian shippers paid expensive shipping costs to their convenience. Air and ground service were integrated to express cargo service. Taipei, Hong Kong, Shenzhen, Manila, Osaka, Bangkok, Kuala Lumpur and Singapore airports were serving as a hub to other 15 major airports in Asia Pacific destinations. Size of local market and terminal services were important parts to either operated by themselves or appoint outside terminal service providers. Competitive evaluation of air cargo express

integrators in South Korean market were explored by Park, Choi, and Zhang (2009). The most importance were accuracy and promptness while price became the most important variables as well. FedEx, TNT, EMS and UPS were the leading companies in the market respectively.

2.6 Gaps between Theories and Current Practices: Air Cargo Terminals

Air cargo operations: Literature review and comparison with practices, Feng, Li, and Shen (2015) reviewed previous academic studies comparing with practical operations of airlines, freight forwarders and air cargo terminal service provider. The gaps between previous researches and daily practices were based on the basic of literature reviews and in-depth interviews with experts in airlines and freight forwarders. The examination illustrated that several gaps between theories and regulated practices relevant to air cargo operations and terminal services. The realities created huge data amount which would emerge to solve problems in air cargo operations. Also, IT infrastructure was able to link several parties in the supply chain and visible to view the cargo moment throughout the operations. Therefore, existing experience and practice by specialists in the air cargo industry was precisely unable to avoid to combine with literature reviews in according to the study of Feng et al. (2015). R.-T. Wang (2007) evaluated "improving service quality using quality function deployment: The air cargo sector of China airlines by integrating literature reviews and interviews with academicians and air cargo forwarders. Then, in-depth interviews with sophisticated experts were conducted. In addition, there were a few academic studies which concentrated deeply on air cargo terminal section. Without interviews from experts, the future studies would not fully be accomplished to cover all aspects.

2.7 International Air Transport Association and Air Cargo Operations

The International Air Transport Association (IATA) is the trade association for the world's airlines, representing some 265 airlines or 83% of total air traffic. Apart from academic researches, IATA (2017a) and IATA (2017c) have involved with airline industry in order to enhance airlines for safety, security, efficiency and economic. IATA (2017a) and IATA (2017c) also support several areas of aviation activities and assist to formulate industry policy on critical aviation issues.

IATA (2016b) defines cargo acceptance in general that the primary objective for cargo acceptance handling is to ensure that consignments are ready for carriage in compliance with customer airlines and IATA regulations, as well as with export rules and regulations of the originating point, with rules and regulations of airport (s) of transit and import rules and regulations of the destination country. This is the main objective for air cargo terminal operators to handle cargo and mail transportation to several requirements from traders, airlines and authorities come from different times. IATA (2016a), the air cargo tariff manual rules so called TACT Rules (October 2016) and IATA standard ground handling agreement 2013 (IATA SGHA 2013) (IATA, 2016d) have established their standard services and requirements for all airlines and the handling companies so called air cargo terminal operators. There is not specific area for any specialized service and handling activity for particular special cargo. The standard service is in general for airlines and air cargo terminals to mutually agree on the contract and service level agreement. The airlines would need to send cargo booking list in each flight to air cargo terminal operator in the particular airport to prepare all necessary cargo onto their flights. Although, airlines appoint air cargo terminal operators but the operators plan, invest and facilitate cargo terminal at its own. There has not been any completed directory of air cargo terminal operators in the world even by IATA. The organization does not collect information for all ground handlers or air cargo terminal operators. So far there is nil such database exist, stated by Iva Pluhackova, Manager, Ground Operations, IATA Montreal meaning there is none of any completed solution for airlines who operate not only in one or two airports but throughout the 6 continents. IATA has only air cargo terminal operators which register with IATA as partners. Still, the partners do not cover all air cargo terminal operators in the world. Each airport would have had its own special arrangement and maybe, with only limited facilities to handle airlines' cargo. Therefore, airlines have to be cautious to know what kinds of facilities and equipment are available in each airport. Moreover, the ability of local authorities as well are unequally provided in the same country such as airports in the US or Thailand while IATA (2016a) has organized its standards to all parties. IATA SGHA 2013 (IATA, 2016d) is the latest version of standard ground handling agreement between the carrier and air cargo terminal operator in Table 7. The listed handling services are for passenger, ramp and cargo & mail including

technical handling part, etc. These are full services stipulated by IATA as for general services.

Table 7: IATA Standard Ground Handling Agreement 2013 (IATA, 2016d)

Sections	Services
Management functions	Representation
	Administrative functions
	Supervision and/or coordination
	Station management
Passenger services	General
	Departure
	Arrival
	Inter-modal transportation by rail, road or sea
Ramp services	Baggage handling
	Marshalling and parking
	Ancillary items
	Ramp to flight deck communication
	Loading and unloading
	Safety measure
	Moving of aircraft
	Exterior cleaning
	Interior cleaning
	Toilet service and water service
	Cabin equipment
	Storage of cabin material
	Catering ramp handling
	De-icing/anti-icing service and snow/ice removal
Load control and flight operations	Load control
	Communications
	Flight operations
	Crew administration

Sections	Services
Cargo and mail warehouse services	Cargo and mail handling- general
	Customs control
	Document handling
	Physical handling outbound/inbound
	Transfer/transit cargo
	Post office mail
Support services	Accommodation
	Automation/computer system including cargo and post office mail handling
	Unit load device (ULD) control including cargo and post office mail ULD
	Fuel farm (depot)
	Ramp fueling/defueling operations
	Surface transport
Security	Passenger and baggage screening and reconciliation
	Cargo and post office mail
	Catering
	Ramp
	Additional security services
Aircraft maintenance	Routine services
	Replenishing of oils and fluids
	Non-routine services
	Material handling
	Parking and hangar space

The main part for cargo and mail handling service is clearly acknowledged on its section while some services related to cargo and mail are in ULD control, automation & computer system and security. In details, each sub-section is still divided into several service items. These service items are widely used between airlines and air cargo terminal operators for any agreement. IATA (2016d) has set standard services to simplify any negotiation and discussion among parties.

IATA (2016a) also regulates and provides airlines to follow information and directory by countries collected globally. Each country including airlines have different requirements and regulations for counter-parties to comply with such obligation. IATA (2016a) combines all essential requirements for all aviation parties. As academic researches, customs concern is a key indicator to classify airports, airline performance and cargo operations. In addition, cargo claim liability is applied when there are irregularities incurred. Without limit of liability ratified by each country, claimants and fault parties would not be successful to close the disputes. Again, each country has unequally ratified legal regime for international convention carriage. There are four conventions for limits of liability to pay claims:

2.7.1 The limitation of liability expressed in the Warsaw Convention 1929 and Warsaw Conventions as mended by Hague Protocal 1955 is 250 francs per kilogram converted to USD 20 per kilogram.

2.7.2 The limitation of liability expressed in the Warsaw Convention as amended by Montreal Protocal 1975 and Montreal Convention 1999 is 19 special drawing rights (SDR) per kilogram converted to USD 25 per kilogram.

IATA (2016a) implements new projects of E-Air waybill and E-freight for cargo to be transported from point to point paperless and less time consuming with any authority electronically. With the upcoming success, shippers and consignees and other related parties would appreciate the faster and lower costs on documentation with fully electronic customs procedures and where regulations support paperless shipments. Regrettably, the two projects are accepted by some countries only. This would be the gap to wholly implement E-Air waybill relevant to freight forwarders, authorities, airlines and E-Freight projects from IATA. The carriers, freight forwarders, air cargo terminal operators, shippers and customs authorities have been involved with E-Freight. The current status of the two projects are clearly unknown: although, IATA (2016a) has strongly stimulated all parties to comply with the projects.

In according to a personal interview with one of three air cargo terminal operators in Hong Kong airport as the largest cargo airport in the world ranked by ACI (2017), ,

Kuah Boon Kiam, General Manager and Moe Chan, Marketing manager, Asia Airfreight Terminal showed their interest in critical factors to evaluate air cargo terminal classification in term of dividing into several groups. The ideal was based on special handling and dangerous goods codes composed in IATA TACT rules (IATA, 2016a). The codes contain three letters to describe cargo commodities. These are examples to explain each cargo commodity in Table 8. Domingues et al. (2014) studied an assessment of the regulation of air cargo security in Europe: A Belgian case study was found that high value cargo such as currency, artwork, laptops, smartphones, and time/temperature sensitive cargo (perishables, organs, for transplants, pharmaceutical products) and dangerous goods (radioactive material, inflammable products, toxic and infectious substances) were transported by air rather than by sea in term of trade value. FedEx could handle any weight, size or dimension in non-general cargo while Singapore airlines was able to maintain temperature for perishable cargo for 48 hours. KLM specialized in handling live animal for 80 years. Lobo and Zairi (1999) and Chen and Chou (2006) examined in A BSC framework for air cargo terminal design: procedure and case study. The provision of air cargo operations and the products would be divided into these services: import general cargo, export general cargo, transshipment cargo, import perishable cargo, export perishable cargo, import express cargo, and export express cargo. Cargo commodities were differed on these categories: electronics, raw material such as textiles, livestock, fresh vegetable and fruit. Express cargo required mainly document handling (Hu & Huang, 2011). Hwang and Shiao (2011) explored Analyzing air cargo flows of international routes: an empirical study of Taiwan Taoyuan international airport with the main criteria of export and import cargo commodities. Kuehne + Nagel as air cargo logistics service provider offered services for air freight on general cargo, charter and special cargo (Neiberger, 2008). With weak demand and internal problems, Luxembourg air cargo hub introduced new services and niches for new air cargo facility of pharmaceuticals and health care products, extravaganza luxury goods such as watches, jewelry, vantage car and collectable items to complete with other cargo airports (Hesse, 2014).

Special handling codes		Dangerous goods codes	
COL	Cool goods	CAO	Cargo aircraft only
EAT	Foodstuffs	DGD	Shipper's declaration for dangerous goods
FRO	Frozen goods	ELI	Lithium metal batteries
GOH	Hanging garments	ICE	Carbon dioxide, solid (dry ice)
MAL	Mail	IMP	Interline message procedure
NWP	Newspaper, magazines	MAG	Magnetized material
PEF	Flowers	RCM	Corrosive
PEM	Meat	RFG	Flammable gas
PER	Perishable	RFL	Flammable liquid
PIL	Pharmaceuticals	RFW	Dangerous when wet
QRT	Quick ramp transfer	ROP	Organic peroxide
RAC	Reserved air cargo	ROX	Oxidizer
SCO	Cargo secure for all cargo aircraft only	RPB	Toxic substance
VAL	Valuable cargo	RPG	Toxic gas
VIC	Very important cargo	RRE	Excepted packages of radioactive material
VUN	Vulnerable cargo	RSC	Spontaneously combustible

Table 8: IATA Special Handling and Dangerous Goods Codes (IATA, 2016a)

IATA Safety Audit for Ground Operations or ISAGO (IATA, 2010) was called a minimum requirement accustomed by Vinoop Goel, Regional Director and Rodrigo Reyes, Regional Manager – Airport, Passenger, Cargo & Security Asia Pacific, IATA. ISAGO is an essential alternative to redundant audits. The current situation is airlines implement its own audits to cargo and mail handling service providers or air cargo terminal operators meaning there would be enormous audit events between airlines and air cargo terminal operators. IATA (2010) has created ISAGO program for both airlines and air cargo terminal operators to join IATA program. IATA (2010) has knowledge from airlines on their requirements from air cargo terminal operators. The joint airlines are unnecessary to perform the audits by themselves. IATA (2010) would arrange

certain times of the years to implement audits on behalf airlines. Airlines are able to reduce times to perform the audits on all airports. ISAGO for cargo and mail handling service comprises of cargo and mail acceptance and handling (general, dangerous goods, live animals and perishables, other special cargo and unit load devices) and the other part is cargo security for facilities and operations.

2.8 Air Cargo Terminals by Different Ownerships and Regulators

Air cargo operations from end to end sectors were inclusive with several dimensions. The air cargo terminal operations were complicated (Rong & Grunow, 2009). C. Lee, Huang, Liu, and Xu (2006), Nsakanda, Turcotte, and Diaby (2004) and (Nobert & Roy, 1998) evaluated air cargo operations complexity by simulation models on cargo and material handling flow. Activities and operations of key players in the services were shippers, freight forwarders, airlines, airports and consignees. Air cargo freight forwarders directly coped with shippers, consignees and airlines. Freight forwarders, consolidators and large shippers were as decision makers to choose airlines to carry their cargo (Ohashi et al., 2005). While airlines had to deal with airports and ground handling operations within the airport itself, warehousing, storage, customs, security clearance, dangerous goods control were inside the airport under air cargo terminal operators. Airlines were essential to appoint air cargo terminal operators to handle their cargo and equipment which were prominently costly. These were mandatory services from airlines to air cargo terminal operators: warehousing, obtain flight manifest, unit load devices (ULD) management track and inventory, receive & send updates on arrival and delivery and lastly message interactions. Shippers and consignees both required shipment tracking and make payments (Feng et al., 2015). There were many researches regarding to the usage of advance technology in terms of airlines, trucking companies, and port operations to communicate and track their shipments (Crum, Johnson, & Allen, 1998; Thomas F. Golob & Amelia C. Regan, 2001; Thomas F Golob & Amelia C Regan, 2001; Holguin-Veras, 2000). This shows the significance to air cargo terminal operators to aware of their commination via IT and electronic data interchange. Ohashi et al. (2005) also focused on customs clearance and reloading activities in air cargo terminals with time consuming and lead to missing the connecting flights. The transshipment was interrelated to connecting time at a transit point. The longer

connecting time would increase the storage time at air cargo terminal. In the past, most time of air cargo movement was on ground and passed through 40 processes and required 12 documents (Chen & Chou, 2006; Lobo & Zairi, 1999). Air cargo operations consisted of cargo and information flow through customs inspection, document process, build-up and break-down or unit load devices (ULDs), ramp transportation and material handling services. The build-up and break-down process took up more manpower (Rong & Grunow, 2009). Outbound cargo was delivered from air cargo logistics providers to air cargo terminal operators in loose or ULDs at truck docks on landside for cargo weighing, screening, building-up and storing for departure. Inbound cargo from airside required breaking down, sorted, scanned, stored in storage area awaiting for consignees to pick up. For The build-up process of cargo onto unit load devices were with more compulsory skillful knowledge than staff breaking-down cargo out of cargo containers. The export cargo staff of break-down was able to do both jobs while import cargo personnel would handle on this task (Nsakanda et al., 2004).

Most airlines subcontracted third parties to perform air cargo terminal service. Unfortunately, the third parties had to have handling licenses granted by the country's civil aviation authority or airport authority. Each airport had only few licensed air cargo terminal operators stated by Dumrongchai Sawangchareon. In case of Thai Airways International, the airlines is airlines and air cargo terminal operator at the same time. Then, speaking of air cargo operations, Thai Airways controls itself for cargo operations in Thailand only. Still, Thai Airways has to appoint third party service providers in other countries in where the airline flies. There are more than 70 airports around the World for Thai Airways network including offline stations. In addition, each local authority like animal quarantine and international authorities such as ICAO or European Union Customs are mandated to strictly implement their own regulations and requirements. Airlines and their subcontracted/ licensed air cargo terminal operators (CTO) must comply with the authorities. Regrettably, there is no one stop solution for CTOs from the authorities. CTO must follow the requirements one by one: for instance, the CTO has to have security matters likewise, CCTV, access control, explosive tracing device, etc. The investment in each requirement could be from USD 1,000 up to USD 1 million considered a huge investment.

In a view of pure global air cargo terminal operators, cargo volume is the prominent factor to invest in air cargo terminal in each airport. The more cargo volume the more revenue is to generate to the company as a result of air cargo terminal operators apply handling charges per kilogram recommended by Rudolf Steiner, Senior Vice President, Global Cargo Sales & Key Account Management, Swissport International and Toralf Sonntag, Senior Vice President, Japan, Korea & China, Swissport Japan. Swissport International is well-known company and has air cargo terminals in 102 airports in 5 continents around the globe.

Besides, air cargo terminal operators, airlines and, air cargo logistics service providers as users are a part of success on air cargo transportation business. Simon Lim, Airlines Relationship and Transshipment Management Manager, Shenker (Thai) Ltd. and Henry Lee, Airfreight Export APAC, Hong Kong and South China, Shenker International (H.K) Ltd. were caution on delivery time and irregularity during air cargo transportation and operations on ground. Asia Airfreight Terminal in HKG concentrated on cargo and post office mail security. All concerned interviewees pointed out that air cargo terminal services and facilities in Table 9 and 10 were based on IATA SGHA 2013 (IATA, 2016d). The service items in IATA SGHA 2013 (IATA, 2016d) are related to equipment installed in air cargo terminals. These below information for each equipment and facility listed in each section of IATA SGHA 2013 (IATA, 2016d) by experts working directly from air cargo terminal operators and the clients of airlines meaning air cargo logistics providers.

Services	Required Facilities and Equipment
Cargo and mail handling - general	Handling staff, terminal space, IT system, truck dock, IATA cargo interchange message, automated air manifest to customs, parking space, roller bed dock, loading pit, elevated transfer vehicle, automated storage and retrieval system, dangerous goods certified staff, freezer, cool room, racking system, slave pallet

Services	Required Facilities and Equipment
Customs control	IT system, IATA cargo interchange message, automated air manifest to customs
Irregularities handling	IT system, weighing scale
Document handling	IATA cargo interchange message, automated air manifest to customs, dangerous goods certified staff, handling staff, IT system, live animal room
Physical handling outbound/inbound Physical handling outbound/inbound	Dangerous goods area, terminal space, IT system, ULD storage, parking space, weighing scale, roller bed dock, loading pit, elevated transfer vehicle, automated storage and retrieval system, freezer, cool room, valuable room, radioactive room, live animal room, racking system, slave pallet, truck dock, handling staff, standard certificates, dangerous goods certified staff
Transfer/transit cargo	IT system, IATA cargo interchange message, freezer, cool room, valuable room, radioactive room, live animal room, slave pallet
Services	Facility and equipment
Post office mail	Mail handling terminal, IT system
ULD control	ULD storage and handling, ULD roller bed dock, slave pallet, IT system, loading pit, elevated transfer vehicle, automated storage and retrieval system, dangerous goods certified staff, racking system, truck dock
Security – cargo and post office mail	X-ray machine, Explosive tracing device, security staff, screening staff, CCTV, IT system, standard certificates, Mail handling terminal, dangerous goods certified staff, valuable room, radioactive room

Table 9: IATA SGHA 2013 for Air Cargo Terminal Facility and Equipment Listed by Well-known Air Cargo Terminal Operators (Swissport Cargo Services and Asia Airfreight Terminal)

Services	Required Facilities and Equipment
Cargo and mail handling - general	Handling staff, security staff, screening staff, CCTV, Dangerous goods area, IT system, IATA cargo interchange message, standard certificates, Mail handling terminal, parking space, weighing scale, ULD roller bed dock, elevated transfer vehicle, dangerous goods certified staff, freezer, cool room, valuable room, radioactive room, live animal room, slave pallet, truck dock
Customs control	IT system, IATA cargo interchange message, standard certificates, Mail handling terminal, automated air manifest to customs
Irregularities handling	X-ray machine, explosive tracing device, security staff, screening staff, CCTV, IT system, IATA cargo interchange message, standard certificates, weighing scale, dangerous goods certified staff, slave pallet, truck dock
Physical handling outbound/inbound	Handling staff, security staff, screening staff, CCTV, Dangerous goods area, terminal space, IT system, IATA cargo interchange message, standard certificates, ULD storage and handling, automated air manifest to customs, parking space, weighing scale, ULD roller bed dock, loading pit, elevated transfer vehicle, automated storage and retrieval system, dangerous goods certified staff, freezer, cool room, valuable room, radioactive room, live animal room, racking system, slave pallet, truck dock
Transfer/transit cargo	Terminal space, IT system, IATA cargo interchange message, ULD storage and handling, automated storage and retrieval system, valuable room, radioactive room, live animal room, racking system, slave pallet
Post office mail	IT system, IATA cargo interchange message, Mail handling terminal, weighing scale, freezer, cool room

Services	Required Facilities and Equipment
ULD control	Terminal space, IT system, IATA cargo interchange message, ULD storage and handling, automated air manifest to customs, ULD roller bed dock, loading pit, elevated transfer vehicle, automated storage and retrieval system, racking system
Security – cargo and post office mail	X-ray machine, explosive tracing device, security staff, screening staff, CCTV, IT system, IATA cargo interchange message, standard certificates, ULD storage and handling, Mail handling terminal, parking space, loading pit, elevated transfer vehicle, automated storage and retrieval system, freezer, cool room, valuable room, radioactive room, live animal room, racking system, slave pallet

Table 10: IATA SGHA 2013 for Air Cargo Terminal Facility and Equipment Listed by Shenker (Thai) Ltd. and Shenker International (H.K) Ltd.

Airports of Thailand presently plans to upgrade its customs free zone in Suvarnabhumi International airport. Khata Vinin, Deputy Director, Free Zone and Cargo Management Center, Airports of Thailand, cargo traffic was upon market demand and the most important flow was from physical cargo and information. The airport is lack of speed for both flows and the airport is still pushing government bodies to upgrade cargo activities to be faster especially in Suvarnabhumi airport. Cargo flow in Thailand has not had any regulated and non-regulated regime yet. The regime is for secured cargo directly from air cargo logistics service providers. Presently, all cargo has to be screened 100% prior uplift on flights. This process makes the flow slow. If regulated cargo were accepted at the airport, the screening process would be exempted and handled much faster. Moreover, customs regulations are not yet free flown from end to end process in Thailand. The customs still requires to follow its current practice. E-Freight is required to have all concerned parties in origin, transit and final destination countries to participate. Local authorities, airlines, air cargo terminals, air cargo logistics service providers should get involved with the process while Thailand is not yet fully complied with IATA E-Freight project. Airports of Thailand is working with other government bodies to have the flow be smoother.

Nevertheless, in order to change laws in Thailand, time is consuming. ICAO (2016) was contacted for in-depth interview. Unfortunately, the statement of ICAO (2016) is one department of United Nations specialized agency on civil aviation and its role is to set the Standards and Recommended Practices (SARPs) for safety and security in international civil aviation and to assist states in the implementation of the SARPs. As such, (ICAO, 2016) is not at a position to receive interviews with individual or private entities. Then, the information from ICAO (2016) was unavailable from the organization as stated above by in-depth interview.

ICAO's Annex 17 to the Convention on International Civil Aviation defines "security" as protection civil aviation against acts of illegitimate intervention, through a combination of measures, human and material resources (ICAO, 2017a). The European state members establish security procedures inside the region and also implement an audit program. The basic standard is that cargo and mail would not be able to be uploaded onto an airplane until being secured cargo under the proper security control (EC, 2017). In the USA, a detailed description of security measures was reviewed and provided by Elias B. (2007) for security risks, cargo screening, and inspection methods. Also the known shipper program, funding and air cargo security R&D were approached by the congress. Macário et al. (2012) and Domingues et al. (2014) pointed out that cargo and mail from third countries outside European Union were suspected with tighten security procedures. The EU revised improvement of its current air cargo and mail legal framework. The interviews were held with experts in air cargo related industries at global, regional, local levels from various identities (academia, airlines, airports, security industry, customs, air cargo logistics service providers and shippers, ground handlers, etc.) on the responsibility of air cargo security and criteria that affected the present air cargo security regime. Moreover, security costs were impacted from the new measures not only cargo screening but also, staff training, securing equipment, production facilities, etc. Then, the EU revised the air cargo and mail security process to strengthen the world framework for aviation security.

2.9 Air Cargo Tonnages and Terminal Services in Thailand

Thailand has generated a significant figure in air cargo transportation comparing to other countries in Asia Pacific. Suvarnabhumi international airport was ranked at 15 from the top 40 international airports by ACI (2017) in Table 3. The first until fourteenth positions were with much higher cargo tonnages respectively.

During 2013 - 2015, AOT (2017) demonstrated cargo tonnages in each international airport in Thailand in Table 11. There was a slight growth of tonnages exclusively in Suvarnabhumi airport while other airports were with limited amount of cargo tonnages leading by Don Muang, Phuket and Chiang Mai international airports respectively. Don Muang airport was with significant number of growth in international cargo volume from 2014 to 2015 with almost 100% increase. The cargo volume in three airports has shown increasing volumes from year 2013 to 2015. These three airports would become more important airports to the regions.

Still, the three airports were with restricted cargo volume: even though, international and domestic cargo volumes were combined and incomparable with other airports such as the fortieth rank as Hanoi International airport in Vietnam (329,358 tons in 2015) whereas Suvarnabhumi airport has been somehow stable in numbers for the past three years. However, to compare with the world leading airports such as Hong Kong, Dubai, Incheon, Shanghai Pudong and Singapore airports, etc., international airports in Thailand are still far behind them in term of international cargo volume. The great efforts to develop are critical from all government bodies to enhance such airports to be more competitive to the region.

Airports	Cargo Volume (tons) Year 2013			Cargo Volume (tons) Year 2014			Cargo Volume (tons) Year 2015		
	Int'l	Dom.	Total	Int'l	Dom.	Total	Int'l	Dom.	Total
BKK	1,190,624	45,599	1,236,223	1,194,331	39,845	1,234,176	1,190,197	40,366	1,230,563
DMK	8,288	10,008	18,296	11,993	17,093	29,086	22,431	23,057	45,488
HKT	16,659	17,236	33,895	22,643	17,698	40,341	23,733	14,126	37,859
CNX	218	18,075	18,293	1,125	17,929	19,054	1,571	17,713	19,284
Total	1,215,789	108,963	1,324,752	1,230,092	107,581	1,337,673	1,237,932	112,682	1,350,614

Table 11: Air traffic report in 2013 – 2015 (AOT, 2017)

One of the major air cargo terminal service providers in the above key four airports as Suvarnabhumi, Don Muang, Phuket and Chiang Mail international airports is Thai Airways International who has air cargo terminals in such airports. The flag carrier presents its air cargo terminal facilities in major airports on www.thaicargo.com. The notice on their facilities are not all locations could handle all kinds of cargo commodities and some locations are able to handle in only incomplete cargo types (THAI, 2017a). In Chiang Mai and Phuket airports, major equipment are still not available such as freezer and radioactive room. Also, there is no service in Don Muang airport even the airport has become second largest cargo airport in Thailand. See Table 12.

Cargo Terminal Information - BKK, HKT, CNX			
Cargo Terminal Facilities and Equipment	Airports		
	BKK	HKT	CNX
Types of Handling Licenses (Domestic and/or International Cargo Service)	International & Domestic	International & Domestic	International & Domestic
Total of Document and Operation Handling Staff	1,180 Staff, 1,008 Outsourced	9 Staff, 33 Outsourced	21 Staff, 8 Outsourced
Cargo Terminal location	On airport at the front row from passenger terminal	On airport at the front row from passenger terminal	On airport at the front row from passenger terminal
No. X-ray machine	13 X-Ray Machines	2 X-ray Machines	2 X-ray Machines
X-ray machine specification and included in TSA list	12 X-Ray Machines TSA Certified	NIL	NIL

Cargo Terminal Information - BKK, HKT, CNX			
Cargo Terminal Facilities and Equipment	**Airports**		
	BKK	**HKT**	**CNX**
No. of Explosive Tracing Device (ETD)	2 units	NIL	NIL
No. of Security staff per day	200 Persons / Day	8 Persons / Day	3 Persons / Day
No. of Screening staff per day	62 Person / Day	2 Person / Day	NIL
No. of CCTV	330 CCTV	32 CCTV	12 CCTV
Total Cargo Terminal space	90,000 sq. m.	1,781 sq.m.	2,000 sq.m.
Cargo IT system	CHORUS	CHORUS	CHORUS
Provide IATA Cargo Interchange Message (FFM, FWB, FHL, FSU)	Full Compliance	Full Compliance	Full Compliance
Quality standard certificates	TSA, ACC3, RA3, ISO 9001:2008, Regulated Agent by Thai Government, THAI Security Program, THAI Cargo Emergency Manual, THAI Dangerous Goods Manual	RA3, THAI Security Program, THAI Cargo Emergency Manual, THAI Dangerous Goods Manual	ISO 9001:2008, THAI Security Program, THAI Cargo Emergency Manual, THAI Dangerous Goods Manual, Applying RA3
Yearly Handling Capacity	1.25 Million Tons	20,000 Tons	20,000 Tons
No. of ULD Container Storage	4,700 Units on ULD and under roof facility	Pallet only	Pallet only
Mail Handling Terminal	18,000 sq.m. separated from Cargo Terminal	Inside Cargo Terminal	Inside Cargo Terminal
Perishable Center	10,000 sq. m. (-20 to 20 degree)	NIL	NIL
DGR Area	Available	Available	Available
Freezers	Available	NIL	NIL
Cool room	Available	Available	Available
VAL Strong Room	Available	NIL	Available
Radioactive Room	Available	NIL	NIL
AVI Room	Available	NIL	NIL
No. of Truck Docks	119 Units	NIL	NIL

Table 12: Cargo Terminal Information (THAI, 2017a)

According to the other air cargo terminal operator, Bangkok Flight Services Company is available in Suvarnabhumi and Don Muang international airports and BAGS Ground Services Company is available in the other international airports in Thailand (BAGS, 2017). The other air cargo terminal operators do not provide a summary of facilities on the websites. Both Thai Airways International and Bangkok Flight Service companies seem to be able to handle all kinds of cargo which there is not any outstanding service to be their flag ships in any specific cargo commodity (BFS, 2017; THAI, 2017a). Air cargo terminals in provinces are fully unable to handle all cargo commodities. There would be an opportunity to enhance the facilities to attract more cargo to/from such airports.

2.10 Research Gaps

Regarding to our observations on the previous studies of Mayer (2016), Wong et al. (2016), IATA (2016d), IATA (2016b), IATA (2010) and IATA (2016a), the three sources emphasis on different variables to evaluate and classify air cargo service and market competitiveness. Mayer (2016) used total cargo throughput (metric tons) per annum (p.a.), cargo work load unit as a percentage of the total WLUs, freighter aircraft movement as a percentage of all commercial aircraft movements and international cargo as percentage of the total cargo volume to classify airports by cargo characteristics. Ohashi et al. (2005) applied numbers of runways, hours of loading/unloading, time for customs clearance, cargo throughput and air cargo processing time on a study of choice of air cargo transshipment airport: an application to air cargo traffic to/from Northeast Asia. Half of cargo was moving at night. Such time became important to air cargo operations (Roelen, Pikaar, & Ovaa, 2000). Shippers preferred to send their shipments at the late evening and night times on daily basic (Bowen, 2004). Oum, Yu, and Fu (2003) applied airport ownership as one of their factors beyond managerial control and cargo tonnages to benchmark airports. Runway length (m), cargo tonnages (tons) and aircraft movements were criteria to a research of Endogenous weight TFP measurement: methodology and its application to Japanese-airport benchmarking among other criteria for passengers such as airport type, terminal size (sq.m.) and numbers of passengers (Yoshida, 2004). Cargo tonnages for airport benchmarking was one of key elements to airport benchmarking for Abrate and Erbetta (2010), Yuan et al. (2010) and other researchers in studies. Work load units were used to study the nature and prevalence of the use of performance measurement techniques by airlines (Francis, Humphreys, & Fry, 2005). Wong et al. (2016) applied international trade value (export amount in million USD), flight frequency (weekly flight frequency), route distribution (geographical distribution of airfreight), national versus foreign carriers flight (%) operated by flags carriers and centrality (betweenness centrality of airports by area) while IATA (2016a), IATA (2016d), IATA (2016b) and IATA (2010) have instituted and focused on other service criteria to enable airlines and their air cargo terminal operators to pay attention on their factors. Air cargo terminal operators' service & requirement criteria and cargo characteristics from the sources are too board and difference. These are only samples of gaps between academic researches based on

actual practices in operations works and regulations from IATA as the aviation regulators. More variables are stated in Table 13 with authors and references. Without the combination from both sides, any study for air cargo terminal would not be fully accomplished. This research is aimed to integrate all relevant variables from academic researches and reliable sources for current regulated practices into one model. The study would represent two criteria parts into a model of air cargo terminal classification from experts and researchers. This Table 13 indicates the gaps between the variables from researchers and IATA. Both sides look into different variables but to integrate them together is a new body of knowledge.

Table 13: Research Gap between Studies from academic researches and IATA Standard Services by Original Sources and Grouped Variables

Original Sources for IATA Standard Services and Academic Researches

Topics	Reviewed and Relevant Criteria	Journals/Reference
Section 5, 6, 7: Cargo & mail warehouse services, support services for automation/Computer systems, support service for unit load device (ULD) control, and security	1. Cargo and mail handling – general	Standard Ground Handling Agreement, IATA SGHA 2013, 2016 Edition
	2. Handling for Customs Control	
	3. Documentation handling	
	4. Physical handling outbound/inbound	
	5. Transfer/transit cargo	
	6. Post office mail	
	7. Automation/computer systems	
	8. Until load device (ULD) control	
	9. Cargo and mail security	
Cargo claims (International convention ratification & limit of liability)	1. Warsaw convention 1929	The air cargo tariff manual rules, October 2016
	2. Warsaw convention as amended by Hague protocol 1955	
	3. Warsaw convention as amended by Montreal protocol 1975	
	4. Montreal convention 1999	
Import/Transit/Export regulations (Customs operating hours)	1. 24 hours	The air cargo tariff manual rules, October 2016
	2. Weekdays (Business hours)	
	3. Weekdays and weekends (Business hours)	
E-Freight implementation & capability status	1. E-freight capability target status	The air cargo tariff manual rules, October 2016
	2. Electronic export goods declaration	
	3. Electronic export cargo declaration	
	4. Electronic import goods declaration	
	5. Electronic import cargo declaration	
	6. Transit freight remaining on board	
	7. Transhipment	
	8. Digitized commercial invoice and packing list acceptance	
	9. Digitized certificates of origin acceptance	
E-Air waybill implementation & capability status	1. Import cargo	The air cargo tariff manual rules, October 2016
	2. Export cargo	
	3. Transit cargo	
	4. Transhipment cargo	

Original Sources for IATA Standard Services and Academic Researches

Topics	Reviewed and Relevant Criteria	Journals/Reference
Special handling and dangerous goods codes	Cargo commodities (divided by codes)	The air cargo tariff manual rules, October 2016
Section 7 - Cargo and mail handling, ISAGO audit	1. Cargo and mail acceptance and handling (general, dangerous goods, live animals and perishables, other special cargo, unit load devices)	IATA Safety Audit for Ground Operations (ISAGO)
	2. Cargo security (facilities, operations)	
Airport classification based on cargo characteristics	1. Total cargo throughput (metric tonnes) per annum (p.a.)	Journal of Transport Geography
	2. Cargo work load unit as a percentage of the total WLUs (Work Load Unit = 1 passenger = 100 kg of cargo)	
	3. Freighter aircraft movement as a percentage of all commercial aircraft movements	
	4. International cargo as percentage of the total cargo volume	
Cargo market competition among Asia Pacific's major airports	1. International trade (export value)	Journal of Air Transport Management
	2. Flight frequency (weekly flight frequency of the selected airports)	
	3. Route distribution (geographical distribution of airfreight)	
	4. National versus foreign carriers (flight (%) operated by flags carriers)	
	5. Centrality (betweenness centrality of airports by area)	
Performance based clustering for benchmarking of US airports	1. Commercial and general aviation movement	Transportation Research Part A
	2. Total cargo transportation	
Roles of the airport and logistics services on the economic outcomes of an air cargo supply chain	Cargo traffic (tonnes)	International Journal Economics
A frontier-based hierarchical clustering for airport efficiency benchmarking	Metric tons of cargo	An International Journal
Joint impact of competition, ownership form and economic	1. Metric tons per year (trucking excluded)	Transportation Research Part A
	2. Annual number of commercial movements	
Germany's changing airport infrastructure: the prospects for "new comer" airports attempting market entry	Runway length (m)	Journal of Transport Geography
	1. 3,800 m (unlimited operations cargo)	
	2. 3,600 m (unlimited intercontinental operations)	
	3. 2,500 m (unlimited operations with medium-range jets e.g. B737, A320)	
	4. 1,800 m (minimum for medium-range jets)	
	5. 1,100 m (minimum for scheduled operations with STOL-aircraft)	
The geography of non-integrated cargo airlines: an international study	1. Origin-destination demand	Journal of Transport Geography
	2. Freight forwarder presence	
	3. Night operations capability	
Express air cargo in the Pacific Rim: Evaluation of prospective hub sites	Size of local market (% of shipments locally generated)	Transportation Research Record
An analysis for the competitive strength of Asia major airports	1. Airport operational time (around the clock or with curfew)	Journal of Air Transport Management
	2. Type of airport operation (private, public, or mixed)	

Original Sources for IATA Standard Services and Academic Researches

Topics	Reviewed and Relevant Criteria	Journals/Reference
Choice of air cargo transhipment airport: an application to air cargo traffic to/from Northeast Asia	1. No. of runways	Journal of Air Transport Management
	2. Capacity (kt per year)	
	3. Length of runway (m)	
	4. Cargo terminal area ($m^{2)}$	
	5. Throughputs (kt)	
	6. Average hours for cargo loading/unloading and Customs clearance time	
Factors influencing cargo airlines' choice of airport: A international survey	1. Night operations	Journal of Air Transport Management
	2. Airport cargo reputation	
	3. Local origin - destination demand	
	4. Influence of freight forwarders (Presence of freight forwarders)	
	5. Airport road access	
	6. Customs clearance times (hours)	
	7. Trucking time to main markets (hours)	
Classification and competition analysis of air cargo logistics providers: The case of Taiwan's	Information service	Journal of Air Transport Management
	1. Tracking and tracing service	
	2. EDI capability	
Devising airport grouping for financial benchmarking	1. Cargo volume (tons)	Journal of Air Transport Management
	2. Serving country capital city	
	3. Ownership type (public, majority public, majority private, private)	
Evaluating competitiveness of air cargo express services	Customs clearance (Seamless Customs clearance)	Transportation Research Part E
Assessing the importance of hub airports for cargo carriers and its	1. Minimum connecting time (hours)	Research in Transportation
	2. Maximum connecting time (hours)	

The 63 Variables from Literature and IATA Standard Service Reviews by Grouped Variables

Reviewed and Relevant Variables	Authors/ References
Cargo and mail handling – general	Standard Ground Handling Agreement, (IATA, 2016d)
Handling for Customs Control	
Documentation handling	
Physical handling outbound/inbound	
Transfer/transit cargo	
Post office mail	
Automation/computer systems	
Until load device (ULD) control	
Cargo and mail security	
Warsaw convention 1929	Cargo claims (International convention ratification & limit of liability), (IATA, 2016a)
Warsaw convention as amended by Hague protocol 1955	
Warsaw convention as amended by Montreal protocol 1975	
Montreal convention 1999	
24 hours	Customs operating hours, (IATA, 2016a)
Weekdays (Business hours)	
Weekdays and weekends (Business hours)	

Reviewed and Relevant Variables	Authors/ References
E-freight capability target status	E-Freight implementation & capability status, (IATA, 2016a)
Electronic export goods declaration	
Electronic export cargo declaration	
Electronic import goods declaration	
Electronic import cargo declaration E-Freight implementation & capability status, (IATA, 2016a)	
Transit freight remaining on board	
Transshipment	
Digitized commercial invoice and packing list acceptance	
Digitized certificates of origin acceptance	
Import cargo	E-Air waybill implementation & capability status, (IATA, 2016a)
Export cargo	
Transit cargo	
Transshipment cargo	
Cargo commodities (IATA three letter codes)	(IATA, 2016a)
Cargo and mail acceptance and handling (general, dangerous goods, live animals and perishables, other special cargo, unit load devices)	IATA Safety Audit for Ground Operations (ISAGO), (IATA, 2010)
Cargo security (facilities, operations)	
Total cargo throughput (metric tons) per annum	(Adler & Liebert, 2014; Mayer, 2016; Meng et al., 2010; Ohashi et al., 2005; Rodríguez-Déniz & Voltes-Dorta, 2014; Vogel & Graham, 2013; Yuan et al., 2010)
Cargo work load unit as a percentage of the total WLUs (Work Load Unit = 1 passenger = 100 kg of cargo)	(Mayer, 2016)
Freighter aircraft movement as a percentage of all commercial aircraft movements	(Adler & Liebert, 2014; Mayer, 2016; Meng et al., 2010)
International cargo as percentage of the total cargo volume (metric tons) per annum	(Mayer, 2016)
International trade (export value)	(Wong et al., 2016)
Flight frequency (weekly flight frequency of the selected airports)	
Route distribution (geographical distribution of airfreight)	
National versus foreign carriers (flight (%) operated by flag carriers)	
Centrality (betweenness centrality of airports by area)	
Runway length: 3,800 m (unlimited operations cargo)	(Behnen, 2004)
Runway length: 3,600 m (unlimited intercontinental operations)	
Runway length: 2,500 m (unlimited operations with medium-range jets e.g. B737, A320)	
Runway length: 1,800 m (minimum for medium-range jets)	
Runway length: 1,100 m (minimum for scheduled operations with STOL-aircraft)	

Reviewed and Relevant Variables	Authors/ References
Origin-destination demand	(Gardiner & Ison, 2008; Gardiner et al., 2005)
Freight forwarder presence	
Night operations capability	
Size of local market (% of shipments locally generated)	(Schwieterman, 1994)
Airport operational time (around the clock or with curfew)	(Park, 2003)
No. of runways	(Ohashi et al., 2005)
Cargo handling capacity (metric tons) per annum	
Cargo terminal area (sq.m.)	
Average hours for cargo loading/unloading and Customs clearance time	
Customs clearance times (hours)	(Gardiner et al., 2005; Park et al., 2009)
Trucking time to main markets (hours)	(Gardiner et al., 2005)
Tracking and tracing service	(Wen et al., 2011)
Electronic Data Interchange capability	
Airport serving country capital city	(Vogel & Graham, 2013)
Airport ownership type (public, majority public, majority private, or private)	(Park, 2003; Vogel & Graham, 2013)
Minimum connecting time (hours)	(Scholz & von Cossel, 2011)
Maximum connecting time (hours)	

In according to above variables in Table 13 from several sources, some of researchers looked at the same variables such as cargo volumes, runways and night operations capability, etc. On the other hands, most of researchers and IATA concerned on different variables. IATA (2016a), IATA (2016d), IATA (2016b) and IATA (2010) certainly intended to concentrate on standard services, cargo commodities and E-Freight & E-Air Waybill projects. The other researchers were with dissimilar variables. All of them looked at different dimensions to study in their own perspectives. The above variables from academic studies, interviews with experts in air cargo industry and IATA were separately investigated and used for mainly airports for air cargo, air cargo hub, airports for cargo airlines, air cargo service and air logistics service provider, express cargo service. Also, gaps between studied theories and current regulated practices were differentiated in air cargo terminals, IATA and air cargo operations and cargo terminals by different ownerships and regulators, air cargo tonnages and cargo terminal service in Thailand. Each researcher used a few variables for its own research and cared for only a particular small scope of study. Some of researchers applied one or two variables as a small part of their studies and totally became second priority to the result which directly related to air cargo criteria and

classification. There are rarely a minimal studies mainly concentrate on air cargo terminal section from the above listed variables.

As shown, a few academic researchers left air cargo terminal segment behind their main studies. Variables those used in previous researches were not directly for air cargo terminal and variables were dispersed in different scopes of studies. Even IATA as the principal to all air transport association, the variables were still available for diverse objectives. There are too many detached manuals and regulations from IATA to entirely heed on air cargo terminal operations all at once. Each variable has its own significance to air cargo study but none of researchers and practitioners gather and study them at the same time. In addition, such variables must be functional to study air cargo but somewhat to air cargo terminal are in uncertainty. Each study would have been extremely useful or unimportant relevance to criteria to study of air cargo terminal classification.

By integration of all reviewed significant variables for air cargo terminal classification, this would lead to see the overall views from varieties of both theories and practical reliability and close the research gap from many researchers and IATA. The existing selected-variables from literature reviews and IATA standard services of 63 variables would be integrated into this study at the first phase to be examined by air cargo terminal experts only on the relevant and important criteria for air cargo terminal classification model. None of any researcher in the world studies these 63 variables at the same time for exploring of significant criteria for air cargo terminal classification.

Figure 2 presents all selected variables to be reviewed and evaluated for this research to classify air cargo terminals. Unfortunately, 63 variables equivalently consist of 32 variables from IATA and 31 variables presented in Table 13 from literature reviews are too many variables in order to display in the figure. Therefore, the Figure 2 displays only parts of variables from both trustworthy sources. Mainly, IATA variables are illustrated and variables from Mayer (2016) and Wong et al. (2016) who are an inspiration to the researcher also displayed. The other variables are stated in other variables in literature and IATA reviews containing different variables and integrated

into the study. Nevertheless, all 63 selected variables are clearly presented and identified in first round questionnaire in Chapter 3 for questionnaire survey to air cargo terminal operators around the world except Thailand in Appendix 1 for any further study and participants to fill out the questionnaire. Moreover, after the survey, such variables would be analyzed by manual and mathematical instrument afterwards.

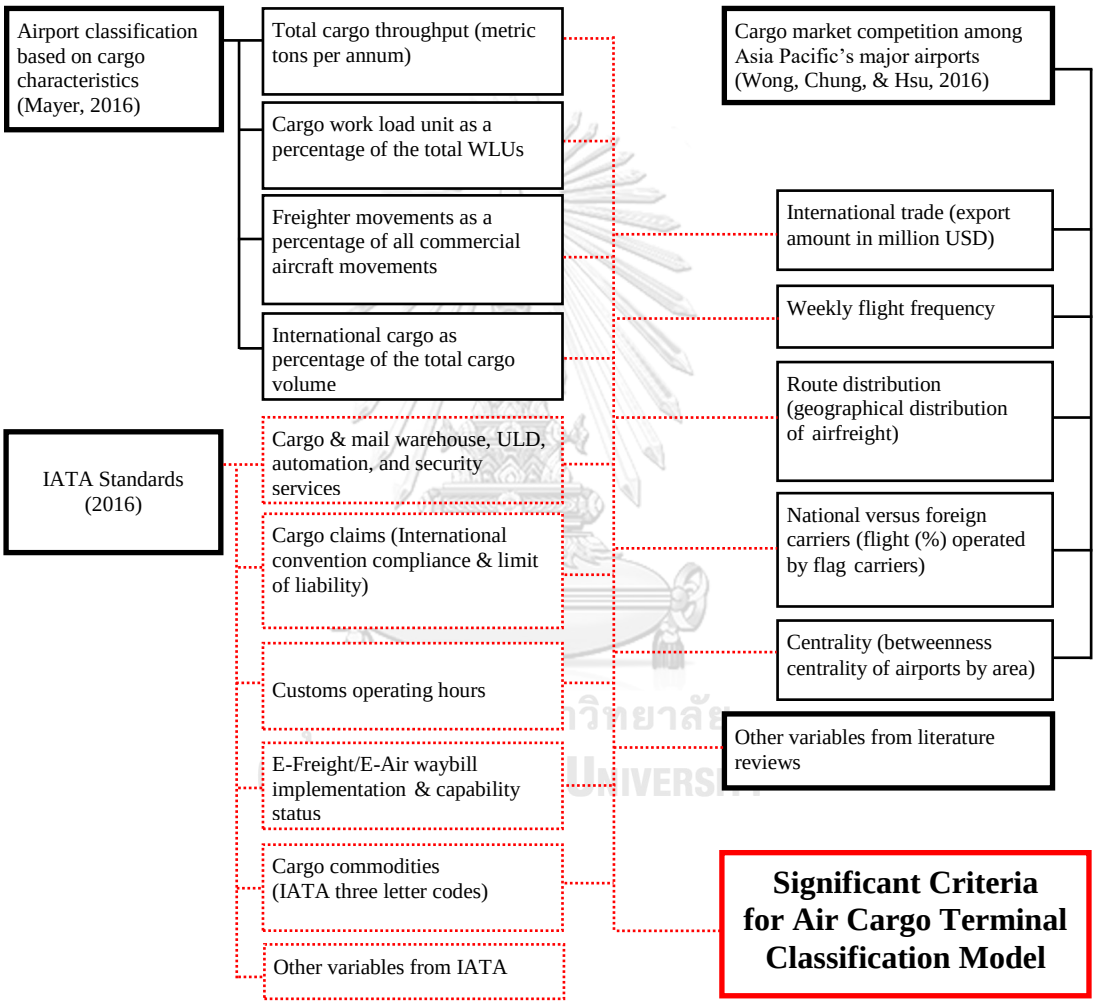


Figure 2: Theoretical Focus and Gap in the Current Literatures & Practical Realities

2.11 Definitions

In order to have the same understanding to this research, there are many terms referred in aviation sector. Nevertheless, these definitions and terminology from reliable sources would be used and described all operations and handling processes and activities. There are two parts to be concerned on definitions and terminology for airlines and air cargo terminal operators. The terms for airlines would be from the flag carrier in Thailand namely Thai Airways International Public Company Limited and the terms for air cargo terminal operators would be from IATA that composes and regulates Standard Ground Handling Agreement (IATA, 2016b, 2016d).

The IATA Standard Ground Handling Agreement is widely used among airlines and air cargo terminal operators for their mutual agreed contracts. The contract is signed for providing cargo and mail handling service to airlines in each airport by air cargo terminal operator (IATA, 2016b, 2016d). For the sake of clarity, the researcher applies the following terms into the research and interpreted as for ground handling service only for air cargo and mail terminal handling operations. These below terms are from IATA and Thai Airways International (IATA, 2016b, 2016d; THAI, 2016):

2.11.1 Air Carrier means airline, which carries or undertakes to carry the cargo under the air waybill or to perform any other services related to such air carriage including the airline issuing the Air Waybill.

2.11.2 BUP is bulk unitization programme, shipper/consignee handled unit

2.11.3 Cargo means any property carried or to be carried in an aircraft other than mail or other property carried under the terms of an international postal convention, baggage or property of the carrier; provided that baggage moving under an Air Waybill is cargo.

2.11.4 Cargo ground handling agent so called air cargo terminal operator mean an authorized agent acting on behalf of carrier on manipulating freight.

2.11.5 Handling (Cargo): Manipulating freight. Terminal: Either end of a carrier line, e.g. airports are often referred to as terminals

2.11.6 Ground handling agent so called air cargo terminal operator means the entity authorized to act for or on behalf of the carrier, for accepting,

handling, loading/unloading, transiting, or dealing with cargo, passengers and baggage.

2.11.7 Cargo means revenue cargo, and non-revenue cargo such as service cargo and company material.

2.11.8 Carrier's aircraft means any aircraft owned, leased, chartered, hired or operated or otherwise utilized by or on behalf of the carrier and in respect of which the carrier has either expressly or implicitly contracted, instructed or otherwise requested the handling company (air cargo terminal operator) to perform or carry out any ground handling service(s).

2.11.9 Electronic Data Interchange (EDI) means the computer-to-computer (application-to-application program processing) transmission of business data in a standard format.

2.11.10 Load means any item carried in an aircraft other than is included in the basic operating weight.

2.11.11 Loads mean baggage, cargo, mail and any aircraft supplies including ballast.

2.11.12 Special shipments includes, but not limited to, perishables, live animals, valuables, vulnerable cargo, news material and dangerous goods.

2.11.13 A specialized cargo product includes but not limited to, express cargo, courier shipments and same day deliver.

2.11.14 Transit flight is an aircraft making an intermediate landing for commercial reasons where a change of loads, passenger and /or crew occurs.

2.11.15 Truck service means a service operated by truck on behalf of an airline carrying loads documented in accordance with the applicable IATA and/or ICAO rules, regulations and procedures. In the SGHA, the word "aircraft" will read "truck" and "flight" will read "truck service" when it concerns the handling of a truck as meant under the above definitions.

2.11.16 Turnaround flight is an aircraft terminating a flight and subsequently originating another flight following a complete change of loads, passenger and/or crew.

2.11.17 Unit Load Device (ULDs) means aircraft until load device (ULD) is an assembly of components comprising either of the following:

2.11.16.1 Aircraft pallet and pallet net

2.11.16.2 Aircraft pallet and pallet net over an igloo

2.11.16.3 Aircraft container

The purpose of the unit is to enable individual pieces of cargo, baggage or mail to be assembled into a standard size until to facilitate rapid loading onto and offloading from aircraft having compatible handling and restraint systems which interface directly with the unit.

2.11.18 IATA area 1 comprises of North and South American continent and the nearby islands, Greenland, Bermuda, the West Indies and the islands of the Caribbean Sea, the Hawaiian Islands including Midway and Palmyra.

2.11.19 IATA area 2 comprises of Europe including the Europe part of Russia and adjacent islands, Iceland, the Azores, Africa and adjacent islands, Ascension Island, Middle East regions.

2.11.20 IATA area 3 comprises of Asia and the adjacent islands, except Middle East regions, Australia, New Zealand and adjacent islands, the islands of the Pacific Ocean except islands in IATA area 1.

2.12 Sources of data

The researcher would concentrate on secondary data as from the reliable and validated sources: for example, IATA, ICAO, ACI, CAAT, World Bank, government bodies, and airport authorities at any available channel such as website, e-mail, tele-conference or personal interview. The data from these parties are actual and tangible in term of numbers and information. In addition, the data is widely utilized and well-acknowledged by international organizations such as airlines and air cargo terminal operators. Moreover, data from experts who are involved with air cargo terminal services such as global, regional and national air cargo terminal operators. Furthermore, air cargo terminal operators, who are authorized with valid cargo and mail handling licenses, could provide air cargo terminal services with their own facilities at BKK,

CNX, DMK and HKT airports in Thailand. Also, air cargo terminal users such as airlines and air cargo logistics providers are appointed to provide information by any accessible communication mode for this study.

2.13 Criteria from Literature Reviews and IATA for Air Cargo Terminal Classification

The list of variables in Table 13 from literature reviews are from several researchers who studied in a related air cargo field of airport, air cargo, air cargo logistics provider air cargo hub, express cargo and carriers. Parts of their researches were accompanied with air cargo industry. In addition, the most reliable sources to airline operations namely IATA is mandatory to refer as new variables to the academic researches. Some researchers referred to IATA but not in deep details for air cargo terminal operations. In order to the integration of both variables for this research, the study would be more fulfillment with variables from academic field and practical operations parts and combine them together for an overall point of views. Not only the new body of knowledge is studied for criteria of air cargo terminal classification but the combination of theory and practice is newly integrated to this research. The study finding would touch upon educational academicians and operations practitioners for air cargo terminal classification and any related industry. The 63 variables in Appendix 1 are used for first round questionnaire survey to participating air cargo terminal operators from outside Thailand to validate on each variable and fill out the relevant and important variables. Irrelevant variables would be marked unimportant and the result may leave out some variables manually. To ensure the variables are statistically validated, Principal Component Analysis shall be applied for variable reduction. Then, the remaining variables would be for second round questionnaire and survey for significant criteria by air cargo experts and air cargo terminal users to classify air cargo terminal operators in the location of study. The second round questionnaire would be filled out by air cargo terminal operators in the four airport in Thailand and be analyzed again by Cluster Analysis to receive classification result per each air cargo terminal and any further evaluation and conclusion. Later, air cargo terminal classification and guideline is proposed to interested parties to apply such results to academic and industrial stake holders. More details are presented in Chapter 3.

Chapter 3

3. Methodology

According to Research Method in Chapter 1 and Appendix 1, first round questionnaire was designed from a study of "Quantitative evaluation model of air cargo competitiveness and comparative analysis of major Asia Pacific airports" by Chao and Yu (2013). The study is similar to this research as literature review and expert opinion were united for measuring air cargo competitiveness in major Asia Pacific airports. In addition, the evaluation of such study was aimed through expert questionnaire survey to selected criteria that were relevant and important to airports. The study was at airport level while this research is at air cargo terminals in each airport. The studied airports in Chao and Yu (2013)'s exploration evaluated air cargo airports and the finding was to provide airports with useful references for operations management and development. As the objectives and processes of study were close to this research: consequently, the questionnaire design was applied to first and second round questionnaire respectively.

3.1 First Round Questionnaire, Population and Sampling Size

The first round questionnaire with all 63 variables itemized in Appendix 1 was designed and sent to air cargo terminal operators to comment and fill out and proved that the questionnaire was understood and validated. There were 63 variables for air cargo terminal operators to fill out or screen out such variables due to too many of them. The irrelevant variables to air cargo terminal classification would be marked as "No" and skipped to next variables. On the other hand, the relevant variables to air cargo terminal classification would be marked as "Yes" and the respondents needed to rate important scores of Likert scales from 1, 3, 5, 7 or 9 scores. The reason to use such score scales with 1, 3, 5, 7 or 9 (Weighing scores: 1 = Unimportant, 3 = Somewhat important, 5 = Quite important, 7 = Very important, 9 = Extremely important) because of sampling sizes were from air cargo terminal business not from academic sectors. To leave intermediate values of scales 2, 4, 6, and 8 between 1 and 3, 3 and 5, 5 and 7, 7 and 9, Saaty (1977) and Berrittella, Certa, Enea, and Zito (2007) had publicized that to

preserve reasonable consistency when developing priorities from paired comparisons between two scales, the number of factors being considered must be less equal to nine. The intermediate values were used to compromise between two judgments in Saata scale. This scale of 1, 3, 5, 7, or 9 has still been used in several researches for comparing two values. The 63 variables were from literature reviews and IATA standards determined by researchers and experts in air cargo terminal industry as described in previous chapters. The variables were selected and listed in first round questionnaire. Due to distance and travel cost limitation, the first round questionnaire was sent by e-mail to air cargo terminal operators around the world via a personal connection of the researcher from his work experience. The e-mails were addressed to a few air cargo terminal operators to validate on the returned response. There was not deadline set as the researcher dependently pleased for the support. However, three air cargo terminal operators acknowledged the e-mail and a few days later sent back their filled questionnaire with marks. The first questionnaire set was not marked on some irrelevant variables and the researcher had to request the respondents again to finish all items. Then, the completed questionnaires were returned again. Irrelevance, relevance and importance of 63 variables were marked and sent back entirely. This was ensured that the first round questionnaire was validated by air cargo terminal operators for their completion and other air cargo terminal operators. The researcher adjusted his introduction on e-mails for distribution of first round questionnaire to the rest of participants with more explanation on the objective of this survey. Then, the e-mails were sent again to request participating air cargo terminal operators to fill out first round questionnaire. 62 air cargo terminal operators were sent first round questionnaire on 13th March 2017 and the responses were gradually corresponded. First group of respondents were only 16 respondents. Then, the researcher reminded the rest a few times. As the result, 14 more respondents returned the filled questionnaires. In total, it was 33 filled questionnaires. Later, the researcher decided to send first round questionnaire to 10 more air cargo terminal operators at the beginning of April 2017 and reminded the first group of air cargo terminal operators. In addition, the plan to cease this survey was the end of April 2017 because the response was slowly and gradually replied and nil feedback from targeted air cargo terminal operators respectively. At the end of April 2017, there were 61 returned questionnaires by

57 operators and the survey operations were discontinued. There were two respondents send 3 replied questionnaires from their different cargo terminal managements. The total response time was from a week until 2 months subject to each respondent after reminder requests. These operators were individual company and companies with branches nationally, regionally and globally.

In air cargo terminal industry, the estimated numbers of air cargo terminals around the globe came from averaged air cargo terminals of 2.55 terminals from Top 40 airport ranking: international cargo in 2015 in Table 14. The estimated population is 3,542 air cargo terminals (1,389 customs airports x 2.55 terminals) in 1,389 customs airports listed in IATA TACT Rules version October 2016 (IATA, 2016a). The population covering customs airports around the world is too large and their information on public broadcasting or even on airport authorities' websites is inadequate or none due to air cargo terminal business is for airlines, air cargo logistics service providers and some truckers. The importance is vital to the aviation businesses and mostly at local basis would be available as mentioned earlier, Rodrigo Reyes from IATA informed that there is nil directory for air cargo terminals collected. The website of www.azworldairports.com was recommended by Mr. Rodrigo Reyes, Regional Manager – Airport, Passenger, Cargo & Security Asia Pacific from International Air Transport Association. However, he was not confident on the up to date of information. Nevertheless, this does not have any choice to find the exact number of population until now. Yet the population estimation was taken place instead based on IATA (2016a) and any available source such as from internet and air cargo network. Moreover, that was impossible for the researcher to visit all of 1,389 customs airport or 3,542 air cargo terminals around the world to collect information either by interview or tele-conference or e-mail with them. Therefore, the sampling size of this study was scheduled to cover air cargo terminal operators as many as they would participate in first round questionnaire to cover all 6 continents in order to represent air cargo terminal characteristics of each continent to this research. The questionnaire was sent by e-mails to 75 air cargo terminal operators who have direct experience of air cargo terminal operations through Thai Airways International's network and support. The flag carrier of Thailand transports air cargo to Asia, Oceania and Europe and used to operate in

North America and Africa continents. However, the airlines still has interline or code share agreements within Star Alliance airlines and other non-Star Alliance airlines covering all continents. The connection with air cargo terminal operators, particularly with the global players are tighten and convenient to receive participation from air cargo terminal operators to fill out first round questionnaire for the relevance and importance of criteria for air cargo terminal classification. Table 14 displays the estimated air cargo terminals of Top 40 airport ranking by international cargo in 2015 from ACI (2017) and the total of air cargo terminal respondents of 57 operators shown in Appendix 2 cover 474 air cargo terminals in 474 airports in 6 continents around the world from 3,542 air cargo terminals of 1,389 customs airports listed in IATA TACT Rule (IATA, 2016a) or equal 13.38%. There are, 4 air cargo terminal operators, global players as described in Chapter 1 provide air cargo terminal services in 319 terminals from 474 airports. The big four operators were encompassed in first round questionnaire survey. Their perspectives are much influencing global aspects as the respondents are from each headquarter which look after the entire operations in all branches. The participations from Big Four supported significant information to this research dramatically.

Ranks	Cities, Countries	Codes	No. of Air Cargo Terminal
1	Hong Kong	HKG	3
2	Dubai, U.A.E	DXB	1
3	Incheon, South Korea	ICN	4
4	Shanghai, China	PVG	2
5	Tokyo, Japan	NRT	4
6	Taipei, Taiwan	TPE	4
7	Anchorage, U.S	ANC	1
8	Frankfurt, Germany	FRA	5
9	Paris, France	CDG	2
10	Singapore	SIN	2
11	Miami, U.S.	MIA	1
12	Amsterdam, Netherlands	AMS	5

Ranks	Cities, Countries	Codes	No. of Air Cargo Terminal
13	London, U.K	LHR	4
14	Doha, Qatar	DOH	1
15	Bangkok, Thailand	BKK	2
16	Chicago, U.S.	ORD	2
17	Los Angeles, U.S.	LAX	5
18	New York, U.S.	JFK	7
19	Leipzig, Germany	LEJ	2
20	Dubai, U.A.E.	DWC	1
21	Abu Dhabi, U.A.E	AUH	1
22	Guangzhou, China	CAN	2
23	Istanbul, Turkey	IST	5
24	Beijing, China	PEK	2
25	Luxembourg, Luxembourg	LUX	1
26	Cologne, Germany	CGN	1
27	Osaka, Japan	KIX	4
28	Liege, Belgium	LGG	3
29	Kuala Lumpur, Malaysia	KUL	2
30	Jeddah, Saudi Arabia	JED	1
31	Bogota, Colombia	BOG	1
32	Milan, Italy	MXP	2
33	Mumbai, India	BOM	2
34	New Delhi, India	DEL	2
35	Brussels, Belgium	BRU	3
36	Louisville, U.S.	SDF	1
37	Mexico City, Mexico	MEX	2
38	Atlanta, U.S.	ATL	1
39	Madrid, Spain	MAD	5
40	Hanoi, Vietnam	HAN	3

Total of Air Cargo Terminals	**102**
Averaged Terminals/ 40 Airports	**2.55**
Estimated Air Cargo Terminals in 1,389 Customs Airports Listed by IATA (2016a)	**3,542**
Respondents in Questionnaire Cover (airports)	**474**

Table 14: Air Cargo Terminals at Top 40 airport rankings: International Cargo in 2015

Sources: (ACI, 2017), (THAI, 2017b), ("Amsterdam Airport Schiphol ", 2017; "Anchorage Ted Stevens International Airport ", 2017; "Atlanta Hartsfield Jackson International Airport ", 2017; "Bogotá - El Dorado International Airport ", 2017; "Chicago O´Hare Airport ", 2017; "Doha International Airport ", 2017; "Liege Airport ", 2017; "Louisville International Airport ", 2017), (MIA, 2017), (LAX, 2017), (PANYNJ, 2017), (K. Airport, 2017; T. Airport, 2017), (L. Airport, 2017), (aena, 2017)

3.2 First Round Questionnaire Results

The respondents of 57 air cargo terminal operators in Appendix 2 from 75 air cargo terminal operators with 61 filled questionnaires provided relevant and important variables from the highest scores of relevance to air cargo terminal classification with important rating on each variable to the lowest or no scores of relevance. However, there were 63 variables in total and only 4 variables marked “irrelevant” more than “relevant” to air cargo terminal classification. Still, 59 variables were marked relevance. Some of them were with more or less equivalent between “relevance and irrelevance” to the classification. Most of them were relevant to air cargo terminal classification. This analysis was manually done by a simple process from the highest to the lowest numbers of relevance to irrelevance respectively. Table 15 demonstrates scores of each variable from the highest score to the lowest score together with important rating summary. Most of variables from IATA received the highest scores of relevance to the classification of 20 variables in Top 30 items while only some of variables from literature reviews were 10 variables in Top 30 items from 63 variables. The last 20 variables were 15 variables from literature reviews. By the manual evaluation, the result shows that variables from IATA standard service were more important to participating air cargo terminal operators than variables from literature

reviews. Some variables were marked “relevance”: nevertheless, still with weighing scores: 1 = Unimportant, 3 = Somewhat important, 5 = Quite important, weighing scores: 7 = Very important 9 = Extremely important. This consequence led to uncertainty to analyze the results from respondents by any manual methodology from the first round questionnaire.

Firstly, the manual examination was unable to reduce variables or group some of them to each other with similarity, as still, marks for relevance were greater than irrelevance in significant numbers. Secondly, there were still too many variables existed and incapable to design next round questionnaires. With 59 variables after 4 variables extracted from the list by first round respondents, the manual inspection would not impact much on the variable reduction from the result. On the other hand, the manual result presented a list of relevant variables by sorting from the highest to the lowest scored variables. Then, the researcher noticed that air cargo terminal operators were interested in cargo & mail warehouse services, support services for automation/Computer systems, support services for unit load device (ULD) control, and security (IATA, 2016b, 2016d), special handling and dangerous goods codes (IATA, 2016a), night operations capability, Electronic Data Interchange capability, IATA Safety Audit for Ground Operations (IATA, 2010), tracking and tracing service and airport operational time (around the clock or with curfew) from the result. For the remaining 59 variables from manual examination, it was assumed that air cargo terminal operators at BKK, CNX, DMK and HKT airports or elsewhere would not fill out the second or next round questionnaires or probably provide uncompleted information on the questionnaire due to long questions and time consuming. As the result, there would be any bias or incapability to continue to evaluate received questionnaires from expected respondents in each airport. Then, the research would look for academic techniques to perform variable reduction into suitable numbers to have participating air cargo terminal operators to be willing to fill out next round questionnaires. As referred in Chapter 1, Factor Analysis using Principal Component Analysis is widely used to analyze the fundamental relationship of large numbers of variables and to reduce variables into a smaller group of principal components on their similarity. The different groups are dissimilar or independent to each other (Suhr, 2005;

Vanichbuncha, 2011; R.-T. Wang, 2007). In addition to Principal Component Analysis, after reduced variables from the technique, such variables were ensured by experts from air cargo related academician, Civil Aviation Authority of Thailand, IATA, International Federation of Freight Forwarders Associations (FIATA) and users of air cargo terminal operators: for instance, two to five major airlines and air cargo logistics providers in Top 25 by cargo tonnages in 2015 in Table 16 would be contacted to re-validate reduced variables. In addition, the first round respondents of 26 air cargo terminal operators in Appendix 3 also provided their own additional indication to divide or classify air cargo terminals in different classifications. The questions were requested and guided them for classifications in cargo commodities, services, locations, and sizes. Also, some of them even pointed out their own classification on air cargo terminals based on their judgment. See Table 17. The summary of air cargo terminal classification provided by 26 air cargo terminal operators were variety and each classification was still with many criteria. Each criteria was identified by each air cargo terminal operator differently. Certainly, the big four air global air cargo terminal operators were one of 26 respondents with their global aspects. There were two from big four operators concentrate on only cargo volumes. One classified with “hub” from cargo volumes. The other two provided an approach to classify air cargo terminals with diversity of all above classifications. This means that there is still not have any standard classification for air cargo terminals. However, the five classifications arranged by the 26 respondents were relevant to this research mainly in the topics which key air cargo terminal operators looked into these criteria. Then, this study would take this liberty to apply such classifications into the research. Principal Component Analysis is a technique to extract many variables into smaller numbers of principal components when variables are highly correlated. The technique was used for results from first round questionnaire survey on important variables from 57 respondents and 61 filled questionnaires: moreover, five recommended classifications for air cargo terminals from 26 respondents.

Questionnaire for the Relevance and Importance of Criteria for Air Cargo Terminal Classification in Asia Pacific's Major Airports

This questionnaire aims to measure the relevance and importance of criteria for air cargo terminal classification in Asia Pacific's major airports.

Select Yes/No to indicate whether the criteria listed below are relevant and then (if "Yes") rate a score (1, 3, 5, 7 or 9) to specify the importance of the relevant criteria. The higher the score, the more important the criteria. Also, please provide the reason why the criteria is irrelevant or provide possible an alternative criteria if (Weighing scores: 1 = Unimportant, 3 = Somewhat important, 5 = Quite important, 7 = Very important, 9 = Extremely important)

Items	Topics	Air Cargo Terminal Classification Criteria	Check to indicate the criteria listed are relevant (Yes) or not relevant (No)		Weighing Score (if "Yes")				
			Yes	No	1	3	5	7	9
1	Cargo & mail warehouse services, support services for automation/Computer systems, support services for unit load device (ULD) control, and security (IATA Standard Ground Handling Agreement 2013)	Cargo and mail handling – general	61				5	22	34
2		Customs Control	61			1	9	13	38
3		Physical handling outbound/inbound	61				5	19	37
4		Transfer/transit cargo	61			3	11	17	30
5		Automation/computer systems	61				6	19	36
6		Documentation handling	60	1		1	7	20	32
7		Cargo and mail security	60	1			2	14	44
8	Special handling and dangerous goods codes (IATA TACT, October 2016)	Cargo commodities (IATA three letter codes)	60	1			3	20	37
9	Others	Night operations capability	60	1	1	3	15	19	22
10	Cargo & mail warehouse services, support services for automation/Computer systems, support services for unit load device (ULD) control, and security (IATA Standard Ground Handling Agreement 2013)	Unit load device (ULD) control	59	2		2	7	25	25
11	Others	Electronic Data Interchange capability	59	2	2		7	14	36
12	IATA Safety Audit for Ground Operations (ISAGO) - Cargo and mail handling	Cargo security (facilities, operations)	57	4	1	1	5	11	39
13	Others	Airport operational time (around the clock or with curfew)	57	4		3	9	17	28
14		Tracking and tracing service	57	4		1	12	21	23
15	E-Air waybill implementation & capability status (IATA TACT, October 2016)	Export cargo	56	5		6	12	21	17
16	IATA Safety Audit for Ground Operations (ISAGO) - Cargo and mail handling	Cargo and mail acceptance and handling (general, dangerous goods, live animals and perishables, other special cargo, unit load devices)	56	5	1	1	6	18	30
17	Others	Customs clearance times (hours)	56	5		4	7	25	20
18	E-Air waybill implementation & capability status (IATA TACT, October 2016)	Import cargo	55	6		6	12	21	16
19	Others	Freight forwarder presence	55	6		3	12	20	20
20		Cargo terminal area (sq.m.)	55	6			6	18	31
21	E-Air waybill implementation & capability status (IATA TACT, October 2016)	Transit cargo	54	7		6	13	17	18
22	Customs operating hours (IATA TACT, October 2016)	24 hours	53	8	1	3	4	19	26
23	Others	Cargo Handling Capacity (metric tons per annum)	53	8		1	6	18	28
24		Average hours for cargo loading/unloading at air side	53	8		2	10	21	20
25	E-Freight implementation & capability status (IATA TACT, October 2016)	Electronic export cargo declaration	52	9	1	2	14	18	17
26		Electronic import cargo declaration	52	9	1	3	13	17	18
27	E-Air waybill implementation & capability status (IATA TACT, October 2016)	Transhipment cargo	52	9		4	16	16	16
28	Cargo characteristics	Total cargo throughput (metric tonnes) per annum	52	9		2	9	12	29

Table 15: Manual Summary of First Round Questionnaire

Questionnaire for the Relevance and Importance of Criteria for Air Cargo Terminal Classification in Asia Pacific's Major Airports

This questionnaire aims to measure the relevance and importance of criteria for air cargo terminal classification in Asia Pacific's major airports. Select Yes/No to indicate whether the criteria listed below are relevant and then (if "Yes") rate a score (1, 3, 5, 7 or 9) to specify the importance of the relevant criteria. The higher the score, the more important the criteria. Also, please provide the reason why the criteria is irrelevant or provide an alternative criteria if possible. (Weighing scores: 1 = Unimportant, 3 = Somewhat important, 5 = Quite important, 7 = Very important, 9 = Extremely important)

Items	Topics	Air Cargo Terminal Classification Criteria	Check to indicate the criteria listed are relevant (Yes) or not relevant (No)		Weighing Score (if "Yes")				
			Yes	No	1	3	5	7	9
29	Cargo & mail warehouse services, support services for automation/Computer systems, support services for unit load device (ULD) control, and security (IATA Standard Ground Handling Agreement 2013)	Post office mail	51	10		1	8	22	20
30	E-Freight implementation & capability status (IATA TACT, October 2016)	E-freight capability target status	50	11		4	12	20	14
31	Others	Minimum connecting time (hours)	50	11	1	5	8	16	20
32	Cargo claims - International convention ratification & limit of liability (IATA TACT, October 2016)	Montreal convention 1999	49	12	1	2	11	10	25
33	E-Freight implementation & capability status (IATA TACT, October 2016)	Electronic export goods declaration	49	12	1	2	13	17	16
34		Electronic import goods declaration	49	12	1	2	12	17	17
35		Transhipment	49	12	2	2	14	18	13
36	Others	Origin-destination demand	49	12		6	11	17	15
37		Size of local market (% of shipments locally generated)	49	12	1	5	14	12	17
38		Trucking time to main markets (hours)	48	13	1	2	11	25	9
39	Customs operating hours (IATA TACT, October 2016)	Weekdays and weekends (Business hours)	47	14		3	8	17	19
40		Weekdays (Business hours)	46	15	3	3	6	13	21
41	Cargo market competition	Flight frequency (weekly flight frequency of the selected airports)	46	15		2	16	12	16
42		Route distribution (geographical distribution of airfreight)	46	15	1	2	12	19	12
43	Others	Maximum connecting time (hours)	46	15	1	6	7	15	17
44	Cargo characteristics	International cargo as percentage of the total cargo volume	45	16	1	4	17	14	9
45	Cargo market competition	International trade (export value)	45	16		8	12	16	9
46	Runway numbers and length (m)	3,800 m (unlimited operations cargo)	42	19	1	1	11	15	14
47	E-Freight implementation & capability status (IATA TACT, October 2016)	Transit freight remaining on board	41	20	3	1	11	12	14
48		Digitized commercial invoice and packing list acceptance	41	20	2	2	10	20	7
49	Cargo market competition	National versus foreign carriers (flight (%) operated by flags carriers)	40	21	2	9	14	9	6
50		Centrality (betweenness centrality of airports by area)	40	21	1	4	11	13	11
51	Runway numbers and length (m)	No. of runways	39	22	1	2	10	14	12
52	Others	Airport ownership type (public, majority public, majority private, private)	39	22	5	7	11	7	9
53		Airport serving country capital city	38	23	3	3	6	12	14
54	Cargo characteristics	Freighter aircraft movement as a percentage of all commercial aircraft movements	37	24	1	4	14	10	8
55	Cargo claims - International convention ratification & limit of liability (IATA TACT, October 2016)	Warsaw convention as amended by Hague protocol 1955	36	25	2	5	10	7	12
56		Warsaw convention as amended by Montreal protocol 1975	36	25	2	4	11	8	11

Table 15: Manual Summary of First Round Questionnaire (continued)

Questionnaire for the Relevance and Importance of Criteria for Air Cargo Terminal Classification in Asia Pacific's Major Airports

This questionnaire aims to measure the relevance and importance of criteria for air cargo terminal classification in Asia Pacific's major airports. Select Yes/No to indicate whether the criteria listed below are relevant and then (if "Yes") rate a score (1, 3, 5, 7 or 9) to specify the importance of the relevant criteria. The higher the score, the more important the criteria. Also, please provide the reason why the criteria is irrelevant or provide an alternative criteria if possible. (Weighing scores: 1 = Unimportant, 3 = Somewhat important, 5 = Quite important, 7 = Very important, 9 = Extremely important)

Items	Topics	Air Cargo Terminal Classification Criteria	Check to indicate the criteria listed are relevant (Yes) or not relevant (No)		Weighing Score (if "Yes")				
			Yes	No	1	3	5	7	9
57	E-Freight implementation & capability status (IATA TACT, October 2016)	Digitized certificates of origin acceptance	36	25	1	1	13	13	8
58	Cargo claims - International convention ratification & limit of liability (IATA TACT, October 2016)	Warsaw convention 1929	35	26	2	5	9	7	12
59	Runway numbers and length (m)	3,600 m (unlimited intercontinental operations)	35	26	1		9	15	10
60		2,500 m (unlimited operations with medium-range jets e.g. B737, A320)	28	33	3	2	5	12	6
61	Cargo characteristics	Cargo work load unit as a percentage of the total WLUs (Work Load Unit = 1 passenger = 100 kg of cargo)	27	34	1	5	7	8	6
62	Runway numbers and length (m)	1,800 m (minimum for medium-range jets)	15	46	4		3	6	2
63		1,100 m (minimum for scheduled operations with STOL-aircraft)	15	46	4		3	6	2

Table 15: Manual Summary of First Round Questionnaire (continued)

Table 16: Top 25 Air Cargo Carriers and Air Forwarders in 2015 (ACN, 2017)

Ranks	Airlines	Ranking +/-	2015 (Tons)	Y-o-Y %	2014
1	Federal Express	0	7,087,000	-0.6	7,127,000
2	United Parcel Service	0	4,482,000	5.7	4,240,000
3	Emirates	0	2,454,000	7.3	2,288,000
4	Cathay Pacific	+1	1,558,000	4.0	1,498,000
5	Korean Air	-1	1,533,000	0.9	1,519,000
6	Qatar Airways	+4	1,466,000	26.6	1,158,000
7	China Southern Airlines	-1	1,389,000	4.2	1,333,000
8	China Airlines	-1	1,306,000	0.8	1,296,000
9	Air China	0	1,256,000	7.3	1,171,000
10	China Eastern Airlines	+1	1,255,000	8.5	1,157,000
11	All Nippon Airways	-3	1,165,000	-3.4	1,206,000
12	Singapore Airlines	0	1,084,000	0.6	1,078,000
13	Lufthansa	0	950,000	-2.5	974,000
14	Etihad Airways	+1	904,000	5.9	854,000
15	Asiana Airlines	-1	856,000	-1.4	868,000

Ranks	Airlines	Ranking +/-	2015 (Tons)	Y-o-Y %	2014
16	Cargolux	+1	757,000	4.0	728,000
17	Polar Air Cargo	+8	685,000	33.5	513,000
18	Lan Airlines	-2	664,000	-13.8	770,000
19	Japan Airlines	+2	659,000	5.4	625,000
20	Turkish Airlines	0	634,000	0.6	630,000
21	Eva Air	-3	624,000	-8.8	684,000
22	Air Bridge Cargo Airlines	+2	615,000	19.0	517,000
23	British Airways	-4	606,000	-5.8	643,000
24	Thai Airways International	-2	542,000	-10.1	603,000
25	Air France	-2	498,000	-7.6	539,000

Ranks	Air Forwarders (2015)	Metric tons	YoY change	Revenues (Million SGD)	YoY change
1	DHL Supply Chain & Forwarding	2,109,000	-7.2%	29,562	-8.2%
2	K+N	1,250,000	4.7%	21,100	-9.4%
3	DB Schenker	1,128,000	1.4%	17,160	-13.6%
4	UPS Supply Chain Solutions	935,300	2.5%	8,215	42.7%
5	Expeditors	872,480	6.0%	6,617	0.8%
6	Panalpina	836,200	-2.5%	6,091	-17.0%
7	Nippon Express	711,354	8.8%	15,822	-11.7%
8	Bollore Logistics (SDV)	580,000	5.5%	3,735	-50.1%
9	Hellmann	561,240	10.6%	3,987	4.9%
10	Sinotrans	522,600	8.4%	7,314	-2.0%
11	Kintetsu World Express	478,000	N/A	2,942	N/A
12	CEVA Logistics	451,000	N/A	6,959	-11.5%
13	Agility	372,700	0.0%	3,907	-9.1%
14	UTI	353,300	-4.0%	3,696	-11.6%
15	Yusen Logistics	344,000	11.0%	3,835	-2.8%
16	DSV	311,193	8.2%	7,574	-12.6%
17	Geodis	299,032	10.5%	5,864	-1.6%
18	Kerry Logistics	282,200	0.0%	2,723	0.0%
19	Dachser	275,300	N/A	6,116	N/A
20	NNR Global Logistics	264,068	N/A	1,683	N/A
21	Dimerco Express	202,000	N/A	489	N/A
22	Hitachi Transport Systems	190,000	11.8%	5,612	-5.2%

Ranks	Air Forwarders (2015)	Metric tons	YoY change	Revenues (Million SGD)	YoY change
23	Demco	180,000	-5.3%	2,740	-14.7%
24	Logwin	137,000	-6.2%	1,175	-21.7%
25	Ch Robinson	115,000	0.0%	13,476	N/A

Table 16: Top 25 Air Cargo Carriers and Air Forwarders in 2015 (continued) (ACN, 2017)

Cargo Commodities	Ranked by 20 Operators	Services	Ranked by 20 Operators
PER (Perishable cargo)	19	Physical cargo handling	15
GEN (General cargo)	17	Document handling	14
DGR (Dangerous goods)	15	Mail/E-commerce handling	8
PIL (Pharmaceuticals)	13	Import cargo handling	5
VAL (Valuable cargo)	12	Trucking service	4
AVI (Live animal)	10	Express cargo handling	4
XPS (Priority cargo)	8	International cargo handling	4

Locations	Ranked by 17 Operators	Cargo Terminal Sizes (Sq. m.)	Ranked by 5 Operators	Cargo Volumes (Tons/ year)	Ranked by 8 Operators
On airport with ramp access	16	Large	4	Large	8
On airport without ramp access	15	Medium	4	Medium	8
Off airport	15	Small	4	Small	8
Cargo village with agents	1	Hub	1	Hub	1

Table 17: Summary of Air Cargo Terminal Classification Provided by Air Cargo Terminal Operators (Total: 26 Operators)

3.3 Factor Analysis by Principal Component Analysis

As the result, Principal Component Analysis is the most used tool for factor analysis and variable reduction (Vanichbuncha, 2011). A large number of highly correlated variables can lead to the multicollinearity and the common solution to this problem is Factor Analysis that reduces to few variables to represent the large amount of observed indicators (Anderson, Tatham, & Black, 1998). Tsai et al. (2007) systematically

reduced variables into new four variables by Factor Analysis. The Principal Component Analysis extracted factor dimensions with eigenvalues lower than one (R.-T. Wang, 2007). Meng et al. (2010) studied criteria for services of air cargo logistics provider: how do they relate to client satisfaction? and simplified several variables to reduce fourth and fifth factors from the list by Principal Component Analysis with the Varimax of orthogonal rotation to gain rotated coefficients (Anderson et al., 1998). (OCDE, 1999) constructed an index by mean of Factor Analysis method as a tool to summarize details of information for air service liberation. The Principal Component Analysis by Varimax rotations of factors is targeted to extract numbers of significant components with factor loading scores greater than 0.5 in each new factor. Factor loading over 0.5 and relative weights are significant (Rousava & Piermartini, 2008).

3.4 First Round Questionnaire Results and Second Round Questionnaire

After the results from first round questionnaire was manually analyzed, the result was still with too many variables for air cargo terminal operators at BKK, CNX, DMK and HKT airports to fill out the questionnaire. The last four variables could have been extracted from the list as the irrelevant score was more than relevant score from all filled out questionnaire. However, the researcher decided to keep all variables on the list for re-analysis by a statistical program for variable reductions mathematically to ensure the relevance and importance of such four variables on top of the manual analysis. Therefore, the remaining variables were analyzed by Factor Analysis by using Principal Component Analysis with Orthogonal rotation of Varimax function and expected to reduce such 63 variables into an appropriate amount for second round questionnaire. The format of second round questionnaire in Appendix 4 was mainly similar to first round questionnaire due to the objective was to find the relevance and importance of criteria for air cargo terminal classification model. A slight difference was to highlight only on a small group of experts to reduce irrelevant and unimportant variables again. The examination result was systematically generated by SPSS program with result tables as following details in Table 18 - 22. Principal Component Analysis performed its variable reduction function properly and the final decision from the analysis's result was based on the researcher judgement. The initial variable reduction was any variable below factor loading of 0.5. Table 18 – 22 show respective stages

of results and the process of judgement gradually until the final judgement taken to reduce variables from 63 to 46 variables for second round questionnaire to Research Question 1.

Descriptive Statistics

Air Cargo Terminal Classification Criteria	Mean	Std. Deviation	Analysis N
Cargo and mail handling – general	7.95	1.296	61
Customs Control	7.89	1.613	61
Documentation handling	7.66	1.741	61
Physical handling outbound/inbound	8.05	1.296	61
Transfer/transit cargo	7.43	1.830	61
Post office mail	6.34	2.774	61
Automation/computer systems	7.98	1.348	61
Unit load device (ULD) control	7.26	1.949	61
Cargo and mail security	8.28	1.416	61
Warsaw convention 1929	4.02	3.238	61
Warsaw convention as amended by Hague protocol 1955	4.08	3.216	61
Warsaw convention as amended by Montreal protocol 1975	4.08	3.174	61
Montreal convention 1999	6.05	3.133	61
Customs operating hours - 24 hours	6.64	2.840	61
Customs operating hours - Weekdays (Business hours)	5.52	3.345	61
Customs operating hours -Weekdays and weekends (Business hours)	5.79	3.083	61
E-freight capability target status	5.72	2.782	61
E-Freight: Electronic export goods declaration	5.69	2.919	61
E-freight: Electronic export cargo declaration	5.98	2.748	61
E-Freight: Electronic import goods declaration	5.75	2.948	61
E-freight: Electronic import cargo declaration	5.98	2.796	61
E-freight: Transit freight remaining on board	4.77	3.268	61
E-freight: Transshipment	5.46	2.884	61
E-freight: Digitized commercial invoice and packing list acceptance	4.61	3.007	61
E-freight: Digitized certificates of origin acceptance	4.21	3.061	61
E-AWB: Import cargo	6.15	2.516	61
E-AWB: Export cargo	6.28	2.450	61
E-AWB: Transit cargo	6.08	2.648	61
E-AWB: Transshipment cargo	5.85	2.695	61
Cargo commodities (IATA three letter codes)	8.15	1.181	61
ISAGO: Cargo and mail acceptance and handling (general, dangerous goods, live animals and perishables, other special cargo, unit load devices)	7.13	2.500	61
ISAGO: Cargo security (facilities, operations)	7.56	2.426	61
Total cargo throughput (metric tons) per annum	6.64	2.887	61
Cargo work load unit as a percentage of the total WLUs (WLU = 1 passenger = 100 kg of cargo)	3.20	2.914	61
Freighter aircraft movement as a percentage of all commercial aircraft movements	4.08	2.979	61

Air Cargo Terminal Classification Criteria	Mean	Std. Deviation	Analysis N
International cargo as percentage of the total cargo volume	4.80	2.845	61
International trade (export value)	4.80	2.868	61
Flight frequency (weekly flight frequency of the selected airports)	5.39	3.007	61
Route distribution (geographical distribution of airfreight)	5.30	2.963	61
National versus foreign carriers (flight (%) operated by flag carriers)	3.89	2.769	61
Centrality (betweenness centrality of airports by area)	4.57	3.122	61
No. of runways	4.67	3.208	61
3,800 m (unlimited operations cargo)	5.05	3.206	61
3,600 m (unlimited intercontinental operations)	4.38	3.236	61
2,500 m (unlimited operations with medium-range jets e.g. B737, A320)	3.36	3.066	61
1,800 m (minimum for medium-range jets)	1.95	2.239	61
1,100 m (minimum for scheduled operations with STOL-aircraft)	2.05	2.327	61
Origin-destination demand	5.56	2.901	61
Freight forwarder presence	6.48	2.501	61
Night operations capability	6.84	2.107	61
Size of local market (% of shipments locally generated)	5.49	2.981	61
Airport operational time (around the clock or with curfew)	7.03	2.380	61
Cargo handling capacity (tons per annum)	6.87	2.705	61
Cargo terminal area (sq.m.)	7.23	2.452	61
Average hours for cargo loading/unloading at air side	6.41	2.642	61
Customs clearance times (hours)	6.67	2.399	61
Trucking time to main markets (hours)	5.43	2.784	61
Tracking and tracing service	6.90	2.234	61
Electronic Data Interchange capability	7.56	2.225	61
Airport serving country capital city	4.51	3.379	61
Airport ownership type (public, majority public, majority private, private)	3.82	3.019	61
Minimum connecting time (hours)	5.89	3.023	61
Maximum connecting time (hours)	5.36	3.173	61

Table 18: Results of 63 Variables Analyzed by Principal Component Analysis

Communalities

Air Cargo Terminal Classification Criteria	Initial	Extraction
Cargo and mail handling – general	1.000	.915
Customs Control	1.000	.729
Documentation handling	1.000	.866
Physical handling outbound/inbound	1.000	.895
Transfer/transit cargo	1.000	.877
Post office mail	1.000	.813
Automation/computer systems	1.000	.775
Unit load device (ULD) control	1.000	.828
Cargo and mail security	1.000	.830
Warsaw convention 1929	1.000	.965
Warsaw convention as amended by Hague protocol 1955	1.000	.963
Warsaw convention as amended by Montreal protocol 1975	1.000	.910
Montreal convention 1999	1.000	.805

Air Cargo Terminal Classification Criteria	Initial	Extraction
Customs operating hours - 24 hours	1.000	.733
Customs operating hours - Weekdays (Business hours)	1.000	.740
Customs operating hours -Weekdays and weekends (Business hours)	1.000	.807
E-freight capability target status	1.000	.838
E-Freight: Electronic export goods declaration	1.000	.958
E-freight: Electronic export cargo declaration	1.000	.945
E-Freight: Electronic import goods declaration	1.000	.948
E-freight: Electronic import cargo declaration	1.000	.946
E-freight: Transit freight remaining on board	1.000	.830
E-freight: Transshipment	1.000	.851
E-freight: Digitized commercial invoice and packing list acceptance	1.000	.773
E-freight: Digitized certificates of origin acceptance	1.000	.736
E-AWB: Import cargo	1.000	.961
E-AWB: Export cargo	1.000	.949
E-AWB: Transit cargo	1.000	.946
E-AWB: Transshipment cargo	1.000	.940
Cargo commodities (IATA three letter codes)	1.000	.805
ISAGO: Cargo and mail acceptance and handling (general, dangerous goods, live animals and perishables, other special cargo, unit load devices)	1.000	.915
ISAGO: Cargo security (facilities, operations)	1.000	.911
Total cargo throughput (metric tons) per annum	1.000	.813
Cargo work load unit as a percentage of the total WLUs (WLU = 1 passenger = 100 kg of cargo)	1.000	.756
Freighter aircraft movement as a percentage of all commercial aircraft movements	1.000	.767
International cargo as percentage of the total cargo volume	1.000	.880
International trade (export value)	1.000	.844
Flight frequency (weekly flight frequency of the selected airports)	1.000	.811
Route distribution (geographical distribution of airfreight)	1.000	.867
National versus foreign carriers (flight (%) operated by flag carriers)	1.000	.807
Centrality (betweenness centrality of airports by area)	1.000	.868
No. of runways	1.000	.837
3,800 m (unlimited operations cargo)	1.000	.873
3,600 m (unlimited intercontinental operations)	1.000	.871
2,500 m (unlimited operations with medium-range jets e.g. B737, A320)	1.000	.841
1,800 m (minimum for medium-range jets)	1.000	.849
1,100 m (minimum for scheduled operations with STOL-aircraft)	1.000	.888
Origin-destination demand	1.000	.812
Freight forwarder presence	1.000	.782
Night operations capability	1.000	.788
Size of local market (% of shipments locally generated)	1.000	.824
Airport operational time (around the clock or with curfew)	1.000	.879
Cargo handling capacity (tons per annum)	1.000	.871
Cargo terminal area (sq.m.)	1.000	.887
Average hours for cargo loading/unloading at air side	1.000	.835
Customs clearance times (hours)	1.000	.864
Trucking time to main markets (hours)	1.000	.822
Tracking and tracing service	1.000	.873
Electronic Data Interchange capability	1.000	.765

Air Cargo Terminal Classification Criteria	Initial	Extraction
Airport serving country capital city	1.000	.710
Airport ownership type (public, majority public, majority private, private)	1.000	.813
Minimum connecting time (hours)	1.000	.905
Maximum connecting time (hours)	1.000	.834

Extraction Method: Principal Component Analysis.

Table 19: Results of 63 Variables Analyzed by Principal Component Analysis

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	17.576	27.898	27.898	17.576	27.898	27.898	7.843	12.449	12.449
2	6.740	10.699	38.597	6.740	10.699	38.597	5.980	9.492	21.942
3	4.043	6.418	45.015	4.043	6.418	45.015	5.927	9.408	31.349
4	3.632	5.766	50.780	3.632	5.766	50.780	4.037	6.409	37.758
5	3.430	5.444	56.224	3.430	5.444	56.224	3.492	5.543	43.300
6	2.450	3.888	60.113	2.450	3.888	60.113	3.313	5.259	48.559
7	2.295	3.643	63.756	2.295	3.643	63.756	3.161	5.017	53.576
8	2.194	3.483	67.238	2.194	3.483	67.238	2.836	4.501	58.077
9	1.793	2.846	70.084	1.793	2.846	70.084	2.609	4.142	62.219
10	1.743	2.767	72.851	1.743	2.767	72.851	2.573	4.084	66.303
11	1.606	2.549	75.400	1.606	2.549	75.400	2.487	3.948	70.251
12	1.522	2.416	77.816	1.522	2.416	77.816	2.291	3.636	73.887
13	1.219	1.935	79.751	1.219	1.935	79.751	2.243	3.560	77.446
14	1.145	1.817	81.568	1.145	1.817	81.568	1.772	2.812	80.258
15	1.104	1.752	83.320	1.104	1.752	83.320	1.669	2.650	82.908
16	1.045	1.659	84.979	1.045	1.659	84.979	1.305	2.071	84.979
17	.937	1.487	86.466						
18	.831	1.319	87.786						
19	.790	1.254	89.039						
20	.628	.998	90.037						
21	.603	.957	90.994						
22	.575	.913	91.908						
23	.469	.745	92.652						
24	.450	.714	93.367						
25	.417	.661	94.028						
26	.390	.618	94.646						
27	.358	.568	95.214						

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
28	.313	.498	95.712						
29	.303	.481	96.193						
30	.293	.464	96.657						
31	.249	.396	97.053						
32	.224	.355	97.408						
33	.192	.304	97.712						
34	.169	.269	97.981						
35	.162	.257	98.238						
36	.148	.235	98.473						
37	.136	.216	98.689						
38	.109	.172	98.862						
39	.101	.160	99.022						
40	.095	.150	99.172						
41	.090	.143	99.315						
42	.068	.108	99.423						
43	.061	.096	99.519						
44	.055	.088	99.607						
45	.048	.076	99.683						
46	.044	.070	99.753						
47	.037	.059	99.812						
48	.023	.036	99.849						
49	.022	.034	99.883						
50	.019	.031	99.913						
51	.017	.027	99.941						
52	.013	.021	99.961						
53	.010	.015	99.977						
54	.006	.009	99.986						
55	.003	.005	99.991						
56	.003	.005	99.996						
57	.001	.002	99.998						
58	.001	.002	100.000						
59	.000	.000	100.000						
60	3.856E-05	6.120E-05	100.000						
61	4.644E-16	7.372E-16	100.000						

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
62	4.230E-16	6.714E-16	100.000						
63	-3.375E-17	-5.357E-17	100.000						
Extraction Method: Principal Component Analysis.									

Table 20: Results of 63 Variables Analyzed by Principal Component Analysis

Component Matrix[a]																
Air Cargo Terminal Classification Criteria	Component															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
E-freight: Electronic import cargo declaration	.786	-.345	-.104		.246		-.159		-.133	-.216		-.131	-.101			
E-freight: Electronic export cargo declaration	.773	-.358			.268		-.166		-.137	-.213		-.110				
E-Freight: Electronic export goods declaration	.772	-.373	-.131		.205		-.225		-.142	-.182				-.200		
E-Freight: Electronic import goods declaration	.758	-.394	-.110		.226		-.203		-.162	-.186				-.176		
E-freight: Transhipment	.694	-.357	-.202	.105	.253				-.245		-.203					
E-freight: Transit freight remaining on board	.691	-.264	-.220		.236	.178		-.130					-.198	-.148	.114	-.182
Customs Control	.690	-.123	.231		-.226		-.197	-.119		.197						.165
Unit load device (ULD) control	.689	-.168	.410		-.210	.110				-.166		.152			.182	
Montreal convention 1999	.677		-.192			.143						-.235		.172	-.407	.164
Minimum connecting time (hours)	.666	.349	-.138	-.192	.210		.128	-.206			.105		-.277	-.251	-.106	
E-freight capability target status	.639	-.258		.177	.122	-.294	-.125				-.339			.132	-.193	-.168
Cargo and mail handling – general	.637	-.192	.526	-.147	-.291	.249			.107							
Automation/computer systems	.634	-.209	.447	-.120					.184	-.192			-.139			
Average hours for cargo loading/unloading at air side	.620			.266		-.299	.215	-.121	-.300		.143		.239		-.194	-.106
Physical handling outbound/inbound	.605	-.220	.491	-.138	-.313	.259	-.133	-.101		-.115						
Origin-destination demand	.579	.456		-.176				.121	-.322	-.101			.111		.258	
Warsaw convention 1929	.570	-.173	-.286	.370	-.321	.162	.346	.218	.171			-.184		-.111		
Centrality (betweenness centrality of airports by area)	.568	.391	-.215	-.219	-.203	.304						-.196		-.250	.214	
Flight frequency (weekly flight frequency of the selected airports)	.563	.541	-.190	-.183		.176	-.141		.198							-.118
International trade (export value)	.561	.420	-.164	-.235		.181	-.153			.286			.248		-.115	-.215
Electronic Data Interchange capability	.557	-.341	.217		.123	-.167					.406			.200		-.107
E-freight: Digitized commercial invoice and packing list acceptance	.557	-.186	-.438	-.147	.123		-.241					.264				-.179
E-AWB: Transit cargo	.552	-.512		-.394	.212		.244	.151	.200		.184		.123			
Warsaw convention as amended by Hague protocol 1955	.550	-.204	-.257	.371	-.355	.176	.309	.242	.182			-.188		-.144		
International cargo as percentage of the total cargo volume	.548	.390	-.265	-.188	-.288	-.147	.332			-.195			.132	.172		
ISAGO: Cargo and mail acceptance and handling (general, dangerous goods, live animals and perishables, other special cargo, unit load devices)	.542	-.195	-.293		-.393				-.228	.397	.160	-.169		.178	.154	

Component Matrix[a]																
Air Cargo Terminal Classification Criteria	Component															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
E-AWB: Export cargo	.542	-.502		-.391	.222		.224	.160	.270		.152					
Documentation handling	.537	-.160	.519	-.185	-.144	.327					.121	.249			-.132	
ISAGO: Cargo security (facilities, operations)	.536	-.150	-.281		-.214	-.178	-.198	-.126	-.372	.415	.134		-.104	.119	.162	
Maximum connecting time (hours)	.530	.325	-.103	-.103	.337		.258	-.319					-.151			.301
National versus foreign carriers (flight (%) operated by flag carriers)	.526	.472	-.284		-.101	.338		-.107			.170			-.182		
Route distribution (geographical distribution of airfreight)	.524	.407	-.259	-.282		.275				.130		.113	.317	-.180		-.134
Customs clearance times (hours)	.518			.184		-.365		-.470	-.101	.231	-.286		.143		.135	
Airport operational time (around the clock or with curfew)	.517	.148		.140	-.171	-.277		-.403	.408		-.140	.125	.164	-.108	-.207	-.113
Freighter aircraft movement as a percentage of all commercial aircraft movements	.506	.478			-.226	-.224	.201	.202						.196	-.113	.135
E-freight: Digitized certificates of origin acceptance	.501	-.342	-.349		.185						-.224	.330				
Tracking and tracing service	.464	.299	.424	-.189	.131		.206		-.325		.117		-.256	.124	.161	-.234
Cargo commodities (IATA three letter codes)	.459	-.202	.411	.252					-.138	.150	.271	-.372	.135	-.102	-.147	
No. of runways	.452	.332			.199	-.171	-.152	.381	.372	.122		.100	-.331			
Cargo and mail security	.438	-.139	.194	.184	-.366		-.314	.147		.128	-.368			.258		-.262
3,800 m (unlimited operations cargo)	.438	.307	.313		.131	-.159	-.281	.271	.288	.371		-.158	-.196			
Freight forwarder presence	.429	.115		.187	-.220	-.218	-.378	.298		-.300			.248		.219	.119
Airport serving country capital city	.427		-.148	.388		-.172	.181				.257	.426	.109		-.141	
Warsaw convention as amended by Montreal protocol 1975	.417	-.174	-.355	.394	-.207	.245	.385	.126			-.215	-.262				.149
Cargo work load unit as a percentage of the total WLUs (Work Load Unit = 1 passenger = 100 kg of cargo)	.351	.256	-.338	-.188		.155		.322	-.198		.268	.187		.194	-.316	
Size of local market (% of shipments locally generated)	.512	.575	-.115	-.139		-.150		.183		-.264	.115			.160	.104	
E-AWB: Transhipment cargo	.446	-.541		-.327	.175	-.205	.342		.147	.155	-.154		.256			
Cargo handling capacity (metric tonnes) per annum (p.a.)	.450	.540	.203	-.179		-.361	.273			-.125	-.188					-.138
E-AWB: Import cargo	.466	-.518		-.364	.319		.254		.255				.158	.144	.185	.111
2,500 m (unlimited operations with medium-range jets e.g. B737, A320)	.288	.515	.190	.280	.447	.136	-.144				.135		.329			
Trucking time to main markets (hours)	.470	.481		-.167	.145	-.131		-.124		.153	-.170	.259	-.186		.185	.300
Transfer/transit cargo	.466	-.101	.501	-.169	-.286	.265			-.206	.139	-.134	.278		-.170	-.160	
1,100 m (minimum for scheduled operations with STOL-aircraft)	.165	.300	.332	.563	.456		.195	.234		.110					.108	
Airport ownership type (public, majority public, majority private, private)	.153		-.226	.563	-.189		.141	-.146	.151		.265	.363	-.129	.114		-.275
1,800 m (minimum for medium-range jets)	.204	.266	.304	.545	.448		.170	.193		.144				-.157	.130	
Customs operating hours - Weekdays (Business hours)	.271	.111		.489	.216	.431		-.296						.236	.129	
3,600 m (unlimited intercontinental operations)	.388	.401	.144		.489		-.279	.168	.121	.257	-.157	-.147	.154		-.157	
Customs operating hours - 24 hours	.388	.182	.300	.122	-.418	-.346		-.169				-.144		-.237		.175
Customs operating hours -Weekdays and weekends (Business hours)	.280	.217	.175	.322	.180	.426	.107	-.420	.132					.343		
Cargo terminal area (sq.m.)	.403	.412	.318	-.207		-.265	.417		-.162		-.155		-.197			-.239
Post office mail	.276	-.168		.302	-.237			.561		.151		.368				.233
Total cargo throughput (metric tonnes) per annum	.436	.427								-.529	-.131			.187		.276
Night operations capability	.419			.148	-.197	-.282	-.266	-.225	.347		.435				.122	
Extraction Method: Principal Component Analysis.																
a. 16 components extracted.																

Table 21: Results of 63 Variables Analyzed by Principal Component Analysis

Rotated Component Matrix[a]

	Component															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
E-Freight: Electronic import goods declaration	.897		.224	.186	.102											
E-Freight: Electronic export goods declaration	.895	.120	.228	.174			.103									
E-freight: Electronic export cargo declaration	.891		.191	.202	.127		.132								.102	
E-freight: Electronic import cargo declaration	.888		.190	.187	.149		.148									
E-freight: Transhipment	.764		.150	.220	.158	.159			.239	-.125		.104			-.209	
E-freight: Transit freight remaining on board	.730	.252	.155	.178	.153		-.121					.186	.206	.115		-.187
E-freight capability target status	.681			.132	.168			.193		.221	.334			-.270		.170
E-freight: Digitized commercial invoice and packing list acceptance	.591	.375		.223		-.219			.135			.108	.300		-.204	
E-freight: Digitized certificates of origin acceptance	.551	.139		.311	.108				.135				.122		-.484	
Montreal convention 1999	.460	.249	.177	.136	.276	-.104	.128		.152	.151		.228		.156	.199	.459
Average hours for cargo loading/unloading at air side	.404		.138	.142		.296	.137	.240	.269	-.208	.297		.367		.220	.241
Route distribution (geographical distribution of airfreight)		.874	.135								.117				-.128	.143
International trade (export value)		.820	.129						.168	.181				-.108		.213
Flight frequency (weekly flight frequency of the selected airports)	.104	.779					.216	.113		.256	.151	.178				
Centrality (betweenness centrality of airports by area)	.174	.759	.171		.251		.190	.126					-.105	.151		-.247
National versus foreign carriers (flight (%) operated by flags carriers)	.110	.753			.194		.125					.190	.151	.254		-.128
Origin-destination demand	.199	.557	.113			.148	.480	.288	.301							
Transfer/transit cargo		.139	.857				-.125	.164				-.121			-.124	.144
Physical handling outbound/inbound	.241		.856				.132					.125	-.120			
Cargo and mail handling – general	.176	.103	.853	.188	.125					.167		.135			.114	
Documentation handling	.103	.135	.850	.227												.171
Unit load device (ULD) control	.291		.710	.178	.120	.102	.200	.106				.116	.182	-.145		-.208
Automation/computer systems	.335		.655	.273			.105	.143	-.114	.184		.115				-.191
Customs Control	.283	.116	.588						.336	.226	.294					
E-Air waybill: Import cargo	.296		.141	.903									-.125			
E-Air waybill: Export cargo	.360		.190	.852		-.100				.119						
E-Air waybill: Transit cargo	.346		.281	.830								-.103				
E-Air waybill: Transhipment cargo	.281		.153	.824	.100					-.131	.271				-.112	
Electronic Data Interchange capability	.366	-.140	.271	.455			.139	.117	.187	.152		.136	.292		.343	
Warsaw convention as amended by Hague protocol 1955	.252	.150	.163		.886								.187			
Warsaw convention 1929	.267	.169	.125		.885								.192			
Warsaw convention as amended by Montreal protocol 1975	.183			.110	.873				.153			.213				
Post office mail			.349		.400	.314	.142	-.236	.154		-.166	-.311	.245	-.104	-.321	.150
1,100 m (minimum for scheduled operations with STOL-aircraft)						.880		.167		.146		.140				
1,800 m (minimum for medium-range jets)						.870		.143		.128		.120				
2,500 m (unlimited operations with medium-range jets e.g. B737, A320)		.353			-.224	.652	.233			.106		.350			.182	
3,600 m (unlimited intercontinental operations)	.185	.381			-.167	.509				.460		.210	-.243			.266
Total cargo throughput (metric tonnes) per annum	.169	.154	.168	-.154			.728	.170	-.182		.134	.239		.112		.133
Size of local market (% of shipments locally generated)	.146	.467				.104	.669	.222		.215						
Freight forwarder presence	.230	.137	.205			.152	.633	-.226		.159	.120	-.164		-.250		-.195
Freighter aircraft movement as a percentage of all commercial aircraft movements		.301			.243		.552	.359		.276			.141	.115		.219
International cargo as percentage of the total cargo volume		.474		.130	.280	-.119	.546	.409	.132	-.103			.123			.155
Cargo terminal area (sq.m.)		.179	.189			.129	.126	.851			.175					
Tracking and tracing service		.194	.360		-.113	.248	.121	.676	.143	.114	-.277	.103			.108	
Cargo handling capacity (metric tons) per annum (p.a.)		.342	.132			.160	.376	.612	-.106	.139	.335	-.134				-.118
ISAGO: Cargo security (facilities, operations)	.361	.137			.110				.843				.116			
ISAGO: Cargo and mail acceptance and handling (general, dangerous goods, live animals and perishables, other special cargo, unit load devices)	.220	.221	.163	.133	.271	-.215			.797							

Rotated Component Matrix[a]																
	Component															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
3,800 m (unlimited operations cargo)		.199	.200			.307			.158	.788					.147	
No. of runways	.168	.214				.173	.178	.170		.780			.106		-.174	
Airport operational time (around the clock or with curfew)	.185	.293	.138							.170	.759	.123	.307			
Customs clearance times (hours)	.252			.102		.116		.215	.461		.663	.172			-.128	
Customs operating hours - 24 hours			.371	-.141	.135		.296	.112	.141	.157	.507	-.166		.167	.288	-.115
Customs operating hours -Weekdays and weekends (Business hours)			.193			.170						.833				
Customs operating hours - Weekdays (Business hours)	.126	.103			.149	.308		-.156				.731	.127			
Airport ownership type (public, majority public, majority private, private)				-.184	.232							.249	.796			
Airport serving country capital city	.216				.173	.257	.124				.152		.671	.122		.162
Night operations capability		.150				-.118	.253	-.193	.271	.359	.306		.414	.156	.258	-.251
Maximum connecting time (hours)	.225	.319		.129		.159		.261	.107		.104	.315		.636		.150
Cargo and mail security	.234		.439	-.133	.198				.237	.248	.168			-.589	-.136	
Minimum connecting time (hours)	.332	.496	.106					.311		.253	.121		.103	.574		
Cargo commodities (IATA three letter codes)	.223		.428		.141	.283			.227		.114				.622	
Trucking time to main markets (hours)	.104	.340	.112		-.134	.169	.248	.228	.212	.283	.208			.404	-.429	
Cargo work load unit as a percentage of the total WLUs (Work Load Unit = 1 passenger = 100 kg of cargo)	.133	.429					.205		.139	.116	-.365		.250	.114		.500
Extraction Method: Principal Component Analysis.																
a. Rotation converged in 16 iterations.																

Table 22: Results of 63 Variables Analyzed and Rotated by Principal Component Analysis

Rotated Component Matrix																
Air Cargo Terminal Classification Criteria	Component															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
E-Freight: Electronic import goods declaration	.897															
E-Freight: Electronic export goods declaration	.895															
E-freight: Electronic export cargo declaration	.891															
E-freight: Electronic import cargo declaration	.888															
E-freight: Transhipment	.764															
E-freight: Transit freight remaining on board	.730															
E-freight capability target status	.681															
E-freight: Digitized commercial invoice and packing list acceptance																
E-freight: Digitized certificates of origin acceptance																
Montreal convention 1999																
Average hours for cargo loading/unloading at air side																
Route distribution (geographical distribution of airfreight)		.874														
International trade (export value)		.820														
Flight frequency (weekly flight frequency of the selected airports)		.779														
Centrality (betweenness centrality of airports by area)		.759														
National versus foreign carriers (flight (%) operated by flags carriers)		.753														
Origin-destination demand																

Rotated Component Matrix

Air Cargo Terminal Classification Criteria	Component															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Transfer/transit cargo			.857													
Physical handling outbound/inbound			.856													
Cargo and mail handling – general			.853													
Documentation handling			.850													
Unit load device (ULD) control			.710													
Automation/computer systems			.655													
Customs Control																
E-Air waybill: Import cargo				.903												
E-Air waybill: Export cargo				.852												
E-Air waybill: Transit cargo				.830												
E-Air waybill: Transhipment cargo				.824												
Electronic Data Interchange capability																
Warsaw convention as amended by Hague protocol 1955					.886											
Warsaw convention 1929					.885											
Warsaw convention as amended by Montreal protocol 1975					.873											
Post office mail																
1,100 m (minimum for scheduled operations with STOL-aircraft)						.880										
1,800 m (minimum for medium-range jets)						.870										
2,500 m (unlimited operations with medium-range jets e.g. B737, A320)						.652										
3,600 m (unlimited intercontinental operations)																
Total cargo throughput (metric tonnes) per annum							.728									
Size of local market (% of shipments locally generated)							.669									
Freight forwarder presence							.633									
Freighter aircraft movement as a percentage of all commercial aircraft movements																
International cargo as percentage of the total cargo volume																
Cargo terminal area (sq.m.)								.851								
Tracking and tracing service								.676								
Cargo handling capacity (metric tons) per annum (p.a.)								.612								
ISAGO: Cargo security (facilities, operations)									.843							
ISAGO: Cargo and mail acceptance and handling (general, dangerous goods, live animals and perishables, other special cargo, unit load devices)									.797							
3,800 m (unlimited operations cargo)										.788						
No. of runways										.780						
Airport operational time (around the clock or with curfew)											.759					
Customs clearance times (hours)											.663					
Customs operating hours - 24 hours																
Customs operating hours -Weekdays and weekends (Business hours)												.833				
Customs operating hours - Weekdays (Business hours)												.731				

Rotated Component Matrix																
Air Cargo Terminal Classification Criteria	Component															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Airport ownership type (public, majority public, majority private, private)													.796			
Airport serving country capital city													.671			
Night operations capability																
Maximum connecting time (hours)														.636		
Cargo and mail security																
Minimum connecting time (hours)																
Cargo commodities (IATA three letter codes)															.622	
Trucking time to main markets (hours)																
Cargo work load unit as a percentage of the total WLUs (Work Load Unit = 1 passenger = 100 kg of cargo)																
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.																
a. Rotation converged in 16 iterations.																

Table 23: Results of 63 Variables Analyzed and Rotated by Principal Component Analysis with 46 Remaining Variables of Over 0.6 Factor Loading

In according to Table 18, Principal Component Analysis was run. Firstly, descriptive statistics were checked in general for means on each variable in Table 18. Then, in Table 19, communality values of all variables were above 0.5 and Eigenvalues in Table 20 for 16 new components or factors were generated by the system. Eigenvalue for important factors greater than 1.0 value were obtained in new components. The rest of variables were extracted by Eigenvalue less than 1.0 value. Each component was independent to the other. All new 16 components presented 84.979% of all variable details. In addition, the new rotation sums of squared value on each new component were increased by Varimax rotation. Still, the new components represented 84.979%. Table 21 shows the result of component matrix of 16 components. In each component, first evaluation was to maintain only variables with greater than 0.5 factor loading. The result was noticed that: for instance, “night operations capability and cargo commodities (IATA three letter codes)” in Table 15 with 60 scores of relevance to air cargo terminal classification by first round questionnaire were with factor loading of 0.419 and 0.459 respectively. In contrast, this means that the two variables would have been extracted on the new components. Then, the researcher decided to rotate all components by Varimax technique displayed in Table 22 and initially analyzed on variables with greater than 0.5 factor loading remained on board. The result was only 4 variables from 63 variables extracted and there were still too many variables on the

list for second round questionnaire. Then, the extreme extraction was attempted with factor loading greater 0.8 and 0.7 respectively with a result of “night operations capability and cargo commodities (three letter codes)” were extracted. Another attempt was to use loading factor of greater 0.6. There were 46 variables remaining important and 17 variables were extracted from the list in Table 23. Moreover, “cargo commodities (IATA three letter codes)” with loading factor of 0.622 remained while “night operations capability” was extracted. However, the variable of “airport operational time (around the clock or with curfew)” was replaceable. Therefore, for second round questionnaire survey, there were 46 variables stated in second round questionnaire shown in Appendix 4 for experts from CAAT, academic institute, FIATA, IATA and users of air cargo terminals to validate and reduce 46 variables again. Consequently, remaining variables after validation would be the relevant and significant criteria for air cargo terminal classification to this study. The second round questionnaire format was similar to first round questionnaire but only with 46 variables stipulated after the result from manual evaluation and Principal Component Analysis respectively.

3.5 Second Round Questionnaire Results (Phase I: Research Question 1)

The 63 variables reduced to 46 variables were evaluated by Principal Component Analysis. The remaining variables were still in large numbers. In order to ensure the validity of variables, the researcher requested 14 experts and users in air cargo terminals including IATA, Civil Aviation Authority of Thailand (CAAT), academician, major selected airlines and air cargo logistics service providers in Table 16 and International Federation of Freight Forwarders Associations (FIATA). The researcher e-mailed second round questionnaire to 14 experts on 4th May 2017 and replies were returned gradually. The last reply was from Rodrigo Reyes, IATA on 12th May 2017. IATA mentioned that there would be a bias on variables from IATA reference. IATA scored most of IATA variables while left variables from literature reviews away. The researcher noted IATA comment and continued to apply scores with other experts as IATA is the principal of aviation section. The rest of 5 were FIATA contacted via IATA office in Singapore and air cargo logistics service providers in Germany communicated via Thai Airways International office in Frankfurt. The logistics service

providers were afraid of Antitrust Law so called Competition Law and uncomfortable to share and provide any idea to any third party. This law is applied in European region. The researcher accepted the decision not to join this second round questionnaire. Consequently, only 9 of fourteen experts and users screened out variables. The result showed that runway length variables of 1,800 m (minimum for medium-range jets) and 1,100 m (minimum for scheduled operations with STOL-aircraft) were extracted by 5 experts from 9 respondents. Then, the remaining variables were 44 left containing variables from IATA and literature reviews demonstrated in Table 24. Nevertheless, most of reduced variables were with similarity to each other from their origins. Only some were independent. Therefore, the researcher integrated 44 variables into 9 main criteria by their similarity and originality to simplify all of variables after several manual and mathematical evaluations by air cargo related experts and academic technique. Variables from IATA were conveniently combined into each section. On the other hand, variables from literature reviews were somehow integrated by contents and characteristics into criteria 8 and 9. Criteria 8 and 9 are called "Airport Facility and Potentiality" and "Factor Impact on Cargo Market Competition". The 9 criteria were proved to be significant for air cargo terminal classification in Table 25. Later, these 9 criteria was constructed into third round questionnaire for 7 air cargo terminal operators in Suvarnbhumi (BKK), Chiang Mai (CNX), Don Muang (DMK) and Phuket (HKT) international airports.

Questionnaire for the Relevance and Importance of Reviewed Criteria by Air Cargo Terminal Operators for Air Cargo Terminal Classification

This questionnaire aims to validate (and reduce) the relevance and importance of reviewed criteria by air cargo operators for air cargo terminal classification.

Select "Yes" or "No" to indicate whether the criteria listed below are relevant and then (if "Yes") rate a score (1, 3, 5, 7 or 9) to specify the importance of the relevant criteria.

The higher the score, the more important the criteria. Also, please provide the reason why the criteria is irrelevant or provide an alternative criteria if possible.

(Weighing scores: 1 = Unimportant, 3 = Somewhat important, 5 = Quite important, 7 = Very important, 9 = Extremely important)

Main Criteria	Description for Main Criteria	Check to indicate the criteria listed are relevant (Yes) or not relevant (No)		Weighing Score (if "Yes")				
		Yes	No	1	3	5	7	9
IATA Standard Ground Handling Agreement - Cargo and Mail Service (Latest version 2013)	Cargo and mail handling – general	9				2	2	5
	Documentation handling	9				2	4	3
	Physical handling outbound/inbound	9				1	4	4
	Transfer/transit cargo	9		1		1	4	3
	Automation/computer systems	9				3	6	
	Until load device (ULD) control	9				1	5	3
E-Freight implementation & capability status (IATA The air cargo tariff manual rules, October 2016)	E-freight capability target status	9			1	4	4	
	Transhipment	9		1	1	3	4	
	Import cargo	9			2	2	4	1
E-Air waybill implementation & capability status (IATA The air cargo tariff manual rules, October 2016)	Export cargo	9			2	2	4	1
	Transit cargo	9			2	2	4	1
	Transhipment cargo	9			2	2	4	1
Special handling and dangerous goods codes (IATA The air cargo tariff manual rules, October 2016)	Cargo commodities (IATA three letter codes)	9				4	1	4
Others	Cargo terminal area (sq.m.)	9		1	1	3	4	
	Customs clearance times (hours)	9		1	1	1	5	1
	Tracking and tracing service	9		1	1	1	2	4
	Maximum connecting time (hours)	9		1	3	2	1	2
Customs operating hours (IATA The air cargo tariff manual rules, October 2016)	Weekdays and weekends (Business hours)	8	1			3	2	3
E-Freight implementation & capability status (IATA The air cargo tariff manual rules, October 2016)	Electronic export goods declaration	8	1		1	3	4	
	Electronic export cargo declaration	8	1		1	4	3	
	Electronic import goods declaration	8	1		1	2	5	
	Electronic import cargo declaration	8	1		1	3	4	
	Transit freight remaining on board	8	1		2	2	4	
IATA Safety Audit for Ground Operations (ISAGO) - Cargo and mail handling	Cargo and mail acceptance and handling (general, dangerous goods, live animals and perishables, other special cargo, unit load devices)	8	1			1	2	5
IATA Safety Audit for Ground Operations (ISAGO) - Cargo and mail handling	Cargo security (facilities, operations)	8	1				3	5
Cargo characteristics	Total cargo throughput (metric tonnes) per annum (p.a.)	8	1	1		4	1	2
Cargo market competition	International trade (export value)	8	1		2	4	1	1
	Flight frequency (weekly flight frequency of the selected airports)	8	1		1	4	1	2
	Route distribution (geographical distribution of airfreight)	8	1		1	4	1	2
Others	Freight forwarder presence	8	1	1	1	2	3	1
	Size of local market (% of shipments locally generated)	8	1	1	2	1	3	1
	Airport operational time (around the clock or with curfew)	8	1	1	2	3	1	1
	Cargo handling capacity (metric tons per annum)	8	1	1	1	4	1	1

Table 24: Second Round Questionnaire Results

Questionnaire for the Relevance and Importance of Reviewed Criteria by Air Cargo Terminal Operators for Air Cargo Terminal Classification

This questionnaire aims to validate (and reduce) the relevance and importance of reviewed criteria by air cargo operators for air cargo terminal classification.

Select "Yes" or "No" to indicate whether the criteria listed below are relevant and then (if "Yes") rate a score (1, 3, 5, 7 or 9) to specify the importance of the relevant criteria.

The higher the score, the more important the criteria. Also, please provide the reason why the criteria is irrelevant or provide an alternative criteria if possible.

(Weighing scores: 1 = Unimportant, 3 = Somewhat important, 5 = Quite important, 7 = Very important, 9 = Extremely important)

Main Criteria	Description for Main Criteria	Check to indicate the criteria listed are relevant (Yes) or not relevant (No)		Weighing Score (if "Yes")				
		Yes	No	1	3	5	7	9
Cargo claims - International convention ratification & limit of liability (IATA The air cargo tariff manual rules, October 2016)	Warsaw convention 1929 (USD 20.00/ Kg)	7	2			3	1	3
	Warsaw convention as amended by Hague protocol 1955 (USD 20.00/Kg)	7	2			3	1	3
	Warsaw convention as amended by Montreal protocol 1975 (USD 20.00/ Kg)	7	2			2	2	3
Customs operating hours (IATA The air cargo tariff manual rules, October 2016)	Weekdays (Business hours)	7	2			1		6
Cargo market competition	National versus foreign carriers (flight (%) operated by flag carriers)	7	2		1	4	2	
	Centrality (betweenness centrality of airports by area)	7	2	1	3	3		
Runway numbers and length (m)	No. of runways	7	2		4	2		1
Others	Airport serving country capital city	7	2	2	1	3	1	
Runway numbers and length (m)	3,800 m (unlimited operations cargo)	6	3	1	2	1	2	
	2,500 m (unlimited operations with medium-range jets e.g. B737, A320)	6	3		3	3		
Others	Airport ownership type (public, majority public, majority private, private)	6	3	1	3	1		1
Runway numbers and length (m)	1,800 m (minimum for medium-range jets)	4	5		3	1		
	1,100 m (minimum for scheduled operations with STOL-aircraft)	4	5	1	2	1		

Table 24: Second Round Questionnaire Results (continued)

Significant Criteria for Air Cargo Terminal Classification		Factor Loading
Cargo and Mail Service Readiness (IATA SGHA version 2013)	Transfer/transit cargo	0.857
	Physical handling outbound/inbound	0.856
	Cargo and mail handling – general	0.853
	Documentation handling	0.850
	Until load device (ULD) control	0.710
	Automation/computer systems	0.655
Cargo Claims - International Convention Ratification & Limit of Liability	Warsaw convention as amended by Hague protocol 1955 (250.00 francs or USD 20.00/Kg)	0.886
	Warsaw convention 1929 (250.00 francs or USD 20.00/ Kg)	0.885
	Warsaw convention as amended by Montreal protocol 1975 (SDR 17.00 or USD 20.00/ Kg)	0.873
Customs Operations	Operating hour - weekdays and weekends (Business hours)	0.833
	Operating hours - weekdays (Business hours)	0.731
	Customs clearance times (hours)	0.663

Significant Criteria for Air Cargo Terminal Classification		Factor Loading
E-Freight Implementation & Capability	Electronic import goods declaration	0.897
	Electronic export goods declaration	0.895
	Electronic export cargo declaration	0.891
	Electronic import cargo declaration	0.888
	Transshipment	0.764
	Transit freight remaining on board	0.730
	E-freight capability target status	0.681
E-Air waybill Implementation & Capability	Import cargo	0.903
	Export cargo	0.852
	Transit cargo	0.830
	Transshipment cargo	0.824
IATA Safety Audit for Ground Operations (ISAGO) Certification	Cargo security (facilities, operations)	0.843
	Cargo and mail acceptance and handling (general, dangerous goods, live animals and perishables, other special cargo, unit load devices)	0.797
Air Cargo Terminal Characteristics	Cargo terminal area (sq. m.)	0.851
	Total cargo throughput (metric tons) per annum	0.728
	Available tracking and tracing service	0.676
	Maximum connecting time (hours)	0.636
	Cargo commodities (IATA three letter codes)	0.622
	Cargo handling capacity (metric tons) per annum	0.612
Airport Facility and Potentiality	Airport ownership types (public, majority public, majority private, private)	0.796
	Runway length: 3,800 m	0.788
	Numbers of runways	0.780
	Airport operational time - available around the clock or with curfew	0.759
	Airport serving country capital city	0.671
	Runway length: 2,500 m	0.652
Factors Impact on Cargo Market Competition	Route and geographical distribution of airfreight (numbers of flights per week)	0.874
	International trade (export value)	0.820
	Flight frequency (weekly flight frequency of the selected airports)	0.779
	Centrality (betweenness centrality of airports by area)	0.759
	National versus foreign carriers (flight (%) operated by flag carriers)	0.753
	Size of local market (% of shipments locally generated)	0.669
	Freight forwarder presence	0.633

Table 25: Significant Criteria for Air Cargo Terminal Classification

3.6 Third Round Questionnaire Survey

After experts as validators verified on second round questionnaire, the third round questionnaire is designed for all air cargo terminal operators at BKK, CNX, DMK and HKT airports to fill out as presented in Appendix 5. The questions stipulated in third round questionnaire were in accordance to criteria in Table 25. In the questionnaire, there are two questions are common to all respondents to reply the same. One is on

question 9.5 for International trade from Thailand to other continents (export value in USD per annum in 2015 or 2016). As the locations of study were in Thailand, the researchers selected all airports in IATA area 3 listed in Top 40 airport rankings: International Cargo in 2015 (ACI, 2017) in Table 3. Then, Hong Kong, South Korea, China, Japan, Taiwan, Singapore, Malaysia, India and Vietnam were on the list and stipulated in question 9.5. The responses to this question 9.5 were retrieved from Ministry of Commerce, the Government of Thailand ("Trade Report," 2017) for all respondents. Moreover, question 9.6 for Centrality (betweenness centrality of airports in the locations of study) was calculated by the researcher as respondents would have been unable to find the figures. J. Wang, Mo, Wang, and Jin (2011) cited that Betweenness Centrality measured the degree to which a specific node lied between other nodes in a linkage. A node tended to be more powerful if it was on the shortest paths concerning many node-pairs as it would be in a location to intermediate networks between these pairs. Guimera, Mossa, Turtschi, and Amaral (2005) examined the global configuration of worldwide air transport network by Betweenness Centrality. Weighted Betweenness Centrality of connections and nodes was commonly investigated (Woolley-Meza et al., 2011). Fleming and Hayuth (1994) designated that locations were situated within the transportation systems. The between true origin-destination and connecting traffic were able to differentiate. Centrality in terms of Betweenness, that was, the degree that the actor was located on the shortest path between other pairs of actors in the network. Pajek was a public available analysis tool to compute Betweenness Centrality and used in researchers of Centrality (Brandes, 2001; Hou, Kretschmer, & Liu, 2007; Leydesdorff, 2007; Leydesdorff & Rafols, 2011). Then, Betweenness centrality of BKK, CNX and HKT airports were analyzed and computed in Pajek in Appendix 6 for the indices among 13 airports of Top 40 airport rankings: International Cargo in 2015 in Table 3 as the best practice airports in IATA area 3 in term of cargo tonnages. The 13 airports consisted of Hong Kong (HKG), Incheon (ICN), Shanghai Pudong (PVG), Narita (NRT), Taoyuan (TPE), Changi Singapore (SIN), Guangzhou Baiyun (CAN), Beijing Capital (BJS), Osaka Kansai (KIX), Kula Lumpur (KUL), Mumbai Chhatrapati Shivaji (BOM), Indira Gandhi New Delhi (DEL) and Hanoi Noi Bai international airports (HAN). International flight schedules to and from BKK, HKT and CNX airports were retrieved and found that

BKK airport had flights to all 13 airports at 0.05714 index while HKT and CNX airports at 0.00 index had not flights to Narita (NRT), Osaka Kansai (KIX), Mumbai Chhatrapati Shivaji (BOM), Indira Gandhi New Delhi (DEL) and Hanoi Noi Bai international airports (HAN) (Vorapojphaisan, 2017). HKT airport was directly not linked with Taoyuan airport also. The three transit points for numbers of direct flights among the 13 airports were leading by BKK, CNX and HKT airports respectively.

The questionnaire survey were sent out by e-mails and requesting for in-depth interviews with the operators one by one. There are 7 operators as the population in all participating airports. At BKK, HKT and CNX airports, there are two operators in each airport while monopoly air cargo terminal operator exists in DMK airport. E-mails with third round questionnaire were sent on 24th May 2017 to Thai Airways International (TG) for air cargo terminals at BKK, HKT and CNX airports, BAGS Ground Services for HKT and CNX airports and Bangkok Flight Services for BKK and DMK airports. Thai Airways International returned the questionnaire within two weeks for HKT, BKK and CNX airports back to the researcher respectively. On 11th June 2017, one reminder was e-mailed to BAGS Services and Bangkok Flight Services. A few days later, Bangkok Flight Services made a phone call and informed that they were uncomfortable to provide such data for BKK and DMK airports. BAGS Services provided filled questionnaires for HKT and CNX airports on 20th June 2017. However, some questions were not filled out completely. According to third round questionnaire, there was one notice of question number 7.3 for Total cargo throughput (metric tons) per annum (p.a.) that inbound and outbound cargo would have been separately indicated also. Therefore, on 21st June 2017, the researcher requested the participating operators to provide more figures including the missing information from BAGS Services. Thai Airways International provided inbound and outbound cargo tonnages for the three locations. Later on 11th July 2017, BAGS was reminded again on the missing information to complete the questionnaire and inbound and outbound cargo tonnages for HKT and CNX locations. Finally, all necessary information in Appendix 5 were completely received from the participating 5 operators from BKK, HKT and CNX airports on 20th July 2017. The data in air cargo terminals was very unique and specific in each local air cargo terminal operator. The operators did not publish their information in

the public area. In addition, the data was very difficult to find and valuable to the industry: even, all required data was not available all at once by IATA, ICAO, ACI, or even airport authorities, etc. who were well-known in the industry. Somehow, some information was considered as confidential. The personal connection and network was a tool to receive responses from air cargo terminal operators.

3.7 Cluster Analysis Technique

Cluster Analysis was selected as a tool to measure similarity for air cargo terminals in BKK, HKT and CNX international airports for air cargo terminal classifications. However, there were two well-known techniques used for classification namely Hierarchical Cluster Analysis and K-Means Cluster Analysis. In according to the techniques, Hierarchical Cluster Analysis was appropriate when numbers of cases less than 200 cases while more than 200 cases were suitable for K-Means Cluster Analysis. In addition, there was unnecessary to know any specific number of clusters or classifications in advance. Also, there was needless to know any variable or case was in any specific cluster or classification beforehand (Vanichbuncha, 2011). Both Hierarchical and K-Means Cluster Analysis used to cluster travelers and the results were with four clusters and five clusters respectively for segmentation of low-cost flights users at secondary airports (Martinez-Garcia & Royo-Vela, 2010; Wedel & Kamakura, 2012). Suau-Sanchez, Voltes-Dorta, and Rodríguez-Déniz (2015) applied Hierarchical Cluster Analysis which presented three-like diagram and provided more informative configuration than other Cluster Analysis such as K-Means. Classification and competition analysis of air cargo logistics providers: the case of Taiwan's high-technology industry was studied and used to classify groups of air cargo forwarders as following to a study of Myers and Mullet (2003). Adikariwattage, de Barros, Wirasinghe, and Ruwanpura (2012) classified 103 airports based on passengers and terminal size. Cluster Analysis has been applied to evaluate airports into groups in many studies (Burghouwta & Hakfoort, 2001; Madas & Zografos, 2008; Malighetti, Paleari, & Redondi, 2009; Sarkis & Talluri, 2004). Cluster Analysis was an appropriate method to differentiate types of into different groups in accordance to their similarity (Härdle & Simar, 2012; Rousava & Piermartini, 2008). There were many researchers applied Cluster Analysis technique to classify cases such as airports. Then, the

5 operators considered as 5 cases were less than 200 cases and Hierarchical Cluster Analysis was suitably analyzed to classify air cargo terminals at BKK, CNX and HKT airports for this research as priority method to classify the air cargo terminal operators. The literature reviews in Table 26 were for Cluster Analysis used in aviation sectors such as air cargo logistics providers, carriers and mostly for airports. This proved that Cluster Analysis technique was appropriate and practical for this research which was related to air cargo or aviation fields for air cargo terminal classification. The previous researches were mostly about airport classification based on passenger, cargo market, cargo characteristics, finance, performance and benchmarking, etc. The technique was used to examine deeply in each criteria and overall picture for air cargo terminals at BKK, CNX and HKT airports. The expected result was on each air cargo terminal classified into each classification and the researcher evaluated the current status of each criteria in Table 25 at each airport. Later, by comparing the results, the study was able to inform the present advantage and disadvantage of each air cargo terminal for any improvement and development. Then, Hierarchical Cluster analysis was suitable to cluster various criteria. Table 26 shows many researchers in air cargo filed had applied Cluster Analysis to their studies. The papers were similar to this research in terms of criteria analysis meaning the same intention to cluster could be applied to this research.

Table 26: Cluster Analysis Applied in Researches

Cluster Analysis			**Journals**
Authors	**Topics**	**Description**	
(Dewulf, 2014)	From Carpet Sellers to Cargo Star…A typology based on management strategies of air cargo carriers	The indicators and key performance indicators have been defined for the most significant key and supporting variables. The data which have been collected for the indicators and key performance indicators for a representative sample of 47 air cargo carriers. The following typology of strategy models was identified: the Carpet Sellers, the Basic Cargo Operators, the Strong Regionals, the Large Wide Body Operators, the Large Americans, the Premium Cargo Operators and the Cargo Stars.	4th National Urban Freight Conference, METRANS 2011, Department of Transport and Regional Economics

Cluster Analysis			Journals
Authors	**Topics**	**Description**	
(Wen et al., 2011)	Classification and competition analysis of air cargo logistics providers: The case of Taiwan's high-technology industry	This paper classifies air cargo logistics providers allowing analysis of high-technology manufacturers' choices of provider. Delivery is found to be the most important factor.	Journal of Air Transport Management
(Adikariwattage et al., 2012)	Airport classification criteria based on passenger characteristics and terminal size	This paper introduce classification criteria for airports that focus on the comparability of passenger terminal facilities. Cluster analysis is used as the technique to identify similar airport groups using passenger volumes as multiple variables.	Journal of Air Transport Management
(Mayer, 2016)	Airport classification based on cargo characteristics	114 airports are grouped according to their cargo business characteristics. Applying a hierarchical cluster analysis, eight distinct clusters are identified.	Journal of Transport Geography
(Wong et al., 2016)	Cargo market competition among Asia Pacific's major airports	13 primary airports in Asia Pacific were investigated. Clustering Analysis was performed to investigate the hierarchy of the selected airports	Journal of Air Transport Management
(Rousava & Piermartini, 2008)	Liberalization of air transport services and passenger traffic	Cluster analysis is a suitable tool to distinguish different types of agreements as groups (clusters) in according to their similarity. The impact of air services agreements were classified into 8 clusters.	World Trade Organization, Economic Research and Statistics Division
(Suau-Sanchez et al., 2015)	Regulatory airport classification in the US: The role of international markets	Clustering analysis is used to classify hub classification for allocating of public funding for capacity development.	Transport Policy
(Rodríguez-Déniz et al., 2013)	Classifying airports according to their hub dimensions: an application to the US domestic network	The alternative airport classification method was potential to improve the existing airport typology by separating traffic generation and connectivity as classification criteria.	Journal of Transport Geography
(Sarkis & Talluri, 2004)	Performance based clustering for benchmarking of US airports	Over the five years period, the total of 13 clusters were identified from 44 major airports in the US. The best performing airport in each of cluster were used by other airports for benchmarking for improvement.	Transportation Research Part A

Cluster Analysis			Journals
Authors	**Topics**	**Description**	
(Rodríguez-Déniz & Voltes-Dorta, 2014)	A frontier-based hierarchical clustering for airport efficiency benchmarking	17 distinct airport clusters were found and the factors of large aircraft type usage and the dominance of low cost carrier is important to improve cost performance to airport industry.	Benchmarking: An International Journal
(Vogel & Graham, 2013)	Devising airport grouping for financial benchmarking	73 airports were classified into 3 clusters comparing the same 9 key performance indicators between 2003 and 2010. The research found that cluster analysis was useful tool to group airports for performance comparison.	Journal of Air Transport Management

3.8 Third Round Questionnaire Results (Phase II: Research Question 2)

The questionnaire results from air cargo terminal operators as TG at BKK, CNX and HKT and BAGS at CNX and HKT showed variety of services, facilities and local market environments. The manual comparison was performed in according to an overall picture of 9 criteria and each criteria stipulated in Table 25. TG BKK presents to meet most of criteria whereas the rest of air cargo terminal operators are more or less equivalent in term of overall criteria. Nevertheless, TG and BAGS in HKT are considered as second row behind TG BKK. Table 27 demonstrates raw data collected from all 5 operators and prepared to input data into SPSS program for Hierarchical Cluster Analysis to classify each operator. In order to satisfy the maximum analysis, the author set the program to classify such 5 operators considered 5 cases into 2 to 4 clusters for further appropriate evaluation. However, one and five clusters were not applicable from the program as results have already presented itself without any methodology. Regrettably, raw data for criteria 2 was filled indifferently from 5 operators. This criteria 2 is applicable for nationwide considering an entire Thailand for one cluster. Other criteria are various from each operator. In order to have the same understanding of results from the technique in Table 28, the 5 operators are called cases as following details: Case 1: TG HKT, Case 2: TG BKK, Case 3: TG CNX, Case 4: BAGS CNX and Case 5: BAGS HKT.

Hierarchical Cluster Analysis was established to classify 2 – 4 clusters with Average Linkage Between Groups including Dendrogram as the cluster method. The technique is to identify relatively homogeneous groups of air cargo terminal operators based on

criteria. In addition, units of all criteria are dissimilar and need to standardize all data from 5 operators. The researcher also changed all criteria to z-scores to regulate equal metrics and weighting. All data was constructed into Ms. Excel format and transferred into SPSS program to start clustering 5 air cargo terminals. Then, the outputs are differentiated by 10 scenarios from overall of 9 criteria to each one from criteria 1 to criteria 9. According to Table 28, air cargo terminals are classified into 2 - 4 clusters regarding to raw data from Table 27 of all 9 criteria, criteria 1, criteria 2, criteria 3, criteria 4, criteria 5, criteria 6, criteria 7, criteria 8 and criteria 9 respectively. The output for 10 times of Hierarchical Cluster Analysis is generated and each experiment produces 4 related results in Table 28.

No.	Criteria	TG HKT	TG BKK	TG CNX	BAGS CNX	BAGS HKT
1	Cargo and mail handling – general	1.00	1.00	1.00	1.00	1.00
	Documentation handling	1.00	1.00	1.00	1.00	1.00
	Physical handling outbound/inbound	1.00	1.00	1.00	1.00	1.00
	Transfer/transit cargo	1.00	1.00	1.00	0.00	1.00
	Automation/computer systems	1.00	1.00	1.00	0.00	1.00
	Until load device (ULD) control	0.00	1.00	0.00	0.00	1.00
2	Warsaw convention 1929 (USD 20.00/ Kg)	0.00	0.00	0.00	0.00	0.00
	Warsaw convention as amended by Hague protocol 1955 (USD 20.00/Kg)	0.00	0.00	0.00	0.00	0.00
	Warsaw convention as amended by Montreal protocol 1975 (USD 20.00/ Kg)	0.00	0.00	0.00	0.00	0.00
3	Customs operations-Weekdays (Business hours)	0.00	0.00	0.00	0.00	0.00
	Customs operations-Weekdays and weekends (Business hours)	1.00	1.00	1.00	1.00	1.00
	Customs clearance times (hours)	3.00	2.00	2.00	1.00	2.00
4	E-freight capability target status	0.00	0.00	0.00	0.00	1.00
	E-freight export goods declaration	0.00	1.00	0.00	0.00	1.00
	E-freight export cargo declaration	0.00	1.00	0.00	0.00	1.00
	E-freight import goods declaration	0.00	1.00	0.00	0.00	1.00
	E-freight import cargo declaration	0.00	1.00	0.00	0.00	1.00
	E-freight transit freight remaining on board	0.00	0.00	0.00	0.00	0.00
	E-freight transhipment	0.00	0.00	0.00	0.00	1.00
5	E-Air waybill-Import.cargo	0.00	1.00	0.00	1.00	0.00
	E-Air waybill-Export.cargo	0.00	1.00	0.00	1.00	0.00
	E-Air waybill-Transit.cargo	0.00	0.00	0.00	0.00	0.00
	E-Air waybill-Transhipment.cargo	0.00	0.00	0.00	0.00	0.00
6	ISAGO-Cargo and mail acceptance and handling	0.00	0.00	0.00	1.00	1.00
	ISAGO-Cargo security	0.00	0.00	0.00	1.00	1.00

Table 27: Raw Data for Third Round Questionnaire from the 5 Air Cargo Terminal Operators

No.	Criteria	TG HKT	TG BKK	TG CNX	BAGS CNX	BAGS HKT
7	Cargo terminal area (sq.m.)	1781.00	90000.00	2000.00	275.00	700.00
	Capacity (metric tonnes) per annum	20000.00	1250000.00	20000.00	1000.00	13200.00
	Total cargo throughput (metric tonnes) per annum	39000.00	927000.00	23000.00	1000.00	7000.00
	Cargo commodities (Three letter codes) (tons)					
	PER (Perishable cargo)	780.00	278100.00	7590.00	500.00	210.00
	GEN (General cargo)	19773.00	458865.00	14950.00	450.00	6090.00
	DGR (Dangerous goods)	0.00	64890.00	0.00	0.00	0.00
	PIL (Pharmaceuticals)	0.00	7416.00	0.00	0.00	0.00
	VAL (Valuable cargo)	39.00	927.00	0.00	0.00	0.00
	AVI (Live animal)	78.00	0.00	115.00	0.00	70.00
	XPS (Priority cargo)	0.00	92700.00	0.00	0.00	0.00
	COL (Cool goods)	195.00	0.00	115.00	0.00	0.00
	HUM (Human Remain in coffins)	39.00	0.00	23.00	0.00	0.00
	VUN (Vulnerable cargo)	39.00	3708.00	23.00	0.00	0.00
	PES (Fish/Seafood)	117.00	0.00	69.00	0.00	0.00
	MAL (Mail)	0.00	20857.50	0.00	0.00	0.00
	BIG (Oversized cargo)	0.00	0.00	0.00	0.00	0.00
	EAT (Food stuff)	0.00	0.00	0.00	40.00	70.00
	HEA (Heavy cargo, 150 kg and over per piece)	0.00	0.00	0.00	0.00	70.00
	BUP (Shipper/consignee handled unit)	0.00	0.00	0.00	0.00	140.00
	CRT (Cool room: +15 C to +25 C)	0.00	0.00	0.00	0.00	70.00
	PEM (Meat)	0.00	0.00	0.00	0.00	0.00
	FRO (Frozen goods)	0.00	0.00	0.00	0.00	70.00
	Transit cargo	17940.00	0.00	23.00	0.00	6860.00
	Free trade zone shipment	0.00	0.00	0.00	10.00	0.00
	Maximum.connecting.time (hours)	24.00	3.00	4.00	2.00	6.00
	Available tracking and tracing service*	1.00	1.00	1.00	0.00	1.00
8	Airport ownership type (public, majority public, majority private, private)	2.00	2.00	2.00	2.00	2.00
	No. of runways	1.00	2.00	1.00	1.00	1.00
	Runway 3,800.m*	0.00	0.00	0.00	0.00	0.00
	Runway 2,500.m*	0.00	0.00	0.00	0.00	0.00
	Runway length (m)	3000.00	4000.00	3400.00	3400.00	3000.00
	Airport operational time (around the clock)*	1.00	1.00	0.00	0.00	1.00
	Airport serving country capital city*	0.00	1.00	0.00	0.00	0.00
9	Weekly flight frequency of your customer airlines (numbers of flights per week)					
	Weekly flight frequency-Freighter cargo carriers	0.00	51.00	0.00	0.00	0.00
	Weekly flight frequency-Conventional carriers	540.00	3099.00	294.00	37.00	185.00
	Route and geographical distribution of airfreight (numbers of flights)					
	Route and geographical distribution-IATA Area 1	0.00	0.00	0.00	0.00	0.00
	Route and geographical distribution-IATA Area 2	120.00	290.00	0.00	0.00	8.00
	Route and geographical distribution-IATA Area 3	420.00	2860.00	294.00	0.74	7.00
	Numbers of flights per week-National carriers	178.20	1291.50	117.60	36.26	64.75
	Numbers of flights per week-Foreign carriers	361.80	1858.50	176.40	0.74	138.75
	Annual cargo througput-National carriers (tons)	28470.00	537660.00	19550.00	990.00	6650.00
	Annual cargo througput-Foreign carriers (tons)	10530.00	389340.00	3450.00	10.00	1050.00
	Size of local market (% of shipments locally generated)					
	Size of local market (%)-Inbound cargo (tons)	13640.00	117045.00	1400.00	180.00	2100.00
	Size of local market (%)-Outbound cargo (tons)	6460.00	157920.00	12800.00	280.00	1400.00
	International trade from Thailand (export value-Mil. USD per annum in 2016)					
	International trade to Hong Kong	11471.60	11471.60	11471.60	11471.60	11471.60
	International trade to South Korea	4074.00	4074.00	4074.00	4074.00	4074.00
	International trade to China	23799.60	23799.60	23799.60	23799.60	23799.60
	International trade to Japan	20481.10	20481.10	20481.10	20481.10	20481.10
	International trade to Taiwan	3374.20	3374.20	3374.20	3374.20	3374.20
	International trade to Singapore	8226.50	8226.50	8226.50	8226.50	8226.50
	International trade to Malaysia	9627.30	9627.30	9627.30	9627.30	9627.30
	International trade to India	5155.20	5155.20	5155.20	5155.20	5155.20
	International trade to Vietnam	9427.20	9427.20	9427.20	9427.20	9427.20
	Major air cargo logistics service providers presence around the airport*	1.00	1.00	1.00	1.00	1.00
	Betweenness centrality index	0.00	0.05714	0.00	0.00	0.00

Remark: Replies on question number 1 - 6 and * mark are for applicable = 1 and not applicable = 0.

Table 27: Raw Data for Third Round Questionnaire from the 5 Air Cargo Terminal Operators (continued)

Table 28: Output from Hierarchical Cluster Analysis for 2 – 4 Clusters (Classifications) from All 9 Criteria and Each Criteria (Vanichbuncha, 2011)

All 9 criteria:

Proximity Matrix					
Case	Squared Euclidean Distance				
	1:Case 1	2:Case 2	3:Case 3	4:Case 4	5:Case 5
1:Case 1 (TG HKT)	0.000	169.027	20.297	76.365	81.456
2:Case 2 (TG BKK)	169.027	0.000	157.200	177.062	178.869
3:Case 3 (TG CNX)	20.297	157.200	0.000	47.233	69.086
4:Case 4 (BAGS CNX)	76.365	177.062	47.233	0.000	83.403
5:Case 5 (BAGS HKT)	81.456	178.869	69.086	83.403	0.000

Proximity Matrix table represents Squared Euclidean Distance of all criteria between cases or operators. The close distance among cases shall be considered put in the same cluster. In Table 28 for all 9 criteria, the distance between TG HKT and TG CNX is 20.297 comparing to TG BKK with 169.027, BAGS CNX with 76.365 and BAGS HKT with 81.456. Then, conditions from 9 criteria for TG HKT are the most similar to TG CNX and these two operators should be in the same cluster while TG BKK is not close to any operator with distances of 157.200 for TG CNX, 177.062 for BAGS CNX and 178.869 for BAGS HKT. This means that TG BKK solely stands alone at its own cluster and far away from the others. TG CNX is closet to TG HKT of course and also closes to BAGS CNX with 47.233 and BAGS HKT with 69.086 distances.

Agglomeration Schedule						
Stage	Cluster Combined		Coefficients	Stage Cluster First Appears		Next Stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	1	3	20.297	0	0	2
2	1	4	61.799	1	0	3
3	1	5	77.982	2	0	4
4	1	2	170.540	3	0	0

Cluster Membership			
Case	4 Clusters	3 Clusters	2 Clusters
1:Case 1 (TG HKT)	1	1	1
2:Case 2 (TG BKK)	2	2	2
3:Case 3 (TG CNX)	1	1	1
4:Case 4 (BAGS CNX)	3	1	1
5:Case 5 (BAGS HKT)	4	3	1

Tables of Agglomeration Schedule and Cluster Membership display how 5 operators are classified into 4 clusters, 3 clusters and 2 clusters. TG BKK is stabilized in cluster number 2 while other operators are classified into different clusters. This examination is aimed into three extreme set up by classifying into 2 clusters, 3 clusters and 4 clusters respectively. The output of the three scenario are follows:

In case of 2 Clusters:

Cluster number 1: TG HKT, TG CNX, BAGS CNX and BAGS HKT

Cluster number 2: TG BKK

In case of 3 Clusters:

Cluster number 1: TG HKT, TG CNX and BAGS CNX

Cluster number 2: TG BKK

Cluster number 3: BAGS HKT

In case of 4 Clusters:

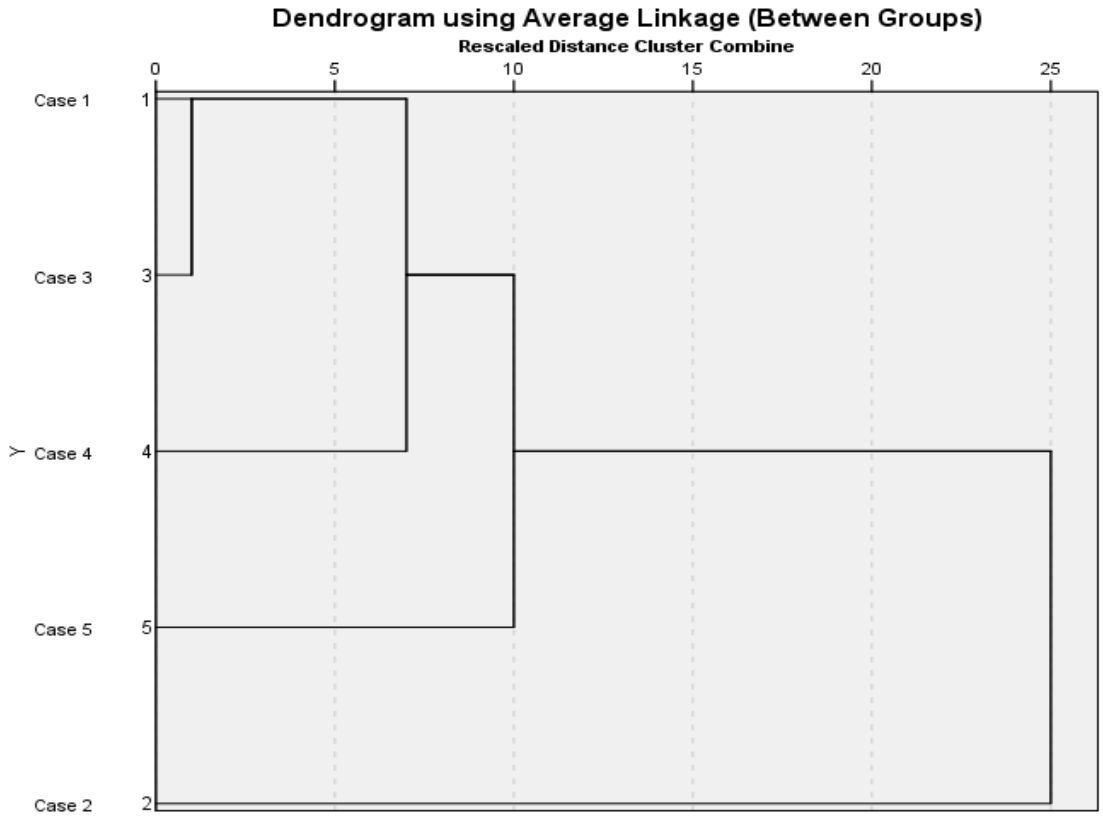
Cluster number 1: TG HKT and TG CNX

Cluster number 2: TG BKK

Cluster number 3: BAGS CNX

Cluster number 4: BAGS HKT

This classification is based on all 9 criteria (44 sub-criteria) as an overall picture.



Dendrogram displays the scale indicate the distance of clusters are joined. The observed distances are with 0 – 25 range. The ratio of the rescaled distances at 5 computes cases into 4 clusters, 10 computes cases into 3 clusters and 15 computes cases into 2 clusters. This Dendrogram of similarity from cases is alike Agglomeration Schedule to present how cases are gradually combined step by step. The judgement is based on an individual judgment. There is no absolute solution from the program to identify any final numbers of clusters.

From this point, the researcher has not decided on numbers of clusters. However, the two clusters eminently demonstrate that TG BKK is purely in one cluster while the other 4 operators are in the other cluster. In reality, BKK airport is the cargo hub of Thailand and the world ranked number 15 in Table 3. This proves that the 2 clusters are correct that TG BKK cargo terminal is the best among 5 operators. For 3 and 4 clusters are on hold for next investigation on clustering criteria 1 to 9 individually prior any judgement of cluster amount.

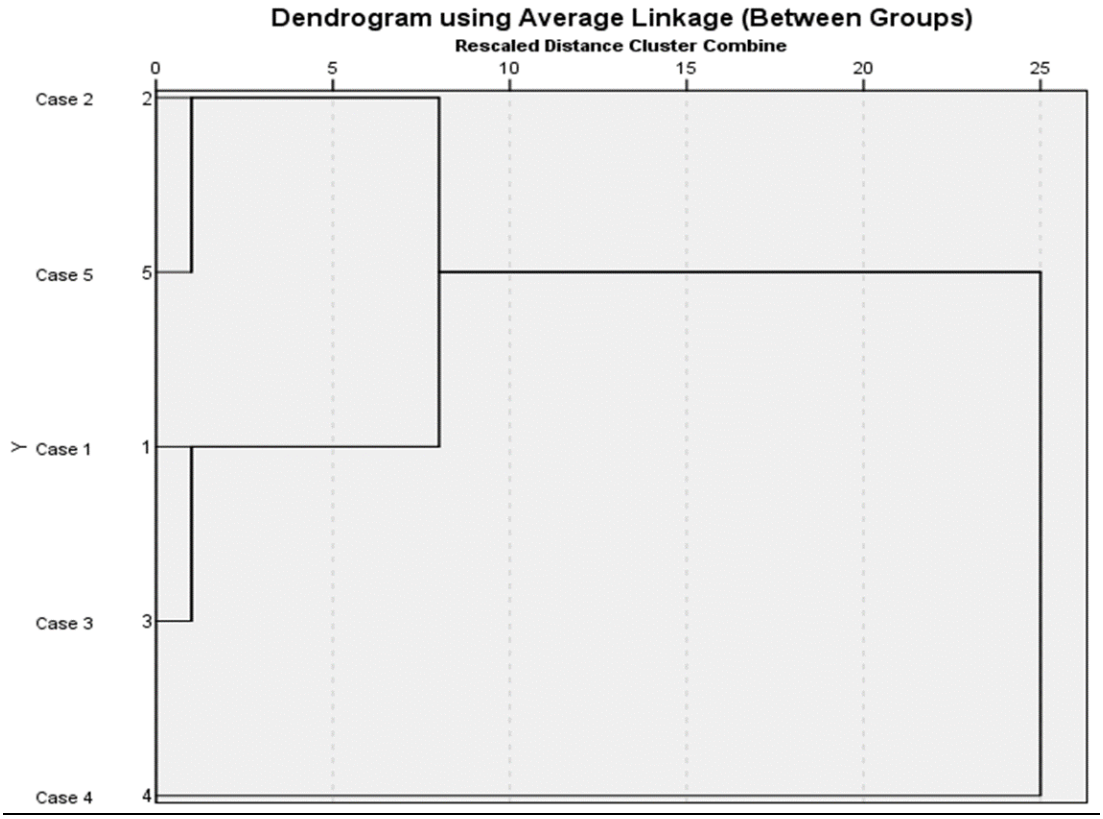
Criteria 1: Cargo and Mail Service Readiness (IATA SGHA version 2013)

Proximity Matrix					
Case	Squared Euclidean Distance				
	1:Case 1	2:Case 2	3:Case 3	4:Case 4	5:Case 5
1:Case 1 (TG HKT)	0.000	3.333	0.000	10.000	3.333
2:Case 2 (TG BKK)	3.333	0.000	3.333	13.333	0.000
3:Case 3 (TG CNX)	0.000	3.333	0.000	10.000	3.333
4:Case 4 (BAGS CNX)	10.000	13.333	10.000	0.000	13.333
5:Case 5 (BAGS HKT)	3.333	0.000	3.333	13.333	0.000

Apart from clusters computed by the program, to specify into details of each criteria, this study also produces clusters in criteria 1 to 9 separately. All 5 operators are clustered individually in criteria 1 of cargo and mail service readiness. From the Squared Euclidean distance between pairs, TG HKT and TG CNX with the smallest difference among three operators are 0.000 whereas TG BKK and BAGS HKT distance is 0.000. BAGS CNX is close to TG HKT with the distance of 10.00 considering to be in one separated cluster. This is to confirm by the raw data in Table 27. TG HKT and TG CNX are similarly able to perform services listed in criteria 1. TG BKK and BAGS HKT are in the same conditions. BAGS CNX offers to provide only 3 of 6 services as the lowest available service. Actually, classification of three clusters for criteria 1 is obviously appropriate to judge the number of clusters based on raw data provided by 5 operators. Agglomeration Schedule, Cluster Membership and Dendrogram supports on cases joined to clusters.

Agglomeration Schedule						
Stage	Cluster Combined		Coefficients	Stage Cluster First Appears		Next Stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	2	5	0.000	0	0	3
2	1	3	0.000	0	0	3
3	1	2	3.333	2	1	4
4	1	4	11.667	3	0	0

Cluster Membership			
Case	4 Clusters	3 Clusters	2 Clusters
1:Case 1 (TG HKT)	1	1	1
2:Case 2 (TG BKK)	2	2	1
3:Case 3 (TG CNX)	3	1	1
4:Case 4 (BAGS CNX)	4	3	2
5:Case 5 (BAGS HKT)	2	2	1

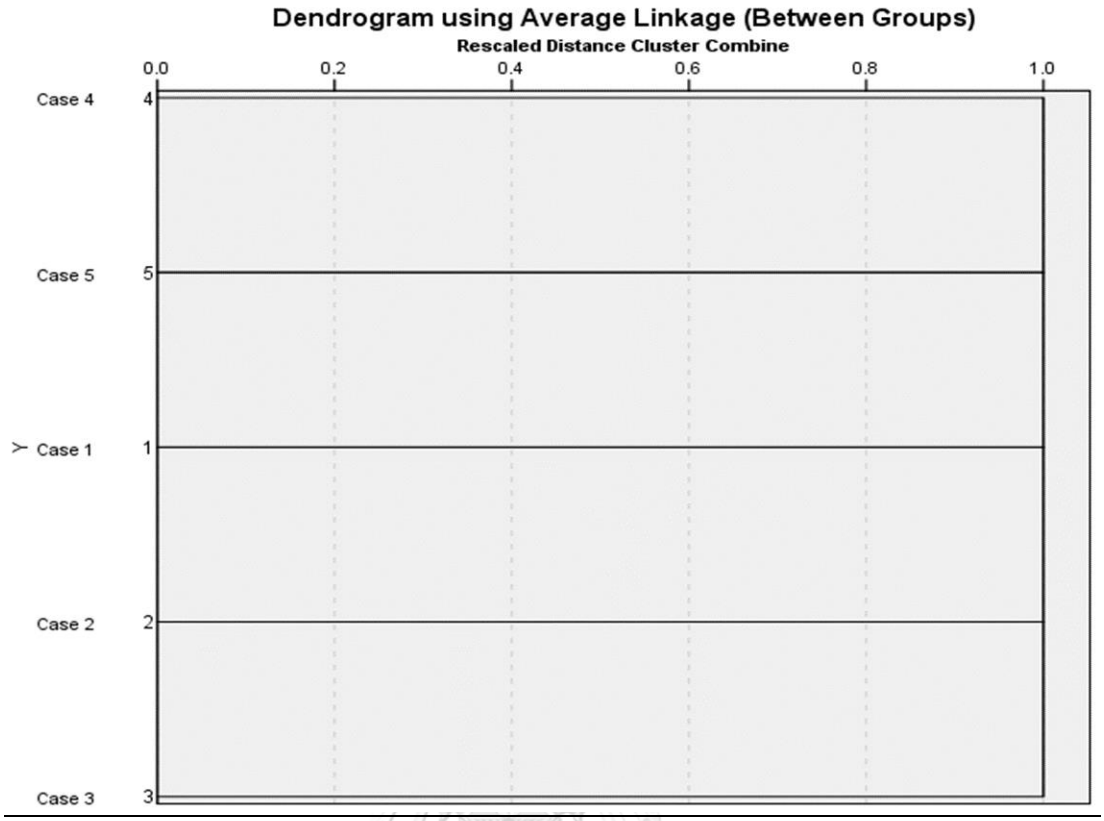


Criteria 2: Cargo Claims – International Convention Ratification & Limit of Liability

Proximity Matrix					
Case	Squared Euclidean Distance				
	1:Case 1	2:Case 2	3:Case 3	4:Case 4	5:Case 5
1:Case 1 (TG HKT)	0.000	0.000	0.000	0.000	0.000
2:Case 2 (TG BKK)	0.000	0.000	0.000	0.000	0.000
3:Case 3 (TG CNX)	0.000	0.000	0.000	0.000	0.000
4:Case 4 (BAGS CNX)	0.000	0.000	0.000	0.000	0.000
5:Case 5 (BAGS HKT)	0.000	0.000	0.000	0.000	0.000

Agglomeration Schedule						
Stage	Cluster Combined		Coefficients	Stage Cluster First Appears		Next Stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	4	5	0.000	0	0	2
2	1	4	0.000	0	1	4
3	2	3	0.000	0	0	4
4	1	2	0.000	2	3	0

Cluster Membership			
Case	4 Clusters	3 Clusters	2 Clusters
1:Case 1 (TG HKT)	1	1	1
2:Case 2 (TG BKK)	2	2	2
3:Case 3 (TG CNX)	3	3	2
4:Case 4 (BAGS CNX)	4	1	1
5:Case 5 (BAGS HKT)	4	1	1



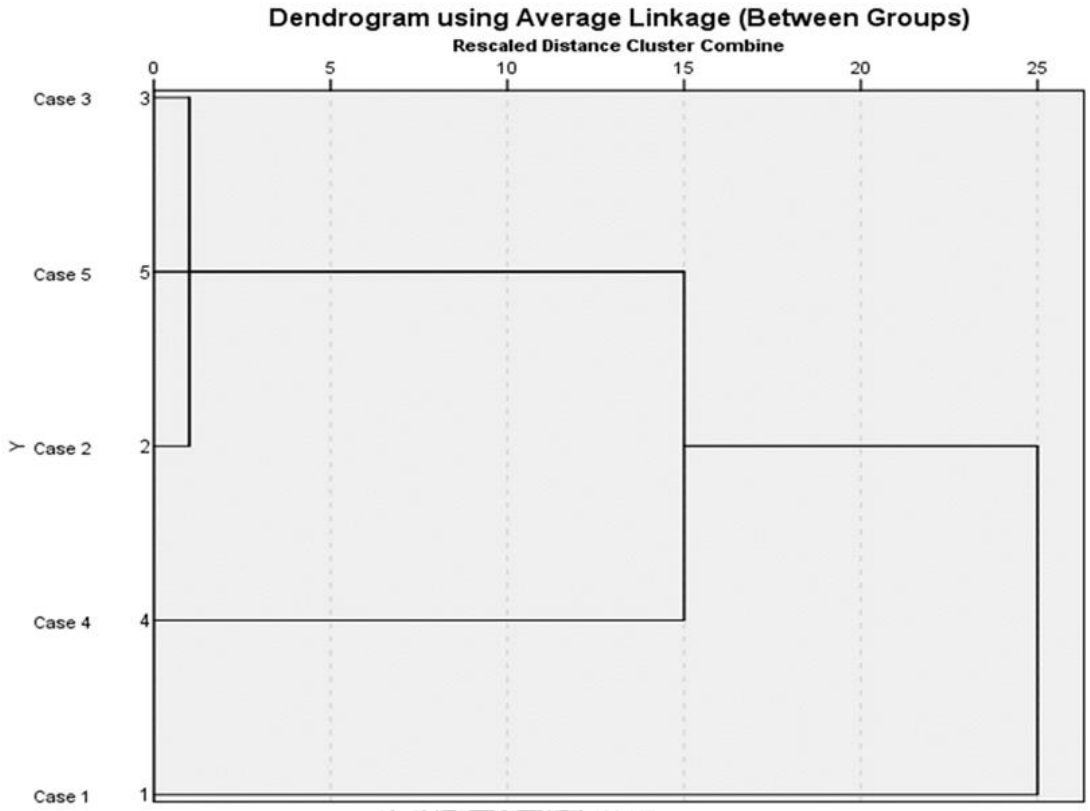
The clustering of criteria 2 is systematically set to 2 – 4 clusters in a regard of all 9 criteria and individual criteria 1 to 9. The program prescribes output to provide 2 – 4 clusters. Nonetheless, there shall be only one cluster as a whole nation of Thailand has not ratified any of the international convention covering the limit of liability of the carrier for air cargo carriage. Squared Euclidean Distance shows the smallest difference of 0.000 for all pairs. Therefore, all 5 operators fill “not applicable or 0” to all articles. However, this criteria 2 from Phase I: Research Question 1 is objective for any air cargo operators anywhere in the world not for only Thailand. In case of any party who would apply the 9 criteria to assessment air cargo terminal operators from different countries. This criteria will enable researchers or users to differentiate and cluster operators significantly.

Criteria 3: Customs Operations

Proximity Matrix					
Case	Squared Euclidean Distance				
	1:Case 1	2:Case 2	3:Case 3	4:Case 4	5:Case 5
1:Case 1 (TG HKT)	0.000	2.000	2.000	8.000	2.000
2:Case 2 (TG BKK)	2.000	0.000	0.000	2.000	0.000
3:Case 3 (TG CNX)	2.000	0.000	0.000	2.000	0.000
4:Case 4 (BAGS CNX)	8.000	2.000	2.000	0.000	2.000
5:Case 5 (BAGS HKT)	2.000	0.000	0.000	2.000	0.000

Agglomeration Schedule						
Stage	Cluster Combined		Coefficients	Stage Cluster First Appears		Next Stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	3	5	0.000	0	0	2
2	2	3	0.000	0	1	3
3	2	4	2.000	2	0	4
4	1	2	3.500	0	3	0

Cluster Membership			
Case	4 Clusters	3 Clusters	2 Clusters
1:Case 1 (TG HKT)	1	1	1
2:Case 2 (TG BKK)	2	2	2
3:Case 3 (TG CNX)	3	2	2
4:Case 4 (BAGS CNX)	4	3	2
5:Case 5 (BAGS HKT)	3	2	2



Criteria 3 is concentrated on Customs operations in BKK, CNX and HKT airports. The answers from 5 operators are different in the same airport. However, the researcher is honored the operators for provided information and compute 2 – 4 clusters into the program. The system generates all clusters as set by the researcher. Simply looking at Cluster Membership table, the output of the three scenario are follows:

In case of 2 Clusters:

Cluster number 1: TG HKT

Cluster number 2: TG BKK, TG CNX, BAGS CNX and BAGS HKT

In case of 3 Clusters:

Cluster number 1: TG HKT

Cluster number 2: TG BKK, TG CNX and BAGS HKT

Cluster number 3: BAGS CNX

In case of 4 Clusters:

Cluster number 1: TG HKT

Cluster number 2: TG BKK

Cluster number 3: TG CNX and BAGS HKT

Cluster number 4: BAGS CNX

By Cluster Membership table, there is not clear statement that how many clusters should be selective from the researcher. Then, Squared Euclidean Distance and raw data are at attention again to cross check. The result shows that TG HKT and BAGS CNX stand-alone separately and TG BKK, TG CNX, BAGS HKT are in the same cluster apart from the first two operators. In this analysis, three clusters are suitable to criteria 3 rather than two or four clusters.

Criteria 4: E-Freight Implementation & Capability

Proximity Matrix

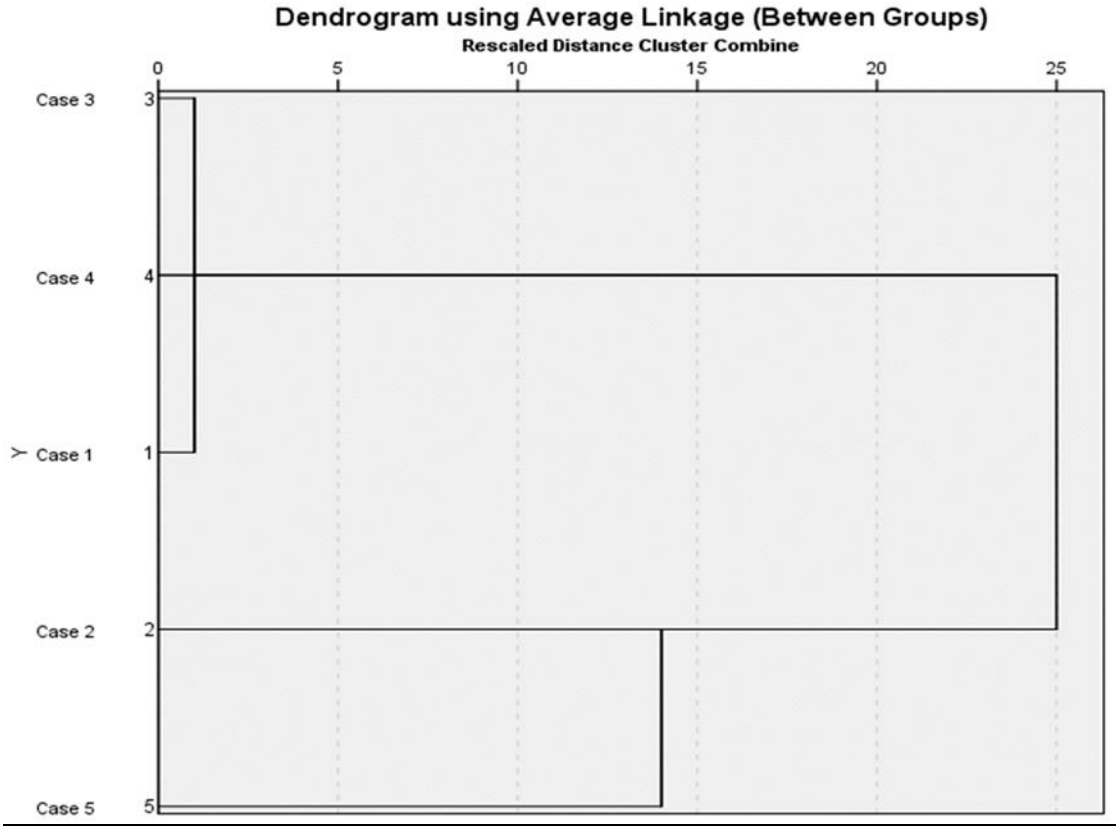
Case	Squared Euclidean Distance				
	1:Case 1	2:Case 2	3:Case 3	4:Case 4	5:Case 5
1:Case 1 (TG HKT)	0.000	13.333	0.000	0.000	23.333
2:Case 2 (TG BKK)	13.333	0.000	13.333	13.333	10.000
3:Case 3 (TG CNX)	0.000	13.333	0.000	0.000	23.333
4:Case 4 (BAGS CNX)	0.000	13.333	0.000	0.000	23.333
5:Case 5 (BAGS HKT)	23.333	10.000	23.333	23.333	0.000

Agglomeration Schedule

Stage	Cluster Combined		Coefficients	Stage Cluster First Appears		Next Stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	3	4	0.000	0	0	2
2	1	3	0.000	0	1	4
3	2	5	10.000	0	0	4
4	1	2	18.333	2	3	0

From lessen and learn from criteria 1 and 3, to shorten the judgement process of numbers of clusters for criteria 4, the researcher looks at Squared Euclidean Distance and raw data from 5 operators. Three clusters from Cluster Membership table is the best for clustering criteria 4 as a result of TG HKT, TG CNX and BAGS CNX are in the same cluster and then TG BKK and BAGS HKT in separated clusters respectively.

Cluster Membership			
Case	4 Clusters	3 Clusters	2 Clusters
1:Case 1 (TG HKT)	1	1	1
2:Case 2 (TG BKK)	2	2	2
3:Case 3 (TG CNX)	3	1	1
4:Case 4 (BAGS CNX)	3	1	1
5:Case 5 (BAGS HKT)	4	3	2



Criteria 5: E-Air waybill Implementation & Capability

The process of clustering criteria 5 is applied the same as criteria 1, 3 and 4. Squared Euclidean Distance and raw data in Table 27 are handful to the research to judge how many clusters is the fitting one. However, in criteria 5 is a bit different as there are only two clusters. TG HKT, TG CNX and BAGS HKT are in one cluster while TG BKK and BAGS CNX are in another cluster. The first cluster is not applicable for E-Air waybill implementation and capability. TG BKK and BAGS CNX apply only 50% of E-Air waybill service of only import and export cargo to airlines. In reality, this criteria 5 is for two clusters. Moreover, the system computes three and four clusters systematically configured by the researcher.

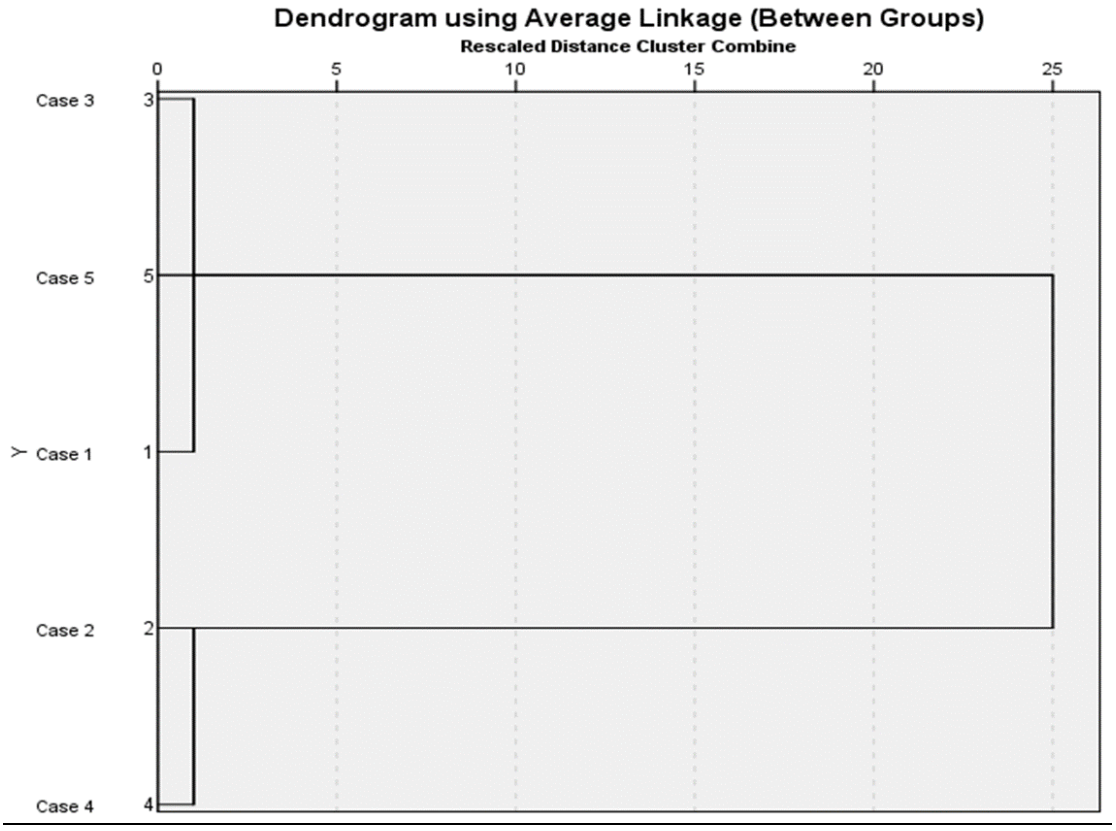
Proximity Matrix

Case	Squared Euclidean Distance				
	1:Case 1	2:Case 2	3:Case 3	4:Case 4	5:Case 5
1:Case 1 (TG HKT)	0.000	6.667	0.000	6.667	0.000
2:Case 2 (TG BKK)	6.667	0.000	6.667	0.000	6.667
3:Case 3 (TG CNX)	0.000	6.667	0.000	6.667	0.000
4:Case 4 (BAGS CNX)	6.667	0.000	6.667	0.000	6.667
5:Case 5 (BAGS HKT)	0.000	6.667	0.000	6.667	0.000

Agglomeration Schedule

Stage	Cluster Combined		Coefficients	Stage Cluster First Appears		Next Stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	3	5	0.000	0	0	3
2	2	4	0.000	0	0	4
3	1	3	0.000	0	1	4
4	1	2	6.667	3	2	0

Cluster Membership			
Case	4 Clusters	3 Clusters	2 Clusters
1:Case 1 (TG HKT)	1	1	1
2:Case 2 (TG BKK)	2	2	2
3:Case 3 (TG CNX)	3	3	1
4:Case 4 (BAGS CNX)	4	2	2
5:Case 5 (BAGS HKT)	3	3	1



Criteria 6: IATA Safety Audit for Ground Operations (ISAGO) Certification

Criteria 6 is simply classified by two clusters in the same method of criteria 5. BAGS CNX and BAGS HKT are available for IATA Safety Audit for ground operation certification of cargo security (facilities, operations) and cargo and mail acceptance and handling (general, dangerous goods, live animals and perishables, other special cargo, unit load devices). The 2 operators pass IATA ISAGO audit. TG CNX, TG BKK and

TG HKT have not had any certificate from IATA. This criteria 6 is prominently demonstrated that two clusters are for clearer interpretation.

There is a recall of clustering all 9 criteria together that two clusters are obvious to present TG BKK separately from the other 4 operators. Criteria 5 and 6 with conditions support the clear result of all 9 criteria clustering for two clusters. There are also three more criteria to evaluate the right amount of clusters for all 9 criteria and individual criteria 1 to 9.

Proximity Matrix

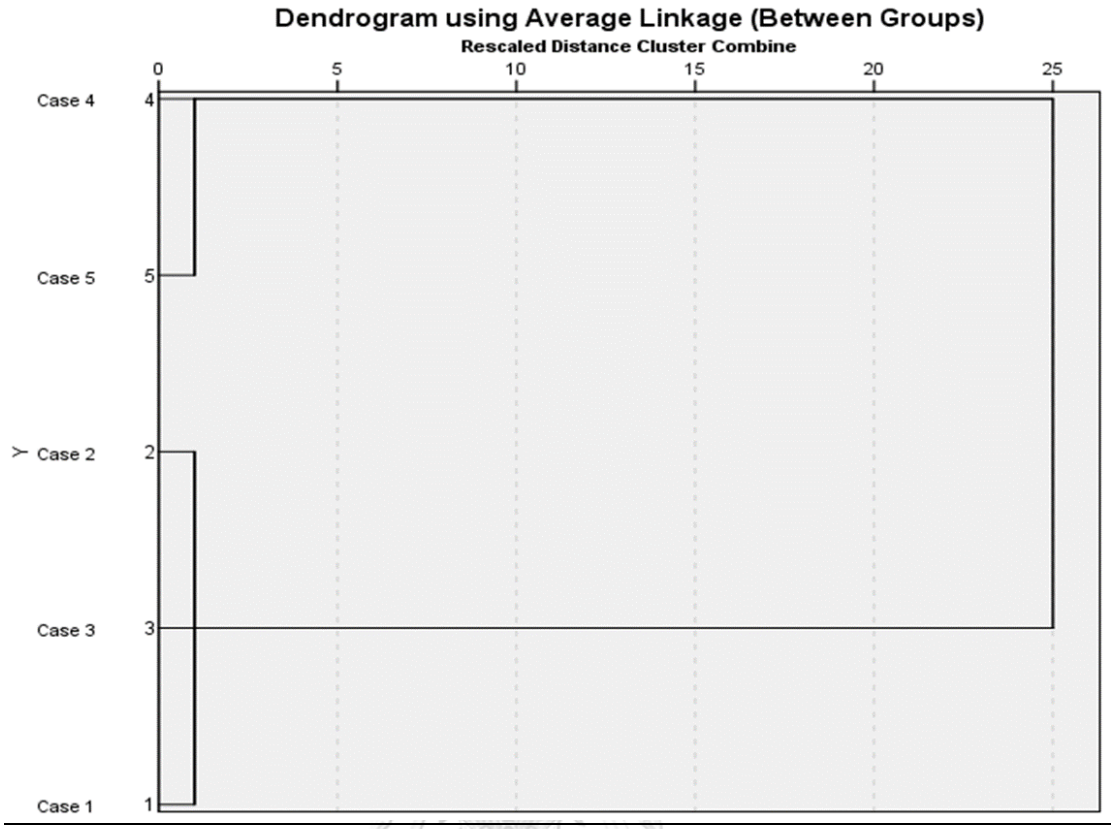
Case	Squared Euclidean Distance				
	1:Case 1	2:Case 2	3:Case 3	4:Case 4	5:Case 5
1:Case 1 (TG HKT)	0.000	0.000	0.000	6.667	6.667
2:Case 2 (TG BKK)	0.000	0.000	0.000	6.667	6.667
3:Case 3 (TG CNX)	0.000	0.000	0.000	6.667	6.667
4:Case 4 (BAGS CNX)	6.667	6.667	6.667	0.000	0.000
5:Case 5 (BAGS HKT)	6.667	6.667	6.667	0.000	0.000

Agglomeration Schedule

Stage	Cluster Combined		Coefficients	Stage Cluster First Appears		Next Stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	4	5	0.000	0	0	4
2	2	3	0.000	0	0	3
3	1	2	0.000	0	2	4
4	1	4	6.667	3	1	0

Cluster Membership

Case	4 Clusters	3 Clusters	2 Clusters
1:Case 1 (TG HKT)	1	1	1
2:Case 2 (TG BKK)	2	2	1
3:Case 3 (TG CNX)	3	2	1
4:Case 4 (BAGS CNX)	4	3	2
5:Case 5 (BAGS HKT)	4	3	2

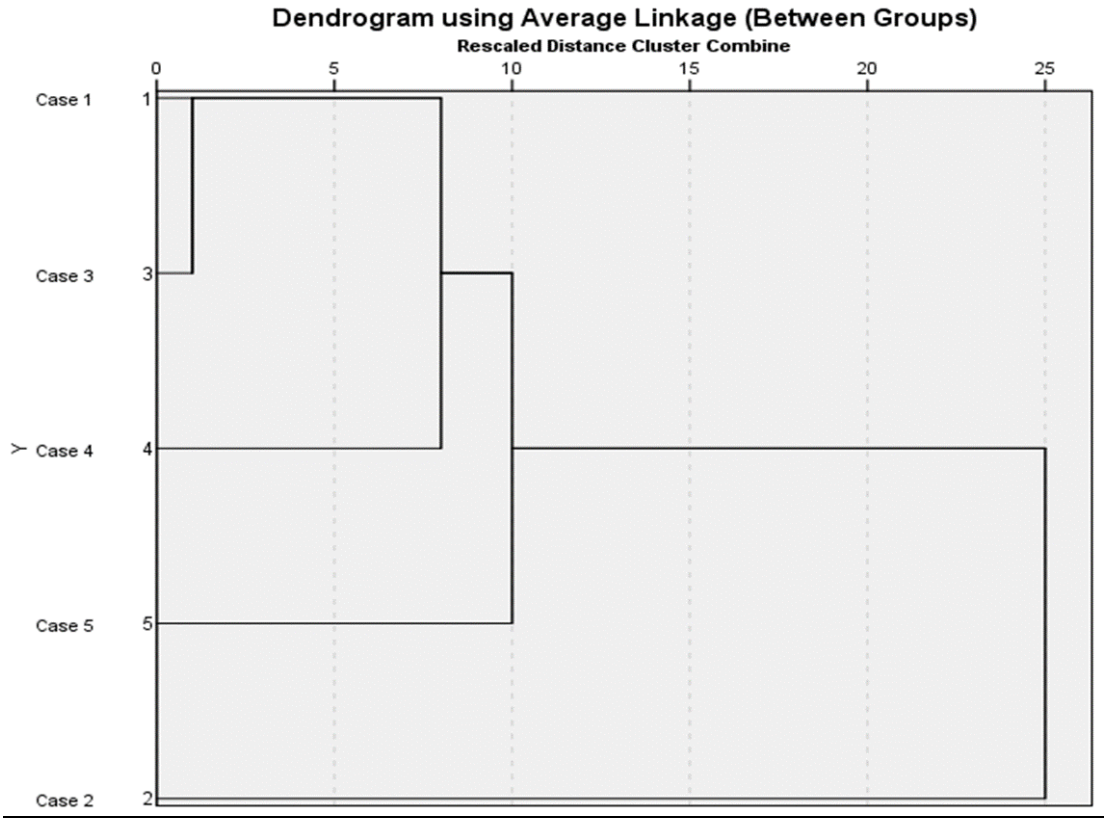


Criteria 7: Air Cargo Terminal Characteristics

Proximity Matrix					
Case	Squared Euclidean Distance				
	1:Case 1	2:Case 2	3:Case 3	4:Case 4	5:Case 5
1:Case 1 (TG HKT)	0.000	81.159	12.917	39.179	44.943
2:Case 2 (TG BKK)	81.159	0.000	64.627	67.376	83.030
3:Case 3 (TG CNX)	12.917	64.627	0.000	21.684	31.356
4:Case 4 (BAGS CNX)	39.179	67.376	21.684	0.000	33.729
5:Case 5 (BAGS HKT)	44.943	83.030	31.356	33.729	0.000

Agglomeration Schedule						
Stage	Cluster Combined		Coefficients	Stage Cluster First Appears		Next Stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	1	3	12.917	0	0	2
2	1	4	30.432	1	0	3
3	1	5	36.676	2	0	4
4	1	2	74.048	3	0	0

Cluster Membership			
Case	4 Clusters	3 Clusters	2 Clusters
1:Case 1 (TG HKT)	1	1	1
2:Case 2 (TG BKK)	2	2	2
3:Case 3 (TG CNX)	1	1	1
4:Case 4 (BAGS CNX)	3	1	1
5:Case 5 (BAGS HKT)	4	3	1



Criteria 7 for cargo terminal area, handling capacity, total cargo throughput per annum and cargo commodities is different and slightly difficult to judge on numbers of clusters due to none of 5 operators are exactly the same provided raw data and Squared Euclidean Distance. TG HKT and TG CNX are with the smallest difference of 12.917 rescaled distance. This is the closet between pairs. TG CNX with BAGS CNX and BAGS HKT are almost close to each other with the distance of 21.684 and 31.356 respectively. Certainly, TG BKK as the cargo hub with highest tonnages, handling capacity and throughput per annum is clustered alone. Therefore, there is an assumption that three clusters are for criteria 7 based on Squared Euclidean Distance.

Criteria 8: Airport Facility and Potentiality

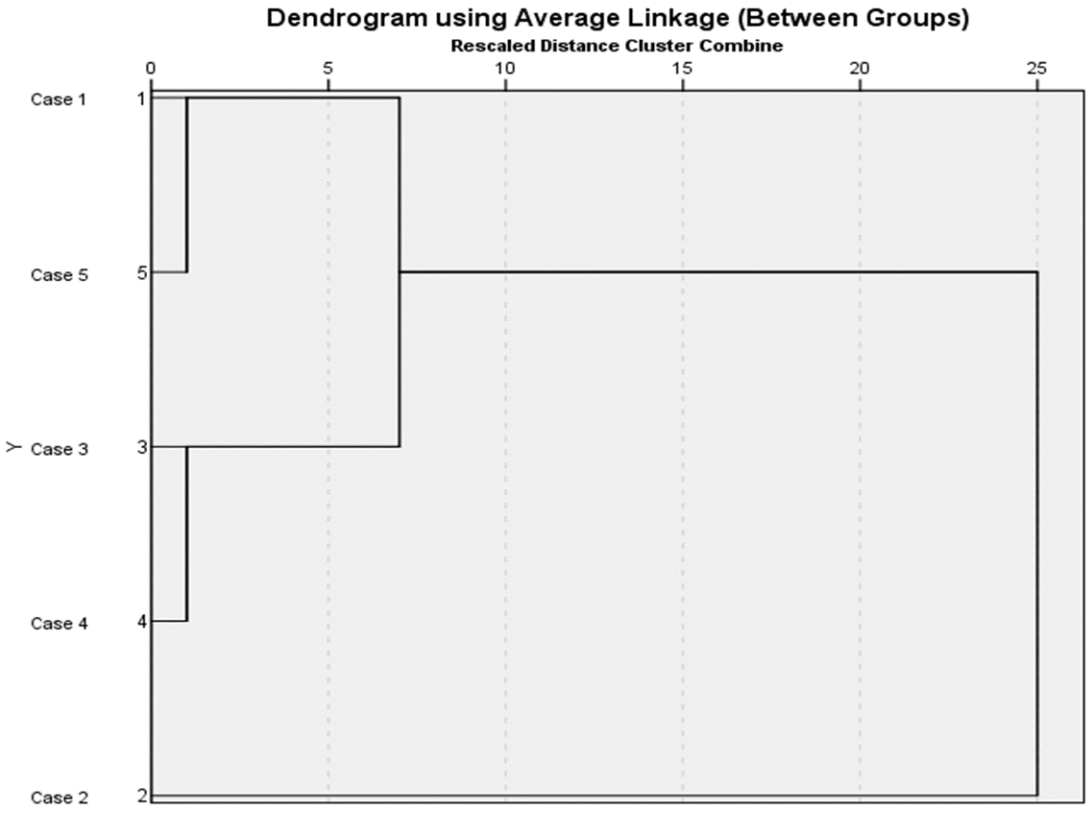
To cluster criteria 8 is simply applied Squared Euclidean Distance and raw data. TG HKT and BAGS HKT are in one cluster and TG BKK is alone by itself. The last cluster is for TG CNX and BAGS CNX. The notice is clusters based on airport facilities. Therefore, three clusters are by airports of airport ownership (public, majority public, and majority private, private), numbers of runways, runway length, airport operational time and airport serving country's capital city.

Proximity Matrix

Case	Squared Euclidean Distance				
	1:Case 1	2:Case 2	3:Case 3	4:Case 4	5:Case 5
1:Case 1 (TG HKT)	0.000	15.952	4.286	4.286	0.000
2:Case 2 (TG BKK)	15.952	0.000	15.476	15.476	15.952
3:Case 3 (TG CNX)	4.286	15.476	0.000	0.000	4.286
4:Case 4 (BAGS CNX)	4.286	15.476	0.000	0.000	4.286
5:Case 5 (BAGS HKT)	0.000	15.952	4.286	4.286	0.000

Agglomeration Schedule						
Stage	Cluster Combined		Coefficients	Stage Cluster First Appears		Next Stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	1	5	0.000	0	0	3
2	3	4	0.000	0	0	3
3	1	3	4.286	1	2	4
4	1	2	15.714	3	0	0

Cluster Membership			
Case	4 Clusters	3 Clusters	2 Clusters
1:Case 1 (TG HKT)	1	1	1
2:Case 2 (TG BKK)	2	2	2
3:Case 3 (TG CNX)	3	3	1
4:Case 4 (BAGS CNX)	4	3	1
5:Case 5 (BAGS HKT)	1	1	1

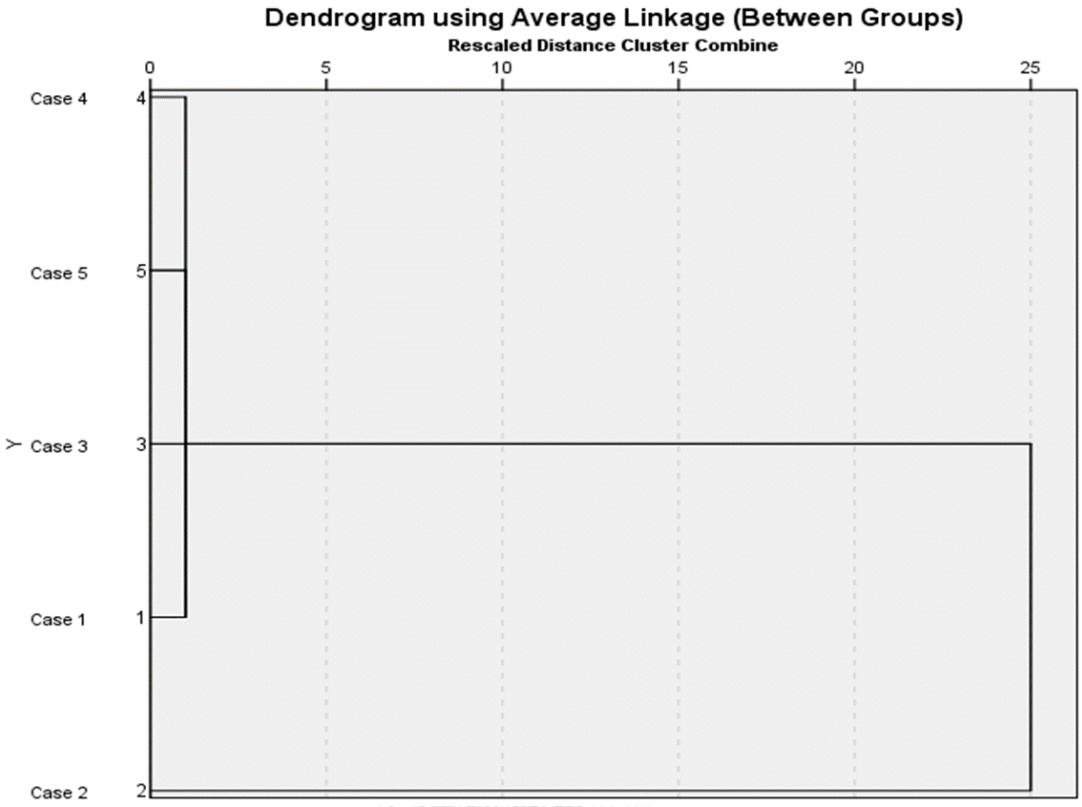


Criteria 9: Factors Impact on Cargo Market Competition

Proximity Matrix					
Case	Squared Euclidean Distance				
	1:Case 1	2:Case 2	3:Case 3	4:Case 4	5:Case 5
1:Case 1 (TG HKT)	0.000	46.583	1.094	1.567	1.180
2:Case 2 (TG BKK)	46.583	0.000	53.764	58.877	56.554
3:Case 3 (TG CNX)	1.094	53.764	0.000	.215	.111
4:Case 4 (BAGS CNX)	1.567	58.877	.215	0.000	.055
5:Case 5 (BAGS HKT)	1.180	56.554	.111	.055	0.000

Agglomeration Schedule						
Stage	Cluster Combined		Coefficients	Stage Cluster First Appears		Next Stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	4	5	.055	0	0	2
2	3	4	.163	0	1	3
3	1	3	1.281	0	2	4
4	1	2	53.944	3	0	0

Cluster Membership			
Case	4 Clusters	3 Clusters	2 Clusters
1:Case 1 (TG HKT)	1	1	1
2:Case 2 (TG BKK)	2	2	2
3:Case 3 (TG CNX)	3	3	1
4:Case 4 (BAGS CNX)	4	3	1
5:Case 5 (BAGS HKT)	4	3	1



Criteria 9 is another recognition that TG HKT and TG BKK are not similar to any operator due to both are joined to others at the last 3rd and 4th stage of Agglomeration Schedule table. By Squared Euclidean Distance, TG HKT seems to close to TG CNX and BAGS CNX with the smallest distance of only 1.094 and 1.567 respectively. However, looking at TG CNX with BAGS CNX and BAGS HKT, the smallest distance are merely 0.215 and 0.111 respectively. Then, the observation is to classify 5 operators into three clusters.

First cluster is for TG HKT. Secondly, TG BKK is another alone cluster while TG CNX, BAGS CNX and BAGS HKT are in cluster number 3. This criteria 9 is with dissimilarity to other criteria in sub-criteria of international trade (export value) and centrality betweenness that all operators should have the same answers as explained earlier. This criteria is from literature reviews and focused on factors that impact on cargo market competition.

Criteria	4 Clusters				3 Clusters			2 Clusters	
	Cluster No. 1	Cluster No. 2	Cluster No. 3	Cluster No. 4	Cluster No. 1	Cluster No. 2	Cluster No. 3	Cluster No. 1	Cluster No. 2
1 to 9	TG HKT	TG BKK	BAGS CNX	BAGS HKT	TG HKT	TG BKK	BAGS HKT	TG HKT	TG BKK
	TG CNX				TG CNX			TG CNX	
					BAGS CNX			BAGS HKT	
								BAGS CNX	
1	TG HKT	TG BKK	TG CNX	BAGS CNX	TG HKT	TG BKK	BAGS CNX	TG BKK	BAGS CNX
		BAGS HKT			TG CNX	BAGS HKT		TG HKT	
								TG CNX	
								BAGS HKT	
2	TG HKT	TG BKK	TG CNX	BAGS HKT	TG HKT	TG BKK	TG CNX	TG HKT	TG BKK
				BAGS CNX	BAGS HKT			BAGS HKT	TG CNX
					BAGS CNX			BAGS CNX	
3	TG HKT	TG BKK	TG CNX	BAGS CNX	TG HKT	TG BKK	BAGS CNX	TG HKT	TG BKK
			BAGS HKT			TG CNX			TG CNX
						BAGS HKT			BAGS HKT
									BAGS CNX
4	TG HKT	TG BKK	TG CNX	BAGS HKT	TG HKT	TG BKK	BAGS HKT	TG HKT	TG BKK
			BAGS CNX		TG CNX			TG CNX	BAGS HKT
					BAGS CNX			BAGS CNX	
5	TG HKT	TG BKK	TG CNX	BAGS CNX	TG HKT	TG BKK	TG CNX	TG HKT	TG BKK
			BAGS HKT			BAGS CNX	BAGS HKT	TG CNX	BAGS CNX
								BAGS HKT	
6	TG HKT	TG BKK	TG CNX	BAGS HKT	TG HKT	TG BKK	BAGS HKT	TG BKK	BAGS HKT
				BAGS CNX		TG CNX	BAGS CNX	TG HKT	BAGS CNX
								TG CNX	
7	TG HKT	TG BKK	BAGS CNX	BAGS HKT	TG HKT	TG BKK	BAGS HKT	TG HKT	TG BKK
	TG CNX				TG CNX			TG CNX	
					BAGS CNX			BAGS HKT	
								BAGS CNX	
8	TG HKT	TG BKK	TG CNK	BAGS CNX	TG HKT	TG BKK	TG CNX	TG HKT	TG BKK
	BAGS HKT				BAGS HKT		BAGS CNX	TG CNX	
								BAGS HKT	
								BAGS CNX	
9	TG HKT	TG BKK	TG CNX	BAGS CNX	TG HKT	TG BKK	TG CNX	TG HKT	TG BKK
				BAGS HKT			BAGS HKT	TG CNX	
							BAGS CNX	BAGS HKT	
								BAGS CNX	

Table 29: Summary of 2 – 4 Clusters from Hierarchical Cluster Analysis for All 9 Criteria and Each Criteria

Criteria 1 to 9 Names:

1. Cargo and Mail Service Readiness (IATA SGHA version 2013)
2. Cargo Claims - International Convention Ratification & Limit of Liability
3. Customs Operations
4. E-Freight Implementation & Capability

5. E-Air waybill Implementation & Capability
6. IATA Safety Audit for Ground Operations (ISAGO) Certification
7. Air Cargo Terminal Characteristic
8. Airport Facility and Potentiality
9. Factors Impact on Cargo Market Competition

Table 29 presents the summary of 2 – 4 clusters from Hierarchical Cluster Analysis for all 9 Criteria and each criteria from criteria 1 to 9. As analyzed earlier, 2 clusters of all 9 criteria classification for 5 operators is outstanding with clear explanation that TG BKK is totally isolated from the other operators. The computed result and reality are inline together and raw data confirms the computation.

3 Cluster Classification:

Also for next step, the researcher attempts to evaluate 3 clusters for all 9 criteria classification of 5 operators. The result is still based on 2 cluster classification that TG BKK is alone. Though, BAGS HKT is another one separated from TG BKK and the other three operators. This classification of 3 clusters provides different identification of operators: especially, TG BKK and BAGS HKT in addition to 2 clusters experiment. The result offers more details in explanation. The researcher looks back at classification in criteria 1 to 9 individually. TG BKK is noticeable to stay in cluster number 2 for all criteria while BAGS HKT is observed to stay in cluster number 3 in classification in criteria 4, 5, 6, 7 and 9. This means that BAGS HKT is in cluster number 3 at 5 of 9 criteria leading to stay alone in cluster number 3 for classification of 3 clusters. BAGS HKT is obviously distinguished in criteria 1 that is equally to TG BKK, criteria 4 as the leading in E-freight cargo and criteria 6 for ISAGO together with BAGS CNX. Looking at Dendrogram for Rescale Distance Cluster Combine, BAGS HKT is the second latest case that is combined into TG HKT, TG CNX and BAGS CNX cluster at Dendrogram distance at 10. TG BKK is separated from others at any Dendrogram distance. The researcher computed Cluster Analysis program to generate 3 clusters so that BAGS HKT is another separated cluster after TG BKK. Furthermore, as explained earlier in Table 28 for criteria 1 to 9 classification, raw data confirms computed results to be 3 clusters. There are 6 of 8 criteria

classification to be 3 clusters by raw data from 5 operators except criteria 2 as to be in one cluster only. However, cluster number 1 and 2 also contain BAGS HKT for 2 criteria each. Likewise, BAGS CNX is in 5 criteria in cluster number 3 while also in cluster number 1 for 3 criteria and in cluster number 2 for 1 criteria. BAGS CNX is closer to cluster number 1 than cluster number 3. Then, BAGS CNX is grouped in cluster number 1 instead by Dendrogram scale because the program set for 3 clusters.

4 Cluster Classification:

Then, another extreme classification of 4 clusters is computed. The consequences display that TG BKK is still in cluster number 2. TG HKT and TG CNX are in cluster number 2 whereas BAGS CNX and BAGS HKT are detached in cluster number 3 and 4 respectively. Therefore, to ensure the decision to select numbers of clusters for the researcher, classification of criteria 1 to 9 is evaluated. TG CNX, BAGS CNX and BAGS HKT are dispersed and moving around mainly in cluster number 1, 3 and 4 and once joined with TG BKK in cluster number 2 of criteria 1. This leads to the confusion to interpret as the main result of all 9 criteria classification shows that TG BKK, BAGS CNX and BAGS HKT are in different clusters. TG HKT and TG CNX are in the same cluster. Moreover, the computed result does not provide any reason between all 9 criteria classification and individual classification of criteria 1 to 9. Both methods are not aligned together and challenging to clarify to select 4 clusters for this study.

Consequently, as the result of homogenous conditions and background information, the researcher decides to select classification of 5 air cargo terminal operators by 3 clusters for both all 9 criteria and 1 to 9 criteria classification. Certainly, 2 clusters are clearly identified that TG BKK is in one of its own cluster number 2 no matter the researcher computes Cluster Analysis in 2, 3 or 4 clusters. 3 cluster classification makes BAGS HKT in cluster number 3 split from cluster number 1 somehow by raw data in criteria 1, 4 and 6 and Dendrogram scale at 10. However, this study is concentrated on TG BKK as the most outstanding with clear identification itself as distinguished from other air cargo terminal operators while the rest of 4 operators are more or less equivalent to each other.

3.9 The Significant 44 Criteria Validation and Grouping for Guideline and Check List (Phase III: Research Question 3)

The executed 44 criteria are dispersed by factor loading scores by the highest to the lowest scores at Phase I: Research Question 1. The original reference is to group dispersed 44 criteria back to similarity and originality. Thus, 44 criteria are combined into 9 main criteria with 44 sub-criteria instead. This allows the researcher and readers understand the simplified finding of Phase I: Research Question 1 conveniently. The 9 main criteria are results of Phase III: Research Question 3.

In July 2017 and August 2015, IATA proposes air cargo industry with IATA Cargo Delivery model (IATA, 2015, 2017b). The model is with a concept of "Global Development, Regional Delivery". The latest version is 2017 concurred by Governance bodies such as cargo committee, cargo services conference, cargo agency conference and cargo network service (CNS) and stake holders at global, regional and local levels such as industry associations, international organizations, airlines, air cargo logistics providers, airports, ground handlers, shippers, etc. There are six area of interests to move forward of air cargo service in Table 30 to validate 9 main criteria in Table 31 and ensure that the finding of significant criteria targeted to be the guideline and check list for air cargo terminal operators are appropriate to IATA Cargo Delivery Model 2017. The model is constructed by IATA and used to drive air cargo industry in the same direction.

IATA Cargo Delivery Model 2017					
Safety & Dangerous Goods	Special Cargo	Border Management	Cargo Operations	Digital Cargo	Cargo Transformation

Table 30: IATA Cargo Delivery Model 2017

9 Main Criteria and 44 Sub-criteria for Air Cargo Terminal Classification		Factor Loading
1. Cargo and Mail Service Readiness (IATA SGHA version 2013)	Transfer/transit cargo	0.857
	Physical handling outbound/inbound	0.856
	Cargo and mail handling – general	0.853
	Documentation handling	0.850
	Until load device (ULD) control	0.710
	Automation/computer systems	0.655
2. Cargo Claims - International Convention Ratification & Limit of Liability	Warsaw convention as amended by Hague protocol 1955 (250.00 francs or USD 20.00/Kg)	0.886
	Warsaw convention 1929 (250.00 francs or USD 20.00/ Kg)	0.885
	Warsaw convention as amended by Montreal protocol 1975 (SDR 17.00 or USD 20.00/ Kg)	0.873
3. Customs Operations	Weekdays and weekends (Business hours)	0.833
	Weekdays (Business hours)	0.731
	Customs clearance times (hours):	0.663
4. E-Freight Implementation & Capability	Electronic import goods declaration	0.897
	Electronic export goods declaration	0.895
	Electronic export cargo declaration	0.891
	Electronic import cargo declaration	0.888
	Transshipment	0.764
	Transit freight remaining on board	0.730
	E-freight capability target status	0.681
5. E-Air waybill Implementation & Capability	Import cargo	0.903
	Export cargo	0.852
	Transit cargo	0.830
	Transshipment cargo	0.824
6. IATA Safety Audit for Ground Operations (ISAGO) Certification	Cargo security (facilities, operations)	0.843
	Cargo and mail acceptance and handling (general, dangerous goods, live animals and perishables, other special cargo, unit load devices)	0.797
7. Air Cargo Terminal Characteristic	Cargo terminal area (sq.m.)	0.851
	Total cargo throughput (metric tons) per annum (p.a.)	0.728
	Available tracking and tracing service	0.676
	Maximum connecting time (hours)	0.636
	Cargo commodities (IATA three letter codes)	0.622
	Capacity (metric tons) per annum (p.a.)	0.612

9 Main Criteria and 44 Sub-criteria for Air Cargo Terminal Classification		Factor Loading
8. Airport Facility and Potentiality	Airport ownership types (public, majority public, majority private, private)	0.796
	Runway length: 3,800 m	0.788
	Numbers of runways	0.780
	Airport operational time - available around the clock	0.759
	Airport serving country capital city	0.671
	Runway length: 2,500 m	0.652
9. Factors Impact on Cargo Market Competition	Route and geographical distribution of airfreight (numbers of flights per week)	0.874
	International trade (export value)	0.820
	Flight frequency (weekly flight frequency of selected airports)	0.779
	Centrality (betweenness centrality of airports by area)	0.759
	National versus foreign carriers (flight (%) operated by flag carriers)	0.753
	Size of local market (% of shipments locally generated)	0.669
	Freight forwarder presence	0.633

Table 31: 9 Main Significant Criteria and 44 Sub-criteria as Guideline for Air Cargo Terminal Classification and Operators

IATA Cargo Delivery Model 2017 is constructed and identified with the 9 significant criteria from this study in Table 31 as follows:

Cargo Safety and Dangerous Goods

Dangerous goods including lithium batteries, air mail safety and unit load device safety are key concerns of IATA for the safety of passengers, aircrafts, crew and other cargo. The air transport of dangerous goods and airmail including rising amount of e-commerce shipment are restricted to regulations and efficient guidance, standards and safety audits to avoid risks. IATA presents the new design of unit load device with fire resistant container and fire containment cover which are important to protect fire at cargo compartment. This part of IATA Cargo Delivery Model is related to main criteria 6 of IATA Safety Audit for Ground Operations (ISAGO) Certification.

Special Cargo

Live animal, perishables and pharmaceuticals, etc. are required to comply with training, regulations and standards. Special cargo is mandated to global standards to cargo acceptance, handling, loading, transport and documentation. Air cargo industry including a supply chain from shippers, air cargo logistics providers, airlines, air cargo terminal operators and consignees are to work closely with national and international governments and authorities. Main criteria 1, 6 and 7 of Cargo and Mail Service Readiness, IATA Safety Audit for Ground Operations (ISAGO) Certification and Air Cargo Terminal Characteristic are respectively involved with this section.

Cargo Border Management

Cargo security, customs and trade facilitation are to support the United Nations Security Council Resolution 2309(2016) that civil aviation security requires states and organizations to strengthen security screening and maximize the proficiency to detect and security threats. IATA also develops electronic messages to communicate with cargo related-data or cargo-XML with World Customs Organization to support the industry and supply chain stake holders. Claim policy and procedures are to assist airlines to the management of cargo claims in a consequent to oblige of all partners in the supply chain. Main criteria 2 of Cargo Claims and 3 of Customs Operations are a part of this project.

Cargo Operations

IATA Cargo Handling Manual is produced to impose in the complexity of cargo operations and align with the Industry Master Operating Plan and other international regulations and standards. Air cargo terminal operators are encouraged to improve the quality of services and facilities through Smart Facility project that concentrate on audits and certifications in cargo handling activities including airmail & e-commerce and unit load device (ULD) management. IATA also assists its members to comply with ULD regulations as ULD is the key success of air cargo transport. Criteria 1 and 7 of Cargo and Mail Service Readiness and Air Cargo Terminal Characteristic are directly concerned on this part.

E-freight & Digital Cargo

E-freight and E-Air Waybill including Cargo-XML messages for customs are unavoidable to transfer information of cargo and mail between parties and to modernize paperless exchange with data quality and complete coverage. These projects are upgraded to Digital Cargo project with communications via smart data and get rid of paper and messages. Main criteria 3, 4 and 5 of Customs Operations, E-Freight and E-Air Waybill Implementation & Capability are directly dealing with this project now and then.

Cargo Transformation

A part of cargo transformation is industry engagement which IATA depends on all industry parties including airlines, air cargo logistics service providers, airports, governments and air cargo terminal operators to mobilize air cargo transport wisely easier and faster. Main criteria 8 and 9 of Airport Facility and Potentiality and Factors Impact on Cargo Market Competition are of the stake holders that IATA cares for their movement and development together.

IATA Cargo Delivery Model 2017	Main Criteria Validation
Cargo Safety and Dangerous Goods	6. IATA Safety Audit for Ground Operations (ISAGO) Certification
Special Cargo	1. Cargo and Mail Service Readiness (IATA SGHA version 2013) 6. IATA Safety Audit for Ground Operations (ISAGO) Certification 7. Air Cargo Terminal Characteristic
Cargo Border Management	2. Cargo Claims - International Convention Ratification & Limit of Liability 3. Customs Operations
Digital Cargo	3. Customs Operations 4. E-Freight Implementation & Capability 5. E-Air waybill Implementation & Capability

IATA Cargo Delivery Model 2017	Main Criteria Validation
Cargo Operations	1. Cargo and Mail Service Readiness (IATA SGHA version 2013) 7. Air Cargo Terminal Characteristic
Cargo Transformation	8. Airport Facility and Potentiality 9. Factors Impact on Cargo Market Competition

Table 32: Main Criteria Validated by IATA Cargo Delivery Model 2017 (IATA, 2015, 2017b)

The 9 main significant criteria and 44 sub-criteria are in according to IATA Cargo Delivery Model 2017 and proven in Table 32 that the criteria are verified and validated to air cargo terminal operators. The guideline and check list in Table 31 that grouped by similar and original reference is relevant and important to major air cargo terminal classification and provide a list of necessary service requirements and arrangements for air cargo terminal operators. Also, the results from Research Question 2 demonstrate that the 9 significant criteria from Research Question 1 are workable and practical to be air cargo terminal classification model. Table 31 is the guideline and check list with loading scores on each main criteria. Air cargo terminal operators are capable to use loading scores to evaluate or audit their present air cargo terminal conditions in a regard of the 9 significant criteria. The total loading score is 34.305 from 44 sub-criteria. Each sub-criteria has its own loading score. This check list is eligible to apply to check air cargo terminals along with 44 sub-criteria and find out loading scores on all 9 main criteria or individual criteria 1 to criteria 9.

Chapter 4

4. Results and Discussions

Referring to Research Questions and Objectives in Chapter 1, there are three expected results from this research in regarding to Phase I: Research Questions 1, Phase II: Research Questions 2 and Phase III: Research Questions 3. The first projected result is to find significant criteria for air cargo terminal classification model. Secondly, as a test of Phase I, such significant criteria is to invite 7 air cargo terminal operators at BKK, CNX, DME and HKT international airports to be classified in according to criteria. Unfortunately, there are only 5 air cargo terminal operators participate the third round questionnaire survey. Then, Phase II is to classify 5 air cargo terminal operators at BKK, CNX and HKT international airports. Classification of clusters is computed and explored. Thirdly, Phase III is to provide guideline and check list validated with IATA Cargo Delivery Model to air cargo terminal operators around the world for bidding and business purpose. After many steps of data collection from questionnaire survey, manual evaluation, academic methods and validation of results by experts, the results of three phases are discovered and interpreted.

4.1 Results of Phase I: Research Question 1, Research Objective 1

This research question is "What are the relevant and important criteria for air cargo terminal classification?". Variables are collected from literature reviews and IATA standards and constructed into first round questionnaire. Air cargo terminal operators around the world except in Thailand participate and maintain only critical variables to classify air cargo terminals. Manual evaluation and Principal Component Analysis are applied to reduced variables from screening out by air cargo terminal operators. Then, such remained 46 variables are validated again by aviation experts. Finally, there are 44 significant criteria for air cargo terminal classification remained. The researcher intends to present 44 significant criteria by factor loading scores from the highest to the lowest. However, these factor loading are cut down and retained only any criteria with factor loading of exceeding 0.6 which considered high figure already. This means that all 44 criteria are very significant.

Factor Loading	44 Significant Criteria for Air Cargo Terminal Classification	Original Reference
0.903	Import cargo	E-Air waybill Implementation & Capability
0.897	Electronic import goods declaration	E-Freight Implementation & Capability
0.895	Electronic export goods declaration	
0.891	Electronic export cargo declaration	
0.888	Electronic import cargo declaration	
0.886	Warsaw convention as amended by Hague protocol 1955 (250.00 francs or USD 20.00/Kg)	Cargo Claims - International Convention Ratification & Limit of Liability
0.885	Warsaw convention 1929 (250.00 francs or USD 20.00/ Kg)	
0.874	Route and geographical distribution of airfreight (numbers of flights per week)	Factors Impact on Cargo Market Competition
0.873	Warsaw convention as amended by Montreal protocol 1975 (SDR 17.00 or USD 20.00/ Kg)	Cargo Claims - International Convention Ratification & Limit of Liability
0.857	Transfer/transit cargo	Cargo and Mail Service Readiness (IATA SGHA version 2013)
0.856	Physical handling outbound/inbound	
0.853	Cargo and mail handling – general	
0.852	Export cargo	E-Air waybill Implementation & Capability
0.851	Cargo terminal area (sq.m.)	Air Cargo Terminal Characteristic
0.850	Documentation handling	Cargo and Mail Service Readiness (IATA SGHA version 2013)
0.843	Cargo security (facilities, operations)	IATA Safety Audit for Ground Operations (ISAGO) Certification
0.833	Weekdays and weekends (Business hours)	Customs Operations
0.830	Transit cargo	E-Air waybill Implementation & Capability
0.824	Transhipment cargo	
0.820	International trade (export value)	Factors Impact on Cargo Market
0.797	Cargo and mail acceptance and handling (general, dangerous goods, live animals and perishables, other special cargo, unit load devices)	IATA Safety Audit for Ground Operations (ISAGO) Certification
0.796	Airport ownership types (public, majority public, majority private, private)	Airport Facility and Potentiality
0.788	Runway length: 3,800 m	
0.780	Numbers of runways	
0.779	Flight frequency (weekly flight frequency of the selected airports)	Factors Impact on Cargo Market Competition
0.764	Transhipment	E-Freight Implementation & Capability
0.759	Airport operational time - available around the clock	Airport Facility and Potentiality
0.759	Centrality (betweenness centrality of airports by area)	Factors Impact on Cargo Market Competition
0.753	National versus foreign carriers (flight (%) operated by flag carriers)	
0.731	Weekdays (Business hours)	Customs Operations
0.730	Transit freight remaining on board	E-Freight Implementation & Capability
0.728	Total cargo throughput (metric tonnes) per annum (p.a.)	Air Cargo Terminal Characteristic
0.710	Until load device (ULD) control	Cargo and Mail Service Readiness (IATA SGHA version 2013)
0.681	E-freight capability target status	E-Freight Implementation & Capability
0.676	Available tracking and tracing service	Air Cargo Terminal Characteristic
0.671	Airport serving country capital city	Airport Facility and Potentiality
0.669	Size of local market (% of shipments locally generated)	Factors Impact on Cargo Market
0.663	Customs clearance times (hours):	Customs Operations
0.655	Automation/computer systems	Cargo and Mail Service Readiness (IATA SGHA version 2013)
0.652	Runway length: 2,500 m	Airport Facility and Potentiality
0.636	Maximum connecting time (hours)	Air Cargo Terminal Characteristic
0.633	Freight forwarder presence	Factors Impact on Cargo Market
0.622	Cargo commodities (IATA three letter codes)	Air Cargo Terminal Characteristic
0.612	Capacity (metric tonnes) per annum (p.a.)	

Table 33: 44 Significant Criteria by Highest to Lowest Factor Loading Scores

The researcher aims to present the highest to the lowest factor loading and similar and original reference in Table 33. The difference of Table 33 and 25 is Table 25 prepared to simplify third round questionnaire to group criteria into similar and original reference as main criteria for better understanding of the questionnaire to air cargo terminal operators at 3 airports in Thailand. This study investigates 63 variables from the reviews of researches and IATA standard services. The first evaluation was performed by 57 air cargo terminal operators with air cargo terminal services covering 6 continents to explore the variables on their relevance and importance in accordance to their expertise. Such experienced operators deal with air cargo terminal services and activities daily and familiar with the operations as well as rate more on IATA variables. Nevertheless, variables from academic researches remained on the list: however, with less important scores. There were 4 variables from academic studies could have been extracted by the manual examination. Still, the researcher included them to Principal Component Analysis with Varimax rotation technique. The 17 variables were excluded by this method and remained 46 variables. Then, in order to reassure the validity of such variables, 9 experts from air cargo related functions such as IATA, CAAT, academician, airlines and air cargo logistics service providers concurred 44 variables and removed 2 variables from the total in second round questionnaire. Such removal was by 5 experts from 9 participants. From several variable reduction and validation, these 44 variables were formerly categorized back to their backgrounds and individually ungrouped-variables were encompassed into available categorizations in according to the associated contents. Therefore, 9 main criteria are for air cargo terminal classification as presented in Table 25 and 33. From the 9 main criteria, 6 of them are categorized and from IATA standard services and 3 categorizations are from academic researches. In each criteria, there are sub-criteria listed from the highest to the lowest factor loading scores. There are 20 sub-criteria with factor loading scores exceeding 0.8 and 13 sub-criteria with factor loading scores between 0.7 – 0.8. The rest of 11 sub-criteria are below 0.7 factor loading score. Also, those 11 sub-criteria are with 3 from IATA and 8 from academic sections. The top 5 of the lowest scores are capacity (metric tons per annum), cargo commodities (IATA three letter codes), freight forwarder presence, maximum connecting time (hours) and runway length: 2,500 m sub-criteria by 0.612, 0.622, 0.633, 0.636 and 0.652 factor loading scores respectively. Top five of

the highest scores are E-Air waybill implementation & capability of import cargo, E-freight implementation & capability of electronic import goods declaration, electronic export goods declaration, electronic export cargo declaration, and electronic import cargo declaration sub-criteria by 0.903, 0.897, 0.895, 0.891 and 0.888 factor loading scores respectively. However, this study uses a scale of factor loading greater than 0.6 while other researches apply factor loading of over 0.5 is considered critical (Rousava & Piermartini, 2008). The finding is exanimated and proved that all remaining 9 criteria are the key influence and success to air cargo terminal operators.

4.2 Results of Phase II: Research Question 2, Research Objective 2

Research question 2 is "What are the significant criteria and classification to classify air cargo terminals differently?". As a result of Phase I, the researcher produces third round questionnaire to air cargo terminal operators at BKK, CNX and HKT international airports to fill out and provide data for Hierarchical Cluster Analysis. This is to ensure that the 9 main criteria make the classification of air cargo terminals differently and determine significant criteria that affect the motivation of Airports of Thailand or Government of Thailand to improve and develop air cargo service requirement and arrangement at the airports. Table 34 is to show the results from Phase II of this research. There are 10 attempts of Hierarchical Cluster Analysis computation to find the outputs that start from classification of all 9 criteria, criteria 1, until criteria 9. The main result from all 9 criteria is significant to view an overall perspective of air cargo terminals or even current air cargo service at BKK, CNX and HKT airports for strength and weakness. This shows that TG BKK has remained unaffected or moved around from cluster number 2 for all circumstances likewise TG HKT in cluster number 1. BAGS HKT and BAGS CNX seem to present itself in cluster number 3 mainly in criteria but not for all criteria conditions. TG CNX is moving around all clusters. However, there are 4 criteria when classification that other air cargo terminal operators join TG BKK in cluster number 2. Each classification in criteria 1 to 9 is independently constructed on available services and capacity. Similarity of cases are joined and dependent within same clusters. On the other hand, different clusters are less correlation independent.

Main Criteria 1 to 9	Sub-Criteria	Factor Loading	Classification of 3 Clusters		
			Cluster No. 1	Cluster No. 2	Cluster No. 3
Criteria 1 to 9	All 9 Main Criteria		TG HKT, TG CNX, BAGS CNX	TG BKK	BAGS HKT
1. Cargo and Mail Service Readiness (IATA SGHA version 2013)	Transfer/transit cargo	0.857	TG HKT, TG CNX	TG BKK, BAGS HKT	BAGS CNX
	Physical handling outbound/inbound	0.856			
	Cargo and mail handling – general	0.853			
	Documentation handling	0.850			
	Until load device (ULD) control	0.710			
	Automation/computer systems	0.655			
2. Cargo Claims - International Convention Ratification & Limit of Liability	Warsaw convention as amended by Hague protocol 1955 (250.00 francs or USD 20.00/Kg)	0.886	TG HKT, BAGS CNX, BAGS HKT	TG BKK	TG CNX
	Warsaw convention 1929 (250.00 francs or USD 20.00/ Kg)	0.885			
	Warsaw convention as amended by Montreal protocol 1975 (SDR 17.00 or USD 20.00/ Kg)	0.873			
3. Customs Operations	Weekdays and weekends (Business hours)	0.833	TG HKT	TG BKK, TG CNX, BAGS HKT	BAGS CNX
	Weekdays (Business hours)	0.731			
	Customs clearance times (hours):	0.663			
4. E-Freight Implementation & Capability	Electronic import goods declaration	0.897	TG HKT, TG CNX, BAGS CNX	TG BKK	BAGS HKT
	Electronic export goods declaration	0.895			
	Electronic export cargo declaration	0.891			
	Electronic import cargo declaration	0.888			
	Transhipment	0.764			
	Transit freight remaining on board	0.730			
	E-freight capability target status	0.681			
5. E-Air waybill Implementation & Capability	Import cargo	0.903	TG HKT	TG BKK, BAGS CNX	TG CNX, BAGS HKT
	Export cargo	0.852			
	Transit cargo	0.830			
	Transhipment cargo	0.824			
6. IATA Safety Audit for Ground Operations (ISAGO) Certification	Cargo security (facilities, operations)	0.843	TG HKT	TG BKK, TG CNX	BAGS CNX, BAGS HKT
	Cargo and mail acceptance and handling (general, dangerous goods, live animals and perishables, other special cargo, unit load devices)	0.797			
7. Air Cargo Terminal Characteristic	Cargo terminal area (sq.m.)	0.851	TG HKT, TG CNX, BAGS CNX	TG BKK	BAGS HKT
	Total cargo throughput (metric tonnes) per annum (p.a.)	0.728			
	Available tracking and tracing service	0.676			
	Maximum connecting time (hours)	0.636			
	Cargo commodities (IATA three letter codes)	0.622			
	Capacity (metric tonnes) per annum (p.a.)	0.612			
8. Airport Facility and Potentiality	Airport ownership types (public, majority public, majority private, private)	0.796	TG HKT, BAGS HKT	TG BKK	TG CNX, BAGS CNX
	Runway length: 3,800 m	0.788			
	Numbers of runways	0.780			
	Airport operational time - available around the clock	0.759			
	Airport serving country capital city	0.671			
	Runway length: 2,500 m	0.652			
9. Factors Impact on Cargo Market Competition	Route and geographical distribution of airfreight (numbers of flights per week)	0.874	TG HKT	TG BKK	TG CNX, BAGS CNX, BAGS HKT
	International trade (export value)	0.820			
	Flight frequency (weekly flight frequency of the selected airports)	0.779			
	Centrality (betweenness centrality of airports by area)	0.759			
	National versus foreign carriers (flight (%) operated by flag carriers)	0.753			
	Size of local market (% of shipments locally generated)	0.669			
	Freight forwarder presence	0.633			

Table 34: Summary of Criteria 1 to 9 Classification for 5 Air Cargo Terminal Operators

Table 34 along with results of Table 28 demonstrate that TG BKK is not similar, less correlation and even independent to other air cargo terminal operators in term of classification for all 9 criteria. The Squared Euclidean Distance of TG BKK is at 169.027 to TG HKT, 157.200 to TG CNX, 177.062 to BAGS CNX and 178.869 to BAGS HKT considered great different distance. This proves that TG BKK is more isolated into its own cluster. To ensure the recognition and interpretation, the researcher re-checks raw data received from all air cargo terminal operators and acknowledge that TG BKK is able to fulfill most of 9 main criteria and 44 sub-criteria listed from Phase I except some sub-criteria. These below Table 35 and 36 list all main and sub-criteria that TG BKK is unable to offer and satisfy as weakness. There are 4 sub-criteria that TG BKK incomparable with other air cargo terminal operators are E-freight and ISAGO availability. The rest are equivalent to others. Again, main criteria 2 is at nationwide imposed by Thailand to other countries. This will be applicable when Thailand adopts the conventions.

On the other hand, cluster number 1 containing TG HKT, TG CNX and BAGS CNX and cluster number 3 with BAGS HKT are not clear and outstanding with no indicator in each criteria. All of these air cargo terminal operators are almost close to each other. Only BAGS HKT is separated from cluster number 1 to be cluster number 3 because the first cluster with three operators are correlated to each other and BAGS HKT is the latest joint into cluster number 1, if computed for only 2 clusters. Also, considering TG HKT is stayed firm in cluster number 1 while TG CNX, BAGS CNX and BAGS HKT are moving around in cluster number 1, 2 and 3. This leads uncertainty to identify BAGS HKT but with raw data, BAGS HKT is keen in criteria 1 of Cargo and Mail Service Readiness (IATA SGHA version 2013) similar only to TG BKK, criteria 4 of E-Freight Implementation & Capability alone and criteria 6 of IATA Safety Audit for Ground Operations (ISAGO) Certification similar to only to BAGS CNX. Still, BAGS HKT is incomparable to TG BKK in all of 9 criteria. TG HKT, TG CNX, BAGS CNX and BAGS HKT are with much more weak points than TG BKK as stipulated in Table 35 for weakness and strenght between TG BKK and other air cargo terminal operators in this study.

Main Criteria 1 to 9	Sub-Criteria	Strength (S) and Weakness (W)									
		TG HKT		TG BKK		TG CNX		BAGS CNX		BAGS HKT	
		(S)	(W)	(S)	(W)	(S)	(W)	(S)	(W)	(S)	(W)
1. Cargo and Mail Service Readiness (IATA SGHA version 2013)	Cargo and mail handling – general	S		S		S		S		S	
	Documentation handling	S		S		S		S		S	
	Physical handling outbound/inbound	S		S		S		S		S	
	Transfer/transit cargo	S		S		S			W	S	
	Automation/computer systems	S		S		S			W	S	
	Until load device (ULD) control		W	S			W		W	S	
2. Cargo Claims - International Convention Ratification & Limit of Liability	Warsaw convention 1929 (USD 20.00/ Kg)		W		W		W		W		W
	Warsaw convention as amended by Hague protocol 1955 (USD 20.00/Kg)		W		W		W		W		W
	Warsaw convention as amended by Montreal protocol 1975 (USD 20.00/ Kg)		W		W		W		W		W
3. Customs Operations	Customs operations-Weekdays (Business hours)		W		W		W		W		W
	Customs operations-Weekdays and weekends (Business hours)	S		S		S		S		S	
	Customs clearance times (hours)		W	S		S		S		S	
4. E-Freight Implementation & Capability	E-freight capability target status		W		W		W		W	S	
	E-freight export goods declaration		W	S			W		W	S	
	E-freight export cargo declaration		W	S			W		W	S	
	E-freight import goods declaration		W	S			W		W	S	
	E-freight import cargo declaration		W	S			W		W	S	
	E-freight transit freight remaining on board		W		W		W		W		W
	E-freight transhipment		W		W		W		W	S	
5. E-Air waybill Implementation & Capability	E-Air waybill-Import.cargo		W	S			W	S			W
	E-Air waybill-Export.cargo		W	S			W	S			W
	E-Air waybill-Transit.cargo		W		W		W		W		W
	E-Air waybill-Transhipment.cargo		W		W		W		W		W
6. IATA Safety Audit for Ground Operations	ISAGO-Cargo and mail acceptance and handling		W		W		W	S		S	
	ISAGO-Cargo security		W		W		W	S		S	
7. Air Cargo Terminal Characteristic	Cargo terminal area (sq.m.)		W	S			W		W		W
	Capacity (metric tonnes) per annum		W	S			W		W		W
	Total cargo throughput (metric tonnes) per annum		W	S			W		W		W
	Cargo commodities (Three letter codes) (tons)										
	PER (Perishable cargo)		W	S			W		W		W
	GEN (General cargo)		W	S			W		W		W
	DGR (Dangerous goods)		W	S			W		W		W
	PIL (Pharmaceuticals)		W	S			W		W		W
	VAL (Valuable cargo)		W	S			W		W		W
	AVI (Live animal)		W		W		W		W		W
	XPS (Priority cargo)		W	S			W		W		W
	COL (Cool goods)		W		W		W		W		W
	HUM (Human Remain in coffins)		W		W		W		W		W
	VUN (Vulnerable cargo)		W	S			W		W		W
	PES (Fish/Seafood)		W		W		W		W		W
	MAL (Mail)		W	S			W		W		W
	BIG (Oversized cargo)		W		W		W		W		W
	EAT (Food stuff)		W		W		W		W		W
	HEA (Heavy cargo, 150 kg and over per piece)		W		W		W		W		W
	BUP (Shipper/consignee handled unit)		W		W		W		W		W
	CRT (Cool room: +15 C to +25 C)		W		W		W		W		W
	PEM (Meat)		W		W		W		W		W
	FRO (Frozen goods)		W		W		W		W		W
	Transit cargo	S			W		W		W	S	
	Free trade zone shipment		W		W		W		W		W
	Maximum.connecting.time (hours)		W		W		W	S			W
	Available tracking and tracing service	S		S		S			W	S	

Table 35: Weakness and Strength of TG BKK to Other Air Cargo Terminal Operators

Main Criteria 1 to 9	Sub-Criteria	Strength (S) and Weakness (W)									
		TG HKT		TG BKK		TG CNX		BAGS CNX		BAGS HKT	
		(S)	(W)	(S)	(W)	(S)	(W)	(S)	(W)	(S)	(W)
8. Airport Facility and Potentiality	Airport ownership type (public, majority public, majority private, private)	S		S		S		S		S	
	No. of runways		W	S			W		W		W
	Runway 3,800.m		W	S			W		W		W
	Runway 2,500.m		W	S			W		W		W
	Runway length (m)		W	S			W		W		W
	Airport operational time (around the clock)	S		S			W		W	S	
	Airport serving country capital city		W	S			W		W		W
9. Factors Impact on Cargo Market Competition	Weekly flight frequency of your customer airlines (numbers of flights per week)										
	Weekly flight frequency-Freighter cargo carriers		W	S			W		W		W
	Weekly flight frequency-Conventional carriers		W	S			W		W		W
	Route and geographical distribution of airfreight (numbers of flights)										
	Route and geographical distribution-IATA Area 1		W	S			W		W		W
	Route and geographical distribution-IATA Area 2		W	S			W		W		W
	Route and geographical distribution-IATA Area 3		W	S			W		W		W
	Numbers of flights per week-National carriers		W	S			W		W		W
	Numbers of flights per week-Foreign carriers		W	S			W		W		W
	Annual cargo througput-National carriers (tons)		W	S			W		W		W
	Annual cargo througput-Foreign carriers (tons)		W	S			W		W		W
	Size of local market (% of shipments locally generated)										
	Size of local market (%)-Inbound cargo (tons)		W	S			W		W		W
	Size of local market (%)-Outbound cargo (tons)		W	S			W		W		W
	International trade from Thailand (export value-Mil. USD per annum in 2016)										
	International trade to Hong Kong	S		S		S		S		S	
	International trade to South Korea	S		S		S		S		S	
	International trade to China	S		S		S		S		S	
	International trade to Japan	S		S		S		S		S	
	International trade to Taiwan	S		S		S		S		S	
	International trade to Singapore	S		S		S		S		S	
	International trade to Malaysia	S		S		S		S		S	
	International trade to India	S		S		S		S		S	
	International trade to Vietnam	S		S		S		S		S	
	Major air cargo logistics service providers presence around the airport	S		S		S		S		S	
	Betweenness centrality index		W	S			W		W		W

Table 35: Weakness and Strength of TG BKK to Other Air Cargo Terminal Operators (continued)

Comparing TG BKK to other 4 air cargo terminal operators in Table 35, TG BKK and Suvarnabhumi International Airport are the best in Thailand and being one of air cargo hubs in the world by ranking 15 of international freight. The current status of TG BKK is unreachable and incomparable to other air cargo terminal operators. Table 36 shows weakness and strength of TG BKK to the others. Main criteria 2 is nation system as explained earlier. Some sub-criteria in main criteria 9 of International trade from

Thailand (export value-Million USD per annum in 2016) and Betweenness Centrality index are based on Thailand and the airports' performance. The result would be calculated on same data and figures could have been changed in according to statistics of the change. Interestingly, main criteria 3 of customs operations is supposed to avail 24 hours while Thailand is open only business hours on weekdays and weekends. However, this is subject to local working environment. In case Thai customs is open 24 hours, counter-partners are able to perform any customs activity. This air cargo transport and terminal services are one of supply chain meaning that there would be no point to have Thai customs open 24/7 while other parties are not working at night.

Main Criteria	Sub-Criteria	TG BKK Weakness
2. Cargo Claims - International Convention Ratification & Limit of Liability	Warsaw convention 1929 (USD 20.00/ Kg)	Not applicable
	Warsaw convention as amended by Hague protocol 1955 (USD 20.00/Kg)	
	Warsaw convention as amended by Montreal protocol 1975 (USD 20.00/ Kg)	
4. E-Freight Implementation & Capability	E-freight capability target status	
	E-freight transit freight remaining on board	
	E-freight transshipment	
5. E-Air waybill Implementation & Capability	E-Air waybill-Transit cargo	
	E-Air waybill-Transshipment cargo	
6. IATA Safety Audit for Ground Operations (ISAGO) Certification	ISAGO-Cargo and mail acceptance and handling	
	ISAGO-Cargo security	
7. Air Cargo Terminal Characteristic	Cargo commodities (Three letter codes) (tons)	Nil raw data provided in third round questionnaire
	AVI (Live animal)	
	COL (Cool goods)	
	HUM (Human Remain in coffins)	
	PES (Fish/Seafood)	
	BIG (Oversized cargo)	
	EAT (Food stuff)	
	HEA (Heavy cargo, 150 kg & over/ piece)	
	BUP (Shipper/consignee handled unit)	
	CRT (Cool room: +15 C to +25 C)	
	PEM (Meat)	
	FRO (Frozen goods)	
	Transit cargo	
	Free trade zone shipment	
	Maximum connecting time (hours)	3 hours

Table 36: Weakness of TG BKK Air Cargo Terminal Operator

Main criteria 4 to 6 are dependent to air cargo terminal operators to comply with. The results would be adjusted if the operators complete all requirements. Main criteria 7 is

on demand and supply. The supply side is cargo facilities. Demand is cargo commodities. Air cargo terminal operators are able to use their figures and statistics to plan cargo facilities to enable to handle cargo and mail in the near future. Moreover, like TG BKK, the operator is capable to promote its cargo terminal to be specialized in any specific cargo. Studying at Table 27, perishable, general cargo, pharmaceuticals, dangerous goods, priority cargo and mail are at significant tonnages. TG BKK could invest and upgrade facilities to expertise these shipments as the hub and compete with other air cargo terminals or airports in this region. Main criteria 8 is on Airports of Thailand or Government of Thailand level to improve and develop air cargo service and support infrastructure such as numbers of runways in the near future. This study concentrates on only airports in Thailand and when any research comparing airports in Thailand with airports in other countries, the results will clearly show how different between airports. Main criteria 9 is impact on cargo market competition to see the situation and factors in local and international markets impact air cargo terminal operators and airlines. This criteria would support the decision of concerned parties to be aware of external conditions from business sections.

For all 9 criteria classification, TG BKK is the best among 5 operators and almost fulfil 9 main criteria and 44 sub-criteria no matter classified into 2, 3 or 4 clusters considered as the national hub. The rest of air cargo terminal operators are more or less equivalent and obviously dispersed into all clusters in case of classification into 3 or even 4 clusters. The 2 cluster classification is clear to identify TG BKK comparing to the other air cargo terminal operators.

In according to the research question 2 and objective 2, the air cargo classification model is to test the model on air cargo terminals at BKK, CNX and HKT airports. There are TG BKK, TG CNX, TG HKT, BAGS CNX and BAGS HKT. The results from Hierarchical Cluster Analysis comparing with raw data from third round questionnaire and the researchers classify the 5 operators into 3 clusters or classification as explained in Table 34. Therefore, there are three classification to the 5 operators as following details. However, the classification names are for the sampling operators only. There would be other classification names in case of the researchers apply the model to

classify air cargo terminals in other regions due to sampling size and natures of air cargo terminals are differently in each airport. The results from such examination will be different to this research. The remark to above classification names are for this research at the location of study at BKK, CNX and HKT airports only.

Classification for TG BKK, TG CNX, TG HKT, BAGS CNX and BAGS HKT

Firstly, TG HKT, TG CNX and BAGS CNX are called “Basic Cargo Terminal” as the three terminals are with common physical and document cargo handling services only. There is not any obvious capability and potentiality comparing to TG BKK and BAGS HKT but the 3 operators are able to handle all kinds of cargo. Moreover, Basic Cargo Terminal classification is with very minor progress of electronic and ISAGO processing for cargo handling service for operations wise. The basic infrastructure is almost the same to each other by Squared Euclidean Distance and raw data from third round questionnaire. For commercial side, air cargo transport is on passenger aircrafts and limited flight frequency. Looking at 9 main criteria and 44 sub-criteria, there is a notice of this Basic Cargo Terminal Classification. The achievement to meet such criteria is similar to the three operators as TG HKT achieves only 5 of 9 main criteria and 19 of 44 sub-criteria. TG HKT does not comply with criteria 2 (Cargo Claims - International Convention Ratification & Limit of Liability), criteria 4 (E-Freight Implementation & Capability), criteria 5 (E-Air waybill Implementation & Capability) and criteria 6 (IATA Safety Audit for Ground Operations (ISAGO) Certification). TG CNX achieves only 5 of 9 main criteria and 21 of 44 sub-criteria. TG CNX does not comply with criteria 2, 4, 5 and 6 as same as TG HKT. BAGS CNX achieves only 7 of 9 main criteria and 23 of 44 sub-criteria. TG CNX does not comply with criteria 2 and 4. Three operators comply with 19, 21 and 23 sub-criteria similarly and respectively. The achieved criteria is considered approximately 47.72% for three operators.

Secondly, BAGS HKT is called “Standard Cargo Terminal” and equipped with facilities that exist in “Basic Cargo Terminal” with a top up by outstanding E-freight, full handling service similar to TG BKK and ISAGO implementation and certification. The special options that are available at BAGS HKT make the distinguish classification.

By Dendrogram using Average Linkage, BAGS HKT is clustered separately from Basic Cargo Terminal classification depend on rescaled distance at 10. The achievement to meet 9 main criteria and 44 sub-criteria is similar to TG BKK but with much smaller scales of data input in raw data received from BAGS HKT in the third round questionnaire. BAGS HKT achieves 7 of 9 main criteria and 31 of 44 sub-criteria. BAGS HKT does not comply with criteria 2 (Cargo Claims - International Convention Ratification & Limit of Liability) and criteria 5 (E-Air waybill Implementation & Capability). There is a remark of this classification that BAGS HKT achieves 7 of 9 main criteria and even 31 of 44 sub-criteria as similar to TG BKK. BAGS HKT is at the same level of TG BKK. However, 7 main criteria and 31 sub-criteria of BAGS HKT are equipped with small scales of all items comparing to TG BKK such as related cargo terminal, airport and market competitiveness conditions.

Lastly, TG BKK is called “International Cargo Hub Terminal” as by much better cargo volume, infrastructure, service, e-cargo, commercial and airport facility conditions, etc. are outstanding among 5 operators by Squared Euclidean Distance and raw data without any doubt. National Cargo Hub Terminal is appropriate to call TG BKK with supporting figures in Table 27 and 28. In addition, TG BKK is not similar to any other terminal for this research and stand alone in cluster number 2 as always. TG BKK achieves 7 of 9 main criteria and 31 of 44 sub-criteria. TG BKK does not comply with criteria 2 (Cargo Claims - International Convention Ratification & Limit of Liability) and criteria 6 (IATA Safety Audit for Ground Operations (ISAGO) Certification). Even though, TG BKK is with the same achievement level of 7 main criteria and 31 sub-criteria, TG BKK performance is much better in all items and incomparable to BAGS HKT. This leads TG BKK is separated in its own cluster for 2 to 4 cluster experiment in Hierarchical Cluster Analysis.

Criteria 2 of Cargo Claims - International Convention Ratification & Limit of Liability is based on the nation as Thailand has not ratified any international convention for limit of liability. When Thailand ratifies any international convention, all air cargo terminals including airlines and air cargo logistics service providers in Thailand will automatically be ratified (IATA, 2016a).

4.3 Results of Phase III: Research Question 3, Research Objective 3

Research question 3 is “What are the relevant and important guideline and check list to major air cargo terminal classification for air cargo terminal operators?”. The guideline and check list are available for air cargo terminal operators or related practitioners around the world to follow for their bidding and business purposes and necessary service requirements and arrangements. Table 37 is formulated from the significant criteria and put into Ms. Excel format for air cargo terminal operators or any interested party to use this guideline and check list to evaluate the current capability and significance of listed criteria that influence to provide air cargo terminal service to airlines and impact to air cargo industry from your air cargo terminal and/or airport's competitiveness. Please mark "Yes or 1" in case of each sub-criteria is applicable, available or relevant on your air cargo terminal service and airport's competitiveness. Otherwise, "No or 0" is marked for when criteria are inapplicable, unavailable or irrelevant on your air cargo terminal service and airport's competitiveness. Remarks are able to be inserted as additional comments or reference under each criteria. Table 38 is Total Score Summary of 9 main criteria for guideline and check list. Each main criteria will have total score and in case of respondents such as Company A and Company B fill out such guideline and check list with “Yes or 1” in all 44 sub-criteria. The grand total score is 34.305 or 100% as an example. The score of any sub-criteria marked “No or 0” is deducted as equal as the factor loading score per such sub-criteria. For instance, Company B is unable to apply main criteria 2 with 3 sub-criteria for Cargo Claims - International Convention Ratification & Limit of Liability in Thailand. The score of 2.644 is deducted to zero score and the grand total score is reduced to 31.661 or 92.3%. The users is able to evaluate and analyze each main criteria as well for the total score and all main criteria 1 to 9 for any further usage and preparation review.

Moreover, Table 37 and 38 are only one example to apply 9 main criteria and 44 sub-criteria with factor loading scores. Air cargo terminal operators and other interested stake holders can adopt and adapt this guideline and check list to other formulations subject to the preference and desire for any further study and analysis of users and practitioners around the world.

Guideline and Check List for Air Cargo Terminal Operator: Company A and B

The 9 main criteria and 44 sub-criteria are to evaluate the current capability and significance of listed below conditions that influence to provide air cargo terminal service to airlines and impact to air cargo industry from your air cargo terminal and/or airport's competitiveness. Please mark "Yes or 1" in case of each sub-criteria is applicable, available or relevant on your air cargo terminal service and airport's competitiveness. Otherwise, "No or 0" is marked for when criteria are inapplicable, unavailable or irrelevant on your air cargo terminal service and airport's competitiveness. Remarks are able to be inserted as additional comments or reference under each criteria.

9 Main Criteria	44 Sub-criteria	Company A			Company B		
		Yes/1	No/0	Remarks	Yes/1	No/0	Remarks
1. Cargo and Mail Service Readiness (IATA SGHA version 2013)	Transfer/transit cargo						
	Physical handling outbound/inbound						
	Cargo and mail handling – general						
	Documentation handling						
	Until load device (ULD) control						
	Automation/computer systems						
2. Cargo Claims - International Convention Ratification & Limit of Liability	Warsaw convention as amended by Hague protocol 1955 (250.00 francs or USD 20.00/Kg)						
	Warsaw convention 1929 (250.00 francs or USD 20.00/ Kg)						
	Warsaw convention as amended by Montreal protocol 1975 (SDR 17.00 or USD 20.00/ Kg)						
3. Customs Operations	Weekdays and weekends (Business hours)						
	Weekdays (Business hours)						
	Customs clearance times (hours):						
4. E-Freight Implementation & Capability	Electronic import goods declaration						
	Electronic export goods declaration						
	Electronic export cargo declaration						
	Electronic import cargo declaration						
	Transhipment						
	Transit freight remaining on board						
	E-freight capability target status						
5. E-Air waybill Implementation & Capability	Import cargo						
	Export cargo						
	Transit cargo						
	Transhipment cargo						
6. IATA Safety Audit for Ground Operations (ISAGO) Certification	Cargo security (facilities, operations)						
	Cargo and mail acceptance and handling (general, dangerous goods, live animals and perishables, other special cargo, unit load devices)						
7. Air Cargo Terminal Characteristic	Cargo terminal area (sq.m.)						
	Total cargo throughput (metric tonnes) per annum (p.a.)						
	Available tracking and tracing service						
	Maximum connecting time (hours)						
	Cargo commodities (IATA three letter codes)						
	Capacity (metric tonnes) per annum (p.a.)						
8. Airport Facility and Potentiality	Airport ownership types (public, majority public, majority private, private)						
	Runway length: 3,800 m						
	Numbers of runways						
	Airport operational time - available around the clock						
	Airport serving country capital city						
	Runway length: 2,500 m						
9. Factors Impact on Cargo Market Competition	Route and geographical distribution of airfreight (numbers of flights per week)						
	International trade (export value)						
	Flight frequency (weekly flight frequency of the selected airports)						
	Centrality (betweenness centrality of airports by area)						
	National versus foreign carriers (flight (%) operated by flag carriers)						
	Size of local market (% of shipments locally generated)						
	Freight forwarder presence						
Total Scores							

Table 37: Guideline and Check List for Air Cargo Terminal Operators' Evaluations

9 Main Criteria and 44 Sub-criteria for Air Cargo Terminal Classification		Total Scores	Company A				Company B			
			1	0	Earned Scores	(%)	1	0	Earned Scores	(%)
1. Cargo and Mail Service Readiness (IATA SGHA version 2013)	Transfer/transit cargo	0.857	1		0.857	100	1		0.857	100
	Physical handling outbound/inbound	0.856	1		0.856	100	1		0.856	100
	Cargo and mail handling – general	0.853	1		0.853	100	1		0.853	100
	Documentation handling	0.850	1		0.850	100	1		0.850	100
	Until load device (ULD) control	0.710	1		0.710	100	1		0.710	100
	Automation/computer systems	0.655	1		0.655	100	1		0.655	100
	Total Score	**4.781**			**4.781**	**100.0**			**4.781**	**100.0**
2. Cargo Claims - International Convention Ratification & Limit of Liability	Warsaw convention as amended by Hague protocol 1955 (250.00 francs or USD 20.00/Kg)	0.886	1		0.886	100		0	0	0
	Warsaw convention 1929 (250.00 francs or USD 20.00/ Kg)	0.885	1		0.885	100		0	0	0
	Warsaw convention as amended by Montreal protocol 1975 (SDR 17.00 or USD 20.00/ Kg)	0.873	1		0.873	100		0	0	0
	Total Score	**2.644**			**2.644**	**100.0**			**0**	**0.0**
3. Customs Operations	Weekdays and weekends (Business hours)	0.833	1		0.833	100	1		0.833	100
	Weekdays (Business hours)	0.731	1		0.731	100	1		0.731	100
	Customs clearance times (hours):	0.663	1		0.663	100	1		0.663	100
	Total Score	**2.227**			**2.227**	**100.0**			**2.227**	**100.0**
4. E-Freight Implementation & Capability	Electronic import goods declaration	0.897	1		0.897	100	1		0.897	100
	Electronic export goods declaration	0.895	1		0.895	100	1		0.895	100
	Electronic export cargo declaration	0.891	1		0.891	100	1		0.891	100
	Electronic import cargo declaration	0.888	1		0.888	100	1		0.888	100
	Transhipment	0.764	1		0.764	100	1		0.764	100
	Transit freight remaining on board	0.730	1		0.730	100	1		0.730	100
	E-freight capability target status	0.681	1		0.681	100	1		0.681	100
	Total Score	**5.746**			**5.746**	**100.0**			**5.746**	**100.0**
5. E-Air waybill Implementation & Capability	Import cargo	0.903	1		0.903	100	1		0.903	100
	Export cargo	0.852	1		0.852	100	1		0.852	100
	Transit cargo	0.830	1		0.830	100	1		0.830	100
	Transhipment cargo	0.824	1		0.824	100	1		0.824	100
	Total Score	**3.409**			**3.409**	**100.0**			**3.409**	**100.0**
6. IATA Safety Audit for Ground Operations (ISAGO) Certification	Cargo security (facilities, operations)	0.843	1		0.843	100	1		0.843	100
	Cargo and mail acceptance and handling (general, dangerous goods, live animals and perishables, other special cargo, unit load devices)	0.797	1		0.797	100	1		0.797	100
	Total Score	**1.640**			**1.640**	**100.0**			**1.640**	**100.0**
7. Air Cargo Terminal Characteristic	Cargo terminal area (sq.m.)	0.851	1		0.851	100	1		0.851	100
	Total cargo throughput (metric tonnes) per annum (p.a.)	0.728	1		0.728	100	1		0.728	100
	Available tracking and tracing service	0.676	1		0.676	100	1		0.676	100
	Maximum connecting time (hours)	0.636	1		0.636	100	1		0.636	100
	Cargo commodities (IATA three letter codes)	0.622	1		0.622	100	1		0.622	100
	Capacity (metric tonnes) per annum (p.a.)	0.612	1		0.612	100	1		0.612	100
	Total Score	**4.125**			**4.125**	**100.0**			**4.125**	**100.0**
8. Airport Facility and Potentiality	Airport ownership types (public, majority public, majority private, private)	0.796	1		0.796	100	1		0.796	100
	Runway length: 3,800 m	0.788	1		0.788	100	1		0.788	100
	Numbers of runways	0.780	1		0.780	100	1		0.780	100
	Airport operational time - available around the clock	0.759	1		0.759	100	1		0.759	100
	Airport serving country capital city	0.671	1		0.671	100	1		0.671	100
	Runway length: 2,500 m	0.652	1		0.652	100	1		0.652	100
	Total Score	**4.446**			**4.446**	**100.0**			**4.446**	**100.0**
9. Factors Impact on Cargo Market Competition	Route and geographical distribution of airfreight (numbers of flights per week)	0.874	1		0.874	100	1		0.874	100
	International trade (export value)	0.820	1		0.820	100	1		0.820	100
	Flight frequency (weekly flight frequency of the selected airports)	0.779	1		0.779	100	1		0.779	100
	Centrality (betweenness centrality of airports by area)	0.759	1		0.759	100	1		0.759	100
	National versus foreign carriers (flight (%) operated by flag carriers)	0.753	1		0.753	100	1		0.753	100
	Size of local market (% of shipments locally generated)	0.669	1		0.669	100	1		0.669	100
	Freight forwarder presence	0.633	1		0.633	100	1		0.633	100
	Total Score	**5.287**			**5.287**	**100.0**			**5.287**	**100.0**
Grand Total Score (Main Criteria 1 to 9)		**34.305**			**34.305**	**100.0**			**31.661**	**92.3**

Table 38: Example of 9 Main Criteria Summary for Guideline and Check List

Chapter 5

5. Conclusions

5.1 Air Cargo Hub and Investment in Thailand's Airports

In according to results from Chapter 4, Thai Airways International (TG BKK) as air cargo terminal operator is actually outstanding in according to all 9 significant criteria from the research apart from other 4 air cargo terminal operators in Thailand's major international airports namely Suvarnabhumi (BKK), Chiang Mai (CNX), Phuket (HKT). Don Muang (DMK)'s air cargo business is about the same size as HKT airport by cargo volume. Regrettably, the air cargo terminal operator at DMK airport does not participate this study. However, BKK, CNX and HKT airports represent Thailand's air cargo transport and service. TG BKK is verified and proven toward other air cargo terminal operators to the other side. Certainly, BKK airport serves Bangkok as the capital city. Though, the results from this sophisticated study is completely affirmative that TG BKK is the best air cargo terminal operator in Thailand. The other air cargo terminal namely BAGS CNX, TG CNX, BAGS HKT and TG HKT are similar to each other. Moreover, TG BKK has cargo tonnages more than 75% of BKK airport (AOT, 2017) as a result of cargo volume from Thai Airways as the flag carrier. This study confirms that air cargo transport and service at BKK airport is the most significant port in the nation.

Thus, BKK airport plays as a hub of air cargo movement and has to continue to grow as only one hub in Thailand. Other airports are far behind BKK airport. All major investment and development from Government of Thailand, Airports of Thailand and other stake holders shall be emphasized on air cargo equipment and facilities rather than invested in other airports. There are still impromptu services and facilities of current air cargo terminal operators in accordance to Table 35 and 36 or this below list. Criteria 2, 4, 5, are 6 are not available at BKK airport at this moment: also, criteria 7 of cargo commodities and maximum connecting time. Not only TG BKK as an air cargo terminal operator but the other air cargo terminal operator as well including relevant organizations and authorities such as Airports of Thailand, Thai customs, airlines and air cargo traders in BKK airport shall carefully invest and develop these 6 significant

criteria as the priority because of these unavailable criteria and unexpected target. There are necessary actions shall be taken by several parties to fulfil criteria.

Main Criteria	Sub-Criteria	Action by
2. Cargo Claims - International Convention Ratification & Limit of Liability	Warsaw convention 1929 (USD 20.00/ Kg)	Government of Thailand (IATA, 2016a)
	Warsaw convention as amended by Hague protocol 1955 (USD 20.00/Kg)	
	Warsaw convention as amended by Montreal protocol 1975 (USD 20.00/ Kg)	
4. E-Freight Implementation & Capability	E-freight capability target status	Air cargo terminals, carriers, air cargo logistics service providers, shippers, customs brokers, customs authorities (IATA, 2016a)
	E-freight transit freight remaining on board	
	E-freight transshipment	
5. E-Air waybill Implementation & Capability	E-Air waybill-Transit cargo	Carriers including air cargo terminal operators and air cargo logistics service providers (IATA, 2016a)
	E-Air waybill-Transshipment cargo	
6. IATA Safety Audit for Ground Operations (ISAGO) Certification	ISAGO-Cargo and mail acceptance and handling	Air cargo terminal operators (IATA, 2010)
	ISAGO-Cargo security	
7. Air Cargo Terminal Characteristic	Cargo commodities (Three letter codes) (tons)	Air cargo terminal operators, carriers, air cargo logistics service providers, shippers and industry experts (IATA, 2017b) and air cargo terminal operators (AAT and HACTL)
	AVI (Live animal)	
	COL (Cool goods)	
	HUM (Human Remain in coffins)	
	PES (Fish/Seafood)	
	BIG (Oversized cargo)	
	EAT (Food stuff)	
	HEA (Heavy cargo, 150 kg and over per piece)	
	BUP (Shipper/consignee handled unit)	
	CRT (Cool room: +15 C to +25 C)	
	PEM (Meat)	
	FRO (Frozen goods)	
	Transit cargo	
	Free trade zone shipment	
	Maximum connecting time (hours)	Air cargo terminal operators (AAT and HACTL)

Table 39: Necessary Actions to Invest and Develop TG BKK Air Cargo Terminal and/or Air Cargo Service at Suvarnabhumi International Airport

Table 39 shows missing significant criteria of BKK airport. In order to accomplish to be the competitive hub of air cargo service and transport in the region, TG BKK including other relevant stake holders shall seriously take the consideration to invest and develop these missing significant criteria at BKK airport. Criteria 2 of Cargo

Claims - International Convention Ratification & Limit of Liability is indirectly related to air cargo terminal operators but the limit of liability of claim has a huge impact to air cargo terminal operators when reimbursement claim to carriers. Government of Thailand is currently not party to any of the international conventions covering the limit of the carrier for carriage by air. Criteria 4 and 5 of E-Freight and E-Air Waybill Implementation & Capability are relevant to several parties and air cargo terminal operators are part of the chain in order to complete this project of IATA. E-Air Waybill process is involved only carriers, air cargo terminal operators and air cargo logistics service providers at origin, transit and final destinations (IATA, 2016a). E-Freight project is for air cargo terminals, carriers, air cargo logistics service providers, shippers, customs brokers, customs authorities to comply with IATA regulations. Still, the completion is challenging all concerned parties for this target from all member countries. Criteria 6 for IATA Safety Audit for Ground Operations (ISAGO) Certification is required to be as a minimum standard for air cargo terminal service by Rodrigo Reyes from IATA. Air cargo terminal operators are able to anticipate the audit program and conform all check lists from IATA in order to receive the certificate (IATA, 2010). These first 4 missing criteria are referred to IATA as the regulator to the world's aviation sector.

Criteria 7 of Air Cargo Terminal Characteristic is partly on IATA Cargo Delivery Model in a section of "special cargo" that special cargo commodities such as live animal, perishable, pharmaceutical or special cargo that are required to transport in compliance with regulations, standards and training. Physical cargo and document acceptance, handling, loading and transportation are with global industry and standard that the supply chain (inclusive air cargo terminal operators, carriers, air cargo logistics service providers, shippers and industry experts) has to work closely and meet all regulatory issues. On the other hand, criteria 7 is associated with air cargo terminal operator in term of air cargo terminal facilities and equipment. TG BKK does not mark on such cargo commodities on the cargo volume aspect as a result of third round questionnaire. However, criteria is concerned with cargo commodities and maximum connecting times. Therefore, the researcher invites Asia Airfreight Terminal (AAT) and

5.2 Additional Recommendation to Suvarnabhumi International Airport Based on Key Success Factors from Hong Kong International Airport

Hong Kong Air Cargo Terminals (HACTL) as two of air cargo terminal operators in Hong Kong international airport as the best practice and world's leading air cargo airport in the world in Table 2 and 3. Kuah Boon Kiam , General Manager from AAT and Ken Lau , Senior Commercial Manager from HACTL provides valuable recommendation and conditions to air cargo terminal and cargo airport specified in Hong Kong airport. There are key success factors that influence Hong Kong Airport to be the world number 1 cargo airport from 2 third of all air cargo terminal operators there as follows:

Recommendation and conditions from AAT:

- 70% of cargo exported from Hong Kong is BUP cargo (Shipper/consignee handled unit) so called pre-built unit load device (ULD) by regulated air cargo logistics service providers and given to air cargo terminal operators. The BUP cargo is to reduce handling activities and shorten the cargo acceptance time at air cargo terminals to move quicker. AAT considers this factor is the most significance to push Hong Kong airport to be the biggest cargo airport in the world.
- Most air cargo logistics service providers are regulated and able to deliver secured cargo to air cargo terminals comparing to all export cargo from China are loosely required 100% security screening at air cargo terminals with much longer handling processes.
- Air cargo terminals are partly in a free trade zone which freely allows cargo movement between air cargo terminals and air cargo logistics service providers' warehouses. AAT gives an example of the well-organized free trade zone in Singapore international airport as well. Air cargo terminals and air cargo logistics service providers are located inside the free trade zone where cargo is able to move between facilities without any check by customs. The cargo are only checked when leaving the free trade zone.

- National airlines such as Cathay Pacific and Singapore airlines rely heavily on transit cargo with shorter connecting time at the home bases to remain competitive hubs. AAT expects to have 60% transit cargo after its new owner as Hong Kong airlines moves in the cargo terminal in November 2017.
- Minimum connecting time is 3 hours for any transit cargo which requires handling activities at the intra-terminal transferred/transit cargo. Aircraft to aircraft cargo transfers/transits are commonly practiced at both Hong Kong and Singapore airports with 2 hours for bulk shipment and BUP cargo. The total minimum connecting time inclusive cargo towing is at least 6 hours between arriving and departing flights in Hong Kong airport.
- Huge cargo demand from China and the status of gateway to the biggest manufacturing countries in the world. Hong Kong airport has benefited from its global network connectivity while this advantage becomes less because Chinese airports offer direct flights to key markets in USA, Europe and Australia. Import and export cargo to/from Hong Kong airport are for South East Asia, USA, Canada, Europe, Mainland China, Taiwan, Japan and Australasia regions.
- More proficient single standard of customs clearance process for export cargo from Hong Kong airport and friendly business taxation export from Hong Kong than China with difference in cities are also key success of being the world's air cargo hub.
- AAT has 2 air cargo terminals. Terminal 1 is with one floor terminal and a multi-story terminal called Terminal 2. In term of cargo flow from landside to airside – vv., a single story terminal is more efficient.
- Most industry experts trust that the expertise in handling special cargo commodities is the success to grow. AAT provides an example of SATS Singapore as an air cargo terminal operator at Singapore airport who invests in Coolport for cool facilities. This Coolport implicitly enhances high yield pharmaceutical volume. Live animal, e-commerce parcels and dangerous goods are required to have special attentions as well.
- Airport facilities for instance runways must be planned well in order to avoid the current landing slots and over all congestion at Hong Kong airport.

HACTL also pinpoints the same conditions for air cargo terminals and Hong Kong airport with AAT . Hong Kong airport has the regulated air cargo logistics service providers (agents) regime (RAR) which required only 1% of cargo to be security screened. Export cargo is built up at air cargo logistics service providers' facilities and deliver the finished cargo to air cargo terminals with a shorter cut-off time. In addition, the airport is a free trade port/zone where customs formality is simple and most cargo are not subject to import duty. The airport is well-equipped with 24/7 air cargo terminals and current 2 runways including over thousands of high experience air cargo logistics service providers. Hong Kong Air Cargo Terminals Company (HACTL HKG) is highly automated with 10,000 storage for prepacked or finished cargo from air cargo logistics service providers. HACTL HKG also informs that there is no maximum connecting time in HKG but the minimum connecting time for inter-terminal transshipment or transit cargo is 7 hours. The benefit of HACTL HKG is over 100 international customer airlines providing an excellent platform for interline and transit cargo opportunities for airlines to expand the cargo business. In 2016, HACTL handled 1.65 million tons of cargo with 25% for import cargo, 66% for export cargo and 9% for transit cargo respectively.

The esteem fact and recommendation of Hong Kong airport from AAT are valuable to this research and for any concerned party in Thailand to double-check the current situation at Suvarnabhumi airport for air cargo service and facility. To simplify the result from this research and comments from the world's best practice of air cargo airport, the researcher interviews Suchart Pratheppladda, Director, Terminal Operations department, Thai Airways International Public Company Limited so called TG BKK. TG BKK shares data and daily complications for providing air cargo terminal service to airlines at Suvarnabhumi airport comparing to Hong Kong airport's services and conditions as stated below in Table 40. The comparison is prepared in rendering to items listed from AAT with information from TG BKK.

Key Factors of AAT and Hong Kong Airport Successes	Factor Availability at TG BKK and Suvarnabhumi Airport
BUP Cargo (Pre-built unit) to/from regulated air cargo logistics service providers at 70% level	Not available
Secured Cargo to/from most regulated air cargo logistics service providers	Not available and 100 security screening required
Electronic customs clearance process	Require electronic data and printed document
Free trade zone for free cargo movement between air cargo terminals and air cargo logistics service providers' warehouses without customs check	Not available
60% transit cargo from national airlines at AAT cargo terminal	42% transit cargo from national airlines at TG BKK cargo terminal
Huge cargo demand from China	Not available
Minimum connecting time is 3 hours at the intra-terminal transferred/transit cargo	Maximum connecting time is 3 hours at the intra-terminal transferred/transit cargo: TG BKK is more competitive than AAT HKG.
One floor cargo terminal for smooth flow	Available at the same condition
Expertise in handling special cargo commodities	Available at the same condition
2 Runways (3,800 m each)	2 Runways (3,700 and 4,000 m) at the almost same condition

Table 40: Comparison of Air Cargo Related Factors between Suvarnabhumi and Hong Kong International Airports

Both experts provide information based on current working environment in Hong Kong and Suvarnabhumi international airports. The researcher uses key successful factors that make Hong Kong airport as number 1 cargo airport in the world for years as element factors and compare with air cargo conditions at Suvarnabhumi airport.

The contrast and disadvantage of TG BKK and Suvarnabhumi are most of all items expect the maximum connecting time which TG BKK is competitive. “One floor cargo terminal and expertise in handling special cargo commodities” are equivalent at the same level for both air cargo terminal operators.

Table 39 and 40 provide needful necessity to concerned stake holders including Government bodies who are cope with aviation and air cargo activities to carefully look into these subjects. The current disadvantages and weaknesses of TG BKK and/or Suvarnabhumi airport are majorly incomparable to AAT HKG and/or Hong Kong airport. These recommendations are pointed out for the quick responses and obligatory actions to invest and develop much more for Suvarnabhumi airport and related regulations to be able to compete with other major cargo airports and catch up Hong Kong airport for being the leading cargo airport in this region or the world.

Key Factors of AAT and HKG Airport Successes	**HKG Airport Model Recommended by AAT**
BUP Cargo (Pre-built unit) from air cargo logistics service providers at 70% level	The new air cargo security standards promulgated by ICAO applicable from 15 July 2013, enhancement to the air cargo security regulated agent regime (RAR) shall be applied for consignors and air cargo logistics service providers (CAD, 2017)
Secured Cargo to/from most regulated air cargo logistics service providers	Regulated Agent shall arrange to conduct random x-ray screening, preferably on a monthly basis, of a minimum of 1% (in weight) of known cargo consignments at their warehouses. This will allow air cargo logistics service providers to build up and deliver secured BUP cargo to air cargo terminals with much shorter cut-off time and reduce handling and acceptance activities for export cargo.

Key Factors of AAT and HKG Airport Successes	HKG Airport Model Recommended by AAT
Electronic customs clearance process	To simply apply electronic clearance process and friendly taxation with timely cargo clearance for airlines and air cargo logistics service providers.
Free trade zone for free cargo movement between air cargo terminals and air cargo logistics service providers' warehouses without customs check	Free trade zone concept shall be completely established and allow free cargo movement inside the free trade zone.
60% transit cargo from national airlines at AAT cargo terminal	Transit cargo from national airlines are a key driven success
Huge cargo demand from China	Huge cargo demand is supportive to air cargo transport

Table 41: Necessary Improvement for TG BKK and Suvarnabhumi International Airport by Hong Kong International Airport Model

Table 41 is to provide solid recommendations to concerned authorities to apply Hong Kong international airport's model for necessary improvement. The recommendations of our current unavailable conditions at Suvarnabhumi airport shall be seriously looked into and urgent improvement is needful from Government of Thailand to push and activate its policy for being more competitive in air cargo hub in this region.

5.3 Necessary Development and Improvement for Air Cargo Terminals at Chiang Mai and Phuket International Airports

In addition to TG BKK and BKK airport, TG HKT, TG CNX, BAGS CNX and BAGS HKT represent CNX and HKT airports. The weakness from raw data in Table 35 and 42 shows disadvantage points to Government of Thailand and interested concerned stakeholders to acknowledge, improve and develop CNX and HKT airports in according to information received from the four air cargo terminal operators.

Main Criteria	Sub-Criteria	Weakness (W) for Further Improvement and Development				
		TG HKT	TG CNX	BAGS CNX	BAGS HKT	Action by
1	Transfer/transit cargo	-	-	W	-	Air cargo terminal operators (IATA, 2016d)
	Automation/computer systems	-	-	W	-	
	Until load device (ULD) control	W	W	W	-	
2	Warsaw convention 1929 (USD 20.00/ Kg)	W	W	W	W	Government of Thailand (IATA, 2016a)
	Warsaw convention as amended by Hague protocol 1955 (USD 20.00/Kg)	W	W	W	W	
	Warsaw convention as amended by Montreal protocol 1975 (USD 20.00/ Kg)	W	W	W	W	
3	Customs operations-Weekdays (Business hours)	W	W	W	W	Government of Thailand (IATA, 2016a)
	Customs clearance times (hours)	W	-	-	-	
4	E-freight capability target status	W	W	W	-	Air cargo terminals, carriers, air cargo logistics service providers, shippers, customs brokers, customs authorities (IATA, 2016a)
	E-freight export goods declaration	W	W	W	-	
	E-freight export cargo declaration	W	W	W	-	
	E-freight import goods declaration	W	W	W	-	
	E-freight import cargo declaration	W	W	W	-	
	E-freight transit freight remaining on board	W	W	W	W	
	E-freight transhipment	W	W	W	-	
5	E-Air waybill-Import Cargo	W	W	-	W	Carriers including air cargo terminal operators and air cargo logistics service providers (IATA, 2016a)
	E-Air waybill-Export Cargo	W	W	-	W	
	E-Air waybill-Transit cargo	W	W	W	W	
	E-Air waybill-Transhipment cargo	W	W	W	W	
6	ISAGO-Cargo and mail acceptance and handling	W	W	-	-	Air cargo terminal operators (IATA, 2010)
	ISAGO-Cargo security	W	W	-	-	
7	Cargo terminal area (sq.m.)	W	W	W	W	Air cargo terminal operators (AAT and HACTL)
	Capacity (metric tonnes) per annum	W	W	W	W	
	Total cargo throughput (metric tonnes) per annum	W	W	W	W	
	Cargo commodities (Three letter codes) (tons)	-	-	-	-	Air cargo terminal operators, carriers, air cargo logistics service providers, shippers and industry experts (IATA, 2017b) and air cargo terminal operators (AAT and HACTL)
	PER (Perishable cargo)	W	W	W	W	
	GEN (General cargo)	W	W	W	W	
	DGR (Dangerous goods)	W	W	W	W	
	PIL (Pharmaceuticals)	W	W	W	W	
	VAL (Valuable cargo)	W	W	W	W	
	AVI (Live animal)	W	W	W	W	
	XPS (Priority cargo)	W	W	W	W	
	COL (Cool goods)	W	W	W	W	
	HUM (Human Remain in coffins)	W	W	W	W	
	VUN (Vulnerable cargo)	W	W	W	W	
	PES (Fish/Seafood)	W	W	W	W	
	MAL (Mail)	W	W	W	W	
	BIG (Oversized cargo)	W	W	W	W	
	EAT (Food stuff)	W	W	W	W	
	HEA (Heavy cargo, 150 kg and over per piece)	W	W	W	W	
	BUP (Shipper/consignee handled unit)	W	W	W	W	
	CRT (Cool room: +15 C to +25 C)	W	W	W	W	
	PEM (Meat)	W	W	W	W	
	FRO (Frozen goods)	W	W	W	W	
	Transit cargo	-	W	W	-	
	Free trade zone shipment	W	W	W	W	
	Maximum connecting time (hours)	W	W	-	W	Air cargo terminal operators (AAT and HACTL)
	Available tracking and tracing service	-	-	W	-	

Main Criteria	Sub-Criteria	Weakness (W) for Further Improvement and Development				
		TG HKT	TG CNX	BAGS CNX	BAGS HKT	Action by
8	No. of runways	W	W	W	W	Airports of Thailand (AAT and HACTL)
	Runway 3,800.m	W	W	W	W	
	Runway 2,500.m	W	W	W	W	
	Runway length (m)	W	W	W	W	
	Airport operational time (around the clock)	-	W	W	-	
	Airport serving country capital city	W	W	W	W	
9	Weekly flight frequency of your customer airlines (numbers of flights per week)	-	-	-	-	All industry stakeholders including airlines, air cargo logistics service providers, airports of Thailand, Government of Thailand and air cargo terminal operators (IATA, 2017)
	Weekly flight frequency-Freighter cargo carriers	W	W	W	W	
	Weekly flight frequency-Conventional carriers	W	W	W	W	
	Route and geographical distribution of airfreight (numbers of flights)	-	-	-	-	
	Route and geographical distribution-IATA Area 1	W	W	W	W	
	Route and geographical distribution-IATA Area 2	W	W	W	W	
	Route and geographical distribution-IATA Area 3	W	W	W	W	
	Numbers of flights per week-National carriers	W	W	W	W	
	Numbers of flights per week-Foreign carriers	W	W	W	W	
	Annual cargo throughput-National carriers (tons)	W	W	W	W	
	Annual cargo throughput-Foreign carriers (tons)	W	W	W	W	
	Size of local market (% of shipments locally generated)	-	-	-	-	
	Size of local market (%)-Inbound cargo (tons)	W	W	W	W	
	Size of local market (%)-Outbound cargo (tons)	W	W	W	W	
	Betweenness centrality index	W	W	W	W	

Table 42: Actions for CNX and HKT Airports' Improvement and Development

The comparison and action recommendation are the parameter to policy makers to recognize the missing criteria from this research to improve and develop air cargo services at both airports. Table 42 presents current statuses of CNX airport (TG CNX and BAGS CNX) and HKT airport (TG HKT and BAGS HKT) for air cargo services. As mentioned earlier that CNX and HKT airports are incomparable and far behind BKK airport. There is huge area and gaps that required to improve and develop. Regrettably, CNX and HKT airports have fulfilled lower criteria from 9 main criteria and 44 sub-criteria. Even BAGS HKT fulfils criteria at the same level to TG BKK but with much smaller scales in term of facilities, airport conditions and market driven factors. This shows that the concerned parties are requested to situate aggressive efforts and investment in order to enhance CNX and HKT airports to be rival or slightly close to BKK airport. This concern is for air cargo service only excluding other activities such as passenger for example in order to at least be able to promote or compete with Top 100 air cargo airports or even with major surrounding airports in ASEAN region.

5.4 Comparison Study between Suvarnabhumi and Hong Kong International Airports by Guideline and Check List

The 9 significant criteria allow air cargo terminal operators in the world to understand mainly relevant concentration that not only global, regional and national air cargo terminal operators but also air cargo transport and air cargo terminal related experts, academicians, authorities and users (airlines and air cargo logistics service providers) considered as expertise in this particular area. In case of such parties preferably desire to specialize in one eminent area or review a whole stipulation, the guideline and check list in Table 37 and 38 assist practitioners to be able to quickly review the list of significant criteria as a shortcut to avoid any time-consuming. The guideline and check list clearly shows that in each criteria, practitioners and air cargo terminal operators are highly recommended to follow the list of sub-criteria inclusive factor loading scores. Air cargo terminal operators prefer to be outstanding in each criteria, this guideline is to follow and realize the implementation as results presented in the guideline and check list.

In order to demonstrate on how the guideline and check list, these sample formats in Table 37 and 38 are experimented with three air cargo terminal operators: AAT HKG, HACTL HKG and TG BKK. The air cargo operators are requested to fill out the guideline and check list in Table 43. The, the researcher input raw data into Table 44. Table 43 of the guideline and check list for AAT HKG, HACTL HKG and TG BKK to fill up the responses in each sub-criteria in October 2017. Betweenness Centrality is a technical term and the researcher needs to explain more in details during the survey. HACTL HKG is explained in a minor stage of Cargo Claims - International Convention Ratification & Limit of Liability, Airport serving country capital city and Size of local market (% of shipments locally generated). Raw data from Table 43 is inserted into the total score calculation in Ms. Excel formula in Table 44. The mark of “Yes or 1” is to calculate as a full score of each sub-criteria and “No or 0” mark is nil score. Each main criteria is with its own total score. At the end, grand total score of main criteria 1 to 9 is computed. AAT HKG and HACTL HKG provide the same answer while TG BKK fills out “No or 0” in criteria 2, 4, 5, 6, 8 and 9 with lower total score each criteria of course.

Guideline and Check List for Air Cargo Terminal Operator: AAT

The 9 main criteria and 44 sub-criteria are to evaluate the current capability and significance of listed below conditions that influence to provide air cargo terminal service to airlines and impact to air cargo industry from your air cargo terminal and/or airport's competitiveness. Please mark "Yes or 1" in case of each sub-criteria is applicable, available or relevant on your air cargo terminal service and airport's competitiveness. Otherwise, "No or 0" is marked for when criteria are inapplicable, unavailable or irrelevant on your air cargo terminal service and airport's competitiveness. Remarks are able to be inserted as additional comments or reference under each criteria.

9 Main Criteria	44 Sub-criteria	AAT HKG			HACTL HKG			TG BKK		
		Yes/1	No/0	Remarks	Yes/1	No/0	Remarks	Yes/1	No/0	Remarks
1. Cargo and Mail Service Readiness (IATA SGHA version 2013)	Transfer/transit cargo	1			1			1		
	Physical handling outbound/inbound	1			1			1		
	Cargo and mail handling – general	1			1			1		
	Documentation handling	1			1			1		
	Until load device (ULD) control	1			1			1		
	Automation/computer systems	1			1			1		
2. Cargo Claims - International Convention Ratification & Limit of Liability	Warsaw convention as amended by Hague protocol 1955 (250.00 francs or USD 20.00/Kg)	1			1				0	
	Warsaw convention 1929 (250.00 francs or USD 20.00/ Kg)	1			1				0	
	Warsaw convention as amended by Montreal protocol 1975 (SDR 17.00 or USD 20.00/ Kg)	1			1				0	
3. Customs Operations	Weekdays and weekends (Business hours)	1			1			1		
	Weekdays (Business hours)	1			1			1		
	Customs clearance times (hours):	1			1			1		
4. E-Freight Implementation & Capability	Electronic import goods declaration	1			1			1		
	Electronic export goods declaration	1			1			1		
	Electronic export cargo declaration	1			1			1		
	Electronic import cargo declaration	1			1			1		
	Transhipment	1			1				0	
	Transit freight remaining on board	1			1				0	
	E-freight capability target status	1			1				0	
5. E-Air waybill Implementation & Capability	Import cargo	1			1			1		
	Export cargo	1			1			1		
	Transit cargo	1			1				0	
	Transhipment cargo	1			1				0	
6. IATA Safety Audit for Ground Operations (ISAGO) Certification	Cargo security (facilities, operations)	1			1				0	
	Cargo and mail acceptance and handling (general, dangerous goods, live animals and perishables, other special cargo, unit load devices)	1			1				0	
7. Air Cargo Terminal Characteristic	Cargo terminal area (sq.m.)	1			1			1		
	Total cargo throughput (metric tonnes) per annum (p.a.)	1			1			1		
	Available tracking and tracing service	1			1			1		
	Maximum connecting time (hours)	1			1			1		
	Cargo commodities (IATA three letter codes)	1			1			1		
	Capacity (metric tonnes) per annum (p.a.)	1			1			1		
8. Airport Facility and Potentiality	Airport ownership types (public, majority public, majority private, private)	1			1				0	
	Runway length: 3,800 m	1			1			1		
	Numbers of runways	1			1			1		
	Airport operational time - available around the clock	1			1			1		
	Airport serving country capital city	1			1			1		
	Runway length: 2,500 m		0			0			0	
9. Factors Impact on Cargo Market Competition	Route and geographical distribution of airfreight (numbers of flights per week)	1			1			1		
	International trade (export value)	1			1			1		
	Flight frequency (weekly flight frequency of the selected airports)	1			1			1		
	Centrality (betweenness centrality of airports by area)	1			1			1		
	National versus foreign carriers (flight (%) operated by flag carriers)	1			1			1		
	Size of local market (% of shipments locally generated)	1			1			1		
	Freight forwarder presence	1			1			1		
Total Scores from 44 Scores		**43**			**43**			**32**		

Table 43: Response Summary from Guideline and Check List by AAT HKG, HACTL HKG and TG BKK (Kiam, 2017; Lau, 2017; Prathepladda, 2017)

Table 44: Grand Total Scores of Guideline and Check List for AAT HKG, HACTL HKG and TG BKK

9 Main Criteria and 44 Sub-criteria for Air Cargo Terminal Classification		Total Scores	AAT & HACTL HKG				TG BKK			
			1	0	Earned Scores	(%)	1	0	Earned Scores	(%)
1. Cargo and Mail Service Readiness (IATA SGHA version 2013)	Transfer/transit cargo	0.857	1		0.857	100	1		0.857	100
	Physical handling outbound/inbound	0.856	1		0.856	100	1		0.856	100
	Cargo and mail handling – general	0.853	1		0.853	100	1		0.853	100
	Documentation handling	0.850	1		0.850	100	1		0.850	100
	Until load device (ULD) control	0.710	1		0.710	100	1		0.710	100
	Automation/computer systems	0.655	1		0.655	100	1		0.655	100
	Total Score for Criteria 1	**4.781**			**4.781**	**100.0**			**4.781**	**100.0**
2. Cargo Claims - International Convention Ratification & Limit of Liability	Warsaw convention as amended by Hague protocol 1955 (250.00 francs or USD 20.00/Kg)	0.886	1		0.886	100		0	0	0
	Warsaw convention 1929 (250.00 francs or USD 20.00/ Kg)	0.885	1		0.885	100		0	0	0
	Warsaw convention as amended by Montreal protocol 1975 (SDR 17.00 or USD 20.00/ Kg)	0.873	1		0.873	100		0	0	0
	Total Score for Criteria 2	**2.644**			**2.644**	**100.0**			**0**	**0**
3. Customs Operations	Weekdays and weekends (Business hours)	0.833	1		0.833	100	1		0.833	100
	Weekdays (Business hours)	0.731	1		0.731	100	1		0.731	100
	Customs clearance times (hours):	0.663	1		0.663	100	1		0.663	100
	Total Score for Criteria 3	**2.227**			**2.227**	**100.0**			**2.227**	**100.0**
4. E-Freight Implementation & Capability	Electronic import goods declaration	0.897	1		0.897	100	1		0.897	100
	Electronic export goods declaration	0.895	1		0.895	100	1		0.895	100
	Electronic export cargo declaration	0.891	1		0.891	100	1		0.891	100
	Electronic import cargo declaration	0.888	1		0.888	100	1		0.888	100
	Transhipment	0.764	1		0.764	100		0	0	0
	Transit freight remaining on board	0.730	1		0.730	100		0	0	0
	E-freight capability target status	0.681	1		0.681	100		0	0	0
	Total Score for Criteria 4	**5.746**			**5.746**	**100.0**			**3.571**	**62.1**
5. E-Air waybill Implementation & Capability	Import cargo	0.903	1		0.903	100	1		0.903	100
	Export cargo	0.852	1		0.852	100	1		0.852	100
	Transit cargo	0.830	1		0.830	100		0	0.000	0
	Transhipment cargo	0.824	1		0.824	100		0	0	0
	Total Score for Criteria 5	**3.409**			**3.409**	**100.0**			**1.755**	**51.5**
6. IATA Safety Audit for Ground Operations (ISAGO) Certification	Cargo security (facilities, operations)	0.843	1		0.843	100		0	0	0
	Cargo and mail acceptance and handling (general, dangerous goods, live animals and perishables, other special cargo, unit load devices)	0.797	1		0.797	100		0	0	0
	Total Score for Criteria 6	**1.640**			**1.640**	**100.0**			**0**	**0**
7. Air Cargo Terminal Characteristic	Cargo terminal area (sq.m.)	0.851	1		0.851	100	1		0.851	100
	Total cargo throughput (metric tonnes) per annum (p.a.)	0.728	1		0.728	100	1		0.728	100
	Available tracking and tracing service	0.676	1		0.676	100	1		0.676	100
	Maximum connecting time (hours)	0.636	1		0.636	100	1		0.636	100
	Cargo commodities (IATA three letter codes)	0.622	1		0.622	100	1		0.622	100
	Capacity (metric tonnes) per annum (p.a.)	0.612	1		0.612	100	1		0.612	100
	Total Score for Criteria 7	**4.125**			**4.125**	**100.0**			**4.125**	**100.0**
8. Airport Facility and Potentiality	Airport ownership types (public, majority public, majority private, private)	0.796	1		0.796	100		0	0	0
	Runway length: 3,800 m	0.788	1		0.788	100	1		0.788	100
	Numbers of runways	0.780	1		0.780	100	1		0.780	100
	Airport operational time - available around the clock	0.759	1		0.759	100	1		0.759	100
	Airport serving country capital city	0.671	1		0.671	100	1		0.671	100
	Runway length: 2,500 m	0.652		0	0.000	0		0	0	0
	Total Score for Criteria 8	**4.446**			**3.794**	**85.3**			**2.998**	**67.4**
9. Factors Impact on Cargo Market Competition	Route and geographical distribution of airfreight (numbers of flights per week)	0.874	1		0.874	100	1		0.874	100
	International trade (export value)	0.820	1		0.820	100	1		0.820	100
	Flight frequency (weekly flight frequency of the selected airports)	0.779	1		0.779	100	1		0.779	100
	Centrality (betweenness centrality of airports by area)	0.759	1		0.759	100	1		0.759	100
	National versus foreign carriers (flight (%) operated by flag carriers)	0.753	1		0.753	100	1		0.753	100
	Size of local market (% of shipments locally generated)	0.669	1		0.669	100	1		0.669	100
	Freight forwarder presence	0.633	1		0.633	100	1		0.633	100
	Total Score for Criteria 9	**5.287**			**5.287**	**100.0**			**5.287**	**100.0**
Grand Total Score (Main Criteria 1 to 9)		**34.305**			**33.653**	**98.1**			**24.744**	**72.1**

Table 44 shows that AAT and HACTL HKG earn 33.653 scores from 34.305 scores or 98.1%. TG BKK earns 24.744 scores from 34.305 scores or 72.1%. The gap of 8.909 scores or 26% between AAT & HACTL HKG and TG BKK give a huge challenge to TG BKK or Suvarnabhumi international airport to much far behind AAT & HACTL HKG or Hong Kong international airport. Noticeably, all air cargo terminal operators are not interested in Runway length: 2,500 meters due to their runways are over 3,800 meters available for both airports. Nevertheless, the 9 main criteria and 44 sub-criteria are for all sizes of air cargo terminals and airports but Hong Kong and Suvarnabhumi international airports are ranked in Top 20 cargo airports in the world. If the researcher evaluates small to medium size airports, this sub-criteria will be applicable.

TG BKK is on process to accomplish of E-Freight Implementation & Capability, E-Air waybill Implementation & Capability and IATA Safety Audit for Ground Operations (ISAGO) Certification. By the time, TG BKK is able to fulfil such three criteria. The grand total score is to be increased to 30.213 or 88.1%. This analysis is additional to results from Table 39, 40 and 41 to recommend the right points to Airports of Thailand and Government of Thailand to understand the weakness of current situation in air cargo transport sector at Suvarnabhumi international airport for any investment and development in the near future to compete with Hong Kong and other major international airports.

5.5 Air Cargo Terminal and Transport Service in Thailand

IATA (2017b) presents that cargo volume growth in 2016 compared to 2015 is +3.8% increased almost two times on the air cargo industry's average growth on the rate of 2.0% for the past 5 years. There are some positive support from stronger export orders from flat line for the last several years. E-commerce depends vitally on air cargo with double digits to deliver e-commerce shipment to online shoppers. Also, high-value specialized cargo especially for pharmaceutical products expected to reach USD 1.12 trillion by 2022. The sign of air cargo is aggressively increasing around the world from several years of economic recession. Air cargo terminal and service at present major airports and upcoming airport such as U-Tapao international airport should seriously

be prepared for the growth of air cargo industry in advance. As the construction of air cargo terminal by Government of Thailand take years to complete while major airports in surrounding countries that have been competitive since many years. Airports of Thailand and Department of Airports which control domestic and international airports in Thailand should plan ahead to build up and look at the results from this research and apply to air cargo terminals and services in their area. The results of significant criteria for air cargo terminal classification model as the global knowhow are suitably the finest shortcut to Airports of Thailand and Department of Airports to understand and utilize to air cargo area under their responsibility without learning by doing process. This approach leads to minimize times for Thailand's air cargo industry to move forward and ready to compete with other airports outside the nation without any delay. Not only for government bodies but also private sectors are able to adopt and adapt the guideline and check list to apply for the air cargo related business purpose partially or wholly.

5.6 Plan for Future Researches

The future research is to apply the significant 9 main criteria along with 44 sub-criteria from Phase I, air cargo terminal classification model from Phase II and the guideline and check list from Phase III for air cargo terminals in major airports in ASEAN and Asia Pacific regions respectively against Thailand's air cargo terminals and airports.

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APPENDIX

Appendix 1: First Round Questionnaire Survey

Questionnaire for the Relevance and Importance of Criteria for Air Cargo Terminal Classification in Asia Pacific's Major Airports

This questionnaire aims to measure the relevance and importance of criteria for air cargo terminal classification in Asia Pacific's major airports. Select Yes/No to indicate whether the criteria listed below are relevant and then (if "Yes") rate a score (1, 3, 5, 7 or 9) to specify the importance of the relevant criteria. The higher the score, the more important the criteria. Also, please provide the reason why the criteria is irrelevant or provide an alternative criteria if possible.

(Weighing scores: 1 = Unimportant, 3 = Somewhat important, 5 = Quite important, 7 = Very important, 9 = Extremely important)

Topics	Air Cargo Terminal Classification Criteria	Check to indicate the criteria listed are relevant (Yes) or not relevant (No)		Weighing Score (if "Yes")					Remark
		Yes	No	1	3	5	7	9	
Cargo & mail warehouse services, support services for automation/Computer systems, support services for unit load device (ULD) control, and security (IATA Standard Ground Handling Agreement - SGHA 2013, 2016 Edition : Section 5, 6, 7)	1. Cargo and mail handling – general								
	2. Customs Control								
	3. Documentation handling								
	4. Physical handling outbound/inbound								
	5. Transfer/transit cargo								
	6. Post office mail								
	7. Automation/computer systems								
	8. Until load device (ULD) control								
	9. Cargo and mail security								
Cargo claims - International convention ratification & limit of liability (IATA TACT - The air cargo tariff manual rules, October 2016)	1. Warsaw convention 1929								
	2. Warsaw convention as amended by Hague protocol 1955								
	3. Warsaw convention as amended by Montreal protocol 1975								
	4. Montreal convention 1999								
Customs operating hours (IATA TACT - The air cargo tariff manual rules, October 2016)	1. 24 hours								
	2. Weekdays (Business hours)								
	3. Weekdays and weekends (Business hours)								
E-Freight implementation & capability status (IATA TACT - The air cargo tariff manual rules, October 2016)	1. E-freight capability target status								
	2. Electronic export goods declaration								
	3. Electronic export cargo declaration								
	4. Electronic import goods declaration								
	5. Electronic import cargo declaration								
	6. Transit freight remaining on board								
	7. Transhipment								
	8. Digitized commercial invoice and packing list acceptance								
	9. Digitized certificates of origin acceptance								
E-Air waybill implementation & capability status (IATA TACT - The air cargo tariff manual rules, October 2016)	1. Import cargo								
	2. Export cargo								
	3. Transit cargo								
	4. Transhipment cargo								
Special handling and dangerous goods codes (IATA TACT - The air cargo tariff manual rules, October 2016)	Cargo commodities (Three letter codes)								
IATA Safety Audit for Ground Operations (ISAGO) - Cargo and mail handling	1. Cargo and mail acceptance and handling (general, dangerous goods, live animals and perishables, other special cargo, unit load devices)								
	2. Cargo security (facilities, operations)								
Cargo characteristics	1. Total cargo throughput (metric tonnes) per annum (p.a.)								
	2. Cargo work load unit as a percentage of the total WLUs (Work Load Unit = 1 passenger = 100 kg of cargo)								
	3. Freighter aircraft movement as a percentage of all commercial aircraft movements								
	4. International cargo as percentage of the total cargo volume								

Appendix 1: First Round Questionnaire Survey (continued)

Questionnaire for the Relevance and Importance of Criteria for Air Cargo Terminal Classification in Asia Pacific's Major Airports

This questionnaire aims to measure the relevance and importance of criteria for air cargo terminal classification in Asia Pacific's major airports. Select Yes/No to indicate whether the criteria listed below are relevant and then (if "Yes") rate a score (1, 3, 5, 7 or 9) to specify the importance of the relevant criteria. The higher the score, the more important the criteria. Also, please provide the reason why the criteria is irrelevant or provide an alternative criteria if possible.

(Weighing scores: 1 = Unimportant, 3 = Somewhat important, 5 = Quite important, 7 = Very important, 9 = Extremely important)

Topics	Air Cargo Terminal Classification Criteria	Check to indicate the criteria listed are relevant (Yes) or not relevant (No)		Weighing Score (if "Yes")					Remark
		Yes	No	1	3	5	7	9	
Cargo market competition	1. International trade (export value)								
	2. Flight frequency (weekly flight frequency of the selected airports)								
	3. Route distribution (geographical distribution of airfreight)								
	4. National versus foreign carriers (flight (%) operated by flags carriers)								
	5. Centrality (betweenness centrality of airports by area)								
Runway numbers and length (m)	1. No. of runways								
	2. 3,800 m (unlimited operations cargo)								
	3. 3,600 m (unlimited intercontinental operations)								
	4. 2,500 m (unlimited operations with medium-range jets e.g. B737, A320)								
	5. 1,800 m (minimum for medium-range jets)								
	6. 1,100 m (minimum for scheduled operations with STOL-aircraft)								
Others	1. Origin-destination demand								
	2. Freight forwarder presence								
	3. Night operations capability								
	4. Size of local market (% of shipments locally generated)								
	5. Airport operational time (around the clock or with curfew)								
	6. Capacity (metric tonnes) per annum (p.a.)								
	7. Cargo terminal area (sq.m.)								
	8. Average hours for cargo loading/unloading at air side								
	9. Customs clearance times (hours)								
	10. Trucking time to main markets (hours)								
	11. Tracking and tracing service								
Others	12. Electronic Data Interchange capability								
	13. Airport serving country capital city								
	14. Airport ownership type (public, majority public, majority private, private)								
	15. Minimum connecting time (hours)								
	16. Maximum connecting time (hours)								
Additional Comment (if any):									

Appendix 2: List of Respondents for First Round Questionnaire Survey

Items	Air Cargo Terminal Operators	Number of Air Cargo Terminals	Filled Questionnaires
1	Worldwide Flight Services	141	1
	Worldwide Flight Services, Belgium		1
	FCS Frankfurt Cargo Services, Germany		1
	WFS/France Handling, France		1
2	Swissport Cargo Services	102	
	Swissport Cargo Services, Belgium		1
	Swissport Cargo Services Deutschland, Germany		1
3	PT Gapura Angkasa, Indonesia	57	1
	PT Khrisna Multi Lintas Cemerlang, Indonesia		1
4	DNATA Global	41	1
	DNATA Australia		1
	DNATA Pakistan		1
	DNATA B.V., Netherland		1
	DNATA Switzerland		1
	DNATA UK		1
5	Menzies Aviation	35	
	Menzies Aviation, Australia		1
	Menzies Aviation Bobba, Bangalore		1
	Hyderabad Menzies Air Cargo, India		1
	Menzies Macau Airport Services, Macau		1
	Menzies World Cargo		1
6	Korean Airlines, South Korea	12	1
7	Singapore Airport Terminal Services Limited, Singapore	6	
	Air India SATS Airport Services, India		1
	Oman Air SATS Cargo, Oman		1
	Asia Airfreight Terminal, Hong Kong		1
8	Spirit Air Cargo Handling	6	
	Spirit Air Cargo Handling, Denmark		1
	Spirit Air Cargo Handling, Sweden		1
	Spirit Air Cargo Handling, Norway		1
9	Air China, China	5	1
10	Philippine Airport Ground Support Solutions Inc., Philippine	5	1
11	Pos Aviation, Malaysia	5	1
12	PT Jasa Angkasa Semesta, Indonesia	5	1
13	SHAHEEN Airport Services, Pakistan	5	3
14	Bhadra International, India	4	1
15	Cargo Center Sweden, Sweden	4	1
16	Cargologic AG, Switzerland	4	1
17	Celebi Aviation Holding, Turkey	4	3
	Celebi Delhi Cargo Terminal, India		1
18	Fiumicino Logistica Europa S.r.l.u, Italy	4	1
19	Royal Airport Services, Pakistan	4	1
20	Aviapartner Cargo, Belgium	3	1
21	Noibai Cargo Terminal Services, Vietnam	3	1
22	Air India, India	2	1
23	LUG Aircargo Handling GmbH, Germany	2	1
24	Air Cargo Services of Vietnam, Vietnam	1	1
25	Chengdu Shuangliu International Airport, China	1	1
26	Delhi Cargo service Center Limited, India	1	1
27	Evergreen Air Cargo Services, Taiwan	1	1
28	Everterminal, Taiwan	1	1
29	Farglory Free Trade Zone, Taiwan	1	1
30	Hung Huang (Lao) Logistics, Laos	1	1
31	JSC Domodedovo commercial service, Russia	1	1
32	Roadfeeder, Norway	1	1
33	Saigon Cargo Service Corporation, Vietnam	1	1
34	Tokyo International Air Cargo Terminal LTD, Japan	1	1
35	Yangon Airport Group, Japan	1	1
36	Cargogate Flughafen München, Germany	1	1
37	ASR Cargo Center, Finland	1	1
38	ALS Cargo Terminal, Vietnam	1	1
	Total	**474**	**61**

Appendix 3: Air Cargo Terminal Classification Provided by 26 Operators

Companies	Recommended Classifications				
	Cargo Commodities	Services	Locations	Sizes	Cargo Volumes
DNATA Global	BUP cargo	Import cargo handling			
	PER	Customer Service			
	Mail	Export cargo and Transhipment			
		Security service			
Menzies Aviation					Small: 0 - 50,000 tons/year
					Medium: > 50,000 - 100,000 tons/year
					Large: > 100,000 tons/year
Swissport Cargo Services					Small: 0 - 30,000 tons/year
					Medium: >30,000 - 200,000 tons/year
					Large: > 200,000 - 500,000 tons/year
					HUB: > 500,000 tons/ year
Worldwide Flight Services	Special cargo (DGR, AVI, VAL, HUM, PER)	Physical Cargo handling	On airport with ramp access		Small: 0 - 600,000 tons/year
	Pharma and temperature sensitive cargo	Cargo Acceptance and release	On airport w/o ramp access		Medium: >600,000 - 1,800,000 tons/year
	Express cargo	Document handling	Off airport		Large: > 1,800,000 tons/year
		Warehousing & Storage	Cargo village with agents		
		Express cargo handling	Free trade zone		
		Export cargo and Transhipment			
WFS France Handling, France	Special cargo (DGR, AVI, HUM, PER)	Physical Cargo handling	On airport with ramp access	Small: niche activities	
	Temperature sensitive cargo	Cargo Acceptance and release	On airport w/o ramp access	Medium: import & export handling	
	Express cargo	Document handling		Large: all handling service	
	Mail	Warehousing			
		Express and mail handling			
		Trucking service			
		Security service			
Spirit Air Cargo Handling, Sweden	Pharma	Cargo handling	On airport		Small: 12,000 - 60,000 tons/year
	GEN	Document handling	Off airport		Medium: > 60,000 - 180,000 tons/year
	Express	Special cargo handling			Large: > 180,000 tons/year
	DGR	Trucking service			
	AVI	Mail handling			
	Other special load				
Swissport Cargo Services Deutschland, Germany	GEN	Cargo Handling	On airport with ramp access		
	Special products (AVI, VAL, VUN, PER, DGR)		On airport w/o ramp access		
	Pharma		Off airport		

Appendix 3: Air Cargo Terminal Classification Provided by 26 Operators (continued)

Companies	Recommended Classifications				
	Cargo Commodities	Services	Locations	Sizes	Cargo Volumes
Delhi Cargo service Center Limited, India	GEN	Physical Cargo handling	On airport		
	Pharma	Document handling	Off airport		
	PER	Information handling & Customs Codination			
	VAL	Customer Service			
Hyderabad Menzies Air Cargo, India	GEN	Cargo & mail handling	On airport		Small: under 120,000 tons/year
	Special cargo (VAL/DGR/PER/AVI/ HUM)	Cargo security - screening	Off airport		Medium: >120,000 - 600,000 tons/year
	Project cargo - HEV, Oversize, Special VAL	Document handling			Large: > 600,000 tons/year
		ULD management			
		Computer system support			
Cargogate Flughafen München, Germany	GEN	GEN handling	On airport		Small: under 100,000 tons/year
	Special cargo (DGR, PER, COL, etc.)	Express cargo handling	Off airport		Medium: >100,000 - 500,000 tons/year
	Mail	Document handling			Large: > 500,000 tons/year
Spirit Air Cargo Handling, Denmark	PIL	Physical Cargo handling	On airport		
	PES	Document handling	Off airport		
	Other special cargo				
Cargo Center Sweden, Sweden	GEN	Document handling	On airport with ramp access	Small: 2,000 - 5,000 sq.m.	
	PER	Physical Cargo handling	Off airport	Medium: >5,000 - 15,000 sq.m.	
	CRT	Mail handling		Large: >15,000 sq.m.	
	PEM	E-AWB/E-Freight Handling			
	PES	Secured and unsecured cargo handling			
	DGR	Customer Service			
	VUN				
	VAL				
	HUM				
FCS Frankfurt Cargo Services, Germany				Small < 50,000 tons/year : 5 ton/sq.m	
				Medium 50,000 - 100,000 tons/year : 8 ton/sq.m.	
				Large 1000,000 - 250,000 tons/year : 10 ton/Sq.m.	
				Hub >250,000 tons/year : 17 ton/sq.m.	
Asia Airfreight Terminal, Hong Kong	PER	Export cargo and Transhipment			
	AVI	Import cargo handling			
	DGR	Express cargo handling			
		Mail handling			
		e-Commerce handling			

Appendix 3: Air Cargo Terminal Classification Provided by 26 Operators (continued)

Companies	Recommended Classifications				
	Cargo Commodities	Services	Locations	Sizes	Cargo Volumes
Saigon Cargo Service Corporation, Vietnam	GEN				Small: under 100 tons/year
	Temperature sensitive cargo				Medium: >100 - 1,000 tons/year
	AVI				Large: > 1,000 tons/year
	VAL				
	VUN				
	DGR				
	HUM				
Cargologic AG, Switzerland	GEN				
	Special cargo (Pharma, Foodstuff, PER, VAL)				
	Express cargo				
Spirit Air Cargo Handling, Norway	Equipment for oil/gas/sub-sea, GEN, Priority cargo	Warehouse handling	On airport with ramp access	Small warehouse - at minor domestic airport	
	PER, Salmon	Freighter cargo handling	On airport w/o ramp access	Line (feeding) terminal - at middle size airport with some int'l flight	
	Pharma and time sensitive cargo	Cargo handling for agent (labelling, packing, etc.)	Off airport	HUB - at main airport	
Fiumicino Logistica Europa S.r.l.u, Italy	GEN	Flown cargo handling	On airport		
	Pharma	Trucked cargo handling	Off airport		
	Express cargo	Mail handling			
	Other special cargo (HUM, VAL, PER, etc.)				
Roadfeeder, Norway	GEN	Full service for all cargo and trucking	On airport with ramp access	Small: 0 - 6,999 sq.m.	
	PER, fish, pharma, fruit, flower, temperature sensitive cargo	Medium service for GEN, document and trucking	On airport w/o ramp access	Medium: 7,000 - 14,999 sq.m.	
	Project cargo - HEV, Oversize, Special VAL	Standard service for document and Customs handling	Off airport	Large: 15,000 - 50,000 sq.m.	
LUG Aircargo Handling GmbH, Germany	GEN	Physical Cargo handling	On airport		
	BUP cargo	Document handling	Off airport		
	Pharma and temperature sensitive cargo	ULD handling			
PT Jasa Angkasa Semesta, Indonesia	PER	Domestic cargo			
	DGR	International cargo			
	VUN				
	Livestock				
Air India SATS Airport Services, India	GEN	International cargo	On airport		Small: under 100,000 tons/year
	PER	Domestic cargo	Off airport		Medium: >100,000 - 1,000,000 tons/year
	Pharma				Large: > 1,000,000 tons/year
	Courier				

Appendix 3: Air Cargo Terminal Classification Provided by 26 Operators (continued)

Companies	Recommended Classifications				
	Cargo Commodities	Services	Locations	Sizes	Cargo Volumes
Everterminal, Taiwan	GCR	Import cargo handling	On airport		
	DGR	Export cargo and Transhipment	Off airport		
	VAL	Document handling			
	VUN	Ground handling for airlines			
	COL	International logistics center			
	FRO				
	CRT				
	COU				
Evergreen Air Cargo Services, Taiwan	GEN	Physical Cargo handling	On airport		
	Transit cargo	Document handling	Off airport		
	PER	Computer system support			
	PIS				
	EHU				
	DGR				
	Mail				
Farglory Free Trade Zone, Taiwan	GEN	Air cargo termial			
	EHU	Free trade zone			
	PER	Ground handling for airlines			
	DGR	Document handling			
	Free trade zone shipment				
Korean Airlines, South Korea			In country		
			In oversea		

Appendix 4: Second Round Questionnaire Survey

Questionnaire for the Relevance and Importance of Reviewed Criteria by Air Cargo Terminal Operators for Air Cargo Terminal Classification

This questionnaire aims to validate (and reduce) the relevance and importance of reviewed criteria by air cargo operators for air cargo terminal classification.

Select "Yes" or "No" to indicate whether the criteria listed below are relevant and then (if "Yes") rate a score (1, 3, 5, 7 or 9) to specify the importance of the relevant criteria. The higher the score, the more important the criteria. Also, please provide the reason why the criteria is irrelevant or provide an alternative criteria if possible.

(Weighing scores: 1 = Unimportant, 3 = Somewhat important, 5 = Quite important, 7 = Very important, 9 = Extremely important)

Main Criteria	Description for Main Criteria	Check to indicate the criteria listed are relevant (Yes) or not relevant (No)		Weighing Score (if "Yes")				
		Yes	No	1	3	5	7	9
IATA Standard Ground Handling Agreement - Cargo and Mail Service (Latest version 2013)	Cargo and mail handling – general							
	Documentation handling							
	Physical handling outbound/inbound							
	Transfer/transit cargo							
	Automation/computer systems							
	Until load device (ULD) control							
E-Freight implementation & capability status (IATA The air cargo tariff manual rules, October 2016)	E-freight capability target status							
	Transhipment							
	Import cargo							
E-Air waybill implementation & capability status (IATA The air cargo tariff manual rules, October 2016)	Export cargo							
	Transit cargo							
	Transhipment cargo							
Special handling and dangerous goods codes (IATA The air cargo tariff manual rules, October 2016)	Cargo commodities (IATA three letter codes)							
Others	Cargo terminal area (sq.m.)							
	Customs clearance times (hours)							
	Tracking and tracing service							
	Maximum connecting time (hours)							
Customs operating hours (IATA The air cargo tariff manual rules, October 2016)	Weekdays and weekends (Business hours)							
E-Freight implementation & capability status (IATA The air cargo tariff manual rules, October 2016)	Electronic export goods declaration							
	Electronic export cargo declaration							
	Electronic import goods declaration							
	Electronic import cargo declaration							
	Transit freight remaining on board							
IATA Safety Audit for Ground Operations (ISAGO) - Cargo and mail handling	Cargo and mail acceptance and handling (general, dangerous goods, live animals and perishables, other special cargo, unit load devices)							
IATA Safety Audit for Ground Operations (ISAGO) - Cargo and mail handling	Cargo security (facilities, operations)							
Cargo characteristics	Total cargo throughput (metric tonnes) per annum (p.a.)							
Cargo market competition	International trade (export value)							
	Flight frequency (weekly flight frequency of the selected airports)							
	Route distribution (geographical distribution of airfreight)							
Others	Freight forwarder presence							
	Size of local market (% of shipments locally generated)							
	Airport operational time (around the clock or with curfew)							
	Cargo handling capacity (metric tons per annum)							
Cargo claims - International convention ratification & limit of liability (IATA The air cargo tariff manual rules, October 2016)	Warsaw convention 1929 (USD 20.00/ Kg)							
	Warsaw convention as amended by Hague protocol 1955 (USD 20.00/Kg)							
	Warsaw convention as amended by Montreal protocol 1975 (USD 20.00/ Kg)							

Appendix 4: Second Round Questionnaire Survey (continued)

Questionnaire for the Relevance and Importance of Reviewed Criteria by Air Cargo Terminal Operators for Air Cargo Terminal Classification

This questionnaire aims to validate (and reduce) the relevance and importance of reviewed criteria by air cargo operators for air cargo terminal classification. Select "Yes" or "No" to indicate whether the criteria listed below are relevant and then (if "Yes") rate a score (1, 3, 5, 7 or 9) to specify the importance of the relevant criteria. The higher the score, the more important the criteria. Also, please provide the reason why the criteria is irrelevant or provide an alternative criteria if possible.

(Weighing scores: 1 = Unimportant, 3 = Somewhat important, 5 = Quite important, 7 = Very important, 9 = Extremely important)

Main Criteria	Description for Main Criteria	Check to indicate the criteria listed are relevant (Yes) or not relevant (No)		Weighing Score (if "Yes")				
		Yes	No	1	3	5	7	9
Customs operating hours (IATA The air cargo tariff manual rules, October 2016)	Weekdays (Business hours)							
Cargo market competition	National versus foreign carriers (flight (%) operated by flag carriers)							
	Centrality (betweenness centrality of airports by area)							
Runway numbers and length (m)	No. of runways							
Others	Airport serving country capital city							
Runway numbers and length (m)	3,800 m (unlimited operations cargo)							
	2,500 m (unlimited operations with medium-range jets e.g. B737, A320)							
Others	Airport ownership type (public, majority public, majority private, private)							
Runway numbers and length (m)	1,800 m (minimum for medium-range jets)							
	1,100 m (minimum for scheduled operations with STOL-aircraft)							

Appendix 5: Third Round Questionnaire Survey

QUESTIONNAIRE SURVEY FOR AIR CARGO TERMINAL FACILITIES:

A STUDY OF CRITERIA FOR AIR CARGO TERMINAL CLASSIFICATION MODEL

The primary objective of this questionnaire survey for air cargo terminal facilities is to classify air cargo terminals at Suvarnabhumi, Donmuang, Phuket and Chiang Mai international airports and create a model of air cargo terminal classification based on the following relevant and important criteria reviewed by CAAT, IATA, well-known airlines and air cargo logistics service providers, academician and air cargo terminal operators located outside Thailand. In the following questions, we would like to elicit your opinion and information as the expert in air cargo terminal operations and business environments in Thailand. Also, please provide your up to date data on all below requests.

Your company name: _____

Location of your air cargo terminal: _____

IATA Standard Ground Handling Agreement - Cargo and Mail Service (Version 2013)

1. Is your company able to perform these following services?

		Applicable (Yes or 1)	or	Not applicable (No or 0)
1.1	Cargo and mail handling – general			
1.2	Documentation handling			
1.3	Physical handling outbound/inbound			
1.4	Transfer/transit cargo			
1.5	Automation/computer systems			
1.6	Until load device (ULD) control			

Cargo Claims - International Convention Ratification & Limit of Liability (IATA The Air Cargo Tariff Manual Rules, October 2016)

2. Does your company or your country accept/ratify the limits of liability below?

		Applicable (Yes or 1)	or	Not applicable (No or 0)
2.1	Warsaw convention 1929 (250.00 francs or USD 20.00/ Kg)			
2.2	Warsaw convention as amended by Hague protocol 1955 (250.00 francs or USD 20.00/Kg)			
2.3	Warsaw convention as amended by Montreal protocol 1975 (SDR 17.00 or USD 20.00/ Kg)			

Customs Operations (IATA The Air Cargo Tariff Manual Rules, October 2016)

3. What are the Customs operating and clearance times (hours) in the airport (please select one answer only)?

		Applicable (Yes or 1)	or	Not applicable (No or 0)
3.1	Weekdays (Business hours)			
3.2	Weekdays and weekends (Business hours)			
3.3	Others if not in item 3.1 and 3.2, please specify:			
3.4	Customs clearance times (hours):	_____		

E-Freight Implementation & Capability (IATA The Air Cargo Tariff Manual Rules, October 2016)

4. Does your company implement and provide IATA E-freight service?

		Applicable (Yes or 1)	or	Not applicable (No or 0)
4.1	E-freight capability target status			
4.2	Electronic export goods declaration			
4.3	Electronic export cargo declaration			
4.4	Electronic import goods declaration			
4.5	Electronic import cargo declaration			
4.6	Transit freight remaining on board			
4.7	Transhipment			

E-Air waybill Implementation & Capability (IATA The Air Cargo Tariff Manual Rules, October 2016)

5. Does your company implement and provide IATA E-Air waybill service?

		Applicable (Yes or 1)	or	Not applicable (No or 0)
5.1	Import cargo			
5.2	Export cargo			
5.3	Transit cargo			
5.4	Transhipment cargo			

IATA Safety Audit for Ground Operations (ISAGO) - Cargo and mail handling

6. Is your company certified by ISAGO?

		Applicable (Yes or 1)	or	Not applicable (No or 0)
6.1	Cargo and mail acceptance and handling (general, dangerous goods, live animals and perishables, other special cargo, unit load devices)			
6.2	Cargo security (facilities, operations)			

Appendix 5: Third Round Questionnaire Survey (continued)

QUESTIONNAIRE SURVEY FOR AIR CARGO TERMINAL FACILITIES:

A STUDY OF CRITERIA FOR AIR CARGO TERMINAL CLASSIFICATION MODEL

The primary objective of this questionnaire survey for air cargo terminal facilities is to classify air cargo terminals at Suvarnabhumi, Donmuang, Phuket and Chiang Mai international airports and create a model of air cargo terminal classification based on the following relevant and important criteria reviewed by CAAT, IATA, well-known airlines and air cargo logistics service providers, academician and air cargo terminal operators located outside Thailand. In the following questions, we would like to elicit your opinion and information as the expert in air cargo terminal operations and business environments in Thailand. Also, please provide your up to date data on all below requests.

Air Cargo Terminal Characteristic

7. Please provide your information based on your present air cargo terminal status in accordance to these below enquiries.

7.1 Cargo terminal area (sq.m.): _____

7.2 Capacity (metric tonnes) per annum (p.a.): _____

7.3 Total cargo throughput (metric tonnes) per annum (p.a.): _____

7.4 Cargo commodities handled in your cargo terminal in percent (%) per each commodity to your annual total cargo throughtput (100%) in item 7.3:

- PER (Perishable cargo): _____
- GEN (General cargo): _____
- DGR (Dangerous goods): _____
- PIL (Pharmaceuticals): _____
- VAL (Valuable cargo): _____
- AVI (Live animal): _____
- XPS (Priority cargo): _____
- COL (Cool goods): _____
- HUM (Human Remain in coffins): _____
- VUN (Vulnerable cargo): _____
- PES (Fish/Seafood): _____
- MAL (Mail): _____
- BIG (Oversized cargo): _____
- EAT (Food stuff): _____
- HEA (Heavy cargo, 150 kg and over per piece): _____
- BUP (Shipper/consignee handled unit): _____
- CRT (Cool room: +15 C to +25 C): _____
- PEM (Meat): _____
- FRO (Frozen goods): _____
- Transit cargo: _____
- Free trade zone shipment: _____
- If other special loads, please specify: _____

7.5 Maximum connecting time (hours): _____

	Applicable (Yes or 1)	or	Not applicable (No or 0)
7.6 Available tracking and tracing service	☐		☐

Airport Facility and Potentiality

8. What is the current airport's facility and Potentiality?

8.1 Airport ownership types: public (1), majority public (2), majority private (3), or private (4): _____

8.2 Numbers of runways: _____

	Applicable (Yes or 1)	or	Not applicable (No or 0)
8.3 Runway length: 3,800 m	☐		☐
Runway length: 2,500 m	☐		☐
If others, please specify: _____			
8.4 Airport operational time - available around the clock	☐		☐
8.5 Airport serving country capital city	☐		☐

Appendix 5: Third Round Questionnaire Survey (continued)

QUESTIONNAIRE SURVEY FOR AIR CARGO TERMINAL FACILITIES:

A STUDY OF CRITERIA FOR AIR CARGO TERMINAL CLASSIFICATION MODEL

The primary objective of this questionnaire survey for air cargo terminal facilities is to classify air cargo terminals at Suvarnabhumi, Donmuang, Phuket and Chiang Mai international airports and create a model of air cargo terminal classification based on the following relevant and important criteria reviewed by CAAT, IATA, well-known airlines and air cargo logistics service providers, academician and air cargo terminal operators located outside Thailand. In the following questions, we would like to elicit your opinion and information as the expert in air cargo terminal operations and business environments in Thailand. Also, please provide your up to date data on all below requests.

Surrounding Factors Impact on Cargo Market Competition

9. Please provide your information based on your present air cargo terminal service in accordance to these below enquiries?

9.1 Weekly flight frequency of your customer airlines (numbers of flights per week):

- All carriers: _____
- Freighter/cargo carriers: _____
- Conventional carriers by freighter and/or passenger aircrafts: _____

9.2 Route and geographical distribution of airfreight (numbers of flights per week per IATA area):

- IATA Area 1: _____
- IATA Area 2: _____
- IATA Area 3: _____

9.3 National carriers (%) versus foreign carriers (%):

- Percent divided by numbers of flights per week: National carriers: ____ % vs. Foreign carriers: ____ %
- Percent divided by annual total cargo througput: National carriers: ____ % vs. Foreign carriers: ____ %

9.4 Size of local market (% of shipments locally generated):

- Inbound cargo: _____
- Outbound cargo: _____

9.5 International trade from Thailand to other continents (export value in USD per annum in 2016):

Hong Kong:	11,468	Million USD
South Korea:	4,044	Million USD
China:	23,810	Million USD
Japan:	20,563	Million USD
Taiwan:	3,363	Million USD
Singapore:	8,215	Million USD
Malaysia:	9,634	Million USD
India:	5,154	Million USD
Vietnam:	9,428	Million USD

http://www.ops3.moc.go.th/infor/thtrade/country_trade/report.asp

Applicable (Yes or 1) or Not applicable (No or 0)

9.6 Major air cargo logistics service providers (agents) presence around the airport [ ] [ ]

9.7 Centrality (betweenness centrality of airports by area in kilometers from XXX airport):

- Hong Kong (HKG) airport: _____
- Incheon (ICN) airport, South Korea: _____
- Shanghai Pudong (PVG) airport, China: _____
- Narita (NRT) airport, Japan: _____
- Taoyuan (TPE) airport, Taiwan: _____
- Changi (SIN) airport, Singapore: _____
- Guangzhou Baiyun (CAN) airport, China: _____
- Beijing Capital (PEK) airport, China: _____
- Osaka Kansai (KIX) airport, Japan: _____
- Kuala Lumpur (KUL) airport, Malaysia: _____
- Mumbai Chhatrapati Shivaji (BOM) airport, India: _____
- Indira Gandhi New Delhi (DEL) airport, India: _____
- Hanoi Noi Bai (HAN) airport, Vietnam: _____

Comments, if any: _____

Appendix 6: Betweenness Centrality Results by Pajek Program

Network betweenness centrality of BKK, CNX and HKT airports:

1. 0.057143 - BKK
2. 0.000000 - HKG
3. 0.000000 - ICN
4. 0.000000 - PVG
5. 0.000000 - NRT
6. 0.000000 - TPE
7. 0.000000 - SIN
8. 0.000000 - CAN
9. 0.000000 - PEK
10. 0.000000 - KIX
11. 0.000000 - KUL
12. 0.000000 - BOM
13. 0.000000 - DEL
14. 0.000000 - HAN
15. 0.000000 - HKT
16. 0.000000 – CNX

Airports by Numbers	Raw Data Input into Pajek Program											
*Vertices 16	*Arcs	*Arcs	*Arcs	*Arcs	*Arcs	*Arcs	*Arcs	*Arcs	*Arcs	*Arcs	*Arcs	*Arcs
1 "BKK"	2 1 3	3 1 6	4 1 10	5 1 15	7 1 12	9 1 13	12 1 14	1 15 16	4 15 9	1 16 4	3 16 6	6 16 15
2 "HKG"	2 1 4	3 1 7	4 1 11	5 1 16	7 1 13	9 1 14	12 1 15	2 15 3	4 15 11	1 16 6	3 16 7	7 16 8
3 "ICN"	2 1 5	3 1 8	4 1 12	6 1 7	7 1 14	9 1 15	12 1 16	2 15 4	4 15 16	1 16 7	3 16 8	7 16 9
4 "PVG"	2 1 6	3 1 9	4 1 13	6 1 8	7 1 15	9 1 16	13 1 14	2 15 7	7 15 8	1 16 8	3 16 9	7 16 11
5 "NRT"	2 1 7	3 1 10	4 1 14	6 1 9	7 1 16	10 1 11	13 1 15	2 15 8	7 15 9	1 16 9	3 16 11	7 16 15
6 "TPE"	2 1 8	3 1 11	4 1 15	6 1 10	8 1 9	10 1 12	13 1 16	2 15 9	7 15 11	1 16 11	3 16 15	8 16 9
7 "SIN"	2 1 9	3 1 12	4 1 16	6 1 11	8 1 10	10 1 13	14 1 15	2 15 11	7 15 16	1 16 15	4 16 6	8 16 11
8 "CAN"	2 1 10	3 1 13	5 1 6	6 1 12	8 1 11	10 1 14	14 1 16	2 15 16	8 15 9	2 16 3	4 16 7	8 16 15
9 "PEK"	2 1 11	3 1 14	5 1 7	6 1 13	8 1 12	10 1 15	15 1 16	3 15 4	8 15 11	2 16 4	4 16 8	9 16 11
10 "KIX"	2 1 12	3 1 15	5 1 8	6 1 14	8 1 13	10 1 16	1 15 2	3 15 7	8 15 16	2 16 6	4 16 9	9 16 15
11 "KUL"	2 1 13	3 1 16	5 1 9	6 1 15	8 1 14	11 1 12	1 15 3	3 15 8	9 15 11	2 16 7	4 16 11	11 16 15
12 "BOM"	2 1 14	4 1 5	5 1 10	6 1 16	8 1 15	11 1 13	1 15 4	3 15 9	9 15 16	2 16 8	4 16 15	11 16 16
13 "DEL"	2 1 15	4 1 6	5 1 11	7 1 8	8 1 16	11 1 14	1 15 7	3 15 11	11 15 15	2 16 9	6 16 7	*Edges
14 "HAN"	2 1 16	4 1 7	5 1 12	7 1 9	9 1 10	11 1 15	1 15 8	3 15 16	11 15 16	2 16 11	6 16 8	
15 "HKT"	3 1 4	4 1 8	5 1 13	7 1 10	9 1 11	11 1 16	1 15 9	4 15 7	1 16 2	2 16 15	6 16 9	
16 "CNX"	3 1 5	4 1 9	5 1 14	7 1 11	9 1 12	12 1 13	1 15 11	4 15 8	1 16 3	3 16 4	6 16 11	

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