CRANFIELD UNIVERSITY

DARSHI PIYATHILAKE

THE ROLE OF AIRPORTS IN NATIONAL CIVIL AVIATION POLICIES

SCHOOL OF AEROSPACE TRANSPORT AND MANUFACTURING
PhD in Transport Systems

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Academic Year: 2012 - 2016

Supervisor: Professor Keith J. Mason and Dr. Pere Suau-Sanchez
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ABSTRACT

The concept of a hub airport has evolved widening its scope as a national civil aviation policy-making tool, due to the ability to deliver wider socio-economic benefits to a country. However, not all airports can be converted into hubs. This research proposes a methodological approach to structural analysis of the airport industry, that could be applied to determine the competitive position of an airport in a given aviation network and devise airport strategies and national policy measures to improve the current position of the airport. This study presents a twelve-group taxonomy of airports, which analyses the changing geography of the airport industry in the East (Asia and The Middle East). Multivariate data have been used in a two-step Agglomerative Hierarchical Clustering exercise which represents three airport strategies: namely, degree-of-airport-activity (size and intensity of operations), network strategies (international and domestic hub), and the market segmentation strategies (service and destination orientation). Principal Component Analysis has been utilised as a data reduction tool. The study confirms the general hypothesis that a sound macro environment and liberalised approach to economic regulation in the air transport industry are important for successful hub operations. In addition, it sheds light on the fact that while the factors of geographical advantage, economic development, urbanisation, tourism and business attractiveness, physical and intellectual infrastructure, and political and administrative frameworks, are all basic prerequisites (qualifiers) for successful hubbing in the region, those factors would not necessarily guarantee a hub status unless the governments are also committed to develop the sector and take timely decisions (differentiators) to allow airports to benefit from the first mover advantage. Application of the proposed taxonomy was tested on a case study of the major international airport of Sri Lanka, to provide policy inputs to develop the airport that is currently identified as being overshadowed by the mega hubs in the region.

Keywords:

Hubs, Airport Classification, Airport Strategies, Principal Component Analysis, Hierarchical Cluster Analysis, Macro Environment, Traffic Shadow Theory

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LIST OF ABBREVIATIONS

CAPA	Centre for Aviation
ICAO	International Civil Aviation Organisation
ATAG	Air Transport Action Group
OAG	Official Airline Guide
PSO	Public Service Obligations
OD	Origin-Destination
HS	Hub-and-Spoke
PP	Point-to-Point
USA	United States of America
MICE	Meetings, Incentives, Conventions and Exhibition
ASK	Available Seat Kilometres
GDP, PPP	Gross Domestic Product based on Purchasing Power Parity
NICs	Newly Industrialised/ing Countries
WECG	World Economic Centre of Gravity
ASEAN	of Association of Southeast Asian Nations
CMB	Colombo Bandaranaike International Airport
ACAC	Arab Civil Aviation Commission
ASAs	Air Services Agreements
BASA	Bilateral Air Services Agreements
LCC	Low Cost Carrier
LLCC	Long-haul Low Cost Carrier
SAARC	South Asian Association for Regional Co-operation
AS1	South Asia
AS2	Central Asia
AS3	Southeast Asia
AS4	Northeast Asia
ME1	Middle East
FAA	Federal Aviation Administration
ACI	Airports Council International
FSC	Full Service Carriers
PTT	Perceived-Travel-Time
IATA	International Air Transport Association

WEF	World Economic Forum
GCI	Global Competitiveness Index
TTCI	Tourism Competitiveness Index
ANS	Air Navigation Services
CIS	Commonwealth of Independent States
MALIAT	Multilateral Agreement on the Liberalization of International Air Transport
GDS	Global Distribution Systems
MIDT	Market Information Data Transfer/ Tapes
DOT	Department of Transport (USA)
WASA	World Air Service Agreements
VRC	Variance Ratio Criterion
AHC	Agglomerative Hierarchical Clustering
PCA	Principal Component Analysis
FA	Factor Analysis
PCs	Principal Components
KMO	Kaiser-Meryer-Oklin measure of sampling adequacy
HHI	Herfindhal–Hirschman Index
RF	Routing Factor
EDB	Ease of Doing Business

1 INTRODUCTION

This chapter delivers a synopsis of the subject of this research. An airport's role and functionality in the global air transport network is largely driven by the national civil aviation policies and the conditions of the political, economic, socio-demographic, geographic and technological environment within which the air transport industry of a country operates. Understanding the relationship between these elements allow policy-makers to make informed decisions on airport strategies and related national civil aviation policies that could improve the competitive position of an airport in the global air transport network, which in turn would improve the airport's contribution to the socio-economic development of a country. Investigation of these relationships and the development of a framework to assist in the airport strategic planning and civil aviation policy-development process has been selected as the primary subject of this research. Motivations for this research originated from the researcher's interest in the changing geography of the air transport industry in the East[1]. Thus, the first part of this chapter provides a comprehensive background to this research. It is useful in defining the research problem and establishing the aim and objectives of the research as explained in the second and third parts of this chapter. The final parts of the chapter are assigned to explain the geographical scope, research design and the contribution of this thesis.

1.1 Research background

1.1.1 Air Transport: A policy instrument for economic development and social welfare

Air transport is not a goal in itself in a nation's policy agenda. Air transport is a means of facilitating the ends - achieving national economic and social benefits. It is a "network-industry"(Button and Stough, 2000) driven on derived demand to connect multiple destinations through links created by airlines, which in turn facilitate the flow of both information (non-physical) through meeting of people

[1] In this study, the term 'East' refers to the Asia and the Middle East regions. See, section 1.4 for the geographical scope of this study.

and creating relationships, and materials (physical) which are central to the development of today's knowledge based economy. A significant relationship exists between the levels of income, urbanisation, industrialisation, education and social-welfare, and the degree of maturity of the air transport system of a country (Hilling, 1996). This is demonstrated by the strong relationship between gross domestic product per capita and air travel penetration levels of different countries (Centre for Aviation (CAPA), 2014a) (Figure 1-1). Level of air travel penetration is high in developed economies.

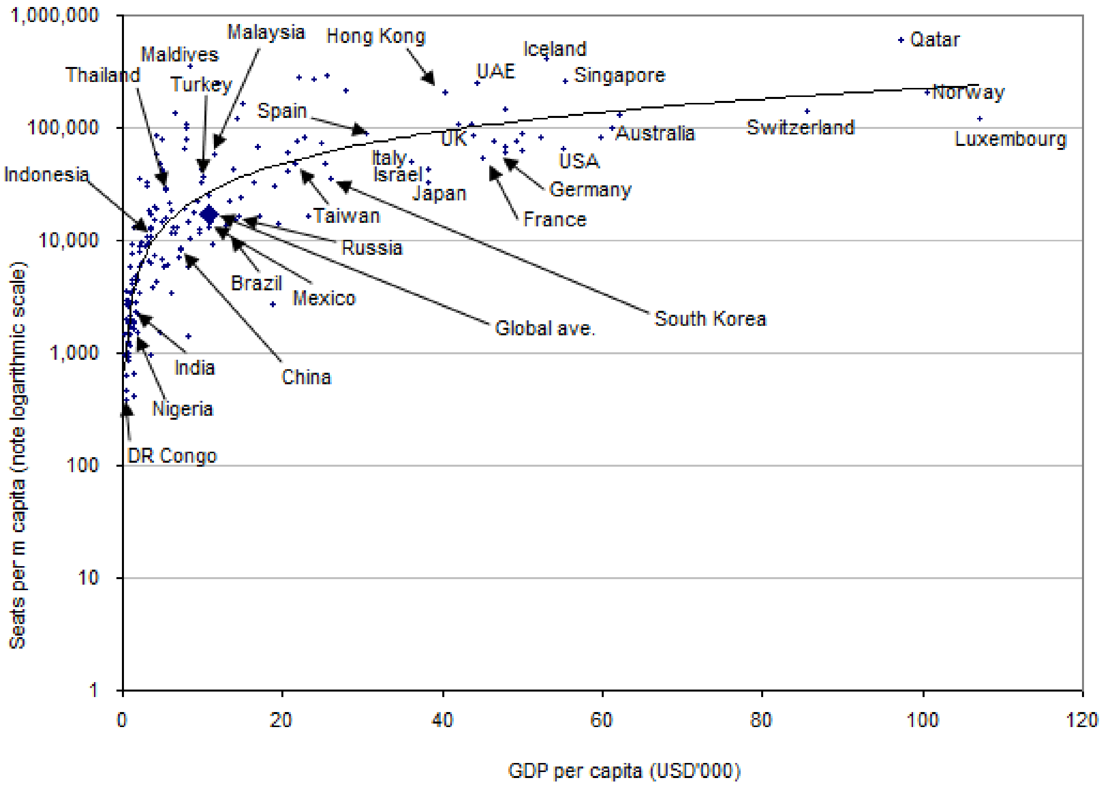

Figure 1-1 Airline Seats Per Capita (vertical axis, logarithmic scale) versus GDP Per Capita (horizontal axis) by country

Source: CAPA (2014a), [OAG (seat data for week of 9-Jun-2014), International Monetary Fund]

As the only globally connected transportation network, the impact of air transport is diverse and not limited to the mere benefits of transportation of goods and people. It also has a range of direct, indirect, induced and catalytic effects on a country's economy and thereby the world economy (Air Transport Action Group (ATAG), 2014; International Civil Aviation Organisation (ICAO), 2005). Examples of these are; the facilitation of international trade and foreign direct investments, the promotion of tourism and other industries and the creation of employment opportunities directly through key stakeholders and indirectly through other industries. Air transport delivers social benefits by improving the quality of life of people across the world. It helps to keep today's complex social structures functioning by bringing together the migrant communities living in every part of the world and allowing the supply chains to be synchronised at the global level. It offers recreational opportunities for people by providing services to worldwide destinations. Air transport services are not always justified on a commercial basis. Through public service obligations (PSO), governments ensure accessibility to remoter regions, thus satisfying their basic social and economic needs and alleviating poverty by promoting social inclusion (Smyth et al., 2012). The social role of air transport further extends to the delivery of humanitarian aid in disaster management (ATAG, 2014; Hilling, 1996).

This role expected from air transport presents a paradox for national policy makers. This is because it is, inevitably one of the most internationalised industries (Button and Stough, 2000; Gudmundsson and Oum, 2002; Wang and Heinonen, 2015) while being "inseparable from the domain of national self-interest" (Graham, 1995) and political advantage, remaining largely nationally controlled and regulated (Wang and Heinonen, 2015). A liberalised or Open Skies approach to international air transport opens up a country's airspace for international carriers. This boosts connectivity of its airports, subsequently improving the economic outlook of the country (Button and Taylor, 2000; Burghouwt and de Wit , 2005; Smyth et al., 2012). Thus, policy makers are encouraged to initiate policies that support liberalisation and deregulation of aviation markets. This enables the international airlines to engage in free movement of people and goods across national borders. This is where the tension between benefits of a market oriented approach and national self- interest comes into play.

Since the early days, the air transport industry has been connected to national interests and considered more as a public utility (Doganis, 2002). It was used as a tool of government policy to promote trade, mail services, political linkages and security of national air space (Dempsey and Gesell, 1997; Graham, 1995). As a result, the industry is still expected to deliver economic wellbeing and social equity by: (i) keeping up with public service obligations to remote regions, (ii) maintaining services to destinations in countries which are allies in the international political arena, (iii) providing employment opportunities, and (iv) playing a strategic role in national security and defence policies (or at least to come under their scrutiny). For these reasons, airlines and airports have traditionally been considered to be national assets coming under government supervision, and national interests lying at the heart of government policy making (Graham, 1995), even when they were privately managed (Dempsey and Gesell, 1997). A good example is the bankruptcy protection provided to airlines in the US, which was a pioneering advocate of liberalisation and deregulation of aviation markets. To this end, policy makers are in some cases reluctant to open up markets to international competition. Therefore, internationalisation and nationalisation of aviation markets, which are both in the best interest of the public are dilemmas often faced by aviation policy makers.

The role air transport plays as a stimulator of economic development and promoter of social welfare has earned it a prominent place in state level policy-making. The trend in the recent decade has been to use air transport as a key policy instrument in national economic development plans by governments, especially in the emerging aviation markets in East Asia (Williams, 2006). Investment in airport construction has been a major strategy pursued by governments to support the development of the aviation industry in order to accelerate the growth of national economies (Bowen, 2000; Lohmann et al., 2009; Williams, 2006). This highlights the role airports play as a central economic engine.

1.1.2 Airports: A central economic engine

Airlines are often attributed with being in the forefront of supporting the development of aviation networks. However, the extent to which a country can involve itself in air transport to reap its economic and social benefits largely depends on the quantity and quality of airport infrastructure that can be provided to attract airlines and support their network development (Hilling, 1996). The size of airport runways and terminals specifications determine the type of aircrafts that an airport can handle. To secure services to long haul destinations and increase passenger volumes, airports should have runway facilities sufficient to service jumbo jets that fly long distances nowadays. For example, for the Airbus A380, the biggest jet to date, certain airside infrastructure upgrades were required at international airports in order to handle the aircraft with a larger wingspan and longer reference field length (A380 Airport Compatibility Group, 2002). Even though Origin-Destination (OD) demand is the primary decision variable of international airlines' choice of destinations, runways, apron facilities, and terminal facilities are important infrastructures that will influence their decision on aircraft type and frequency.

Overall, airports are identified as "significant growth poles" (Hilling, 1996) around which the airlines develop their networks, creating multi-faceted relationships between different industries. In this way, not only airlines, but also the other related service industries such as fueling, catering, handling services, and hotels will set up businesses around the airport. Having a good network will facilitate the setting up of industries around the airport that require international connections for movement of goods and transfer of tacit knowledge through meetings of people (Bel and Fageda, 2008). Therefore, airports have become one of the key infrastructure elements in the development of modern cities (O'Connor, 1995; O'Connor and Scott, 1992). Kasarda, (2006) refers to this as, "airports are undergoing a metamorphosis, taking on many of the commercial functions of a metropolitan Central Business District". He coined the term "aerotropolis" to describe this form of urban development led by airports, naming it as the fifth-wave of transportation-induced urban development in the world. Hence, airports receive greater attention in national civil aviation policy-making and national planning owing to their contribution to the national economy. This is especially the case with hub airports.

1.1.2.1 Air transport hubs: a tool for internationalisation while safeguarding national interests

The hub-and-spoke system (HS) has become a predominant network structure (Reynolds-Feighan, 2001) alongside its counterpart point-to-point (PP) networks (Castillo-Manzano, Lapez-Valpuesta and Pedregal, 2012) in the liberalised aviation market pioneered in United States of America (USA) in the late 1970's (Button and Stough, 2000; Doganis, 2002; Graham, 1995; Hansen, 1990; Kahn, 1993). In a HS network, the number of flights linking different origins and destinations is reduced by the establishment of a central airport (Bryan and O'Kelly, 1999) which coordinates banks of arrival and departure flights, serving as a transfer point for passengers and cargo (Button and Stough, 2000; Doganis and Dennis, 1989; Jayalath and Bandara, 2001).

Figure 1-2 demonstrates how a system of four spoke airports linked by a hub airport is creating ten connections between the five airports with only four flights. Thus, in the airport hierarchy, hub airports "are *special nodes* that are part of a *network*, located in such a way to facilitate connectivity between interacting places" (O'Kelly, 1998, p.171). Though the HS system was not a new outcome of deregulation (Button and Stough, 2000), it attracted the airline operators in the post-deregulatory market due its marketing benefits and cost economies (Reynolds-Feighan, 2001). Hubs also provide passengers with a wider choice and increased accessibility and airports with an increased revenue potential. Table 1-1 summarises advantages and disadvantages of the HS system for different stakeholders in the aviation system; i.e. airlines (creators of the network), airports (facilitators of the network), passengers (users of the network) and economy/society (beneficiary of the network).

The airlines can operate at a reduced cost due to economies of scale, scope and density associated with HS operations. Economies of scale exist when the airlines can concentrate their resources at a hub airport. By pooling traffic from feeder services, the airlines can increase passengers at the hub airport. This will increase the load factors and as well allow the airlines to use larger aircraft, which will eventually result in lower unit costs per passenger. Economies of scope occur when more spokes are connected to the hub. This allows the creation of multiple connections without an additional effort. Hence, the cost of production is less than that of different airlines operating the services. An increase of traffic at the hub eventually increases the traffic between two OD nodes allowing average unit cost of production to be reduced. This is termed as economics of traffic density (Burghouwt, 2007; Button, 2002; Button and Stough, 2000; Doganis, 2002; Holloway, 2008; Kahn, 1993). A hub carrier gains additional benefits from economies of market presence (Button and Stough, 2000; Button, 2002), creating a “halo effect” (Kahn, 1993) leading to relationships with supply chain partners at the hub (travel agents/airport/ handling agents). Further marketing advantages are the impact made on image and the ability to offer frequent flyer programmes in order to attract passengers.

On the demand side, the market presence benefits passengers by offering a wider choice and accessibility at reduced costs. According to Button (2002), small communities can benefit from being able to link with rest of the world, something that would otherwise be ignored due to non-economic operations. Moreover, online connections reduce the risk of lost baggage for passengers (Kraus and Koch, 2006) compared to offline connections.

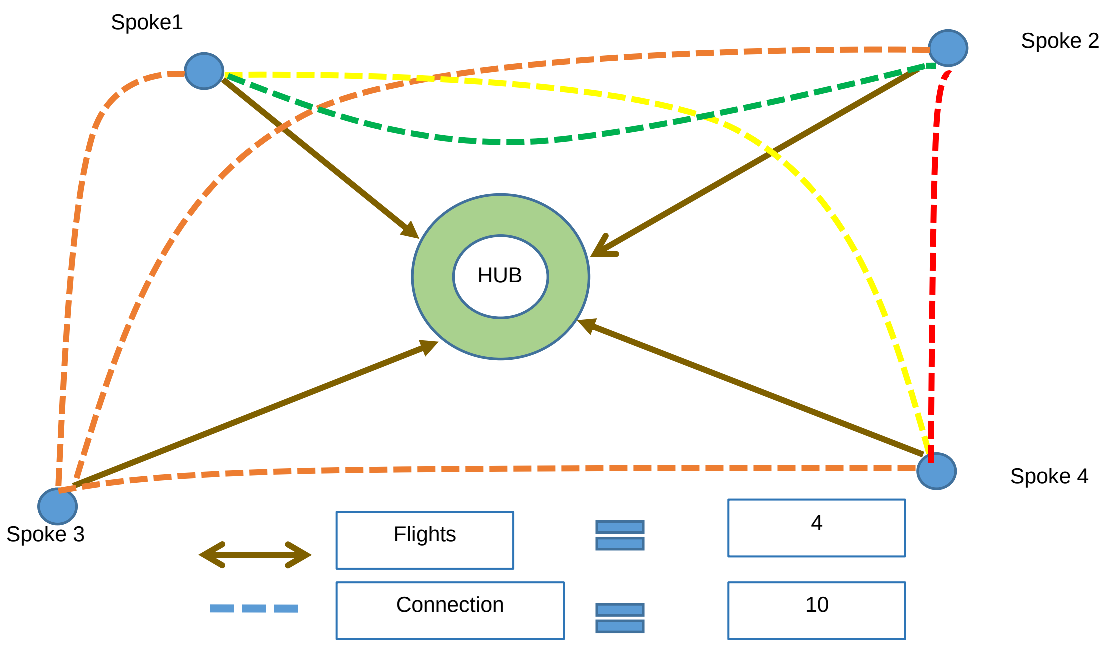

Figure 1-2 Hub and spoke operations structure

Source: Own Elaboration

Table 1-1 Advantages and disadvantages of hub-and-spoke system

	Advantages	Disadvantages
Airlines	• Economies of scale - increase in city-pair coverage increases the network size leading to rise in passenger volumes allowing the use of larger aircraft which reduces cost per passenger • Economies of scope – joint production of heterogeneous products such as carrying OD passengers and passengers *en-route* to another destination on the same flight which reduces average cost per passenger • Economies of density- as a result of the multiplier effect in city-pair coverage, even if the network size does not change, traffic volumes grow on the routes between hub and the spoke airports which leads to increase of traffic between two points leading to reduction in average cost per passenger • Discourage competitors on the same route • Capitalise on Alliance partnerships to create multiple hub operations • Marketing economies of scale	• Extra flying /block hours due to breakdown in number of legs reduce the average sector distance flown by aircrafts which can push up the unit costs • Increase in airport related costs by having to pay airport charges per passenger and baggage handling etc. twice for the different flight legs flown • Costs of flight delays are higher due to the ripple effect one delay can cause on the flight complexes • Network duplication costs in situations where the hub carrier compete against itself when there are multiple hub operations
Airports	• Widened geographical scope • Increased revenue potential which can be reinvested in improving the efficiency of the systems to minimise congestions and delays	• Peak pressure and congestion • When majority of the operations are by the hub carrier the airlines can take control over the airport operations
Passengers	• Wider range of destinations • Economies of schedule frequency • More direct connections from the hub airport • Use of larger aircrafts by airlines increase comfort • Convenience and reliability from using single airline (ease of baggage transfer) • Can increase the benefits of frequent flyer programmes • Lower average fares • Better services and frequency on previously thin routes where direct services were not viable • More opportunities for same day return flight	• Loss of direct connections due to hubbing that otherwise be operated • Longer journey times and detours • If there is no competition on certain routes/or no alternative routing hub carriers may charge higher fares • Possible delays due to the scale of operations
Economy/Society	• Provision of direct employment • Promotion of the region/city as a business destination leading to agglomeration of industries/ development of aviation clusters/ aerotropolises • Improves the tourism prospect of the destination through the connections to many origins • Stimulation of high-technology new economy job growth • Stimulate the growth in average per capita income	• Negative externalities of noise and pollution due to peaking and congestion

Sources: Ater (2012); Brueckner, Dyer and Spiller (1992); Brueckner and Zhang (2001); Burghouwt (2007); Button (2002); Button and Lall (1999) ; Button and Stough (2000); Doganis (2002); Doganis and Dennis (1989); Dresner and Windle (1995) ; Kahn (1993); Kanafani and Ghobrial (1985); Kraus and Koch (2006); Nero (1999); Rodrigue, Comtois and Slack (2006)

Turning an airport into a hub confers benefits upon a society through the wider impact it makes on the local economy. It is also one of the few opportunities that an airport pursue to grow beyond its local market (Suau-Sanchez, Burghouwt and Pallares-Barbera, 2014). According to O'Kelly (1998), hubs are "geographical" and serve a specific region, and act as a catalyst for agglomeration. Industries tend to locate near a hub to reap the benefit of access to freight services. As previously explained, today's multinational time sensitive businesses require quick access to their partners and clients dispersed around the world. The value of a hub for the development of an aerotropolis is the rapid connectivity and wider range of destinations it can offer (Yeo, Wang and Chou, 2013), like in the cases of Singapore Changi, Hong Kong, Seoul Incheon, Dubai, Washington Dulles and Amsterdam Schiphol (Kasarda, 2015). Hub airports open up a region's/country's opportunities to explore new markets; one of these being the Meetings, Incentives, Conventions and Exhibition (MICE) sector. A hub brings together people from different parts of the world to one place, allowing the region to promote itself as a MICE destination. Proximity to a hub airport stimulates high technology job growth in a region (Button et al., 1999). This leads to higher average per capita income in the region.

Jian, Huiyun and Ting (2011, p. 516) very well summarise how hubs serve as a policy instrument in enabling internationalisation of a country's aviation industry while safeguarding its national interests. They state that, "hub airports are windows and bridges for the opening-up of a country or a region, as well as an important foundation for the regional economy to participate in the international cooperation and competition". Therefore, from a national policy-making perspective, hub airports receive top attention and airport development strategies have come to play a central role in national economic development policies (Bowen, 2000). Thus, drawbacks of hubbing (Table 1-1) are easily disregarded and it remains an attractive option for seeking a competitive advantage in the increasingly deregulated global aviation market (Dennis, 1994a), especially in the fast growing emerging aviation markets of the East.

1.1.3 Development of air transport in the East: Drive towards super-hubs

Asia-Pacific and the Middle East are leading the growth in the global aviation market. As of 2013 (Figure 1-3), ASP was the world's largest aviation market with 32% of total capacity in terms of Available Seat Kilometres (ASK) and the Middle East region was the fastest growing market with an 11.9% year on year growth (ICAO, 2014). The magnitude of the growth is shown in the World's Aviation Top 10 lists of recent years (Table 1-2). Nine out of ten busiest/densest air routes are between airports in Asia-Pacific. Both Boeing (2014) and Airbus (2014) forecast that more than 60% of wide bodied/ twin-aisle aircraft orders will head towards the East in 20 years' time, demonstrating the potential the region has for growth in its aviation markets. It is fair to say that nations in the entire region of Asia and the Middle East are geared up to capitalise on the growth of their aviation markets to become the super-hubs in the region. Therefore, "airports remain high on the agenda of public policy" in the Asian markets (Hooper, 2002, p.289).

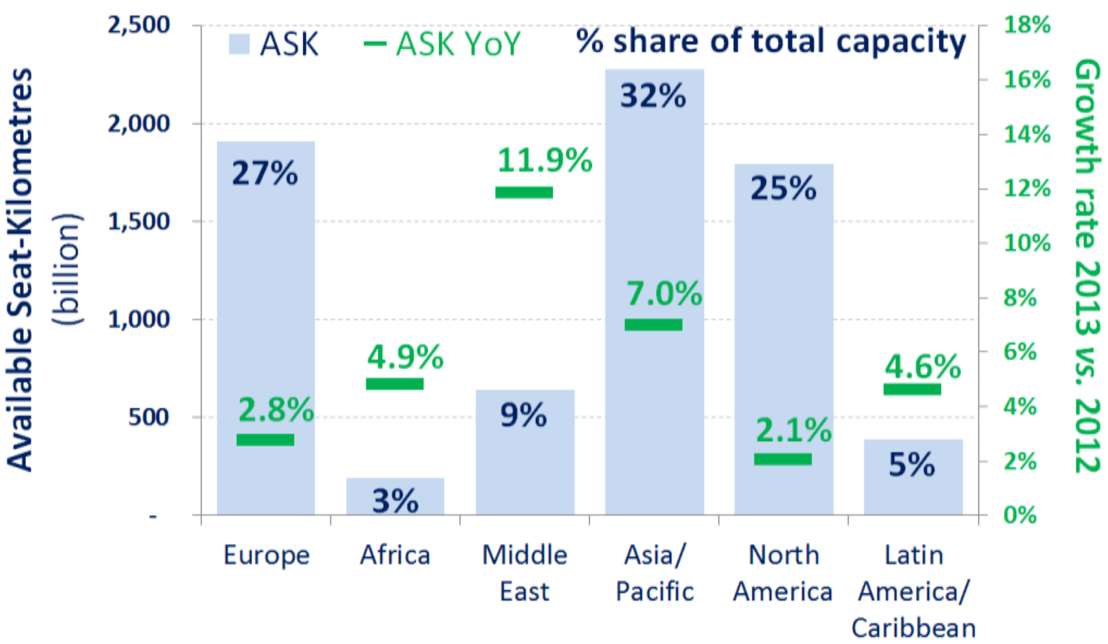

Figure 1-3 Capacity and Growth by World Regions

Source: ICAO (2014)

1.1.3.1 Hub pioneers

Historically cities and ports in the East have played an important role since the beginning of trade relations between the West and the East. When air transport started developing as an international industry, long-haul flights between European countries and their furthest colonies in Australasia (two regions with strong colonial ties) promoted the development of airports in the Asian and the Middle East regions. The unique advantage of the geographical positioning of the region on the crossroads of Europe and Southwest Pacific has promoted the growth of hubs in the region ever since. The region is also strategically placed for its geographical proximity to world population. Hong Kong is within six hours' flying time of 50% of the world population (Williams, 2006) and Dubai is within 8 hours' flying time of 80% of the world population (CAPA, 2013a). Therefore, the airports in the region hold a strategic importance in connecting people across Asia-Pacific, Europe, Africa and the Americas. The largest region pairing is between Southwest Pacific (Australia/New Zealand) and Western Europe (24 million seats in May 2012) which consists of most of the densest continental routes flown via an airport in the East (Table 1-3).

O'Connor (1995) and Hooper et al. (2011) document how Southeast Asia and the Middle East have occupied a central place in the flow of international trade and commerce by materialising "principle axis shifts" and redefining centrality, intermediacy and proximity in the pattern of air transport networks. Singapore and Hong Kong were the first to drive the development of international hubs in the eastern part of the region (i.e. Southeast Asia and Northeast Asia). In the western part of the region (i.e. Middle East), Bahrain took the lead but later the growth was intensified by developments in Dubai (Hooper et al., 2011; O'Connor, 1995). Today, the three hub carriers at the three airports, Singapore Airlines (SQ), Cathay Pacific Airlines and Emirates Airlines respectively, are among the world's top ten international airlines in terms of international available seat kilometers. Dubai and Hong Kong airports are among the world's top ten airports (Table 1-2) despite their very small or non-existent domestic market.

Table 1-2 World's Top 10 routes, international airlines, and airports in 2012

World's Top 10 Busiest Routes	
Route	**Seat Capacity**
Tokyo Haneda (HND) -Sapporo Chitose (CTS)	*6,182,133*
Seoul Gimpo(GMP) -Jeju (CJU)	*5,298,574*
Sydney Kingsford Smith (SYD) -Melbourne (MEL)	*5,120,367*
Fukuoka(FUK) -Tokyo Haneda (HND)	*4,979,223*
Taipei Taiwan Taoyuan (TPE) -Hong Kong (HKG)	*4,632,823*
Shanghai Hongqiao (SHA) -Beijing Capital (PEK)	*3,887,486*
Sao Paulo (CGH) - Rio de Janeiro (SDU)	3,720,602
Mumbai(BOM)-Delhi (DEL)	*3,482,607*
Okinawa Naha (OKA) -Tokyo Haneda (HND)	*3,352,204*
Osaka Itami (ITM) -Tokyo Haneda (HND)	*3,206,565*

World's Top 10 International Airlines	
Airline	**International ASKs (Billions)**
Emirates(EK)	*221*
Lufthansa (LH)	176
British Airways(BA)	165
United Airlines(UA)	164
Delta Air Lines(DL)	155
Air France(AF)	143
Cathay Pacific Airways(CX)	*120*
Singapore Airlines(SQ)	*119*
American Airlines(AA)	114
KLM-Royal Dutch Airlines(KL)	100

World's Top 10 Airports	
Airport Name	**Seat Capacity**
Atlanta Hartsfield-Jackson Intl (ATL)	55,620,763
Beijing Capital Intl (PEK)	*52,488,724*
London Heathrow (LHR)	47,129,153
Tokyo Haneda (HND)	*44,956,234*
Chicago O'Hare International (ORD)	40,579,561
Los Angeles International (LAX)	38,790,415
Frankfurt International (FRA)	37,912,615
Dubai International (DXB)	*37,823,663*
Paris Charles de Gaulle (CDG)	37,255,563
Hong Kong International (HKG)	*36,921,434*

Source: OAG (2012)

Table 1-3 Top 10 densest one-stop routes flown via the Eastern region, May 2012

Route	Distance (Km)	Seats Available
London Heathrow (LHR) - Sydney Kingsford Smith (SYD)	17,020	1,579,141
London Heathrow (LHR) - Melbourne International (MEL)	16,908	1,260,973
Frankfurt International (FRA) - Sydney Kingsford Smith (SYD)	16,498	796,305
Paris Charles de Gaulle (CDG) - Sydney Kingsford Smith (SYD)	16,944	756,561
London Heathrow (LHR) – Brisbane BNE)	16,543	723,262
London Heathrow (LHR) – Auckland International(AKL)	18,354	684,324
Frankfurt International (FRA) - Melbourne International (MEL)	16,314	616,183
London Heathrow (LHR) - Perth (PER)	14,508	584,902
Amsterdam (AMS) - Sydney Kingsford Smith (SYD)	16,658	555,971
Paris Charles de Gaulle (CDG) - Melbourne International (MEL)	16,756	505,108

Source: OAG (2012)

1.1.4 Drivers of aviation growth in the East

Apart from the geographical advantage, several other factors have contributed to the successful hubbing at these major airports, which in turn has stimulated the continued growth of the region's aviation markets.

1.1.4.1 Shift in economic geography

The accelerated levels of traffic growth observed in the East have been due to the rapid economic growth experienced by the region in the recent decades. The region's economy measured by Gross Domestic Product based on Purchasing Power Parity (GDP, PPP) has more than doubled from 18,313 to 41,891 International Dollar billions in the last 15 years. Rising income levels of people have stimulated air travel by more than 200% during the period in terms of ASKs (Figure 1-4) despite the major shocks of 9/11, SARS outbreak in 2002/04, and global financial crisis in 2008/09 (See, Table A-2 for values). Japan was the first economy in Asia to reach a super power status and still is one of the largest economies in the world in spite of more than a decade-long economic stagnation[2] (Nakatani and Skott, 2007). In addition, East Asia is the home for many of the Newly Industrialised/ing Countries (NICs) including the Four Tigers; Singapore, Hong Kong, Taiwan and South Korea, and other economies of Thailand, Malaysia, Philippines, and Indonesia, which have followed suit, more than doubling their GDPs. Structural transformation of the economies has been a key feature of economic growth in the East. As shown in Figure 1-5, the contribution of manufacturing and services industries to the real GDP has increased over the last 20 years in the region (ADB, 2013; Dabla-Norris et al., 2013).

[2] In 2012, ranked fourth in terms of GDP (PPP, constant 2011 international dollars). A declining trend in GDP growth rates are observed with annual growth rates standing below 2% since 2010 as a result of the two decade long economic stagnation.

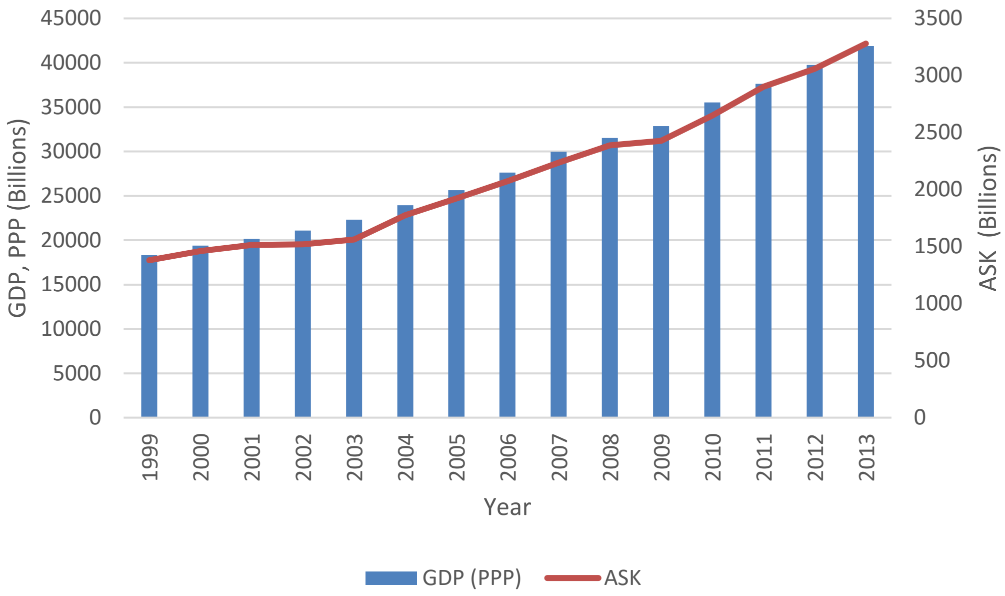

Figure 1-4 Growth of GDP* and ASKs in the Eastern Region**

Source: World Development Indicators Database-World Bank (2013) and OAG (2013)

*GDP (PPP) in 2011 International Dollars rates

**ASKs are for the non-stop flights to-and-from 45 countries in the Asia and the Middle East

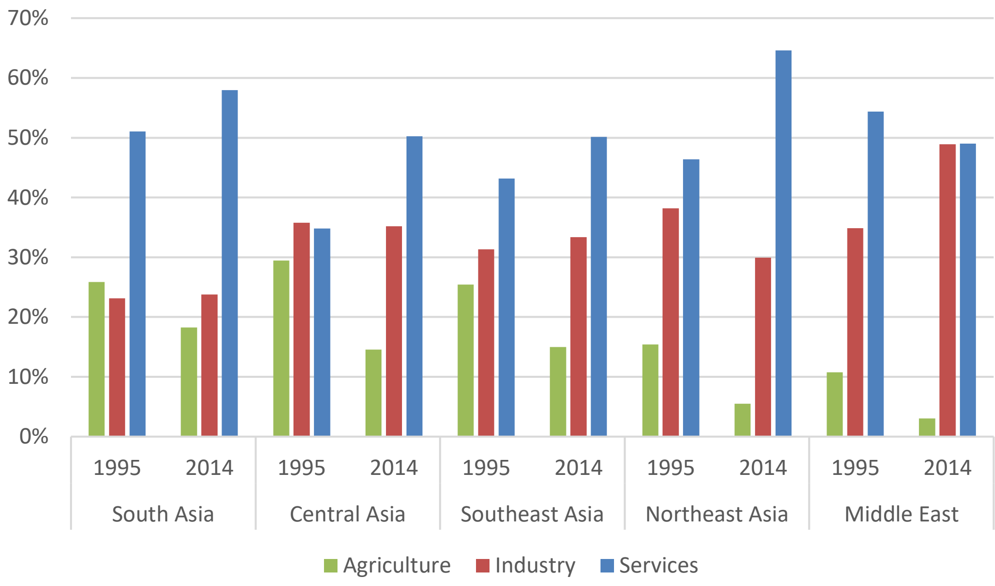

Figure 1-5 GDP sectoral share comparison for the sub-regions of the East

Source: World Development Indicators Database-World Bank (2014)

The role of the region in shifting world economic geography is enhanced by the two emerging superpowers; China and India. These two economies have surpassed Japan (Figure 1-6) and have climbed to be the first and the second largest economies in the region in terms of GDP based on PPP with annual growth rates averaging around 9% and 7% respectively since the beginning of the millennium. Airbus (2014) global market forecasts for new aircrafts are based on the assumption that China and India will become the first and third largest economies in the world by 2023.

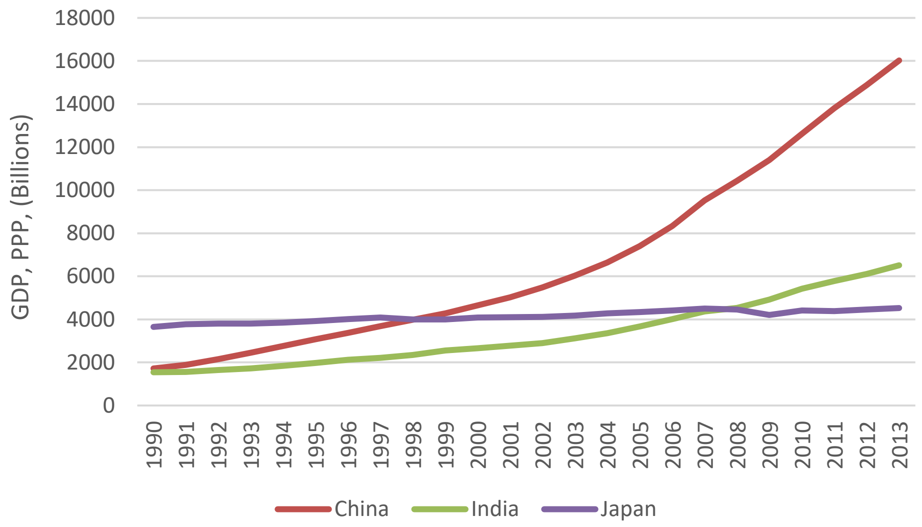

Figure 1-6 GDP* of the Three Largest Economies in Asia

Source: World Development Indicators Database-World Bank (2013)

* GDP (PPP) in 2011 International Dollars rates

Pushed by these accelerating economies of the region, the global economic balance measured by the World Economic Centre of Gravity (WECG) (Figure 1-7) is rapidly and steadily moving towards Asia (Dobbs et al., 2012; Grether and Mathys, 2010) and is predicted to locate between India and China in 2050 (Quah, 2011).

Figure 1-7 The World's Economic Centre of Gravity, 1980–2007*

* Calculations at three-year intervals, values until 2007 in black and thereafter extrapolations in red

Source: (Quah, 2011)

1.1.4.2 Demography

The world population has nearly tripled (grown 2.89 times) since 1950 and the East houses the largest share (60%) of the 7 billion people on earth (Figure 1-8) with China, India, and Indonesia being the first, second and fourth largest populations in the world. Structural transformation of demographics in Asia has promoted the growth of air travel in the region. The rate of urbanisation in the region is the second highest in the world standing at 1.1% per annum (United Nations, 2013) and the more urbanised a country becomes, the more economic opportunities there are for people to raise their income levels and consumption of goods and services. This leads to the growth of the middle class, which provides a solid ground for economic progress. In the East, the middle class is projected to grow by up to 66% by 2030 (Kharas, 2010; Pezzini, 2012). This demonstrates the potential that the region is having in terms of air travel induced by population growth in the future.

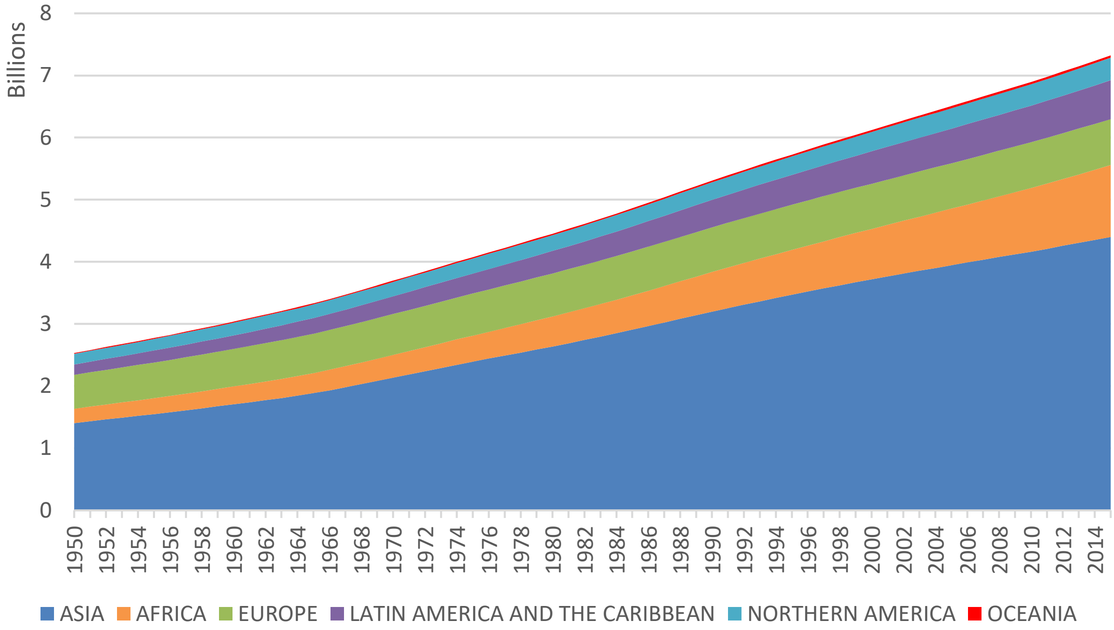

Figure 1-8 Growth of World Population

Source: United Nations, Department of Economic and Social Affairs, Population Division (2014)

1.1.4.3 Developmental role of government

Numerous studies have referred to the commitment by governments in supporting the development of the aviation sector in the region (Bowen, 2000, 2002; Feldhoff, 2003; Homsombat, Lei and Fu, 2011; Hooper et al., 2011; Lohmann et al., 2009; O'Connell, 2006; O'Connor, 1995; O'Connor and Scott, 1992; Tsai and Su, 2002; Wang and Heinonen, 2015; Williams, 2006). The development of the Southeast Asian aviation sector is attributed to the 'Developmental State' model in aviation strategic planning (Bowen, 2000), a phenomenon specifically attributed to state-led economic development in Asia (Johnson, 1999). Governments, which follow this model, exercise their political power in extensive planning, regulation and intervention on economic activities. Governments invest in industries that are vital for economy, around which other industries will develop, maximising the economic and welfare benefits to society.

The growth of the pioneering Southeast Asian hub of Singapore Changi is attributed to the strategies followed by the government by vertically integrating related stakeholder parties in the aviation industry (Lohmann et al., 2009). Likewise, strong support from governments has led to the development of aviation networks in Thailand and Malaysia, turning them into major hubs in the region (Bowen, 2000; Homsombat, Lei and Fu, 2011). Lohmann et al. (2009) further records that the unprecedented growth that has taken place in the Gulf region aviation sector is also a result of the aggressive growth strategies pursued by governments, especially Dubai. This has enabled governments to keep control of the industry, intervening where necessary to keep the industry activities aligned with overall development goals of the state. In Northeast Asia, Hong Kong presents a case where government commitment to aviation has taken a different form to its major hub counterparts in other sub-regions. Being cited as the freest economy in the world, Hong Kong has promoted a liberal policy in aviation. However, it has retained control over the hub airport under the government statutory body, Hong Kong Airport Authority (Wang and Heinonen, 2015). Respectively in Northeast Asia ,airport investment has been or is a key strategy of the governments of Japan (Feldhoff, 2002; Hasegawa, 1996), South Korea and (now) China, which consider aviation as a geopolitical tool for distributing returns of economic reforms (Williams, 2006).

1.1.4.4 Infrastructure and capacity investments

Due to the importance of air transport in the national economic plans of governments in the East, the global aviation industry has continued to witness huge airport infrastructure investments in this region during the last few decades. The trend has been either to build new airports to replace the existing airports as in the cases of Singapore Changi (1981), Riyadh King Khalid International Airport (1983), Kuala Lampur (1998), Hong Kong (1998), and Bangkok (2006), or to continuously expand the existing airports such as Dubai and Abu Dhabi airport expansions after 1970’s, Shanghai/Pudong (1999), Seoul/Incheon (2001) Guangzhou (2004) (De Wit et al., 2009). The trend has continued and CAPA global airport construction database (2014b) records that the majority of the expensive airport investment projects in 2013/14 were from Asia exceeding a cost of USD 115 billion (Figure 1-9).

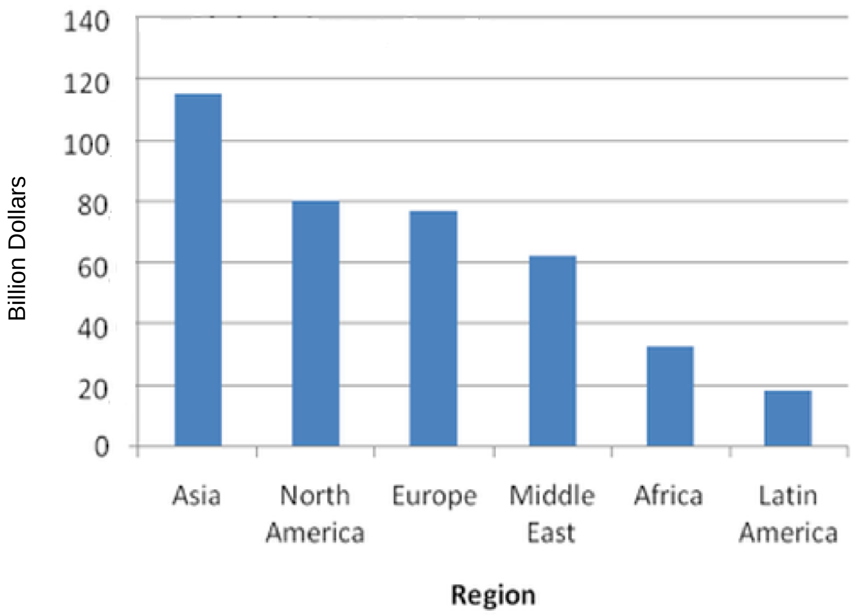

Figure 1-9 World Airport Project Investments by Region 2013

Source: (CAPA, 2014b)

1.1.4.5 Liberalisation

Governments in the region have understood the importance of liberalised aviation policies (Chin, 1997) as a key tool for traffic growth and hub development. Several progressive attempts have been made across the region. Singapore was one of the earliest countries in Southeast Asia to declare 'Open skies' (Chin, 1997) with reciprocal benefits to their flag carrier Singapore Airlines in other markets, which had led to the development of the carrier's international network and the strengthening of the hub status of Singapore. Further, Southeast Asia provides a case of liberalisation that has moved beyond bilateral open skies agreements to establish a regional agreement in the community of Association of Southeast Asian Nations (ASEAN). ASEAN single aviation market came into full ratification in 2015(The ASEAN Secretariat, 2016). The opening up of skies has helped Southeast Asian airports to expand their geographical focus and develop as international hubs.

As a leading economy, Japan stands as the most liberalised aviation market in Northeast Asia to pursue the national economic interests of merging with the global economy (Feldhoff, 2002). Japan has entered into several bilateral open skies agreements including with China, Taiwan, South Korea and Europe and has opened up the market for Middle Eastern carriers at the expense of Japan's national airlines (CAPA, 2013b). Taiwan, South Korea and Hong Kong have progressively liberalised their markets with the view to promoting their airports as international hubs. Though very slow, during the last 30 years China too has progressed in liberalising its markets to a certain degree, which had not occurred previously (Fu et al.,2015; Wang, Mo and Wang, 2014; Wang and Heinonen, 2015).

In the Middle East, the most liberalised market, United Arab Emirates has Air Services Agreements (ASAs) with 147 countries, of which 113 are open skies (ICAO and United Arab Emirates, 2013). Intra-regional air travel in the Middle East is governed by the plurilateral Intra-Arab Freedom of the Air Programme of Arab Civil Aviation Commission's (ACAC). However, Cristea, Hillberry and Mattoo (2014) claims that there is more room for further liberalisation in the region. International air travel is still under separate bilateral ASAs with few open skies between pairs of countries. The liberal approach to ASAs has facilitated the growth of Emirates Airlines and Singapore Airlines by establishing directional hub operations based on the Dubai and Changi airports and exploiting the 6th freedom traffic rights[3]. Though limited in scope, the liberal policies adopted by different countries /country groups in Northeast Asia, Southeast Asia and Middle East have enabled them to establish themselves as important hubs in the region.

1.1.4.6 Privatisation and commercialisation of airports

Most of the time, airports with a private entity's involvement either in management or ownership tend to be more efficient and profitable (Graham, 2008a). One of the reasons for this is that the privatised airports are keener on giving themselves a commercial identity by diversifying their sources of revenue from purely aeronautical to commercial businesses (Oum, Adler and Yu, 2006). Graham (2011) in a review of extant literature has identified the following as the main objectives of airport privatisation: providing investments, improving efficiency,

[3]See, Chapter 2- literature review for the 'Freedoms of the Air'

improving quality, improving management, and providing financial benefits to the state. Unlike airlines, privatisation of airports was initiated much later by governments and even in the most liberalised and deregulated US market, airports remain under government ownership. Asia has been cited as lagging behind airport privatisation initiatives compared to the rest of the world (Forsyth, 1997). However, Hooper (2002) in a review of airport ownership models in Asia has found that governments have embraced privatisation as a means of financing airport infrastructure developments to meet the accelerating demands in the growing aviation markets. A survey conducted by ICAO in 2007 (Table A-1) revealed that 42 out of the 89 sampled airports in the East were operated under a concession or by leasing arrangement with private interests.

1.1.4.7 Development of the Low Cost Carriers

With the start of the millennium, pushed by the success made elsewhere in the world, Asia embraced the Low Cost Carrier (LCC) business model (Airbus, 2014; Boeing, 2014; CAPA, 2014c; Lawton and Solomko, 2005), hopeful of the potential it had for serving geographically diverse, separate and large domestic and regional markets, especially those in Northeast Asia (Japanese archipelago and China), Southeast Asia (Mainland Southeast Asia and Malay archipelago) and South Asia (India). Accordingly, the last decade has witnessed a significant change in the region's aviation network structure. Growth in terms of seats made available by LCCs has been tremendous; from 6.23 million seats in 1999 to just under 287 million, capturing a share of 21% of the total seats made available by all the carriers operating to, from and within the East in 2013 (Figure 1-10) (See, Table A-2 for values).

South East Asia is the largest LCC market in the region having a share of 41% (149 million seats) of the total seats made available to, from and within South East Asia in 2013. The region is the home base for the parent company of the largest LCC airline in the region, Air Asia. The carrier is also noted for making the Long-haul Low Cost Carrier (LLCC) business model a reality (Homsombat, Lei and Fu, 2011) and the region now has seven LLCC operators. Compared to Northeast Asia at the beginning of the decade, South Asia has made a remarkable growth thanks to the Indian LCC market. The effect has been dampened in Northeast Asia owing to the slow progress in Japan caused by competitive rail infrastructure, an ageing population (Boeing, 2014) and low internet penetration (Lawton and Solomko, 2005). Though slow, it is steadily growing. China too was late to adopt the model. The first LCC, Spring Airlines came onto the market in 2005. Growth has been slow and the market has relatively low LCC penetration levels, 3.5% and 6.5% in international and domestic markets respectively, owing to the regulatory controls favouring the big carriers and inflexible cost structures such as airport charges etc. (CAPA, 2012a). The CAPA (2012) report states that China has 214 airports that have the potential to serve LCCs. Therefore, given the size of the market, there is still a huge untapped potential in the region to grow its LCC market. The Middle East LCC market has been growing since the first LCC Air Arabia was introduced to the market in 2003. With an 11% market share in the region, they have extended services to the growing Central Asian market (Boeing, 2014; CAPA, 2013c) whose LCC capacity share is lowest in the region, but has an enormous growth potential. In addition to this, Middle Eastern LCCs such as flydubai and Jazeera Airways have experimented with hybrid models offering first class products on-board.

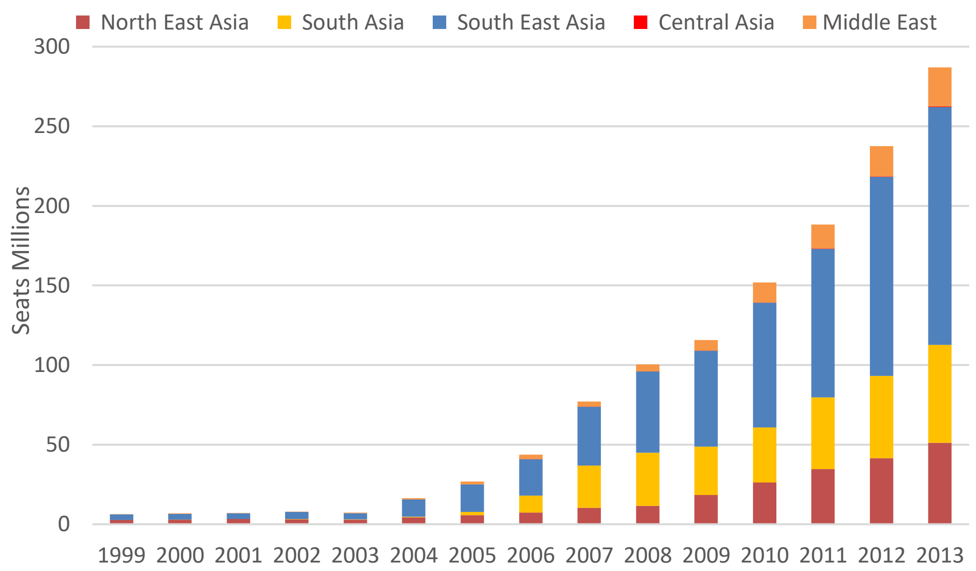

Figure 1-10 Growth of Low Cost Carriers Capacity in Asia and Middle East

Source: OAG (2013)

In terms of opportunities, LCC's offer huge potential for the expansion of secondary/ regional and provincial airports which has been the case in Europe and North America (CAPA, 2012a). However, the growth of LCCs in Asia has suffered from the failure of small airports to provide the facilities of a secondary airport to fulfil the requirements of LCCs or the rather limited number of airports in metropolitan areas with such facilities (Zhang et al., 2009). Thus, the Asian LCCs have developed their businesses out of the primary airports in the region. Major airports have been facilitating the business model, either by adopting to the requirements of the LCCs or developing dedicated terminals for LCCs. Examples are Singapore Changi, Malaysia Kuala Lampur, China's Xinzheng and Xiamen airports. Therefore, opportunities remain open for both airlines and airports in Asia to capitalise on low cost travel products in a fast growing air travel market.

1.1.5 Unevenness in the air transport development in the East

Despite the fact that Asia and The Middle East together have outperformed the rest of the world in size and rate of aviation growth, this is very much a diverse region with countries at different evolutionary stages in the aviation industry. Compared to its large populations, its market is still small, with only 56% of the global average number of airline seats per head. Accordingly, there is a big gap between the air travel penetration rates (measured by seats per capita) among the countries in the region (CAPA, 2014a). In addition to this, there is a vast difference between the sub-regions in terms of their capacity share of the market (Figure 1-11). Unarguably Northeast Asia gets the biggest share owing to the size of the Chinese market (the largest in the region/world both in terms of population and landmass) and developed Japanese market. Compared to other sub-regions, South Asia's contribution is much lower despite the fact that it is home for big populations such as India (2nd largest in the world), Pakistan and Bangladesh (3rd and 4th in terms of population in the region). Even though Central Asia is the fastest growing market in the region (double-digit growth in the last few years), it only accounts for a 1% share in the total market with 20 million seats in 2014 (See, Table A-2, for values). Both sub-regions have recorded comparatively volatile growth rates during the last decade, showing their vulnerability to global events. According to (CAPA, 2014a) Bangladesh and Turkmenistan are two countries in the bottom part of the list of air travel penetration rates in the world.

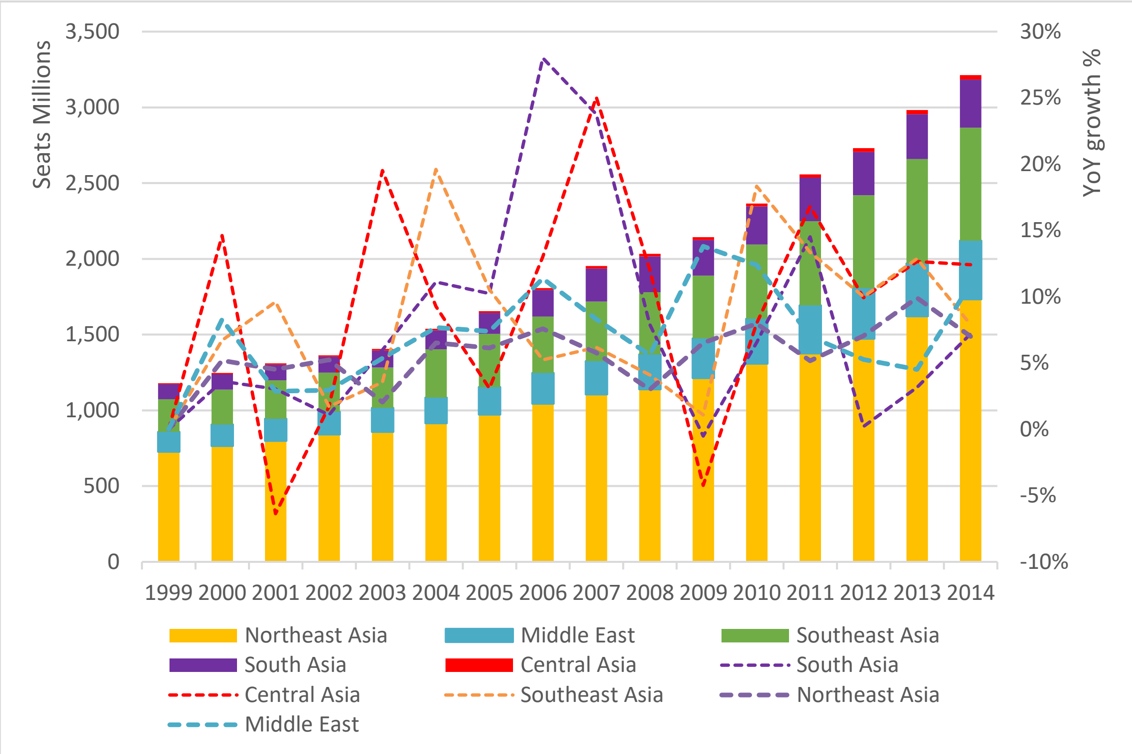

Figure 1-11 Capacity share and growth of the aviation markets in the East

Source: OAG (2014)

Apart from the differences between sub-regions, vast differences between countries within sub regions exist too. For example in Southeast Asia, there exists a huge difference in the level of sophistication in the air transport industry between world class airports and their carriers, such as in Singapore, Malaysia and Thailand, and underdeveloped aviation markets like Laos, Myanmar and Cambodia (Williams, 2006). In Northeast Asia, there is a stark difference in aviation policy between the politically isolated North Korea and the rest of the Northeast Asian countries. In the Middle East too, there is polarisation to a higher degree between the three leading hubs (Dubai. Abu Dhabi, Qatar) and international airports in other countries. Even though the region has contributed to make a significant shift in the centrality in the global air transport network, this has happened in an uneven pattern. While some airports/ cities/ countries have immensely benefitted from the change and have stimulated further change, some are comparatively underperforming and remain isolated. The region provides empirical evidence of the unevenness in the development of airline networks (Bowen, 2002) and the distribution of its benefits to societies.

1.1.6 The traffic-shadow effect

As explained above, the aviation industries of states in the region are currently at different stages of evolution: ranging from small aviation markets to mega-hubs regions. This trend has led to the concentration of market power in the hands of these major hubs, at times challenging the survival of smaller airports. Taaffe (1956) refers to this competitive phenomenon as a “traffic-shadow-effect” casted by the major airports / hubs on the small airports in the vicinity. Taaffe first explained how New York, Boston and Washington as “primate cities” cast a traffic-shadow on the cities in-between on the eastern coast of United States. When a node airport within a network develops as a significant hub, it can also result in a shadow being created over smaller airports in that network (O’Connor, 1995). What happens is that, when a large hub airport is present, the international airlines get attracted to that hub airport (for its infrastructure/ facilities/liberal policies) and the airports in the vicinity receive less attention. Then, those small airports start performing the role of feeder airports to the big hub and subsequently take a secondary or tertiary role in the airport hierarchy, creating a vicious cycle leading to the reduction in direct international services. According to O’Connor (1995), shadowing is a result of the proximity of hubs to other airports. Thompson (2002) mentions a similar effect on the third level airports in France; one of the cases being the Grenoble airport coming under the shadow of Lyon airport, despite the saturated agglomeration and the attempts to develop the airport as an industrial base. This demonstrates the use of traffic-shadow theory in airport catchment area analysis. Suau-Sanchez, Burghouwt and Pallares-Barbera (2014) explain that catchment areas for large airports are extended over long distances and that they can shadow the airports located even within densely populated areas.

A shadow effect is discernible in the pattern of growth of mega-hubs in the East. In the Post-World War II period, Japan took the primary role of a gateway to Asia and so catered for more than 80% of Asia-US traffic, creating a monopolar hub system (Feldhoff, 2003). East Asian economies greatly relied on Japan up until the late 1970's, since when the rise of the Southeast Asian aviation hubs came about. O'Connor (1995), reviewing the development of Southeast Asian Airports reports the shadow effect created by the emergence of Singapore and Hong Kong as central economies/places in the 1980's. The proximity of the main national airports of Kuala Lampur, Jakarta, Taipei and Manila to the established destinations of Singapore and Hong Kong led to the aggregation of traffic from those airports (which were destinations themselves) at these two big airports. Improvement in aircraft flying ranges also contributed to the disappearance of previously important stopping points in the Indian subcontinent, Middle East and East Asia on the routes from Europe to East Asia and beyond (Australasia). Thus, the importance of Singapore and Hong Kong grew further.

O'Connor (1995) further notes that the impact of the traffic-shadow on airports is limited by the will of respective national governments to establish the country/airport as a destination and safeguard the direct network of the national carrier. Bangkok was an example of a successful airport, which could maintain its position as a destination at that time, thanks to tourism, industrialisation and the domestic travel demand. But later, revival efforts of Kuala Lumpur by expanding its infrastructure in 1998 and building up of a HS network by the national carrier Malaysian Airlines generated significant pressure on Changi airport (Williams, 2006). Likewise, strong government backing and liberalisation has increased the importance of other major airports like Jakarta, Manila, Seoul-Incheon, and Taipei in the airport hierarchy in East Asia. However, O'Connor (1995) says that such strategies are not always workable, especially when scale economies favour the established hubs. Airlines get attracted to where the big demand is. Subsequently feeder services get attracted to where the big airlines fly. Thus, in spite of the protectionism and government support received, national carriers in countries with smaller aviation markets may find it difficult to operate sustainable long-haul networks.

In the pre-jet age, the Middle East also witnessed the growth of Beirut, Damascus, Bahrain, Baghdad, Amman, Jeddah, Tehran, Kuwait etc. as significant stopover points on the Europe to Australasia route (Feiler and Goodovitch, 1994). An increase in the range of the long-haul aircraft in the 1970's marked the downfall of some of the established airports/airlines, leading to a structural change in the region's air transport, exerting pressure for consolidation and capacity reduction (Hooper et al., 2011). The way was paved for a new era in air transport in the region when Emirates (started in 1987) from the Dubai airport started capitalising on 6th freedom traffic rights to drive a wave of mega hubs in the region. This was followed by Qatar (started in 1993) from the Doha airport and Etihad (2003) from the Abu Dhabi airport. Today Dubai is the 4th largest airport in terms of seats offered and Emirates with a fleet of 251 aircraft is the largest airline in terms of international available seat kilometers (Table 1-2). The success of these hubs has more or less left the region's other airports behind.

1.1.6.1 South and Central Asia: Emerging under a traffic-shadow

As reviewed in section 1.1.5, South Asian and Central Asian aviation industries are examples of the uneven patterns in the development of the air transport industry in the region. Whereas there are many contributory factors, such as the bureaucratic regulatory and fiscal frameworks, nationality oriented civil aviation policies, low productivity and overcapacity in the market, and political unrest (CAPA, 2013d, CAPA, 2013e; O′Connell et al., 2013; Saraswati, 2001), in light of the traffic shadow theory, it can be deduced that to a certain degree, Southeast Asian and Middle Eastern mega-hubs are casting an extended traffic-shadow over these regions.

For instance, Dubai can cover most of the major airports in Central Asia and South Asia within 3.5 hours of flight (generally considered a short-haul flight) time. Singapore too has the advantage over the east coast of India, Bangladesh and Sri Lanka (Figure 1-12). These two hubs (as well as other established hubs) can easily service the region's airports with short to medium haul flights to generate feeder traffic for their long-haul hub networks. The implications of this for the region's airports are twofold. The first is losing the 'international destination status' to attract direct services and the second consequence is losing the chances of developing a hub status. While countries with strong aviation industries can counter the pressure exerted by big hubs (possibly India given the size of its market), countries with small aviation industries face considerable challenges. For the month of May 2012 The Middle East offered nearly 30 million continental connecting (excluding intra-regional (Eastern) connections) seats to the market while South Asia and Central Asia only had 0.15 and 0.04 million seats respectively. This demonstrates the marginal role played by the two regions as an intercontinental connection point (Figure 1-13).

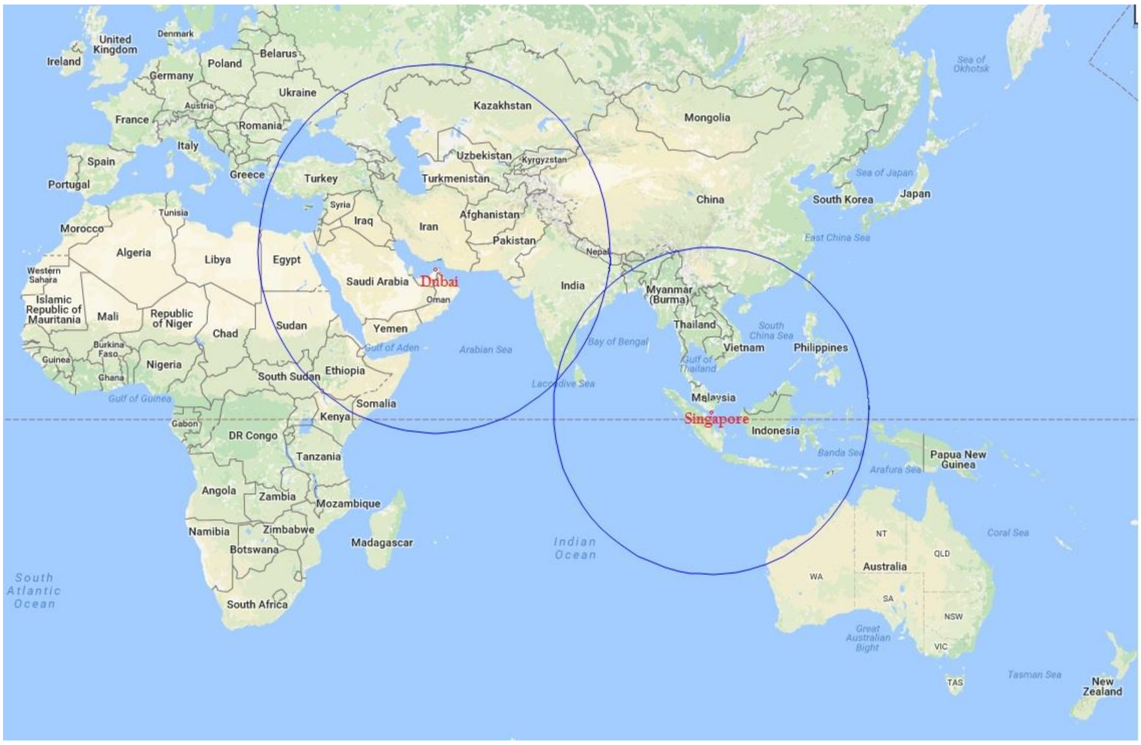

Figure 1-12 Catchment Areas of Dubai International Airport and Singapore Changi International Airport within a 3.5 hours* flight radius

* Cruising speed 878kmph assumed, 3073 km radius

Source: Own elaboration using www.freemaptools.com

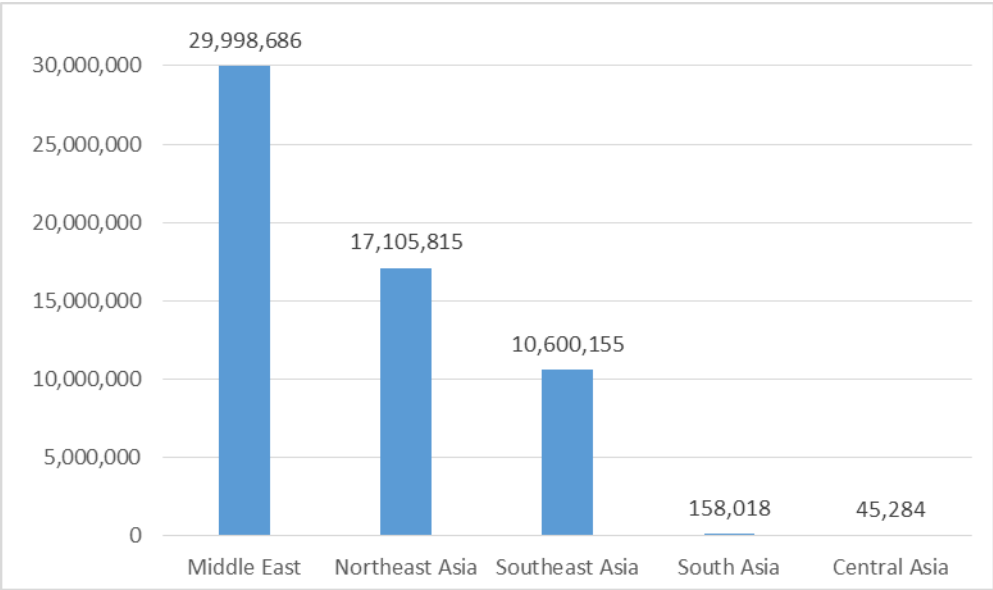

Figure 1-13 Connecting Seats offered by airlines via the East, May 2012

Source: OAG (2012)

1.2 Research problem

Air transport provides the speed required in modern day economic and social processes; overcoming the obstacles of space and distance in the shortest possible time. A review of the economic and social role of air transport (section 1.1.2) and the development of the aviation industry in the East (section 1.1.3) confirmed that maturity in the aviation industry system and the level of economic development of a country have a close relationship with each other. The developed and emerging economies in the East have ranked aviation as a key strategic priority in their development agenda, and airports are seen as a central piece of physical infrastructure in building modern cities. Airports have become a key resource with which to create a competitive edge over the other countries/cities. In this context, hub airports receive greater attention from policy-makers for the benefits they confer upon a society and they are commonly used as an instrument to achieve national economic and social development goals. Today, the region is home to several leading mega-hubs in the world that has completely shifted centrality of the global air transport network towards the East.

However, as is the case of any development process in history, unevenness has been a part of the development of the aviation networks in the region. Major hubs benefit from traffic flows being increasingly concentrated at those markets, casting a traffic shadow over the airports within a short to medium haul flight distance. Very small/local airports with limited options for improvement gain an advantage from this situation by being able to increase their accessibility. However, the small or average international airports (those which are in the middle of the hierarchy) wishing to improve their position are challenged by this situation. They are held back from establishing viable direct connections. This happens due to the inability of small international airports to generate as much OD demand as is being generated by a hub airport by pooling feeder traffic. Major international airlines get attracted to the volumes generated by hub airports and smaller international destinations are discounted because of lack of sufficient demand. Consequently, direct long-haul connections to and from small international airports become unsustainable in the long run. Even if they wish to emerge as a hub, small airports are deprived of the opportunity to secure a strong HS system and develop the airport's position. With a few connections on offer, they cannot compete head to head with bigger hubs that offer frequent connections to worldwide destinations. On the other hand, when long haul routes are not profitable, national/hub/main carriers at these airports benefit by carrying feeder traffic to the major hub airports, eventually pushing the airport to a secondary role in the network. From a 'national-self-interest' perspective, this presents considerable challenges for less developed economies, should they wish to develop their airports (into hubs) with the intention of stimulating economic growth and enhancing social benefits. This becomes further complicated in a world where competition between airports has become a competition between nations and cities to emerge as global commercial centres.

From a network perspective, a hub airport is a special node in a network that works together with airlines by sequencing arrival and departure flights to maximise the connections offered to a wider range of destinations. In a theoretical sense, a HS system is beneficial to the market as it rationalises the network structure and delivers benefits to airlines and passengers. However, not all airports can play the role of a hub and not all the hubs in a network can play the hubbing role to the same degree. Therefore, it is unrealistic for all the airports in a network to aspire to become a mega-hub. A hierarchy of airports exists in the global air transport network as it does in the case of any origin-linkage-destination travel system. Nodal function played by the airport/places defines its role in the network, from simple OD airports (spokes in HS system), to gateways (entry point to a region) and hubs (connection point) (Pearce et al., 2001). These airports take different nodal functions at different times and at different degrees, varying their services (Ivy, 1993) and, from a global point of view, create a hierarchy of network components (airports) (Graham, 1995).

Thus, a country wishing to anchor its growth around the investment and development of its airport systems should carefully analyse the current position (nodal function) of its airports in the global airport hierarchy. Competitor analysis becomes very important to the average international airport that faces a threat from the developing mega-hubs in the region (as reviewed in sections 1.1.5 and 1.1.6) as it would help airport planners to identify the nodal function that the airport play in relation to the global hierarchy of airports. It would help in setting directions for the future of the airport/s in terms of whether it should take the role of a hub/gateway/OD airport (or any other variations to it) and to what degree it should plan to play that role. In doing so, the airport/s can develop strategies across different dimensions (market share, firm size, network, market segmentation etc.) to improve its position in such a way that it can secure a sustainable strategic position in the network.

The review of drivers of aviation industry growth (and hubbing) in the East (section 1.1.4) revealed that, apart from the geographical location which determines the initial connectivity advantage, there are other contributory factors for the development of a successful aviation industry and airport systems. *Inter alia,* these include a strong economy with a substantial output generation through industries and services to generate OD travel demand, and resulting urbanisation (demographic structural transformations). Government commitment provides a conducive political and administrative environment, which promotes infrastructure investments, privatisation, liberalisation and deregulation in the industry. Realistically a country would require a stable and sustainable macro environment to sustain a competitive edge in any industry (Cho and Mun, 2000; Itani, O'Connell and Mason, 2014; Porter, 1986, 1990; World Economic Forum, 2012). This would ensure the development of favourable industry policies. Evaluation of an airport's network position against the industry policies /regulations and the macro environmental conditions of a country will facilitate the development of conducive policies and regulations that support the growth of an airport by optimising its competitive position in the network. Therefore, a framework that can establish a link between an airports position in a network and the conditions of the respective civil aviation policies and the macro environment would provide a platform for such policy decisions.

The explanation above highlight the importance of a holistic approach to airport strategic planning, national civil aviation policy-making and other macro government policies. To this end, a framework to assess the competitive position of an airport within a network and the respective national policies would be very valuable to both airport strategic-planners and civil aviation policy-makers. Research in this area has room for contribution to the existing literature on airport strategic planning. This research is proposed to address the needs that would both fulfil a strategy and policy making need of the industry and contribute to the existing literature on airport strategic planning, by developing a methodological approach to airport competitor analysis and national civil aviation policy development.

1.3 Research aim and objectives

1.3.1 Aim

This research aims to develop a framework to assist in the airport strategic planning process and related national civil aviation policy development to optimise the positioning of an airport in the aviation network of the East.

1.3.2 Objectives

1. Propose a methodological approach to comprehend the competitive structure and geography of the network of airports in the East.
2. Identify the factors that shape up the growth of an airport and interpret the causes for the differences in the airport hierarchy.
3. Application of the methodological approach to recommend airport strategy and civil aviation policy measures to improve the status of an International Airport identified to be under the traffic shadow created by developed hubs in the East.

Knowledge outcomes from objectives 1 and 2 are used to achieve the 3rd objective (application in a case study).

1.4 Geographical scope of the research

The empirical focus of the research is on the development of aviation in the East. Therefore, the geographical boundaries of the thesis were drawn to include a network of airports generally considered to be in the 'Asian Continent or Eastern World' in *metageographic*[4] terms. The world map is divided into regions under different themes; the fundamental building block of world geography being the idea of continents; the large land masses separated by the seven seas. Lewis and Wigen (1997) challenges conventional frameworks of world geography influenced by the physical separation of landmass and calls for context-specific regionalisation of the world, based on criteria specific to the subject in concern.

[4] Metageography is the "set of spatial structures through which people order their knowledge of the world; the often unconscious frameworks that organise studies of history, sociology, anthropology, economics, political science and even natural history"(Lewis and Wigen, 1997) p. ix)

Thus, a context specific regionalisation has been used for the purpose of this study.

ICAO uses a six-part regionalisation of the world aviation network, namely; Africa, Asia-Pacific, Europe, Latin America and Caribbean, Middle East and North America. In the light of the empirical subject of the research, the airport network was selected from Asia (excluding the Pacific) and Middle East, regions that compete for a common intercontinental transfer market. Southwest Pacific countries of Australia, New Zealand and the rest of the islands were excluded on the basis that they do not belong to the same competitor circle. It is worth mentioning that this categorisation was mostly in line with the commonly used division of regions based on geographical proximity, similarities shared by countries in economic, political, and cultural activities. In particular, it was influenced by the OAG categorisation of regions, as most of the data came from their databases. Thus, Asia as a region was subdivided into four regions, South Asia, Central Asia, Southeast Asia and Northeast Asia. Then, a group of countries in the Middle East adjoining the Asian boundaries was selected as the western end of the Asian region. The United Nations Statistical Division's geoscheme® follows a similar introduction to the Middle East as West Asia. In this study, the term 'East' collectively refers to South Asia (AS1), Central Asia (AS2), Southeast Asia (AS3), Northeast Asia (AS4) and Middle East (ME1).

1.5 Research design and structure of the thesis

This research is multidisciplinary in its theoretical foundation. It draws on prior knowledge of air transport economics, geography and network theory and concepts in strategic management to build the conceptual and analytical framework of the study. Figure 1-14 presents a graphical overview of the research design of this study and subsequent chapter organisation in the thesis.

Chapter 1 presents the background, problem, objectives and defines the geographical scope of this research. It discusses the contribution of this research on structural analysis of airport competition and issues of unevenness in the development of air transport in the East. Chapter 1 also reviews extant literature on the air transport industry of Asia and The Middle East, hub airports as a national policy-making tool and traffic shadow-theory in developing the background of this research.

Chapter 2 extends the review of literature on the key concepts that this research is built on. The first part of the chapter contains the discussion of airports as a business and their impact on the economy, forms of airport competition and the role of an airport from a network perspective. The second part reviews literature on factors driving competitiveness in the aviation industry. The chapter revisits the research objectives and explain their contribution to fill the gaps in the literature.

Chapter 3 presents the research design of the thesis. It discusses the 'strategic group theory', the main research strategy of this study, which deals with the classification of airports in the aviation network of the East. The study is based on this classification exercise to identify the structure of airports in the East. It answers the first research objective of this study. Subsequent analysis is based on comparing key indicators of aviation competitiveness between the airport types in the proposed taxonomy. Secondary data and desk research methods are presented with the data sources as the primary research method of this study. The chapter also elaborates hierarchical cluster analysis (HCA), principal component analysis (PCA) and analysis of variance (ANOVA) that were used in the airport classification and subsequent analysis. Selection of the study sample consisting of 450 airports is presented followed by the discussion of contributions of the pilot study to the final study.

Chapter 4 presents the proposed taxonomy of airports in the aviation network of the East. The first part of the chapter proposes key strategic dimensions suitable for a structural analysis of the airport industry. The subsequent sections combine the discussions of methodological procedures of the HCA and the PCA (as a data reduction tool for multivariate data on airport network strategies and segmentation strategies), and the presentation of the results of the twelve-group taxonomy of airports. This chapter meets the first research objective of this study.

Chapter 5 deals with the second objective of this study. It compares seven airport groups in the proposed airport taxonomy across seven macro environmental indicators. The comparison is aimed at determining whether there are significant differences across the group mean values (ANOVA) of these indicators which could be identified as factors promoting successful airport developments (hubs and other forms of airports that are at the top of the hierarchy). It also evaluates the effect of the degree of liberalisation in the economic regulation of air transport on an airport's network role.

Chapter 6 addresses the third objective of this research. It applies the proposed taxonomy of airports to the case of Sri Lanka and its main international airport, which is identified as an airport shadowed by the nearby hub regions. Recommendations are made at three levels to improve the position of the airport. Airport/airline level strategies are recommended based on the benchmarking exercise using the strategic dimensions of the airport cluster analysis. Industry and national level policy directions are based on the economic regulations and macro environmental profiling of airports.

Chapter 7 concludes the thesis. It reviews the aim and the three objectives of this research against the findings and contribution of this research to the literature. Delimitations are discussed in terms of the data, sample and methods used in the study. The chapter concludes with proposals or future research in the area.

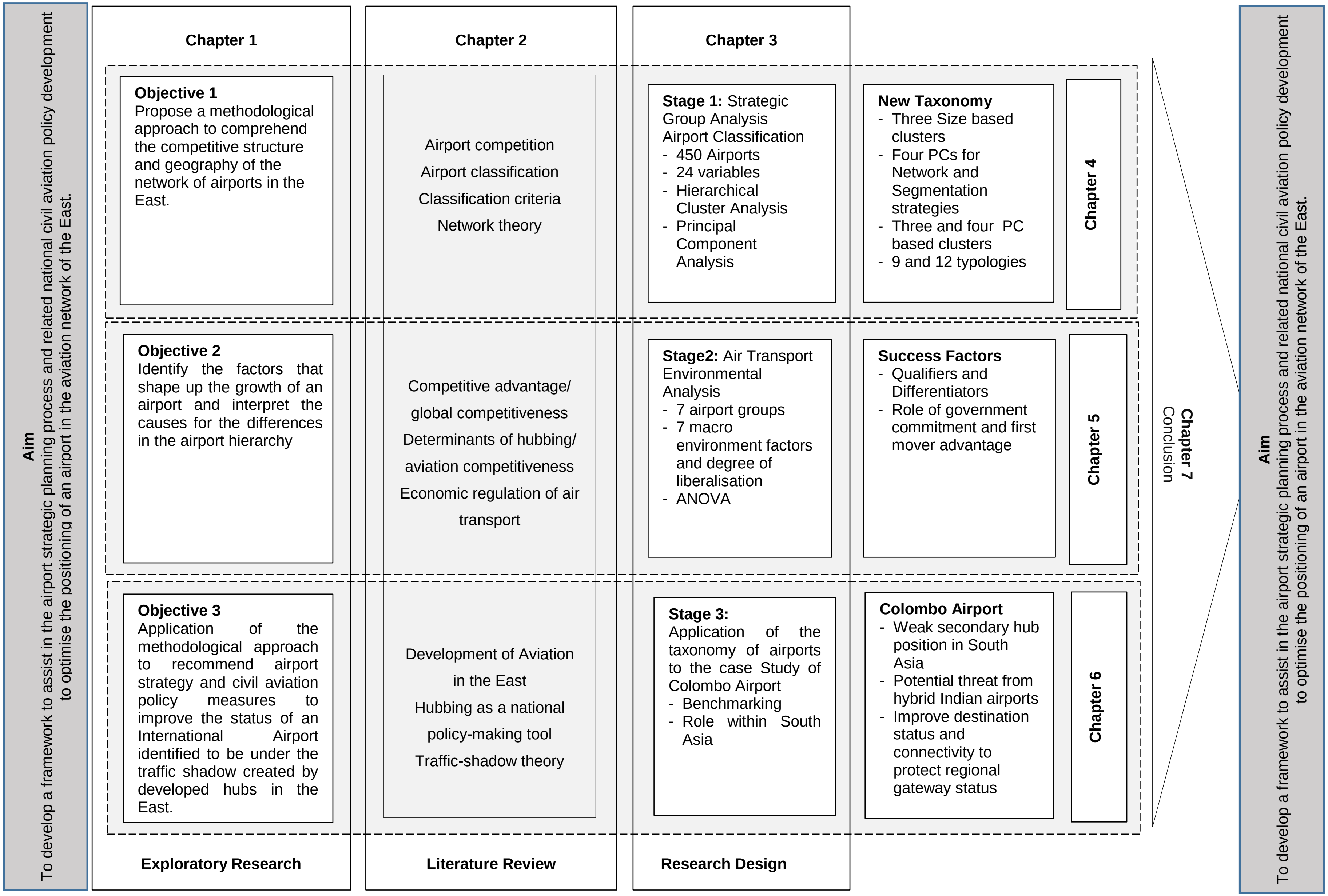

Figure 1-14 Research design and structure of the thesis

Source: Own elaboration

1.6 Contribution of the study

1. Methodology

The main contribution of this study to the existing knowledge is methodological. Currently several studies use airport classification for different purposes. Those include providing a frame of reference for the allocation of public funding or planning investments by differentiating hubs from non-hubs (FAA, 2012; Neufville, 1995; Rodriguez-Deniz, Suau-Sanchez and Voltes-Dorta, 2013; Suau-Sanchez, Voltes-Dorta and Rodríguez-Déniz, 2015),airport performance/ efficiency analysis and service quality benchmarking (Adikariwattage et al., 2012; Barros, 2009; Rodríguez-Déniz and Voltes-Dorta, 2014; Vogel and Graham, 2013), evaluating the impact of deregulation and liberalisation on the development of aviation network and airports (Burghouwt and Hakfoort, 2001; Graham, 1998; Malighetti, Paleari and Redondi, 2009), and assessing connectivity level or differentiating airport types (Guimera et al., 2005; Ivy, 1993; Mason, 2007). Some of the studies use two or less variables and researcher's judgement (FAA, 2012; Neufville, 1995; Graham, 1998) or statistical analysis (Guimera et al., 2005; Ivy, 1993; Rodriguez-Deniz, Suau-Sanchez and Voltes-Dorta, 2013; Suau-Sanchez, Voltes-Dorta and Rodríguez-Déniz, 2015) for classification. Others use multiple variables and researcher's judgement (Mason, 2007) or statistical analysis (Adikariwattage et al., 2012; Barros, 2009; Burghouwt and Hakfoort, 2001; Malighetti, Paleari and Redondi, 2009; Rodríguez-Déniz and Voltes-Dorta, 2014; Vogel and Graham, 2013) for classification.

The current study is different from the above studies in its purpose to classify airports from a competition perspective based on key strategies that define an airport's role in a network. In addition, it uses multivariate data (24 variables) that represent different airport strategies, more than have been used in previous studies. Therefore, the study uses both HCA and PCA in a carefully articulated stepwise method in devising a classification of airports from a large sample (450 airports). In addition, the study extend the current classification studies by introducing air transport policy and macro-environmental indicators to profile airports. This further helps to define the common features of industry and national level policies of airports belonging to similar categories. Therefore, the current study contributes to the existing literature on airport classification through its methodology adopted to clustering airports using multivariate data.

2. Expanding the geographical scope

The existing airport classification studies are mainly based on the US and the European aviation networks (FAA, 2012; Neufville; Rodriguez-Deniz, Suau-Sanchez and Voltes-Dorta, 2013; Suau-Sanchez, Voltes-Dorta and Rodríguez-Déniz, 2015; Adikariwattage et al., 2012; Barros, 2009;; Burghouwt and Hakfoort, 2001; Graham, 1998; Malighetti, Paleari and Redondi, 2009; Ivy, 1993; Mason, 2007) or on a global sample of airports (Guimera et al., 2005; Rodríguez-Déniz and Voltes-Dorta, 2014; Vogel and Graham, 2013). They do not provide a comprehensive understanding of the structure of the airport network in the East. This study expands the geographical scope of airport classification studies to the East. It is the first in its kind to cover the entire region, which captures the changes taking place in Asia and The Middle East as fastest growing aviation markets in the world.

3. A policy making tool

The taxonomy is useful in its application as an aviation policy-making tool. The classification helps to identify the role (nodal function) of an airport within a competitive network. Thereby, it provides a framework for benchmarking an airport against airports with similar profiles to identify its competitive position in terms of the strategic strengths and weaknesses. The advantage of benchmarking against airports with similar profiles is that it allows a more profile-specific strategic comparison with the best-in-class practices. Then it is easier for an airport to devise a strategic path that it should take to improve the current position. The profiling of airports based on the air transport policy and macro environmental conditions of the respective countries helps to understand the necessary policy interventions in order to improve the status of an airport. The usefulness of the taxonomy is greater in its application at different levels - an individual airport or a local or a national government to evaluate an airport system.

1.7 Conclusion

This chapter presented the background to the subject of this thesis and the researcher's motivations in establishing the aim and objectives of this research. The central role that airports play in national economic development was reviewed at the beginning of the chapter with a special reference to Asia and the Middle East where development of mega-hubs has received government interest. Deductions were made on the possible effect of a traffic shadow casted by these mega-hubs on the nearby international airports, especially in the cases of South and Central Asia. In this background, the importance of a methodological approach to identify the competitive position of an airport in the global aviation network in the process of airport strategic planning was identified. Furthermore, the influence of the conditions of the air transport industry and the general macro environment of a country, on the role and functionality of its airports in the global aviation network was highlighted. Therefore, a framework that can guide policy-makers in establishing the relationships between these elements that help shape the growth of an airport was identified as useful.

Hence, the research aim of this thesis was established as *'to develop a framework to assist in the airport strategic planning process and related national civil aviation policy development to optimise the positioning of an airport in the aviation network of the East'.* The chapter defined the empirical focus of this study, which is on Asia and Middle East. The thesis is structured over seven chapters. Contribution of the thesis are threefold; methodological, geographical and policy development.

Prior to establishing a research design to achieve the objectives of this study, it is essential for the researcher to deepen the understanding on the key concepts underpinning this research. This chapter provided a background to the empirical context of this study and the concept of hub airports and their relationship to the wider economy. It laid the background to the selection of the case study airport for this research (as later justifies in chapter 6), that addresses the third research objective of this study which focuses on the *'application of the methodological approach to recommend airport strategy and civil aviation policy measures to* *improve the status of an International Airport identified to be under the traffic shadow created by developed hubs in the East.'* The next chapter further reviews literature on the following areas to develop a conceptual framework to achieve the first and second research objectives of the study.

1. Evolution of the airport business.
2. The nature and scale of airport competition.
3. Network theory.
4. Key strategic dimensions that define an airport's role in a network.
5. Methods of identifying different airport typologies.
6. Key infrastructure for successful hub operations.
7. Drivers of a successful aviation industry.

2 LITERATURE REVIEW

2.1 Introduction

The previous chapter reviewed research related to the development of aviation in the East, as a preamble to the research problem of this study. This literature review is conducted as a sequel to the first chapter in order to improve the breadth and depth of the theoretical concepts underpinning this study. First part of this review deals with literature relevant to the part of the research problem addressed by the first research objective of this study. Thus, section 2.2 to section 2.6 review literature that derives the key study variables to build a framework for airport competitor analysis. The review looks at the evolution of the concept of airport business, airport competition, theory of air transport networks, roles and functionalities of airports that define different airport typologies and the key success of hub airports. Section 2.7, reviews literature on theories of national competitive advantage, factors driving successful hub location and competitiveness in the aviation industry and the regulatory aspects of air transportation that creates the governing framework of civil aviation in a country. The review is helpful in developing a conceptual framework to address the second research objective of this study. Final part of the chapter present the theoretical conclusion and identify the research gap that this study seeks to fulfil through its objectives.

2.2 Airport business and its impact on the national economy

> *"As a gateway and principal location for air transport operations, airports act as magnets for commercial activities in local and regional economies."*(ICAO, 2005)

The above extract from the ICAO's circular on Economic Contribution of Civil Aviation puts in perspective the role of an airport in the wider economy. Its primary role as the 'principal location' is to act as a forum for airlines, passengers and freight, air navigation service providers, handling services, security, fire services, fuel suppliers, catering facilities, maintenance service providers, and many other diverse stakeholder parties to come together. Thus, the modern day airport goes beyond the traditional ‘piece of infrastructure (runways, taxiways, aprons, terminals, gates etc.) ’ definition to encompass the wider role it plays as an economic stimulator (Doganis, 1992; Graham, 2008a).

Doganis(1992) categorises airport activities into three areas. These are: *essential operational services,* which include air traffic control, meteorological, telecom, security, fire and rescue services, which are primarily concerned with safety and security of aircraft and passengers; *traffic handling services,* which include ramp handling, passenger, baggage and cargo handling; and *commercial activities,* ranging from small shops, restaurants, airport hotels, shopping malls, banks, cinemas, to recreational activities and many more of a non-traditional nature. It is this commercial role that has expanded within and outside the airport borders to its vicinity and beyond, that is seen as delivering economic and social benefits to communities (This role of airports was briefly discussed in section1.1.2).

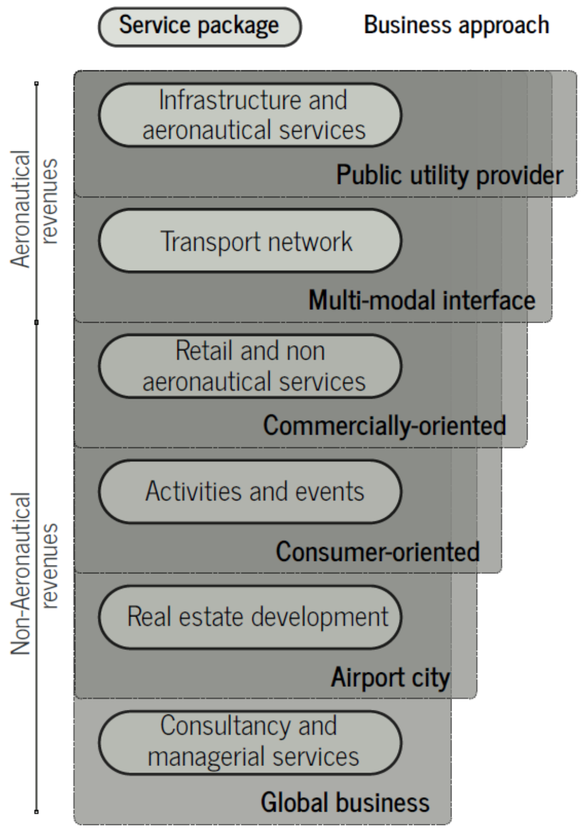

Figure 2-1 The airport product as six service packages and associated approaches to the airport business

Source: Perez (2014)

Perez (2014), identifies six evolutionary steps in the development of an airport as a business, which he names as ‘service packages or products’ that an airport can choose to grow (Figure 2-1). According to him, at the initial phases an airport’s focus is more on aeronautical revenue. This is seen at small airports offering services to general aviation, pilot training, aerial services, or servicing remoter regions. As airports grow, the developers have come to realise their potential in generating revenues by providing opportunities for non-aeronautical businesses, within or in the near vicinity of the airports. The expansion of an airport beyond its boundaries is an evolutionary step of its role in the economy by converting the metropolitan areas it serves into airport cities; a form of agglomeration of socio-economic activities with airports at the centre. (Kasarda, 2006; O’Connor, 1995; O’Connor and Scott, 1992; Reiss, 2007). This form of growth promotes spatial concentration of diverse businesses around the airport, such as hotels, leisure attractions, mega duty free and luxury shopping centres, exhibition and convention centres, business complexes to house headquarters of multinational companies(ICAO, 2005), manufacturing businesses, logistics solution providers, and free trade zones (Lee and Yang, 2003). Further agglomeration of industrial parks, logistics centres, aero clusters and urban residential developments around the airport cities are creating aerotropolises which are seen as the newest form of transport-induced urban developments in the world (Kasarda, 2006, 2015). Going beyond the real estate development package, airport managers and developers have started diversifying their businesses to utilise the expertise they have gained over the years in airport management. This is achieved by establishing global airport management companies and consultancy services. These types of businesses move into the acquisition of international airports or management contracts and providing consultancy services on airports planning, construction and operations (Perez, 2014).

Therefore, airports play a central role both within the aviation industry and outside of it in the national economy, delivering direct, indirect, induced and catalytic benefits on a larger scale. The impacts of these wider benefits are measured in terms of the contribution to the economic output (GDP) and employment generated (ATAG, 2005; ICAO, 2005). The direct contribution of airports to an economy comes from the total output generated by the airport operations and is measured by taking the values of primary and intermediate inputs in the process of generating airport activities. Direct employment takes into account both all the staff employed by the airport operator at various points of service, and the service providers directly related to the airport's main operations. In 2010 airport operators generated 0.5 million direct jobs (6% of total jobs) and other airport on-site businesses (in retail outlets, restaurants, hotels and government border agencies) generated 4.9 million (58.5% of total jobs) (ATAG, 2012). The indirect contribution comes from activities and suppliers to the airport businesses and may include manufacturers and service providers of equipment used in airports, electricity suppliers and manufacturers of goods sold in airport retail, construction and maintenance companies that build airport facilities, aviation fuel suppliers, business services providers such as banks, call centres, accounting, software and IT services. Induced contribution comes from the spending of the salaries earned by the employees (direct and indirect) on day-to-day consumption of goods and services. Through that, they support the generation of output and employment across diverse manufacturing, retail and service industries (ATAG, 2005).

The catalytic impact is the most attractive of all incentives for policy-makers to promote investment in airports as it supports and promotes the growth of trade, tourism, investments and productivity and market efficiency, consumer welfare, and labour supply (Airports Council Internationl (ACI), 2015; ATAG, 2005). For most of the tourism dependent economies (especially islands), air transport is indispensable as it is virtually the only transport mode that brings in travellers. The size of the airport and its facilities determine the type of airlines that fly into the country and the types and sizes of aircraft and eventually the number of tourist arrivals (Forsyth, 2006; Roberto, 2006). Air transport provides the safest and fastest mode of travel. For high value and perishable goods, it is the preferred mode of transport. ACI (2015) reports that, in terms of value of traded goods, about 35% is transported by air. At the same time by bringing together trade partners, air transport facilitates the closing of many successful business deals and foreign direct investments. The trickle-down effect on the economy and wider society makes airports an indispensable policy instrument in economic development frameworks.

2.3 Airport competition

Historically, airports have mostly enjoyed natural monopolies, and competition in the industry has been minimal for several reasons. One key factor has been the 'geographically constrained' feature of the markets they serve. Generally, people within a catchment area of an airport are not willing to travel far outside of it, unless there are more convenient schedules or better services offered at an airport elsewhere or unless catchment areas of certain airports are overlapping. Hence, the role of the airport is determined by the demand in the catchment area (Graham, 2008a). Secondly, regulatory constraints in the industry have also been a major barrier. The industry has long been constrained by bilateral air service agreements limiting the choice of airports available to airlines, thus limiting opportunities for competition. Besides, regulations on airport charges restrain airports from price competition (Barrett, 2000; Doganis, 1992; Graham, 2008a; Starkie, 2002). Thirdly, economic barriers such as huge capital investments required for airport infrastructure restrict the possibility of substitution from new ventures (Graham, 2008a). Moreover, the social and political will of national and local government agents have further limited natural competition. They prefer to control the airports as the key access points to the country and as a base of political power. On the other hand, accessibility is key for social welfare and a government's responsibility is to ensure this. Thus, airports are protected from natural competition to ensure survival.

However, liberalisation and deregulation in the aviation industry, moves towards increased privatisation and commercialization of airports and entry of low cost carriers have led to increased competition between airports. Competition in the airport industry exists in different ways and at different levels; between airports and within the airports (Barrett, 2000; Cranfield University Air Transport Group et al., 2002; Doganis, 1992; Graham, 2008a; Starkie, 2002). Competition between airports can fall into following categories.

2.3.1 Competition between airports to attract new inbound services

Airports compete (although they are geographically apart) to attract new inbound passengers from a tourism and business destination standpoint (Cranfield University Air Transport Group et al., 2002; Graham, 2008a; Perez, 2014; Productivity Commission, 2002). Attractiveness of the region that the airport is serving will determine the demand for inbound traffic to the airport. This will subsequently influence the decision of airlines to provide services to the airport. Perez (2014) further classifies competition between airports to attract airlines to three categories: hub or base, traffic node and an airline station, which is dependent upon the degree of OD traffic generation at the airport.

Airport charges will only play a marginal role when it comes to an airlines' decision to introduce new city pairs. Competition in these instances is described as between cities rather than airports (Cranfield University Air Transport Group et al., 2002; Productivity Commission, 2002). Therefore, airport competition has grown from selling pure aeronautical services to incorporating commercial services and destination promotion. Thus, airports are making strategic moves by encouraging business agglomerations around the airport, development of aviation clusters, airport cities and aerotropolises (Kasarda, 2006, 2008, 2015; O'Connor, 1995; O'Connor and Scott, 1992) as a brand icon in destination branding (Henderson, 2007; Lohmann et al., 2009).

2.3.2 Competition between airports within the same metropolis or with overlapping catchment areas

The catchment area of an airport is the land area from which the majority of the outbound passengers originate and to which inbound passengers travel and is often expressed in terms of population living within a certain journey time (Morrell, 2003) or distance (Suau-Sanchez, Burghouwt and Pallares-Barbera, 2014) from the airport. Airports within the same metropolis or with overlapping catchment areas compete with each other to attract local outbound traffic, freight and airlines serving the respective markets (Cranfield University Air Transport Group et al., 2002; Graham, 2008a; Perez, 2014; Starkie, 2002).

The type of competition varies with the services made available by the airline at the airport. The competition is intense between the airports located close to each other, which serve short and medium haul flights. One reason is that availability of close alternatives provides an opportunity for airlines to choose an airport, which will allow them to reduce costs and pass the benefits to passengers, in turn increasing their attractiveness (Cranfield University Air Transport Group et al., 2002). Therefore, price (airport charges) competition is more severe in these markets. The other reason is that passengers have a choice over the closest airport that serves their needs. For short-haul journeys, one factor that determines passengers' choice is the travel time to the airport, as they evaluate the journey time to the airport in relation to the total travel time by air (Morrell, 2003). The other factor is the cost involved. Passengers are less concerned about comfort in short-haul journeys, even business travellers, in the case of choosing a LCC (Mason, 2001).

The airports offering long haul services (international airports) face competition at a different degree. For long-haul flights, the catchment areas are wider as passengers are willing to travel longer distances to take a long-haul-flight of an airline providing a comfortable/ superior service, given the journey time by air (Graham, 2008a, Morrell, 2003). When there is more than one international airport within a metropolis or if the catchment areas are largely overlapping, such as in the case of the three London airports; Heathrow, Gatwick and Stansted, one would take a leading role while others play a secondary role (Graham, 2008a) as a result of the proximity effect (O'Connor, 1995). Thus, in long-haul markets, large airports with stronger networks can shadow the small international airports (See, chapter 1 section 1.1.6 for the traffic-shadow theory).

2.3.3 Competition for hub status

Another type of competition comes from the growing interest and developments in hubbing at airports for transfer traffic (Doganis, 1992). Transfer traffic takes different forms; domestic, regional, continental, and transfers from domestic or regional flights to international flights. Accordingly, hubs take different forms ranging from domestic hubs, regional hubs, inter-continental hubs (directional hubs) or hinterland hubs (gateways). Even though the number of stops that has to be made on long-haul routes has reduced, thanks to the innovative aircraft technology, continental transfer traffic markets remain lucrative for several reasons. One is the limitation of the maximum range of today’s long-range aircraft to nautical miles of less than 9000[5] making it unfeasible for ultra-long haul routes. Second, though non-stop flights are more convenient and time saving, passengers are attracted to the benefits of higher frequency; lower prices and the range of destinations offered through hub and spoke systems (Bauer, 1987; Holloway, 2008). Longer travel times are often disregarded for the benefits received.

Though airports are thought to be having limited influence themselves on developing as a hub (Cranfield University Air Transport Group et al., 2002), nowadays airports take a leading role in promoting themselves as hubs. They do this by offering sufficient infrastructure such as runways, aprons, terminals and gates; assisting hub carrier operations by facilitating minimum connecting times; efficient handling of passenger and baggage; and offering reduced/no airport charges on transfer passengers (Doganis, 1992). Detour distances (routing factor) is used as a major selling point by international hubs in attracting airlines to the airport. When airports are located closer to major air traffic flows, detours from the direct routes are minimal which decreases their circuitry values and allows them to offer faster travel time connecting the origin and destination through two flight legs via the hub This could nearly match the timings of a direct flight. In addition, competition between airline alliances also stimulates competition between hubs as member airlines focus upon connecting their services through a designated hub airport (Starkie, 2002).

2.3.4 Competition for State aid

Airports also compete to attract state aid in the form of funds/grants/subsidies/ tax exemptions from (local/national) governments (Cranfield University Air

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[5] Boeing 777-200LR has the highest recorded range of 8,555nm (15,844 km), with 317 passengers on a two-class seating configuration, total cargo volume of 150.9m^3 , maximum take-off weight 347,450 kg, flying at cruising speed of Mach 0.84(Boeing, 2016).

Transport Group et al., 2002, Morrell, 2003, Perez, 2014). This is observed in the case of multi-airport systems, where airports within a country/locale need to justify the need of funds from the government.

2.3.5 Competition from other transport modes

The competition from other modes of transport should not be completely disregarded in the case of airport competition. High-speed rail, long distance coaches, and car journeys (Graham, 2008a, Perez, 2014) provide reasonable alternative transport options. High-speed rail is particularly regarded as a very close substitute for short-haul air travel (Givoni and Banister, 2007; Graham, 2008a; Morrell, 2003). Thompson (2002) holds TGV high-speed rail partly responsible for destabilising third level airports in France. Similarly, the slow growth of LCCs in Japan is partly attributable to the Shinkansen high-speed rail network (CAPA, 2012a; Graham, Saito and Nomura, 2012).

2.4 Air transport networks

2.4.1 Definition of a network

> *"The term network refers to the framework of routes within a system of locations, identified as nodes. A route is a single link between two nodes that are part of a larger network that can refer to tangible routes such as roads and rails, or less tangible routes such as air and sea corridors" (Rodrigue, Comtois and Slack, 2006)*

A link between two nodes is termed as an edge/route, and links passing through several nodes are termed as paths (Goedeking, 2010). Thus, a network can be expressed as a collection of nodes and different forms of connections between them (Figure 2-2).

Air transportation moves people or goods from one place to another. Airlines move the people and goods in aircrafts and use airports as places to connect. From network theory perspective, airports act as 'nodes' and airlines create the 'link' by operating services between nodes to connect people and goods. These 'networks' can take different forms and are not only common to transportation but also seen in abundance across different industries ranging from communication, IT to banking (O'Kelly, 1998).

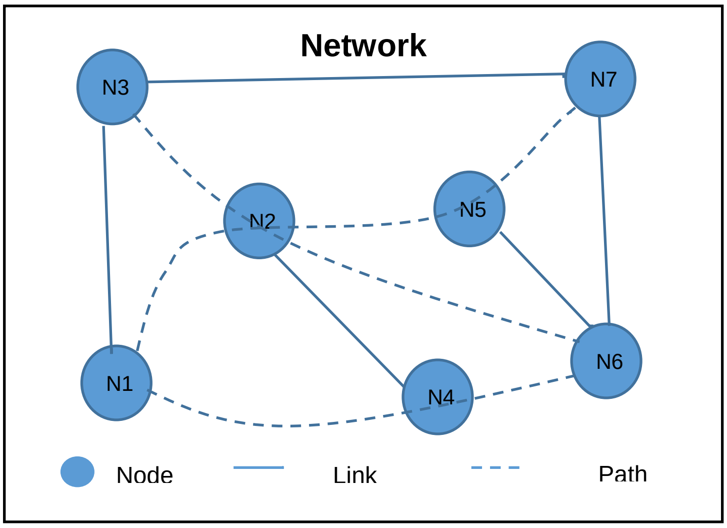

Figure 2-2 Nodes, Link, Paths and Networks

Source: Own elaboration based on Goedeking (2010)

2.4.2 Approaches to airline network theory

Burghouwt (2007) has identified two approaches that are used in academic literature to explain aviation networks; spatial and temporal methods. This review will follow the categorisation by Burghouwt(2007) in appraising the airline network properties. Given below is an outline to the two approaches which is expanded in later discussions.

The spatial approach deals with attributes related to creating networks on a geographic space. Graph theory, hub location and allocation theories, and network concentration measures are the spatial approaches to comprehending aviation networks.

1. *Graph theory:* Fundamental to the theory of networks is the graph theoretical approach to defining a network. Graph theory looks at a network and its connectivity in abstraction (Rodrigue, Comtois and Slack, 2006). Geographers define a graph as consisting "of a set of points and a set of relationships between pairs of points" (Tinkler, 1977, p.3) which "enable one to represent

the basic structure of the flows within a network" (Fuebla, 1987, p.489). Graph theory has been applied in air transport network analysis in three ways: one, to conceptualise the shape or structure of aviation networks (morphology) (Hanlon, 2007; Tinkler, 1977); second, to evaluate the degree of accessibility/ connectivity of a network (Arvis and Shepherd, 2011; Ivy, 1993; Shaw, 1993); and third, to explain centrality or intermediacy or betweenness of the nodes in a network (Guimera et al., 2005; Malighetti, Paleari and Redondi, 2008, 2009; Paleari, Redondi and Malighetti, 2010; Redondi, Malighetti and Paleari, 2011; Rodriguez-Deniz, Suau-Sanchez and Voltes-Dorta, 2013).

2. *Hub network design problems*: The optimal location of hubs and allocation of nodes to them is a problem that is being widely analysed (Aykin, 1995; Bryan and O'Kelly, 1999; Horner and O'Kelly, 2001; Marianov and Serra, 2003; O'Kelly, 1986, 1998; O'Kelly and Miller, 1994). Thus, two node types are distinguished: hubs and spokes. Optimality is reached by way of minimising the total network cost by location of nodes and determining the hierarchy, and determining catchment area/hinterlands routing.
3. *Spatial concentration:* The distribution of traffic across nodes in a network is analysed in order to evaluate the level of concentration and dispersion. This provides an understanding of the share of each airport and the bearing they have over an airline's network. The traditional market concentration indexes, such as Hirschman and Herfindhal index (HHI) (Costa, Lohmann and Oliveira, 2010) and Gini Index (Alderighi et al., 2007; Burghouwt, Hakfoort and Jan Ritsema, 2003; Reynolds-Feighan, 1998) are used to assess the level of spatial concentration in aviation networks.

The Temporal aspect of a network focusses on the degree of connectivity of a node (airport) in a network with respect to the daily variation of flights at an airport. It looks at how best their arrival and departures are scheduled to a wave-system-structure (Bootsma, 1997) or a complex (Doganis and Dennis, 1989) in order to provide the best connecting times, with minimum de-routing and wider choice of connecting options for passengers (Burghouwt and de Wit, 2005; Danesi, 2006; Dennis, 1994a, 1994b; Lijesen, Rietveld and Nijkamp, 2001; Veldhuis, 1997).

2.4.3 Factors influencing the structure and development of a network

The development of a network involves creating interconnectivity (connections between more than two single points) (Button and Stough, 2000), which is stimulated by different factors related to cost, demand, regulation and airline operators.

2.4.3.1 Regulatory regime

A key driver of the airline network development is the regulations governing international air transport, which define the market structure in which air transport services are provided (Burghouwt, 2007; Button and Stough, 2000). International air transport is primarily governed by the Chicago Convention (1944) and subsequent agreements that lead to the definitions of Freedoms of the Air (Figure B-1) and development of a framework for ASAs which specifies how states negotiate air services between them. Thus the establishment of an air service between two international airports is bound by a respective BASA between two states. This restricts free access to markets (airports) by airlines. Therefore, initial forms of networks took linear (Button and Stough, 2000) or star (Burghouwt, 2007) shapes (Figure 2-3). BASA did not necessarily rule out on setting up HS operations by airlines in the pre-deregulatory era. There were spatially concentrated (Burghouwt, 2007) interchange nodes in the networks, especially in countries with one international airport that was designated as the key point of access by governments during bilateral negotiations (Button and Stough, 2000). But it is only after the deregulation and liberalisation of international markets began that HS operations became popular owing to the freer market access enabling airlines to exploit economies of scale, density and scope (Table 1-1). Thus, international economic regulation (especially traffic rights) of air transport has shaped the form and development of aviation networks.

2.4.3.2 Demand and cost considerations

Air transport network configurations are primarily lead by passenger demand. Passengers prefer direct non-stop flying to indirect flying via a hub in most circumstances (Holloway, 2008). However, most markets do not have the traffic to support a direct service and airlines have to make a choice of routes to gain maximum benefit from the prevailing network economies. Having a network that provides connectivity allows airlines to expand their services to a larger customer base, which increases economies of scale (Button and Stough, 2000). There are cost advantages through economies of scope (joint production) for airlines in combining passengers flying to different destinations into one aircraft at least for one part of their journey (Burghouwt, 2007; Holloway, 2008). For example, when Singapore Airlines carry passengers on the route from Colombo to Singapore, they will carry not only passengers destined to Singapore but to points beyond, such as Sydney, Melbourne, Auckland, and Tokyo. When passenger volume increases overtime between points, the cost benefits of traffic density will allow an airline to use larger aircrafts to bring down per unit costs. Thus, airlines would prefer a HS structure to traditional linear structures (Hanlon, 1989; Holloway, 2008) and adopt a wave-system structure minimising waiting times to counter the loss of demand through excessive waiting time (Burghouwt, 2007). The demand side would have additional benefits of having access to a wider range of destinations (Button, 2002).

2.4.3.3 Types of the airline operators

Passenger carriers are fundamentally different to cargo carriers because of the nature of their customers. While passengers have preferences about the choice of airlines, routings and waiting times, transporters of cargo work towards optimising cost and time involved. Therefore, cargo is less sensitive to routings, and bulk channelling of freight through HS systems is cost beneficial. This is not always possible with regard to passenger carriers (Button and Stough, 2000; Dennis, 1994b; O'Kelly, 1998) who are "user-attracting systems" (Burghouwt, 2007). On the other hand passengers trips are most of the time 'round-trips' involving a return journey whereas in the freight industry the network flow is one-way (Wensveen, 2007). Among passenger carriers also, the networks vary depending on the airline's business model. Traditional Full Service Carriers (FSC) mostly originated as national flag carriers at the beginning of the civil aviation industry in the pre-deregulatory era and so have different cost structures to Low Cost Carriers. Though demand plays a key role, FCS networks have evolved over the years with the influence of political, economic and social requirements as well

(Graham, 1998). Thus, they have developed network structures (predominantly HS systems) that allow them to consolidate traffic on low-density routes to counter the increasing unit costs. Conversely, LCCs operate PP services on medium to high-density routes, which allows them to bring down unit costs owing to the high demand (Burghouwt, 2007).

2.4.3.4 Different patterns of air transport networks

For the different reasons explained above, aviation networks take a variety of forms. These different structures of networks are named for their pattern (morphology), concentration of flights on the routes, and coordination of flight schedules (Burghouwt, 2007; Button and Stough, 2000; Doganis and Dennis, 1989; Goedeking, 2010; Hanlon, 2007; Holloway, 2008). From a customer's point of view, Hub-and-Spoke (HS) and Point- to-Point (PP) are two network extremes providing two different services (Goedeking, 2010; Holloway, 2008). Burghouwt (2007) presented different types of networks on a "time-space continuum" (Figure 2-3), based on the degree of spatial concentration and temporal coordination properties, which gives a framework to define these different types of networks.

A Linear structure is a form of a PP network that was the most common network structure in the pre-deregulatory era (Button and Stough, 2000; Hanlon, 2007; Holloway, 2008). Nodes are connected by the paths passing through them. For example, an airline would fly from A to D with stops at B and C making connections between A-B, A-C, A-D, B-C, B-D, and C-D. Some of the linear networks took the form of a coordinated chain (Burghouwt, 2007; Button and Stough, 2000) as they were temporally coordinated. While direct connections were possible between points, the services came with a high cost to passengers, lower frequency, and lower quality of service for passengers flying from A to D having to make stops in between (Button and Stough, 2000; Hanlon, 2007; Holloway, 2008).

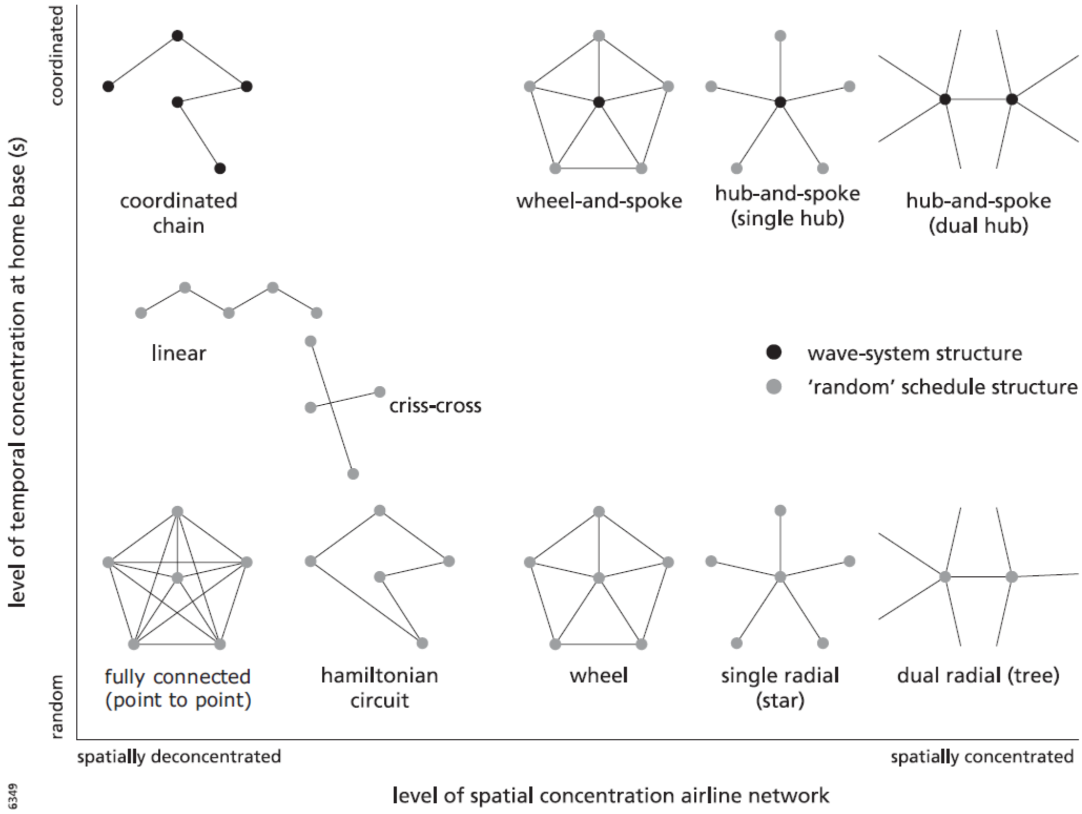

Figure 2-3 Time - space continuum of airline network configurations

Source: Burghouwt (2007)

A Grid structure is a form of a fully connected PP network (Burghouwt, 2007) that has short to medium non-stop and multi-stop flights between locations without a conscious effort to concentrate traffic spatially or temporally. USA and Indian domestic markets are cited as typical examples of grid networks. Some LCC network structures in Europe have also started to take this form. The focus is on optimising the flow of the aircraft and utilisation of crew and connecting all the locations in the network (Hanlon, 2007; Holloway, 2008).

A Radial network is spatially concentrated, and has a node at the centre, with services radiating out-and-back from it. However, connections are made randomly since schedules are not coordinated. The structure can take 'single-radial' and 'multi-radial' forms having several central nodes and even a 'wheel' shape (Burghouwt, 2007; Holloway, 2008). LCC route networks, and networks associated with small international airports take this form since flights are originating from one airport and bound for another airport or the central node of another radial network.

A Hub-and-Spoke (HS) is a radial network, which satisfies both spatial concentration and temporal coordination properties. Flights from spoke airports are routed via a central airport (Hub) with a coordinated schedule to maximise connectivity. A HS system became popular when deregulation and liberalisation began in the aviation industry. Table 1-1 summarised advantages and disadvantages of a HS system to different stakeholder parties of a network). There can be multiple hub networks where one airline will operate two HS systems at two airports linking them with flights (Burghouwt, 2007; Doganis and Dennis, 1989; Holloway, 2008).

2.5 Role of the airport in the network: The nodal functions

An airport (as a terminal) provides key infrastructure for network operations, by enabling access to the network. Hence, the airports handling capacity is a key determinant of network flows. According to Rodrigue et al. (2006. p.7), "terminals (here, airports) are jointly characterized by their nodality and the linkages that are radiated from them". Based on the nodal function and associated network, airports are primarily distinguished in a continuum of OD airports (or Non-hubs) and Transfer/Intermediate (Hub) airports (Ivy, 1993; Graham, 1995; Graham, 1998; Reynolds-Feighan, 1998; Pearce et al., 2001; Burghouwt and Hakfoort, 2001; Kraus and Koch, 2006; Burghouwt, 2007). An OD airport is a location either for originating (source area) passengers or terminating (end point) passengers. The linkage between an Origin and a Destination airport takes the shape of a point-to-point network. A Hub airport is a location, which functions as a crossroads for passengers moving from one origin to a destination. Therefore, the network takes the shape of a hub-and-spoke. Whereas this provides a primary distinction between two extreme configurations, there are different classifications of the role of an airport in a network that have been carried out using different criteria. This section first reviews these criteria and then looks at the different classifications that exists in the airport classification literature.

2.5.1 Airport (node) classification criteria and measures

Apart from the two network properties Burghouwt (2007) has used, there are other network properties and non-network properties that can be used to distinguish between different airport types depending on the purpose of classification. Examination of these characteristics allows us to comprehend the different typologies of airports and their roles in a network along different dimensions with greater understanding.

2.5.1.1 Network based criterion

Since airports facilitate the creation of a network, it is useful to profile an airport based on the network it is associated with. In doing this, different measures capturing different features of a network have been used. Following the same approach as Burghouwt (2007), Table 2-1 presents a summary of these measures used in various studies which have attempted to differentiate between different airports types.

The spatial approach

1. *Graph theoretical concepts*

There are three types of measures that look at different spatial characteristics of the network associated with an airport.

a. Network morphology

Physical topology looks at the abstract presentation of the spatial structure of the network (Ivy, 1993; Rodrigue et al., 2006) supported by the airport. Based on how the nodes and links are arranged in an abstract graph, airports have been categorised as gateways and hubs (Mason, 2007) or hubs into further different types (Doganis and Dennis, 1989).

b. Centrality and Intermediacy

Fleming and Hayuth (1994) identify centrality and intermediacy as key characteristics of transport hubs. Centrality is characterised by the geometric property of centricity (axis). Generally, central places are locations where economic and transportation activities are centred. The associated network is centripetal driving true OD traffic to and from the place due to its central role in the wider socio economic context at different scales (local to global). Intermediacy or "in-betweenness" is the locational attribute of being situated *en route* between important places. Therefore, a central place would essentially have the quality of intermediacy as well. Hence, centrality has often been defined and measured in terms of betweenness. Freeman (1977, p.35) defines it as the "degree to which a point falls on the shortest path between others and, therefore, has a potential for control of information" (here, the traffic flow). Fleming and Hayuth (1994) conclude that a hub is a place that has both features, a central place and an *en route* place. Locations with only intermediacy attributes are gateways or way-ports in the air transport context.

Centrality was initially measured by Hayuth and Fleming (1994) using the percentage figure of the true OD at the airport. The higher the figure they concluded, the greater its central role in the transport network. Rodriguez-Deniz, Suau-Sanchez and Voltes-Dorta (2013) develops this idea into a relative measure which improves the comparability between airports by taking the ratio of OD passengers (od_i) to the total network passengers (P). This indicates an airport's importance as a central place or a "traffic generator".

Following the graph theoretical concepts of shortest-path length Freeman (1977) introduced the measure of betweenness centrality as an indicator of centrality of a node in a network. It is the count of the number of particular nodes (airports) falling between the shortest path connecting any two other nodes in the network. Using the same measure Malighetti, Paleari and Redondi, (2008, p. 55) defines "essential betweenness" as the "number of unavoidable minimal paths passing through an airport when there are no other alternatives for two airports to connect". They have incorporated a time dependent minimum path approach in calculating betweenness. Malighetti, Paleari and Redondi (2009) further uses these betweenness and limited percentage (% time the airport cannot be bypassed through routes of similar duration) as measures of connectivity in the classification of European airports. Guimera et al. (2005) uses normalised betweenness as an alternative measure.

Another set of measures uses the concept of network flow to measure centrality. Fleming and Hayuth (1994) initially used the percentage (%) of through traffic at an airport to measure the level of intermediacy. Rodriguez-Deniz, Suau-Sanchez and Voltes-Dorta (2013) propose “flow centrality" as a good measure of betweenness, following Freeman, Borgatti and White (1991). In social networks, Freeman, Borgatti and White (1991) suggested that flow centrality of a node (x_i) can be explained by the ratio of the total flow that passes through x_i to the total flow between all other pairs of nodes in the network where x_i is neither a source or sink in the information flow. Adapting this to an air transport network, Rodriguez-Deniz, Suau-Sanchez and Voltes-Dorta (2013, p.190) define flow centrality of an airport x_i as a “quotient between the total number of passengers that connect through airport x_i and total network passengers that travel in all markets that do not start or terminate at x_i”. The ratio takes a value between 0 and 1, the higher the number the higher is the betweenness.

c. Accessibility and Connectivity

Accessibility is the “capacity of a location to be reached by, or to reach different locations” (Rodrigue, Comtois and Slack, 2006, p.28). The degree of accessibility of a node is determined by its relative location and distance to other nodes. Distance is a function of the friction of space and it is lessened by the degree of connectivity between nodes. Connectivity exists when a direct or indirect link exists between the nodes. Hence, accessibility is often measured through the notion of connectivity. Connectivity encompasses diverse aspects; having a direct or indirect transportation link, physical distance, travel time and travel cost (Arvis and Shepherd, 2011; Rodrigue, Comtois and Slack, 2006) or generalised cost (Reynolds-Feighan and McLay, 2006) and has been given different meanings depending on the context in which it is being used. While there are numerous measures for accessibility and connectivity from a spatial point of view (Kansky, 1989), a basic measure of connectivity can be reached through matrix manipulation methods by Taaffe and Gauthier (1973). The most basic measure of Degree of a node (C_i) is calculated by creating a matrix of rows and columns equal to the nodes in the network and giving a value of one if there is a link between two nodes and a zero if otherwise. Summation of the values for a column or a row provides the total accessibility/connectivity of a node. The T-Matrix was developed later (Taaffe and Gauthier, 1973) by powering the original connectivity matrix C_i to the network diameter (Nth order) and summation of all the matrices. This *Gross Vertex Connectivity (T)* index takes indirect connections into consideration, widening the scope of connectivity. Following Garrison (1960), Ivy (1993) used a *Weighted Gross Vertex Connectivity* index by assigning a weight for each airport in the node in his hub classification study. The weight for each airport was calculated by taking the share of direct connections by each airport from the total direct connections in the network. Ivy (1993) used the connectivity matrix based accessibility index to measure the hub strength of each airport and classified them accordingly.

2. *Network concentration measures*

The concentration measures present another feature of a network in terms of the diversification of the routes/connecting destinations. They can be computed for airline networks as well as for airports as a measure of network configuration indicating how traffic is distributed across different routes. Different network concentration measures (Herfindhal index, Co-efficient of variation, Theil and Gini Index) have been evaluated for their efficiency in terms of sensitivity and ability to summarise the total effect. While Gini-index is proposed as a superior measure (Reynolds-Feighan, 1998), Herfindhal Index (HHI) is a basic measure widely being used as a market concentration measure in air transport studies (Costa, Lohmann and Oliveira, 2010). Malighetti, Paleari and Redondi (2009) use the HHI index to measure route distribution in classifying European network airports. HHI is obtained by dividing the sum of squares of the number of seats on each route in relation to the total seats offered by the airport, by the sum of squares of the number of seats on each route if seats were equally distributed on all routes in relation to the total seats.

Table 2-1 Summary of network measures used in airport classification studies

Category	Measures	
Spatial structure (morphology)	Canonical shape (gateways) and circle shape (hubs) (Doganis and Dennis, 1989; Mason, 2007)	
	Hourglass shape (directional hubs) and star shaped (hinterland hubs) (Doganis and Dennis, 1989)	
Spatial centrality and intermediacy	Centrality	**OD traffic** $\% \text{ of OD} = \left(\frac{ODtraffic}{Totaltraffic}\right)\%$ (Fleming and Hayuth, 1994)
		Traffic Generation $\text{Traffic Generation (ODi)} = \left(\frac{od_i}{P}\right)$ od_i= OD passengers at airport i P= Total network passengers Rodriguez-Deniz, Suau-Sanchez and Voltes-Dorta (2013)
	Betweenness /intermediacy	**Intermediacy** $\text{Intermediacy} = \left(\frac{Throughtraffic}{Totaltraffic}\right)\%$ (Fleming and Hayuth, 1994)
		Betweenness $C_B(x_i) = \sum_{j}^{n} {}_{<} \sum_{k}^{n} \frac{g_{jk}(x_i)}{g_{jk}}$ $j \neq k \neq x \in X$ g_{jk} = number of minimum length paths connecting $j \in X$ and $k \in X$ $g_{jk}(x)$ = number of such paths in which some $x \in X$ lies on (Freeman, 1977; Malighetti, Paleari and Redondi,2009)
		Normalised betweenness $C'_B(x_i) = \frac{2C_B(x_i)}{n^2 - 3n + 2}$ (Freeman, 1977; Guimera et al., 2005)
	Betweenness /intermediacy	**Essential betweenness (Limited percentage)** $C_B(x'_i) = \sum_{j}^{n} {}_{<} \sum_{k}^{n} \frac{g_{jk}(x'_i)}{g_{jk}}$ $j \neq k \neq x \in X$ g_{jk} = number of minimum length paths connecting $j \in X$ and $k \in X$ $g_{jk}(x')$ = number of such paths in which some $x \in X$ lies on and cannot be bypassed by any other path (Malighetti, Paleari and Redondi,2009)

Table 2-1 continued…

		Flow centrality $\boldsymbol{C}_i = \frac{c_i}{P - od_i}$ od_i= OD passengers at airport i P= Total network passengers c_i = Connecting passengers at airport i Rodriguez-Deniz, Suau-Sanchez and Voltes-Dorta (2013))
Spatial Accessibility and Connectivity	**Weighted Gross Vertex Connectivity Index** $$T = sC1 + s^2C2 + s^3C3 + \cdots + s^NCN$$ s= scalar value based on the individual nodes share of the total direct connections in the network Ci= powered matrix Ivy(1993)	
Spatial concentration	**Route level HHI per airport** $$HHI = \frac{\sum \left({x_{ij}}/{T_i} \right)^2}{\sum \left({e_{ij}}/{T_i} \right)^2}$$ x_{ij}= number seats for route j at airport i e_{ij}= number of seats for route j at airport i when seats are equally distributed T= total seats offered by airport i (Malighetti et al., 2009)	
Temporal Connectivity	Number of hub waves/complexes (Doganis and Dennis, 1989; Dennis, 1994b; Burghouwt and de Wit, 2005; Danesi, 2006; Kraus and Koch, 2006) Minimum and Maximum Connecting Times (Doganis and Dennis, 1989; Dennis, 1994; Burghouwt and de Wit, 2005; Danesi, 2006) Connectivity ratio (Dennis, 1994a; Dennis, 1994b) NETSCAN (Veldhuis, 1997) Weighted indirect connection number (Burghouwt and de Wit, 2005) Weighted connectivity ratio (Danesi, 2006) Hub connectivity Indicator (Li et al, 2012)	

Source: Own elaboration

The temporal connectivity approach

Since Doganis and Dennis (1989) first highlighted the importance of schedule coordination for successful hub operations, the 'time' dimension of connectivity has been measured using different indexes. These measures look at the time involved in offering connecting/transfer flights at airports and travel times involved in the journey. Goedeking (2010) defines connectivity as the ability to offer competitive connections which satisfy the conditions of minimum connecting times, reasonable detour, bi-directional flights, and traffic rights restrictions.

Hub waves (a complex), is the first attribute brought forward by Doganis and Denis (1989) that an airport should have in order to be turned into a successful hub. A complex is a pair of series of arrival flights within a short period and a series of departing flights after allowing a sufficient time for transfer. A wave-system-structure is how these individual complexes are structured within a 24-hour day (Bootsma, 1997; Doganis and Dennis, 1989; Burghouwt and de Wit, 2005; Kraus and Koch, 2006; Danesi, 2006). The number of waves indicates the level of hub operation. By looking at the destinations these flight waves are serving, the orientation of the hub operation can be identified (whether it is domestic/international/regional/gateway) (Kraus and Koch, 2006).

The minimum (MCT) and maximum acceptable connecting times (MACT) decide the number of viable connections within a time window. A viable connection is one that departs after the applicable MCT at each airport and before the completion of the MACT, so that convenient connections can be made (Doganis and Dennis, 1989; Dennis, 1994; Burghouwt and de Wit, 2005; Danesi, 2006). Connectivity ratio (Doganis and Dennis, 1989; Dennis, 1994; Dennis, 2001) measures whether these viable connections are results of timetable coordination or purely random incidents. The above measures only look at the quantity of the connections made.

Veldhuis (1997) proposed that 'quality' of the connections offered is also a key measurement area. By quality, he meant that the connection options made available via a hub as an alternative to a direct flight should be attractive to customers in terms of price, frequency, travel time and comfort. The NETSCAN model (Burghouwt and Veldhuis, 2006; Veldhuis, 1997) which provided for some of these aspects stimulated a branch of literature on temporal connectivity measures (Burghouwt and de Wit, 2005; Danesi, 2006; Wenkan, Miyoshi and Pagliari, 2012). The NETSCAN model proposed to include travel time (including waiting time) and frequency in order to measure the quality of the connections offered via a hub. The model assigned a quality index between zero and one to every connection made via the hub. To accommodate the disutility associated with an indirect flight owing to longer travel times, the concept of 'Perceived-

Travel-Time' (PTT) was used. PTT captures both the travel time and the transfer times involved. To account for the inconvenience involved in transferring between flights a penalty factor has been used by multiplying the actual transfer time by 3 (Burghouwt and Veldhuis, 2006; Veldhuis, 1997). Later developments to the model have introduced a Routing Factor (RF) to account for the efficiency of the hub in terms of routing passengers between two points with a minimum circuitry (Burghouwt and d, 2005; Danesi, 2006; Wenkan, Miyoshi and Pagliari, 2012).

2.5.1.2 Non-network based criterion

The earliest reference to airport classifications by FAA (Ivy, 1993) was based on non-network properties. By non-network, it is meant those other airport related features (apart from spatial and temporal qualities of the associated network) that have been used in categorising airports. Table 2-2 provides a summary of such criteria that have been used to differentiate airport types or define hubs from non-hubs.

The most common criterion used for airport categorisation across the body of literature available is 'airport size' measurements. The size of an airport is indicated using different measurements, depending on the context. Accordingly, size is expressed in terms of capacity, volume of output, scope and relative size (Butler and Huston, 1999; Cranfield University Air Transport Group et al., 2002). Capacity is the processing capability of a firm over a given time period which is expressed in terms of the maximum number of operations that can be handled (Horonjeff et al., 2010). In the context of an airport it is expressed in terms of the handling capacity of the runway (number of movements per given hour), terminals (passengers per given hour), air traffic control (landing and take-offs) and boarding gates (which control the ultimate handling capacity) (Adikariwattage et al., 2012; Butler and Huston, 1999; Jian, Huiyun and Ting, 2011).

Output or volume is an utilisation measure of the capacity offered. An airport has two types of customers; airlines and passengers. Thus, measurement of volume of output[6] is twofold. The first is the supply of flights and seats by airlines and the secondr is the resulting total passenger throughput (demand). The number of airlines present at the airport (Mason, 2007) provides an indication on the range and variety of operations (Cranfield University Air Transport Group et al., 2002). The flight movements are used in a variety of ways to assess different dimensions of output. Malighetti, Paleari and Redondi (2009) use flights per day as a density measure. The percentage of direct flights (Button and Lall,1999), the same day return flights (Bruinsma, Rietveld and Brons, 2000; Button and Lall, 1999), and the ratio of number of destinations with daily frequency to total destinations (Jayalath and Bandara, 2001) are all used to measure outputs from a 'hubbing' perspective. Measurements based on seats made available by all the airlines at the airport (Burghouwt and Hakfoort, 2001; Malighetti, Paleari and Redondi, 2009) and passenger throughput (Graham, 1998) are interchangeably used to measure the traffic volume at the airport.

Scope measures the magnitude of the diversity of an airport's business in terms of its connections with other airports and major hubs (Burghouwt and Hakfoort, 2001; Butler and Huston, 1999; Button and Lall, 1999). An airport's share of the country's total passenger enplanements in classifying airports in the National Plan of Integrated Airport Systems (NPIAS) by FAA (2012) is a 'relative size' measure in which the role of an airport in the total airport system is measured and is helpful in determining funding requirements.

A key feature of a hub airport is a strong hub carrier or carriers. The network of the airline defines the degree of spatio-temporal coordination at the airport. Several studies have measured this integrated airline-airport interchange (Graham, 1995) by using the capacity share of the airline at the airport (Irandu

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[6]On a different note to this discussion; it should be noted that airport output is measured using different indicators. In output and performance measurement studies airport throughput is measured using both passenger and freight volumes. Weight has been used to combine both passenger and freight volumes to provide a standard measure of output. Workload unit (WLU) is one such concept, which assumes a passenger weighs 100kg including his baggage. This weight is substituted to calculate the passenger throughput in kilogrammes/tonnes and is added to the freight volume to calculate the total WLUs (1 workload unit=1 tonne). Airport Throughput Unit (ATU) is a concept, which builds on this to combine all three outputs air traffic movements, passengers and freight volumes (Doganis, 1992; Graham, 2008a).

and Rhoades, 2006; Kraus and Koch, 2006; Malighetti, Paleari and Redondi, 2009; Mason, 2007).

Table 2-2 Summary of node-features used for airport/ hub classification studies

Category		**Measure**
Size	*Capacity*	Gates (Adikariwattage et al., 2012; Butler and Huston, 1999; Jian, Huiyun and Ting, 2011) Runway/ATC/terminal capacity (Jian, Huiyun and Ting, 2011)
	Volume of Output	**Flights** Flight Density - flights/day (Malighetti, Paleari and Redondi, 2009) Percentage of direct flights offered (Button and Lal, 1999). Number of same day return flights (Bruinsma, Rietveld and Brons, 2000; Button and Lall, 1999) Number of destinations with daily frequency/number of total destinations (Jayalath and Bandara, 2001)
		Airlines Total number of airlines serving at the airport(Cranfield University Air Transport Group et al., 2002; Mason, 2007)
		Seats Number of seats available on schedule flights - seats/day (intensity) (Malighetti, Paleari and Redondi, 2009) Average seat capacity (size) (Burghouwt and Hakfoort, 2001)
		Passengers Passenger throughput(Cranfield University Air Transport Group et al., 2002; Graham, 1998)
	Scope	Number of cities /destinations served (Burghouwt and Hakfoort, 2001; Butler and Huston, 1999) Number of different hubs linked (Button and Lall, 1999)
	Relative size	An airport's share of the country's total passenger enplanements(FAA, 2012)
Role of Hub carrier		Dominance by main carrier/Strength of home carrier (Irandu and Rhoades, 2006; Kraus and Koch, 2006; Mason, 2007) Base – number of airlines considering the airport as a main reference (% of the overall number of seats available with one airline) (Malighetti, Paleari and Redondi, 2009)
Market Segmentation	Geographic	Number of international flights (Butler and Huston, 1999) Average intercontinental destinations – to capture intercontinental orientation (Burghouwt and Hakfoort, 2001) Percentage of type of destination (EU/Domestic) (Malighetti, Paleari and Redondi, 2009) HHI (Hirschman and Herfindhal Index) is used to identify the traffic distribution at route level as a relative figure(Malighetti, Paleari and Redondi, 2009)
	Customer: Passenger	Numbers or percentage of domestic/continental/intercontinental (Mason, 2007) Percentage of type of traffic handled (international transfer/intercity - EU/domestic) (Graham, 1998) Percentage of connecting/OD traffic (Mason, 2007;Ivy, 1993)
	Customer: Airline	Percentage of seats offered by low cost airlines (Malighetti, Paleari and Redondi, 2009)

Source: Own elaboration

Market segmentation is an important strategy of any business firm. Airports focus on serving various markets by differentiating types of flights, airlines and passengers. Some airports take a more international (long-haul) role, focusing on FSCs, while others focus on regional or domestic (medium to short-haul) flights with a LCCs focus. Some airports may choose to serve a combination of carriers such as the Kuala Lampur International airport that has a separate low cost terminal for Air Asia. An airport's infrastructure, facilities and service strategies would vary depending on its target markets (based on geographical, flight-length or carrier orientation). To identify this market orientation of the airport, the percentage of types of flights, the percentage of types of passengers or the percentage of seats by types of carriers have been used in different ways by Burghouwt, (2007), Cranfield University Air Transport Group et al. (2002), Graham, (1998), Ivy (1993); Malighetti, Paleari and Redondi (2009), and Mason, (2007) in airport classification studies.

2.5.2 Airport typologies: A summary of different airport classifications

The act or process of classifying objects is a basic human learning process. It is a tool used across diverse subject disciplines to differentiate objects under examination, identify similarities and track patterns of evolution. In the air transport academia (and industry) too, classification or categorising has been frequently used to differentiate between aircraft, airlines, flights, passengers, and airports. The previous two sections (2.5.1.1and 2.5.1.2) reviewed different classification criteria (network and non-network properties) that have been used to distinguish hubs from non-hubs or classify airport typologies. Two branches of literature exist on the subject of airport classification. One branch of studies is based on rigorous classification exercises on a selected sample (context specific) of airports using some form of an analytical/judgmental tool (next paragraph). The other branch of studies refers to different typologies in abstract form (Burghouwt, 2007; Button, 2002; Button and Lall, 1999; Cranfield University Air Transport Group et al., 2002; Doganis and Dennis, 1989; Graham, 1995; Huston and Butler, 1991; Kanafani and Ghobrial, 1985; Pearce et al., 2001).

Table 2-3 presents a self-explanatory summary of such studies and reports belonging to the branch that has used context specific airport classifications. Airport classification predominantly had a regulatory function attached to it when traced back to the early days of such an attempt by FAA (still being used in the NPIAS). The contribution by both academia and industry to the body of literature available on the subject today has used it for different purposes; such as, providing a frame of reference for the allocation of public funding or planning investments(FAA, 2012; Neufville, 1995) by differentiating hubs from non-hubs (Guimera et al., 2005; Rodriguez-Deniz, Suau-Sanchez and Voltes-Dorta, 2013; Suau-Sanchez, Voltes-Dorta and Rodríguez-Déniz, 2015), airport performance/efficiency analysis and service quality benchmarking (Adikariwattage et al., 2012; Barros, 2009; Rodríguez-Déniz and Voltes-Dorta, 2014; Vogel and Graham, 2013), evaluating the impact of deregulation and liberalisation on the development of aviation networks and airports (Burghouwt and Hakfoort, 2001; Graham, 1998; Malighetti, Paleari and Redondi, 2009), and differentiating hub services (Ivy, 1993) and gateways (Mason, 2007). Most of the studies have used dual or multiple variables to improve the dimensionality of classification to better comprehend the differences. These studies have 'labelled' airports to match the context of categorisation.

Figure 2-4 attempts to bring together both branches of literature in order to develop a common understanding on key airport typologies.

Table 2-3 A summary of airport classification studies

Author and Geographical coverage	Study Variables	Classification Method	Clusters
(Ivy, 1993) *USA*	Transfer passengers, Accessibility Index(Gross vertex connectivity number)	One dimensional iterative partitioning(K-means)	**Eight**: Super Hubs, Major hubs (A, B),Moderate Hubs (A,B), Minor hubs (A,B), Insignificant hubs
(Neufville, 1995) *Global*	Passengers. Airport function/role	Criteria based judgement	**Two:** Primary, Secondary
(Graham, 1998) *EU*	Airport function/role, Airport Throughput	Criteria based judgement	**Seven:** Intercontinental hubs, Metropolitan region, Major regional, Peripheral core-city, Leisure destination, Secondary regional, Local
(Guimera et al., 2005) World	Betweenness Centrality based pattern of intracommunity and intercommunity connections.	Network Analysis	**Eight (Cities):** Peripheral, Ultra peripheral, non-hub connectors, Provincial hubs, Connector hubs
(Burghouwt and Hakfoort, 2001) *EU*	Average seat capacity, Average intercontinental destinations, Average number of destinations	Hierarchical clustering	**Five:** Primary Hubs, Secondary hubs Medium airports, Small airports, Very small airports
(Mason, 2007) *USA & EU*	Passenger numbers, % of connecting passengers, Number of airlines, Distance from continental coast, Correlation co-efficient between population and throughput	Criteria based judgement	**Three**: Gateways, Hybrid airports, Hubs
(Malighetti, Paleari and Redondi, 2009) *EU*	Number of seats /day (intensity), Number of flights/day (density), Number of destinations served (scope), % of type of destination, HHI at route level, Betweenness, Limited Percentage, % of seats offered by LCCs,Number of airlines considering the airport as base	Hierarchical clustering using Ward Linkage method	**Eight:** Worldwide hubs, Large or medium hubs Secondary gates, LCC concentrated airports No 'low cost' gate, Regional, LCC regional Local
Barros (2009) *UK*	Passengers, Air Transport Movements, Price of Labour, Price of capital investment, Price of capital premises, Operational cost	Latent class model	**Three:**(Homogeneity based on market share): Large, Average, Small

Table 2-3 continued…

Author and Geographical coverage	Study Variables	Classification Method	Clusters
Adikariwattage et al (2012) *USA*	Domestic OD passenger volume Domestic Transfer passenger volume International passenger volume Number of Gates	K-means clustering using cluster centres generated from Ward Linkage method	**Sixteen**: by a matrix of *Size* - Small, Medium, Large, Very Large *Passenger characteristics*- Domestic Airports, International Airports, OD airports, Transfer Airports
(FAA, 2012) *USA*	Percentage share of total US passenger enplanements	Criteria based judgement	**Five:** Large hub, Medium hub, Small hub, Non-hub primary, Non-primary commercial service
Graham and Vogel (2013) *USA, EU and Global*	Profitability, Revenue Generation, Cost efficiency, Cash generation, Capital structure, Capital productivity, Investment management	Hierarchical clustering using Ward Linkage method	**Three:** European; North American; European, North American and Global
(Rodriguez-Deniz, Suau-Sanchez and Voltes-Dorta, 2013) *USA domestic*	Airports traffic generation, Flow centrality	Agglomerative Hierarchical Clustering using Complete-Linkage	**Six:** Three Traffic Generators and Three Hubs
(Rodríguez-Déniz and Voltes-Dorta, 2014) *Global*	Domestic/international passengers, hedonically adjusted aircraft movements, Cargo(MT), non-aviation revenue, Input process: capital, material, personnel	Agglomerative Hierarchical Clustering using Average-Linkage	**Seventeen**
(Suau-Sanchez, Voltes-Dorta and Rodríguez-Déniz, 2015) *USA domestic and international*	Airports traffic generation, Flow centrality	Agglomerative Hierarchical Clustering using Complete-Linkage	**None :** Three Traffic Generators and Three Hubs ,Three Super Hubs

Source: Own elaboration

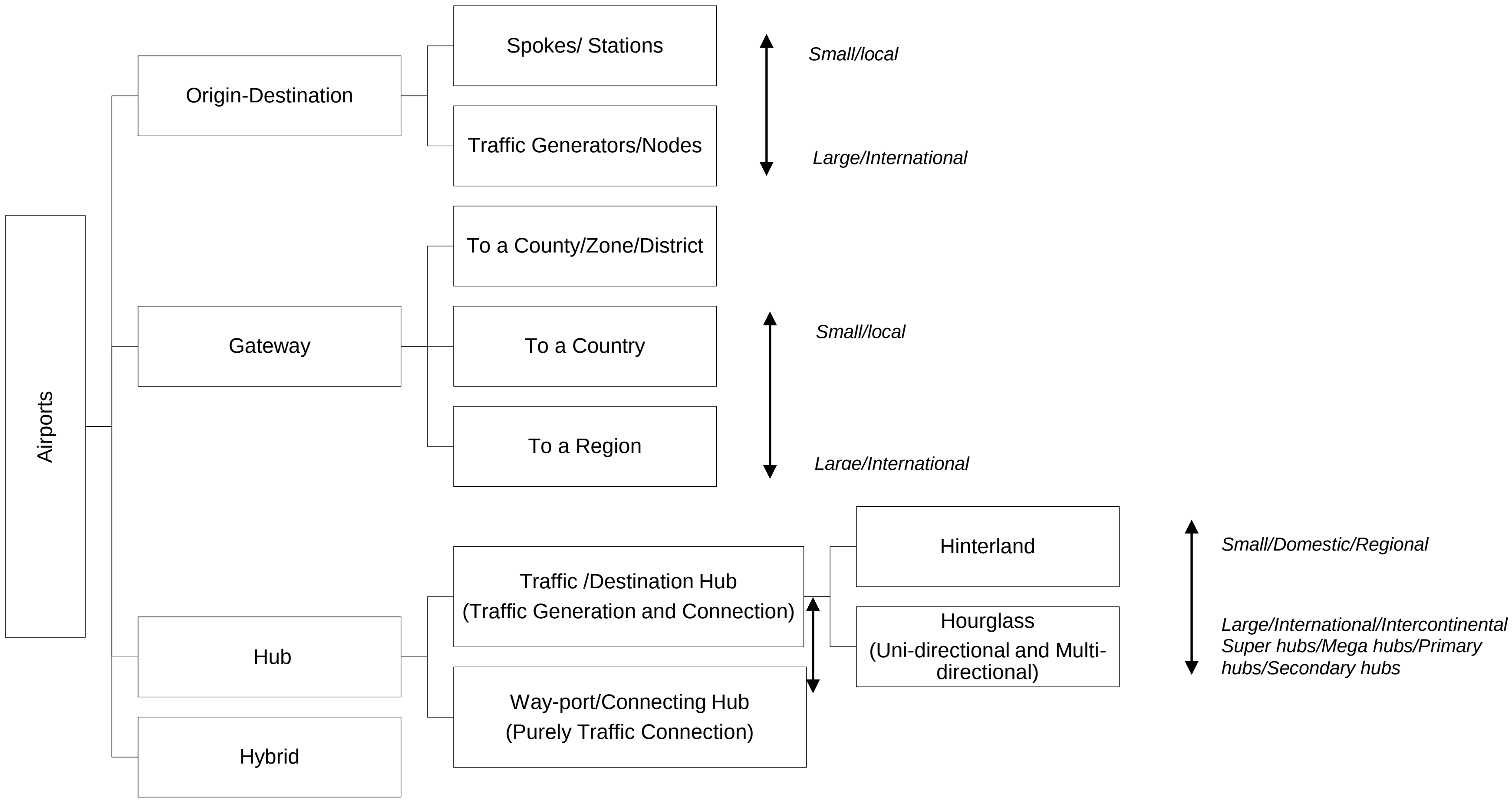

Figure 2-4 Different airport types

Source: Own elaboration

2.5.2.1 Origin-Destination airport

The simplest form is an OD airport where the primary role of handling outbound traffic (Origin) and inbound traffic (Destination) takes place. Burghouwt (2007) refers to the small scale OD airports as “airline stations” which are mostly small local/domestic airports and can take the role of a spoke in a larger HS system or a LCC airport. Traffic is not spatially and temporally coordinated and they will only have a small share in the total network traffic. OD airports that have a significant share of the total market and are spatially concentrated are called “traffic nodes” (Burghouwt, 2007) or “traffic generators” (Rodriguez-Deniz, Suau-Sanchez and Voltes-Dorta, 2013). Most of these are international or regional airports where most of the traffic is routed only through the major airport in the country.

2.5.2.2 Gateway airport

The gateway concept has been borrowed by air transport network theory from geography. Burghardt (1971) first defined gateway cities as an entry or exit point located between regions that have differing intensities or type of production (two contrasting homogenous regions). Thus, a reciprocal flow is necessary from one area to the other in terms of trade (freight), passengers and information (knowledge). A gateway for entry/exit was necessary when there were obstacles for a free flow between regions that can be physical (seas, mountains etc.) or political (territorial boundary-sovereignty over an air space). A transportation gateway provides accessibility to a larger regional hinterland/catchment area and is equipped with transport infrastructure (land–junctions, terminals /maritime-port/airport). A transportation gateway plays a role of an origin, a destination and a transit point (Pearce et al., 2001; Rodrigue, Comtois and Slack, 2006).

Mason (2007), evaluating the usefulness of the ‘gateway’ concept to aviation markets (as a geographically unconstrained mode of transport in comparison to land and sea) highlights that the needs of gateway airports are largely driven by regulatory barriers, technical capability of aircraft, spare capacity at the preferred airport, and economic interests of airlines. Thus, a gateway airport is a special type of airport created by artificial barriers to entry. When entry points are designated in the BASAs between countries, gateway airports are formed. They have the spatial quality of being located near the periphery of a region and the network of a gateway airport takes the shape of a cone (Mason, 2007); the international (long-haul) flights arriving at the periphery and regional/domestic (short-haul) transport modes (flights, roads, railway) emanating from the border to the hinterland. Therefore, gateway airports can take the forms of domestic gateways or regional gateways. Mason (2007) differentiates gateway airports from hubs based on number of terminating passengers. Gateways have a higher number of terminating passengers. A gateway airport in a network is spatially concentrated, but may or may not be temporally coordinated.

2.5.2.3 Hub airport

A hub airport is established as a kind of a node in a network that satisfies both temporal coordination and spatial concentration properties. Accordingly, a hub airport will consolidate traffic by one or two major hub carriers to banks of arrival and departure flights to create a wave system structure to facilitate connectivity. Therefore, an ideal hub usually has a higher percentage of transfer passengers and a radial network structure. Based on the length and direction of routes in the associated network of the airport (Doganis and Dennis, 1989) differentiated between;

- *Hinterland hub*: connecting international trunk routes and continental/domestic routes as spokes of the system and,
- *Directional/hourglass hub:* intercontinental long distance routes directed through the hub. Directional hubs can be *"Uni-directional"* and **"***Multi directional"* (Burghouwt, 2007) (Figure 2-5).

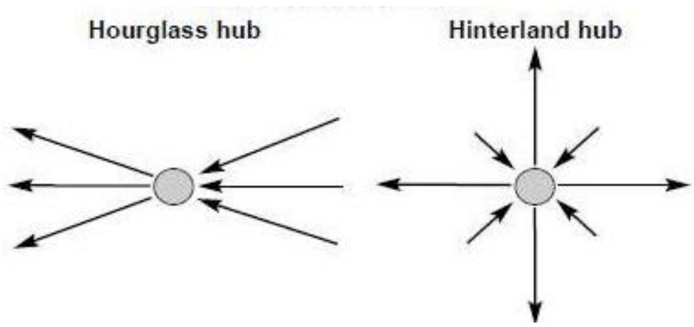

Figure 2-5 Hinterland and Hourglass Hub

Source: Doganis and Dennis (1989)

In addition, depending on the type of traffic or airlines (domestic/ regional/ intercontinental) handled by the airport, a hierarchy of hubs exists in the global airport network: domestic hubs, regional hubs, and intercontinental hubs (Adikariwattage et al., 2012; Graham, 1998; Malighetti, Paleari and Redondi, 2009). A degree of 'hub service' at airports takes a variety of forms (Ivy, 1993) as well. Based on connectivity levels Guimera et al., (2005); Ivy, (1993); Malighetti, Paleari and Redondi, (2009); Rodriguez-Deniz, Suau-Sanchez and Voltes-Dorta, (2013); and Suau-Sanchez, Voltes-Dorta and Rodríguez-Déniz, (2015) rank airports as Super-hubs/ Mega-hubs/ Primary-hubs or Secondary hubs/ Major/ Minor hubs etc.

A way port is an exclusive form of a hub taking advantage of excellent geographical location in relation to traffic flows between continents/regions in which the primary purpose is to provide a connecting point for passengers and the OD share of the airport is very insignificant (Huston and Butler,1991). de Wit and van Gent (1996) as cited in Burghouwt (2007) refer to a way port as an airport having more than 60% of transfer passengers.

2.5.2.4 Hybrid airport

Mason (2007) defines a hybrid airport as an airport that plays both the role of a hub and a gateway. They have significant proportions of terminating and connecting passengers (between 25-40% connecting) and are located between 200 and 550 km from the continental coast. A hybrid airport is the major international airport of a country that has historically evolved to take up a hub role owing to the growth of its network. Mason (2007) identifies Heathrow, Madrid, Paris, and Montreal as hybrid airports.

2.6 The key success factors of a hub airport

Critical success factors are "those things that must be done if a company is to be successful" (Rockart, 1979). Identification of key success factors allows a firm to develop strategy (Leidecker and Bylwo, 1984), effectively manage, and control the key variables of success towards one direction (Wong, 2005). While understanding external environmental conditions is key for the identification of opportunities and threats to assist in a firm's strategy development exercise, Leidecker and Bylwo (1984) contend that a firm's success is ultimately determined by how best it identifies its strategic priorities relative to the industry in which it operates, in order to compete successfully in the market.

A comprehensive review of HS systems[7] has delivered a thorough understanding of the characteristics of hub airports. Jian, Huiyun and Ting, (2011) has identified five areas for evaluating a competent hub; demand, service, spatial, facility and management. They have presented a combination of external and internal factors in their list. Table 2-4 follows a similar approach but not exhaustively the same list of factors. The key success factors focussed on here are internal to a hub airport as a business firm.

Air transport is a network industry, thus, a key success factor for a hub airport is getting it right. *Network* strategy should aim to promote a HS system at the airport by satisfying two important requirements of hubbing: traffic generation and hub connectivity. A hub requires *infrastructure* to facilitate preponderance of arrival and departure flights peaking at times and should have state-of-the-art landside and airside handling systems to ensure efficient operations of hub activities with the potential for expansion. Accessibility to the airport plays a key role for hub airports as getting to the capital/key markets is vital. Landside *services*, especially the quality of main handling systems and service areas are critical for an airport that is expecting to handle passengers arriving from different destinations in a

[7] Section 1.1.2.1 provides an introduction to a hub airport as an economic agent and advantages and disadvantages of a HS system to key industry stakeholders, section 1.1.3 and 1.1.4 reviewed evolution of successful hubbing in the East, section 2.4.4 explains the properties of a HS network and section 2.5.2.3 introduces a hub airport as a node in a network and different variations to it.

rush to connect to flights departing to diverse destinations. Therefore, a spacious and clean ambiance is important. Extra facilities to allow passengers to spend quality time at the airport will contribute to minimising the inconvenience of waiting. Competitive *prices*/airport charges will encourage international hub carriers to consider the airport as a base and allow them to pass down the benefits to passengers.

Table 2-4 Critical success factors for a hub airport

Strategic Area	Key Success factor
Network	Traffic Generation / a stable OD market (Fleming and Hayuth, 1994; Jian, Huiyun and Ting, 2011; Rodriguez-Deniz, Suau-Sanchez and Voltes-Dorta, 2013)
	Spatial concentration (Burghouwt, Hakfoort and Jan Ritsema, 2003; Reynolds-Feighan, 1998)
	Optimal spatial connectivity/accessibility (Ivy, 1993; Rodriguez-Deniz, Suau-Sanchez and Voltes-Dorta, 2013)
	Optimal temporal connectivity through schedule coordination (Burghouwt and de Wit, 2005; Danesi, 2006; Dennis, 1994b; Doganis and Dennis, 1989; Wenkan, Miyoshi and Pagliari, 2012)
	A wave system structure (Burghouwt and de Wit, 2005; Danesi, 2006; Dennis, 1994b)
	Acceptable waiting times/minimum - maximum connecting times(Danesi, 2006; Jayalath and Bandara, 2001; Jian, Huiyun and Ting, 2011; Kraus and Koch, 2006; Veldhuis, 1997)
	Higher frequency of flights to diverse destinations and same day return flights(Bruinsma, Rietveld and Brons, 2000; Button and Lall, 1999; Rietveld and Brons, 2001)
Size of Physical Infrastructure and Systems	Key airport infrastructure: runway, aprons, terminals, gates/bridges with potential for expansion (Bootsma, 1997; Burghouwt, 2007; Button and Stough, 2000; Dennis, 1994b; Holloway, 2008; Jian, Huiyun and Ting, 2011; Martín and Román, 2003)
	Accessibility to airport - Multimodal airport access facilities from key markets/ commercial capital cities, car parks with reasonable prices, taxis with reasonable rentals(Bruinsma, Rietveld and Brons, 2000; Graham, 1998; Jian, Huiyun and Ting, 2011)
Service	Quality of service - Quick convenient check-in facilities, user friendly passenger guidance, clean and tidy buildings, spacious terminal areas, reliable baggage handling systems(Bruinsma, Rietveld and Brons, 2000; Jayalath and Bandara, 2001; Jian, Huiyun and Ting, 2011)
	Wider choice of airlines (Jayalath and Bandara, 2001)
	Extra services- tax free shopping, restaurants, casino, cinema, hotels etc. (Rietveld and Brons, 2001)
Price	Competitive airport charges (Jayalath and Bandara, 2001; Jian, Huiyun and Ting, 2011; Rietveld and Brons, 2001; Mason, 2007)
	Price/cost effectiveness to passengers – cheaper fare than flying direct and free/cheap accommodation options(Jayalath and Bandara, 2001; Rietveld and Brons, 2001)

Source: Own elaboration

2.7 What makes a competitive aviation industry?

This section draws on extant literature on two themes; (i) theory of national competitive advantage, global competitiveness and aviation competitiveness (Cho, Moon and Kim, 2009; Cho and Moon, 2005; Cho and Mun, 2000; Itani, O'Connell and Mason, 2014; Moon, Rugman and Verbeke, 1998, 1995, Porter, 1986, 1990; World Economic Forum (WEF), 2012)and (ii) determinants of hubbing (Bauer, 1987; Bhadra and Hechtman, 2004; Butler and Huston, 1999; Huston and Butler, 1993), in order to develop a framework to study the macro environmental conditions influencing the national aviation industry.

2.7.1 National competitiveness

2.7.1.1 Porter's Diamond Framework– theory of competitive advantage of nations

At national policy making level, a nation's competitiveness in a particular industry in relation to others is a primary concern. "Porter's Diamond Framework" (Figure 2-6); a model based on the theory of "competitive advantage", explains why certain countries succeed in certain industries while others fail (Porter, 1986, 1990).

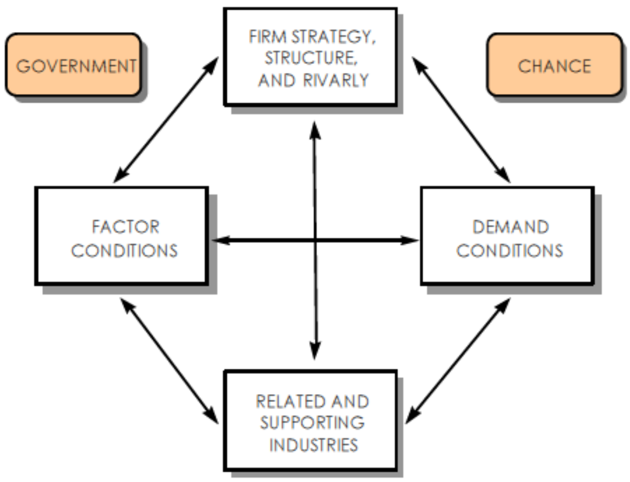

Figure 2-6 Porter's Diamond framework

Source: Porter (1990)

Porter proposed four factors that characterise any "national industry" and ultimately contributes to the creation of a competitive edge over global companies. They are;

1. Factor conditions – Possession of factors of production (human, physical, knowledge, capital, infrastructure both at basic and advanced level) important to the particular industry and the ability to create them,
2. Demand conditions- An established domestic demand for the industry output,
3. Related and supporting industries – Sophistication in the related industries and internationally competitive supply chain, and
4. Firm strategy, structure and rivalry - A concrete framework to create, organise and manage industry firms and the domestic rivalry.

He contends that the 'government' plays an influencing role in the integration of the four factors. 'Chance' captures the exogenous events outside the industry or the government's control which impact on the performance. The hypothesis Porter made in 1990, that, "without a strong home-base, an industry is unlikely to be internationally competitive"; was later opposed by Cho (1994) and Moon, Rugman and Verbeke (1998, 1995). This school of academics explain that small nations such as Singapore and Korea have achieved competitiveness in certain industries by expanding and sustaining the four corners of the diamond in spite of international competition. Hence, a country's competitiveness in globalised industries depends on how successful it is in managing the 'international diamond' ("Generalised Double Diamond" by Moon, Rugman and Verbeke (1995)). Additionally, Cho (1994) contended that human factors - workers, politicians and bureaucrats, entrepreneurs, and professionals (proposing a "Nine Factor Model") have a much larger role in determining competitiveness of developing nations. They later proposed a "Dual Double Diamond" (Figure 2-7) capturing the factors explained in all the other previous models which hypothesise that a country's competitiveness depends on the sources of competitiveness (physical and human) and scope of competitiveness (domestic and international).

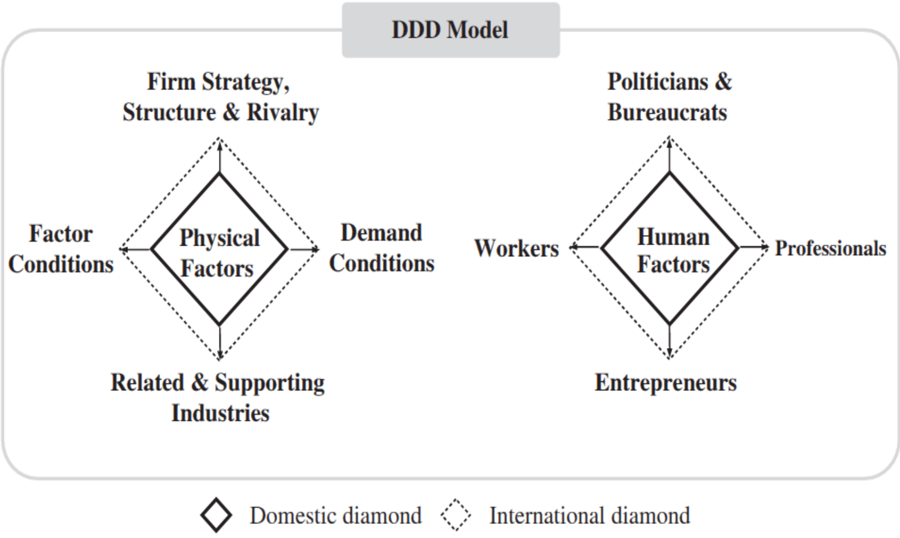

Figure 2-7 Generalised Dual Diamond

Source: Cho et al. (2009)

2.7.1.2 Global Competitiveness Index

Based on Porter's theory, the WEF has developed a Global Competitiveness Index (GCI) to assess competitiveness of countries in the global scale (WEF et al., 2002). Competitiveness is defined "as *the set of institutions, policies, and factors that determine the level of productivity of a country"* (WEF, 2012). It is a comprehensive index, which is constructed of 11 pillars across 3 sub-indexes which distinguish between the degrees of economic development of countries (Figure 2-8 and Table B-1). The contention here is that an economy moves through 3 developmental stages until it becomes a fully developed innovation driven economy which is a function of the degree of competitiveness. Degree of competitiveness is a fundamental requirement for a country to be competitive in any industry.

Using the above hypothesis, the WEF produced an industry specific competitiveness measure: The Travel and Tourism Competitiveness Index (TTCI) (Figure 2-9 and Table B-2). It is based on 14 pillars of travel and tourism divided into three sub-indexes, namely; travel and tourism regulatory framework, travel and tourism business environment and infrastructure, and travel and tourism human, cultural and natural resources (World Economic Forum, 2013).

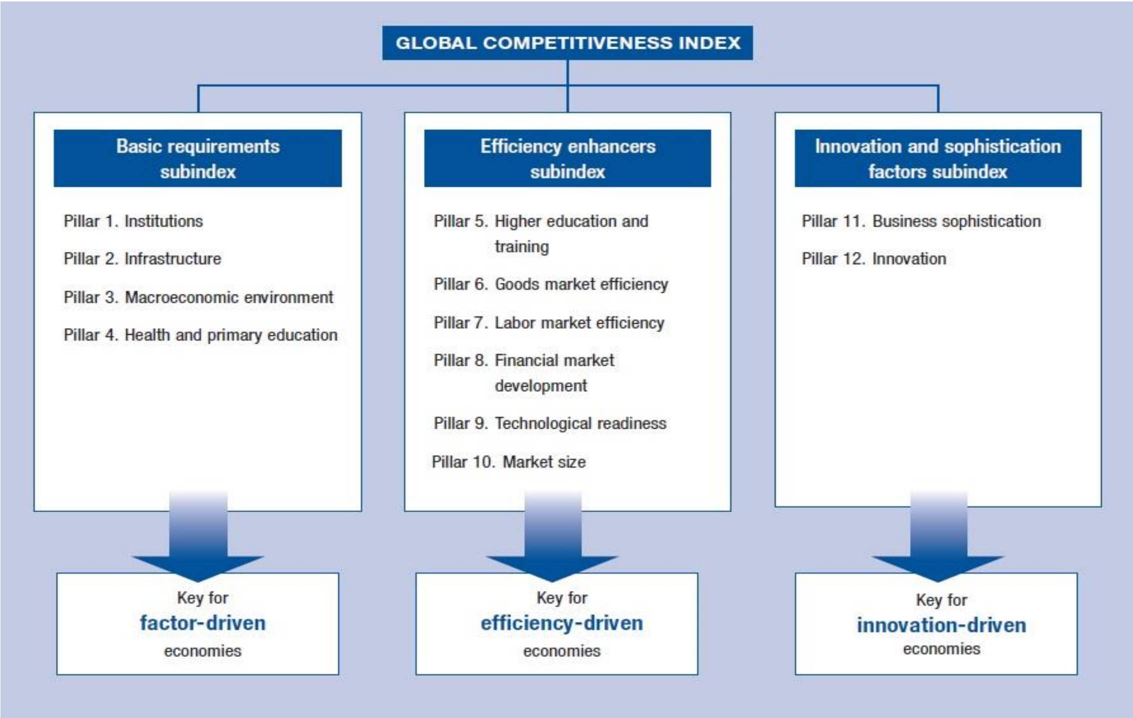

Figure 2-8 The Global Competitiveness Index framework

Source: WEF (2012)

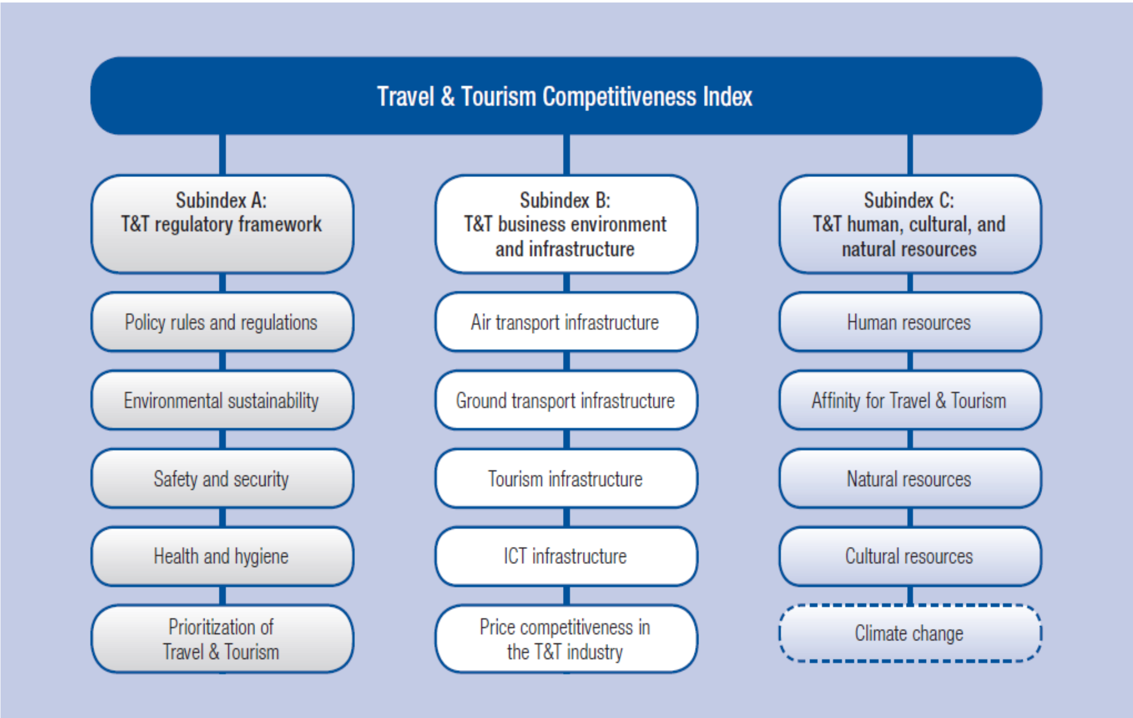

Figure 2-9 Travel and Tourism Competitiveness Index Framework

Source: WEF (2013)

2.7.2 Determinants of hubbing and aviation competitiveness

The configuration of air transport network flows between regions is largely driven by the level of economic development, location, population, urbanisation and degree of competition from other transport modes (Graham, 1995, 1998). Network configuration ultimately determines the role of each airport. Bauer (1987), Bhadra and Hechtman, (2004), Butler and Huston (1999),Huston and Butler (1991, 1993), and Liu, Debbage and Blackburn (2006) used demography, climatology, economics and geography as determinants to calibrate Econometric Models in order to predict the location of hubs/major air passenger markets in US and EU (Table 2-5). Using Probit (Bauer, 1987; Butler and Huston, 1999; Huston and Butler, 1991, 1993; Liu, Debbage and Blackburn, 2006) and Logit models (Bhadra and Hechtman, 2004) they predicted the probability of a city to have a hub airport.

Table 2-5 Studies on determinants of hub location/air passenger markets

Determinant	Measurement variable
Demography	Market – population for whom the city is closer than any other current hub (Bauer,1987; Butler and Huston, 1999; Huston and Butler, 1991, 1993). Distance to the airport from the city (Bhadra and Hechtman, 2004) Population density (Bhadra and Hechtman, 2004) % of people living in urban areas (Liu, Debbage and Blackburn, 2006)
Climatology	Weather – number of days of sun/fog/snow/ thunderstorms, frozen precipitation (Bauer,1987; Butler and Huston, 1999; Huston and Butler, 1991, 1993; Bhadra and Hechtman, 2004; Liu, Debbage and Blackburn, 2006)
Economy	Average/per capita income of the area (Bauer,1987; Butler and Huston, 1999; Huston and Butler, 1991, 1993; Bhadra and Hechtman, 2004; Liu, Debbage and Blackburn, 2006) Demand Drivers – Tourist/Business destination (Bauer,1987; Butler and Huston, 1999; Huston and Butler, 1991, 1993) Percentage employed in finance, finance, insurance or real estate, professional, scientific or technical services and management activities, and the information technology sector (Liu, Debbage and Blackburn, 2006)
Geography	Distance to the nearest main hub (Bhadra and Hechtman, 2004) aviation market (Liu, Debbage and Blackburn, 2006) Desirability of a city's geographic location for providing connecting service (Butler and Huston, 1999) Number of competing hubs within 200 miles of the city (Butler and Huston, 1999) Number of competing hub gates in the market including other airports in the market region (Butler and Huston, 1999)

Source: Own Elaboration

By and large, the determinant factors of hub location, and factors of competitive advantage, global competitiveness, and travel and tourism competitiveness correspond with the analysis of external environment: macro (Political, Legal, Economics, Social, Demographic, Technological, and Natural Environment) and micro (*inter alia*, Consumers, Suppliers, and Competitors) factors in the strategic planning process (Ginter and Duncan, 1990; Hambrick, 1982; Leidecker and Bylwo, 1984). Thus, it can be proposed that a sound external environment is essential for promoting air transport activities in a country. Based on a similar premise, Itani, O'Connell and Mason (2014) have proposed a framework for assessing aviation competitiveness. The framework is grounded on the Porter's diamond framework of competitive advantage, and the GCI and TTCI by WEF. They present a four factor model (with 12 competitiveness drivers) applied within the Porter's framework to determine aviation competitiveness of a nation. They are;

1. Strategy and structure: institutional framework of a country
2. Demand conditions: goods market efficiency, market size, and travel and tourism activity
3. Related and supporting factors: health and primary education, higher education and training, innovation, and political and security stability
4. Factor conditions: infrastructure, macroeconomic environment, labour market efficiency and country size

As well as the general environment, the aviation industry regulation too plays a pivotal role in determining to what degree the key stakeholders in the aviation industry can freely engage in aviation activities that boost commercialisation of the industry. The next sections elaborate on the drivers of successful aviation markets from a hubbing perceptive.

2.7.2.1 Geography

Geography is referred here as the 'relative location' of the country/airport with respect to air traffic flows, population and other airports. A unique geographical location that has spatial qualities of centrality (central point for locations) and intermediacy (in between locations) with respect to the other connecting destinations is considered as one of the key natural determinants of an airport's potential to be a hub (Fleming and Hayuth, 1994; Hayuth and Fleming, 1994). In the case of directional hubs, Dennis (1994a) contends that the location of the airport closer to major air traffic flows is a key geographical advantage for hubbing. This means that the airport/country is located in between long-haul OD flows that need an intermediate connection. This results in lower detour distances, which promote the airport as a near proxy for a direct flight. Routing/de-routing factor has been cited as an important geographical advantage (Bootsma, 1997; Burghouwt and de Wit, 2005; Redondi, Malighetti and Paleari, 2011; Veldhuis, 1997; Wenkan, Miyoshi and Pagliari, 2012). It is calculated by;

$$Detour\ factor = \frac{(Great\ circle\ distance\ for\ Leg\ 1) + (Great\ circle\ distance\ for\ leg\ 2)}{Great\ circle\ distance\ between\ Origin\ and\ Destination}$$

The closer the ratio is to one, the better located is the airport between origin and destination.

Location relative to the dispersion of world population determines how best the airport can attract airlines to fly direct in order to develop a hub network by connecting populations across the region. The percentage of population that can be reached within a given flying hour (CAPA, 2013a; O'Connell, 2006; Williams, 2006) is a way of expressing the desirability of the location. As previously mentioned, Gulf region airports are well known for exploiting their central position to develop directional hubs (section 1.1.3.1). Butler and Huston (1999) measured this relative location by dividing the catchment area of the airport (from the centre of the airport) into eight regions and taking the aggregate of the lowest of the populations on the opposite regions (e.g. lower figure from Northeast–Southwest, likewise on four region pairs). The distance to near hubs (Bhadra and Hechtman,

2004) or hubs within a certain distance (Butler and Huston, 1999; Huston and Butler, 1991) is taken as a measure of geographic advantage over competition.

2.7.2.2 Economy

Economic development and growth of the aviation industry have reciprocal benefits to each other. Discussion at the beginning this chapter showed that the impact of aviation on national output extends beyond the direct contributions to GDP and employment (section 2.2). Conversely, the level of economic activity as a key driver of air travel is an established fact, and GDP is widely used in air travel demand forecasting studies as a key predictor variable (Doganis, 1992; Holloway, 2008). Demand for air travel rises and falls twice as fast as the change in GDP growth rates (Doganis, 2002). Growth in GDP partly means that the industries or business enterprises in an economy have been doing well. On the other hand, it hints at the rise in individual income (per capita GDP). Both signal positive outcomes for the aviation industry in terms of increased business and leisure travel. The population’s propensity to travel is expected to rise with rising income levels (Holloway, 2008), subsequently increasing the probability of the location of larger air passenger markets (Liu, Debbage and Blackburn, 2006). Empirical evidence was described in the discussion of the remarkable growth in the aviation industry and development of mega-hubs in the East, which was largely attributed to the accelerated economic developments in that region in the last decades (section 1.1.4.1). Thus, as suggested by Porter (1990), wealth or capital is a necessary “factor condition” for competitive advantage. To measure the level of economic development, apart from GDP and GDP per capita, other indicators such as rates of inflation, government debt, budget balance and gross national savings (WEF, 2012) are used indicate the overall stability and health of the macro economy of a country.

2.7.2.3 Demography

Population is an important demand driver, for it is people who finally get on the aircraft to fly to another corner of the world. A sound OD market to generate enough traffic is a prerequisite for successful hub operations (Button, 2002; Dennis, 1994a; Doganis, 2002; Rodriguez-Deniz, Suau-Sanchez and Voltes-

Dorta, 2013). It justifies the idea of Porter (1990), that the success of an industry at the global level is determined by the home-market demand conditions. There are number of benefits of a strong established demand for air travel, both for domestic and international travel. A strong local market enhances the chance of bigger hubs (Liu, Debbage and Blackburn, 2006) and it also provides opportunities for the learning and growth of new airlines and business models, an example being the role US domestic market has played in LCC invention by Southwest Airlines. On the other hand, when demand for international OD flights is high, the airport will have more international carriers flying directly to it, increasing the direct connectivity of the airport, thus having a multiplying effect on city- pairs served by the airport. This will lead to promotion of transfer traffic at the airport (Rodriguez-Deniz, Suau-Sanchez and Voltes-Dorta, 2013). Total catchment area population, distance to the city/key market, propensity to travel by air and the percentage of urban population are measures used to define the advantage to an airport of being located in populous area.

2.7.2.4 Business attractiveness

The air travel market is segmented based on the purpose of flying. ‘Business’ is a primary reason for people to travel by air as it meets the needs of speed required in today’s fast paced business world. To reap the benefits of comparative cost advantage, the trend now is to locate business and production processes internationally. Thus, emergence of international business centres across the world is a form of structural change witnessed by industry today (Williams, 2006). The role of the airport catchment area as a business centre has been used as an explanatory variable in the hub location determinant studies (Butler and Huston, 1999; Huston and Butler, 1991, 1993). Previous discussions on airport competition and aviation markets in the East corroborated the fact that modern day airport competition is more or less intertwined with the competition between cities (Cranfield University Air Transport Group et al., 2002) to become global/mega-cities, to be financial capitals and manufacturing and logistics centres. For an airport, attractiveness of the country/area as a business destination is very important in establishing a strong OD demand necessary for a hub. WEF (2012) contends that sophisticated business processes and practices are crucial for achieving higher rates of efficiency. Formation of business clusters is cited as one advanced form of business networks seen in innovation driven economies.

2.7.2.5 Tourism attractiveness

Leisure and tourism is the other major purpose for people to travel by air. The impact of tourism on air travel is twofold; inbound travel and outbound travel. Graham (2008b) has identified outbound tourism as a potential driver of demand for air transport in India and China in the coming decades. When income levels rise, the ability to generate outbound travel in these markets is increased (Graham, 2008b). On the other hand, air transport provides supporting transport infrastructure for tourism and if provided in high quality (Roberto, 2006) increases the attractiveness of a destination (Khadaroo and Seetanah, 2007, 2008; World Economic Forum, 2013) thereby increasing inbound travel. This contribution is identified as a major catalytic impact of the air transport industry on national output (ATAG, 2005; ICAO, 2005). The benefit is that the tourism industry supports the generation of true OD traffic both ways, which is essential for a stable air passenger market. Thus, air transport and tourism industries are complementary to each other (Beiger and Wittmer 2006; Forsyth 2006; Graham, 2008b). This corresponds to Porter's (1990) contention that degree of sophistication in the related industries is a factor/source of competitive advantage. Thus, the degree of attractiveness of a country/catchment area as a tourist destination is a key determinant to establish an airport as a "destination hub"; a popular travel destination with large number of non-stop flights from different destinations (Ivy, 1993), with the potential to give it hub status. On the other hand, Lohmann et al. (2009) suggests that successful hubs can convert themselves into "destination hubs", referring to the transformations of Singapore and Dubai in the last decades. The degree of tourism attractiveness is measured by quantifying tourist attractions (natural/cultural/heritage) in a given catchment area/country by Bauer (1987), Butler and Huston (1999) and Huston and Butler (1991, 1993) in hub determinant studies. WEF (2013) extends the concept to a country level TTCI as explained earlier.

2.7.2.6 Physical and Intellectual Infrastructure

An efficient system of basic *physical infrastructure* such as transport, telecommunications and electricity are seen as primary pillars/factor conditions of global competitiveness (Cho, Moon and Kim, 2009; Cho and Moon, 2005; Itani, O'Connell and Mason, 2014; Moon, Rugman and Verbeke, 1998, 1995; Porter, 1990; WEF, 2012). A sound logistics and transport system is seen as a vital ingredient to keep the economy connected with the global economy (World Bank, 2012). *Human capital* is equally important (Itani, O'Connell and Mason, 2014; Porter, 1990; WEF, 2012) or more important for developing economies (Cho and Moon, 2005; Cho, Moon and Kim, 2009; Moon, Rugman and Verbeke, 1998, 1995) to sustain a productive work force. Thus, access to basic facilities such as healthcare, education and training, water and sanitary facilities is essential for a productive workforce. (*Human) Intellectual infrastructure (knowledge) is an* efficiency enhancer and driver of innovation in an economy. A knowledgeable work force delivers technological innovations to improve the quality of life, business and trade. Thus recipes for success in advanced nations are built upon both physical and intellectual infrastructure and supporting industries (WEF, 2012). When supporting infrastructure and industries are in place, socio-economic conditions of a country improve, industries will perform better and living conditions of people will improve, which all have a positive impact on demand for both passengers and cargo transport.

2.7.2.7 Political, Regulatory and Administrative Framework

Following Acemoglu and Robinson (2012) who argued that socioeconomic differences experienced in the modern world are more or less a result of polity/institutions rather than geography, culture or demographics, Wang and Heinonen (2015) concluded that political institutions define the boundaries for the operations of economic institutions and this has a direct impact on aeropolitics, the framework within which aviation industry operates. They concluded that "polity-level institutional framework to aeropolitics cannot be overstated (p.176)". The success or failure of aviation markets is a result of the multi-scalar relationship between national aviation policy and regulations, national and international power and politics (Figure 2-10).

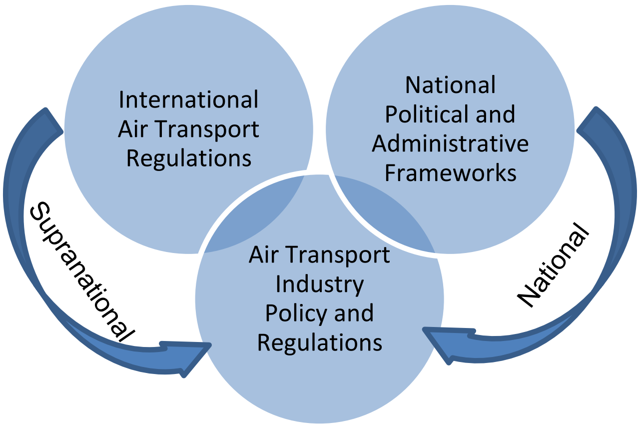

Figure 2-10 Multi-scalar dimensions of air transport regulation

Source: Own elaboration

2.7.2.7.1 Economic Regulation of International Air Transport

*"**Regulation** is the giving of authoritative direction to bring about and maintain a desired degree of order…* Similarly, all regulation involves ***regulatory structure**, i.e. the organizations or other entities involved and the legal framework* (such as licences, regulations and agreements) … Finally, all regulation involves ***regulatory content**, the particular subjects being regulated* (such as market access, pricing and capacity)." (ICAO, 2004) p.iii)

The above is an extract from the ICAO Manual on the Regulation of International Air Transport. Air Transport is internationally regulated by the policies and guidelines set by the ICAO. It came into force as a result of the Convention on International Civil Aviation *(*Chicago Convention) of 1944 which aimed to foster development of international civil aviation "in a safe and orderly manner" and to establish international air transport service on the basis of equality of opportunity and sound and economical operation. The ICAO as the supreme body issues directives on the technical (safety, security, navigation etc.) and economic regulation (market access, exchange of traffic rights, airline capacity, international fares and rates, airline/airport/navigation services ownership and economics, airport charges, computer reservations system and taxation) of international air transport, under the Chicago Convention and subsequent Annexes and the respective manuals/policy documents. This section focuses on economic regulation of international air transport with a special emphasis on regulating market access. The other relevant guidelines are jointly discussed under national regulation of air transport.

Regulation of markets access

One of the key issues dealt with at the Chicago conference was the sovereignty over airspace and the right to commercial flights (Doganis, 2002; Wensveen, 2007). There were two opposing views on this; on the one hand some contended that freer airspace promotes the development of air transport and that there should not be any restrictions on international flying, capacity, routes or tariffs, while others held the opposite view. The Convention recognised that each state has sovereignty over airspace above its territory (ICAO, 2004). The Final Act of the Chicago conference produced two international agreements (ICAO, 2008a), which are of value to the international exchange of traffic rights.

1. International Air Services Transit Agreement

   States agreed on granting the first two "Freedoms of the Air"; right to fly across territory and privilege to land for non-traffic purposes. These two were vital for the conduct of commercial flight and, by May 2007, 123 States were parties to the agreement (ICAO, 2008a).
2. International Air Transport Agreement

   This agreement put forward the following five "Freedoms of the Air" aimed at promoting liberal air transport policies across the world (Figure B-1).
   - The privilege to fly across its territory without landing.
   - The privilege to land for non-traffic purposes.
   - The privilege to put down passengers, mail and cargo taken on in the territory of the State whose nationality the aircraft possesses.
   - The privilege to take on passengers, mail and cargo destined for the territory of the State whose nationality the aircraft possesses.
   - The privilege to take on passengers, mail and cargo destined for the territory of any other contracting state and the privilege to put down passengers, mail and cargo coming from any such territory.

However, it was not received with much enthusiasm by all states, and to date only 11 states are parties to the Agreement (ICAO, 2008a). As a result, until today international air transport services between countries remain bilateral.

Bilateral regulation of international air transport (BASA)

Despite the fact that BASA was the form by which countries exchanged traffic rights prior to Chicago, much of the BASA now in force came post-Chicago (mostly influenced by the 1946 Bermuda I Agreement between the United Kingdom and United States which had provisions for capacity and tariffs) and is the largest bundle of documents (around 2500 registered in the World Air Services Agreement database of ICAO) relating to international air transport until today. A BASA is an agreement between two parties (states or groups of states) drafted on the basis of "fair and equal opportunity" and granting, *inter alia*, traffic rights, designation of air carriers, capacity in terms of frequency and seats, tariff establishment procedures and mechanisms (e.g. through IATA). A typical bilateral document would consist of the textual body (preamble, articles of agreement and signatures), annexes (schedule of routes and other annexes), and attachments and agreed amendments (Table B-3).

There are two formats in use: the Chicago-type (set by ICAO at the Chicago Convention typically with no provisions for capacity and tariff provisions), and the Bermuda I- type agreements (rather, Bermuda I- type agreements with clauses of predetermination of capacity). Compared to the Chicago-type, the Bermuda I-type patterned predeterminist agreements were the most widely adopted agreement type (ICAO, 2004, 2008a). Thus, initial BASA's were very much restrictive and rarely were any fifth freedom traffic rights granted. Airlines were bound by government actions and opportunities for growth were limited in terms of opening up new routes, increasing frequency or seats, and pricing. Purchasing of traffic rights orpaying a royalty to the designated airline for use of fifth and sixth freedom traffic rights became quite common when carriers, who wanted to expand and operate connecting routes, opted to do so in the subsequent periods until liberalisation came into force (Doganis, 2002).

Sixth Freedom carriers/hubs

The 6th Freedom of the Air, where a carrier has the right to transport traffic originating from one state (B) to another state (C) via the home state (A) was not necessarily granted through BASAs, neither is it officially recognized by the ICAO, but rather it is a way of combining the 3rd and 4th freedoms by claiming to have the "ownership" of traffic originating/terminating between a pair of states. With the growth of air travel, 6th Freedom traffic became very popular and carriers of countries located central to major air traffic flows emerged as bridge carriers. Despite the controls introduced by states of disadvantaged carriers (True origin-destination states of the journey – B and C) such as royalty charges, declining to negotiate routes, limiting capacity, restricting advertising of such routings by bridge carriers, 6th freedom carriers flourished in the growing air travel markets and eventually controls were abandoned (Doganis, 2002; ICAO, 2004). Likewise, they started the Hub and Spoke operations in the post-liberalisation era and continued to grow with the subsequent liberalisation and deregulation.

Liberalisation and deregulation

The Bermuda II agreement in 1977 and subsequent deregulation of the US domestic market in 1978 paved the way for the development and renegotiation of less stringent BASAs in the following decades that removed restrictions on capacity and tariffs. Thus, between the 1970s and the 1990s BASAs progressively went on to take a liberal 'open market' approach mainly pushed by the initiatives of US with Netherlands and Singapore, which spurred the interest in intra-European markets (Doganis, 2002; Odoni, 2009). The decades following 1990 witnessed the growth of an 'open skies' approach to bilateral negotiation, the first of the kind being between US and Netherlands in 1992 (Doganis, 2002). The beginning of the millennium witnessed regional, plurilateral or multilateral open skies agreements being negotiated (e.g. in Europe), changing the way states negotiated ASAs, and promoting the further unification of international air transport. Based on the approach by Doganis (2002), Table 2-6 lists the different approaches that have been used until today to reach agreements on air services around the world.

Table 2-6 Approaches to air services agreements

	Traditional	Open Market	Open Skies
Bilateral	Specified points of access Limited 5th freedom Single designation of airlines	Multiple points open access Extensive 5th freedom grants Multiple designation	Unlimited access Unlimited 5th freedom Multiple designation
	Substantial ownership and effective control of carriers by designating State		
	Agreed capacity Tariff (Double Approval)	No capacity controls Tariffs (Double Disapproval/country of origin rules)	No capacity controls Free pricing Code sharing
Plurilateral		Two or more than like-minded States that share similar regulatory objectives (not widely held among many to invite for a multilateral) come together and sign an agreement leaving provisions for additional parties to join later. e.g. Multilateral Agreement on the Liberalization of International Air Transportation by Asia-Pacific Economic Cooperation Forum (the “Kona Agreement”/MALIAT)	
Multilateral		Many parties/countries that does not share similar regulatory objectives, come together and negotiate to create a common agreement leaving provisions for additionally parties to join later. Multilateral regulations has an Institutional Approach to it. e.g. Multilateral Agreement on the Establishment of a European Common Aviation Area (ECAA)	

Source: Adapted elaboration from Doganis (2002) based on ICAO (2004, 2008a)

2.7.2.7.2 National regulation and policies of air transport

ICAO’s policies and regulations for international air transport and other related issues are adopted by individual states through their national regulatory system. National regulatory structure of air transport in a state has two components to it: the organisational and the legal components. The organisational component consists of the institute/s vested with authority to regulate every aspect of air transport (economic and technical) within the territory of the state. The legal component consists of the body of acts, bills or laws, rules and regulations, judicial decisions, licences and permits, policy statements, and international agreements which the state is a party to (ICAO, 2004).

National regulator

The organisational component is responsible for the functioning and operation of the legal component. In doing that, the functions carried out are located in a single body named in different ways (Ministry of transport, Department of Civil Aviation, Civil Aviation Authority etc.) which may have different degrees of autonomy (as per the state's policy on liberalisation and privatisation). A state that exercises rigid control over industries will choose to locate the regulatory duties within a ministry or a department, directly under government control, whereas states that are inclined to a more liberal approach choose to set up autonomous or semi-autonomous civil aviation authorities. The ICAO recommends the latter which is seen as providing efficient services (ICAO, 2004).

Likewise, the regulatory approach which a state takes resembles its policies regarding deregulation, liberalisation and privatisation. A state favouring liberal policies will promote deregulation in the domestic air transport market and promote a more liberal approach to International ASAs. One key area is the deregulation of ownership rules for key aviation stakeholders: airports, air navigation service providers and nationality rules/foreign ownership rules of airlines. From the post-World War II period to up until 1980's, traditionally, these institutions have been under government ownership and control.

Airlines

Airlines operated mostly in monopolistic markets or there were strict regulations in place to control competition, as in the case of US (Odoni, 2009). As 'flag carriers' airlines took a political role and were icons of 'national prestige'. Though airlines were subsequently privatised in the decades that followed, some still remain under government control. However, what has not changed over the years is the 'nationality requirement' in designating airlines in ASAs. The clause, "Substantial ownership and effective control by the national….. state/community of interest" remains a requirement for an airline to be designated as a state airline in BASAs (ICAO, 2008a). The state specifies how much foreign ownership is allowed in shareholding and personnel on the boards of directors of airlines. This percentage varies from 0-49% (Odoni, 2009).

Airports

Since airport infrastructure provision was mostly seen as a public service (Graham, 2008a), privatisation was rarely considered an option by states. Thus, airports mostly remained under public ownership. However, with the growing demand for air travel, it was realised that airports are separate industries that can flourish on their own as autonomous entities owing to the "predictability of cash flow and above average growth" (Graham, 2011, p.4), provided that necessary regulations are in place to ensure fair competition, consumer welfare and safety and security of aircraft (Hooper, 2002; Odoni, 2009; Oum, Adler and Yu, 2006). The ICAO has identified several approaches (Figure 2-11) to airport privatisation that states can adopt depending on the degree of autonomy sought.

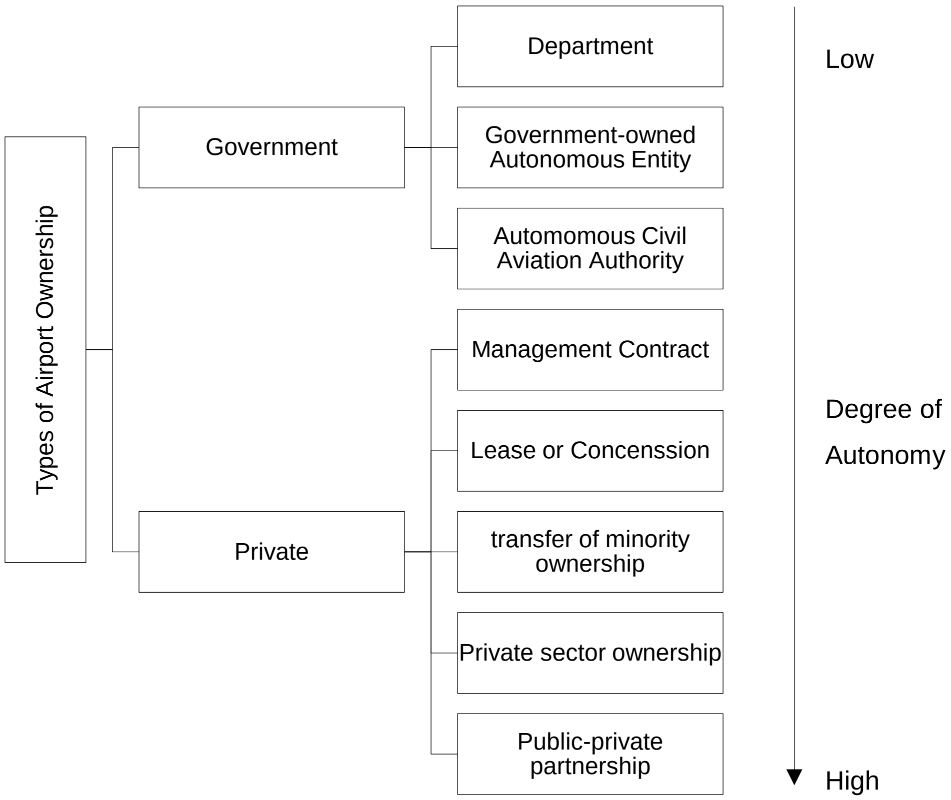

Figure 2-11 Types of Airport Ownership

Source: ICAO (2012, 2013a)

Air navigation services (ANS)

Provision of ANS has mostly been assigned to either the civil aviation regulator or airport service providers. ANS privatisation has been taken very cautiously by governments due to the close relationship it has with the national security and border controls (ICAO, 2012). Parallel to the growth in air travel, the need for more efficient ANS systems became a priority for governments and huge investments were required to update equipment in order to keep up-to-date with state-of-the-art technology which is essential for safety of the aircraft. Thus, corporatisation was seen as a way of commercialising the sector (Odoni, 2009). Ownership models of ANSs nowadays include government departments, government owned autonomous entities (corporatisation), private ownership, and private participation in ownership, management and control (ICAO, 2013b).

2.7.2.7.3 National political and administrative institutional framework

National regulation of air transport is influenced by the national policies of respective governments and the resulting public and private institutional/administrative frameworks (Itani, O'Connell and Mason, 2014). Therefore, the political environment plays a major role in the development of the air transport sector (Wang and Heinonen, 2015). The areas of influence range from political stability to a state's involvement in the promotion of an industry sector. Thus, the following areas are identified as essential to assess the conduciveness of the political environment for a successful air transport industry.

1. Safety, security and political stability are primary decisive factors for choosing a destination by travellers (Itani, O'Connell and Mason, 2014; WEF, 2013). Governments take an interest in the safety and security of their people and from time to time issue travel advice, concerning crime, violence, political instability, terrorism, war situations in certain countries. At the same time, airlines are reluctant to fly to destinations where such emergencies exist and the airspace is not safe. Therefore, to ensure a safe and secure political environment is a primary role of government to support the aviation industry.

2. A sound and fair institutional environment ensures efficiency in both the government and private sectors. Fair legal and judiciary systems, zero corruption, ethical behaviour of firms, protection of property rights, transparency and efficiency in government undertakings, and accountability of firms are all seen as indispensable to be globally competitive (Itani, O'Connell and Mason, 2014; WEF, 2012)
3. Policies and regulations which promote travel and tourism are also important for developing a strong inbound travel market. In addition, governments should ensure a conducive environment for international businesses. WEF (2013) identifies, *inter alia*, visa regulations, rules on foreign direct investments and foreign ownership, and openness of ASAs as essential areas for governments to be less restrictive and more cooperative.
4. WEF (2013) suggest that prioritisation of the travel and tourism industry through investments and regulatory facilitation indicates the degree to which governments are promoting the industry. Similarly, it can be deduced that prioritisation of investments and budgetary allocations for the air transport sector indicate the government's commitment to it.

2.8 Theoretical conclusion and the research gap identification

The above literature review helped to elaborate the research problem (section 1.2) and identify the gaps in literature that this research seek to fulfill through the objectives of this study. The review explained that airports have developed into a global business, which play a significant economic and social development role within an economy (section 2.2). Therefore, it is important for an airport to stay competitive within the global network as a destination attracting inbound passengers, a place generating outbound travel from a wider catchment area and a hub airport offering wider connecting options for passengers (section 2.3).

In order to stay competitive, an airport should carefully identify its network role and competitive position that would help in devising a strategic plan for the future, which is the focus of the first research objective of this study. The discussion in chapter 1, on the developments in the aviation industry of the East with reference to the rise of mega-hubs and shadows casted by them on the underperforming markets presented empirical evidence on the diversity in the geography of airports in a network. The review of network theory in section 2.4 helped to understand the spatial and temporal properties that define different network types of linear, grid, radial, and hub and spoke systems, which provides a good theoretical foundation to study the above phenomena. Taking a network perspective helps to define the role (nodal function) played by an airport in a given network by generating/ attracting traffic, and transferring traffic.

Section 2.5 reviewed literature that define the role and functionality of an airport using different criteria that were categorised under network properties and non-network properties. Network properties address the spatial and temporal qualities of the associated network of an airport. The criteria categorised as non-network properties are airport size, airline dominance and market focus related features that helps to define the scale, scope and specialization of operations at an airport. The group of studies on airport classification have used both properties to a varying degree in their classifications. Generally, the act of classification provides a frame of reference for comparison. Thus, it provides the relevant structure to study competition by way of profiling different airport typologies.

However, the current studies are limited in their scope of application for competitor analysis. They are focused on providing a frame of reference for the allocation of public funding or planning investments (FAA, 2012; Neufville, 1995; Rodriguez-Deniz, Suau-Sanchez and Voltes-Dorta, 2013; Suau-Sanchez, Voltes-Dorta and Rodríguez-Déniz, 2015),airport performance, efficiency or service quality benchmarking (Adikariwattage et al., 2012; Barros, 2009; Rodríguez-Déniz and Voltes-Dorta, 2014; Vogel and Graham, 2013), evaluating the impact of deregulation and liberalisation on the development of aviation network and airports (Burghouwt and Hakfoort, 2001; Graham, 1998; Malighetti, Paleari and Redondi, 2009), and assessing connectivity level or differentiating airport types (Guimera et al., 2005; Ivy, 1993; Mason, 2007). Therefore, they do not capture wider strategic scope required in a competitor analysis. Certain studies use one or two non-network properties (FAA, 2012; Neufville, 1995; Graham, 1998) or network properties for classification (Guimera et al., 2005; Ivy, 1993; Rodriguez-Deniz, Suau-Sanchez and Voltes-Dorta, 2013; Suau-Sanchez, Voltes-Dorta and Rodríguez-Déniz, 2015). Others that use multiple dimensions are mostly restricted to non-network properties (Mason, 2007; Adikariwattage et al., 2012; Barros, 2009; Burghouwt and Hakfoort, 2001; Rodríguez-Déniz and Voltes-Dorta, 2014; Vogel and Graham, 2013) or simple network measures such as degree of node (number of direct connecions) (Burghouwt and Hakfoort, 2001) or the percentage of transfer traffic (Mason, 2007). Only Malighetti, Paleari and Redondi (2009) have used multiple dimensions including betweenness to assess network properties. However, this study is also limited in its geographic application, similar to all other airport classification studies mentioned above which are confined to US, Europe or a global sample that does not represent a true picture of the market in the East. While on one hand above attempts to analyse the structure of an airport network are limited in its application to competitor analysis, use of wider strategic dimensions and geographical scope; on the other hand, the extant literature on the developments and competition in the airport industry of the East (section 1.1.3 to section 1.1.6) have the following limitations.

First, those studies that analyse competition between airports have failed to capture the geographic diversity of airports in Asia, as South Asia and Central Asia are missing in the analysis. Their focus have been divided between developed markets in Middle East and Asia-Pacific (Bowen, 2000, 2002; De Wit et al., 2009; Feldhoff, 2003; Homsombat, Lei and Fu, 2011; Hooper et al., 2011; Lohmann et al., 2009; Murel and O'Connell, 2011; O'Connell, 2011; O'Connell, 2006; O'Connor, 1995; O'Connor and Scott, 1992; Tsai and Su, 2002; Wang and Heinonen, 2015; Williams, 2006; Yeo, Wang and Chou, 2013). Thus, the discussion of competitive positions are limited to the major hub airports in the region.

Second, since the studies are mostly focused on development and competition between the major hub airports, position of second and third level airports have not been addressed at large. Airports have been arbitrarily chosen for comparison without looking into their strategic profile. For example, in the study by Homsombat, Lei and Fu (2011), they compare the major hub airports of Singapore Changi International Airport, Kuala Lumpur International Airport, Bangkok Suvarnabhumi International Airport, and Hong Kong Chek Lap Kok International Airport in their study, which have differences in their traffic profiles and source markets. Hong Kong and Singapore are highly dependent on international markets while Kuala Lumpur and Bangkok have a significant domestic market as well. Therefore, even though they may be directly competing for hub status, their business models are different. When there are differences in strategic profiles of competitors, the patterns of competition within an industry is altered (McGee and Thomas (1986). A good example from the airline industry is the differences between FSCs and LCCs. Though their ultimate competition is to attract passengers, their strategies of doing so are different. In such markets, identification of the relative competitive position is important to conduct a situational analysis prior to drawing up strategic plans for the future (McGee and Thomas (1986). In this respect, the current studies does not have the required depth in competitor analysis and does not provide a framework to identify relative competition that take note of the hierarchy in the airport network of the East.

Thirdly, they lack the required strategic breadth. This is because most of the studies are limited to size (traffic, seat capacity, number of airlines) related comparisons. Use of network related properties (connectivity) are limited to the studies by Bowen, (2000) and De Wit et al., (2009) which are exclusively focused on East Asia and the Pacific. There is no single study that uses a variety of dimensions such as; size, network connectivity, geographical scope, type of airlines, pricing strategies (airport charges), revenue profile, ownership etc. that provides a comprehensive strategic profile of an airport which is helpful to identify the relative competitive position of an airport. This is mainly because; the above studies serve different research objectives.

The first research objective, which is '*to propose a methodological approach to comprehend the competitive structure and geography of the network of airports in the East'*, contributes to fill the following gaps in literature.

- The need for an airport classification that can assist airport strategists to identify their relative competitive position within an airport hierarchy, which would eventually help in developing future strategies and monitoring/evaluating their performance by benchmarking against airports with similar profiles. Subsequently the study will address;
    - The gap of a study on airport competition evaluation in the body of literature on airport classification.
    - The gap of a study with a wider strategic scope in airport competition evaluation.
- Absence of studies that take a holistic view of the diversity in the geography of the airport industry of the East.

For the purpose of the first objective, the following hypothesis is generated from the literature review. *'Role and functionality of an airport within the global aviation network varies depending on the airport's strategic choice of the scale, scope and intensity of operational activity (size related dimensions), associated network, geographical market focus and service type (airline) orientation'.*

The second part of the chapter (section 2.7) focused on reviewing literature related to the second objective of the study. The models of national competitiveness (section 2.7.1) that identify a country's positioning advantage compared to others have advanced to encompass variety of dimensions, since Porter's (1990) diamond framework on competitive advantage of nations. These studies provide an all- inclusive view of a country's competitiveness in a global industry (WEF, 2012; WEF, 2013). The framework by Itani, O'Connell and Mason (2014) to assess aviation competitiveness is grounded on these theoretical notions. However, the study only looks at the national level competitive factors. It does not address the policy implications at the airport level. Studies on determinants of hubbing (section 2.7.2) looks at how macro environmental factors (economic, geographic/climatic and demographic measures) can be used to predict the establishment of a hub in a region (country/county/metropolis). However, these studies (Bauer, 1987; Butler and Huston, 1999; Huston and Butler, 1991, 1993; Liu, Debbage and Blackburn, 2006; Bhadra and Hechtman, 2004) only provide a measure of likelihood of hub formation and is limited to US and Europe. These predictions are less useful in a time where the concept of a hub have evolved along multiple dimensions introducing variations to airport and hub types as reviewed in section 2.5. On the other hand, the airport classification studies discussed above are limited to airport related features and does not extend beyond to look at the behavior of the air transport policy and regulatory environment or the macro environment. The two branches of research on airport classification and determinants of hubbing/ national aviation competitiveness have so far stayed segregated from each other. However, there is an obvious relationship between the two. A firm's performance is largely influenced by its immediate industry environment and the conditions of the macro environment.

The second research objective, which is to *'identify the factors that shape up the growth of an airport and interpret the causes for the differences in the airport hierarchy',* contributes to fill the following gaps in literature.

- Absence of a study that investigates the conditions of the national aviation industry and the general macro environment in relation to the different airport types in a network. This will address the gap for an airport classification study that profile airports based on both airport related strategic features and environmental conditions.

Based on evidence from previous research, the study hypothesises *that 'the role played by an airport in the global aviation network is determined by the conditions of the national aviation industry and the factors that shape up the general macro environment of a country'.* Studies on the determinants of hubbing, aviation competitiveness and national competitiveness advantage and policies/regulations of air transportation are synthesised to propose eight elements that shape up the 'National Aviation Industry Environment' of a country. They are; geography, economic development, demographic trends, business attractiveness, tourism attractiveness, intellectual and physical infrastructure political and administrative framework and the air transport policy and regulatory conditions.

Third research objective on the '*application of the methodological approach to recommend airport strategy and civil aviation policy measures to improve the status of an International Airport identified to be under the traffic shadow created by developed hubs in the East'*, would address above research gaps empirically through a case study. Chapter 1 deduced the possibility of a traffic shadow effect casted by the airports of the developed markets of Southeast Asia and Middle East on the airports of Central and South Asia, which was identified as one reason for the unevenness observed in the development of air transport markets in the East. The choice of the case study airport is guided by this proposition, which would demonstrate the significance of the contribution to literature aimed through the first and second objectives of this study.

2.9 Conclusion

This chapter reviewed extant literature on evolution of airport business, airport competition, air transport geography and network theory, airport classification, hub airports, national competitiveness, aviation competitiveness, hub location determinants, air transport policy, and economic regulation. The review helped to elaborate the research problem addressed through the objectives of this study further and identify the gaps in literature that they seek to fulfil. The research objectives will meet the requirements of a study that provides a framework to assess the relative competition in the airport industry of the East and identify the aviation industry policies/ regulations and conditions of the macro environmental elements that shape up the strategic profile of each airport type. The review highlighted the usefulness of 'airport classification' as a methodological approach. In light of the theories of structural analysis of industries, this concept closely correspond to the 'strategic group theory' proposed by Hunt (1972), who viewed an industry as a number of groups of firms. Next chapter will examine this theory in setting up the research design to achieve the objectives of this study.

3 RESEARCH DESIGN

3.1 Introduction

"A research design is the actual framework of a research that provides specific details regarding the process to be followed in conducting the research" (Sreejesh, Mohapatra and Anusree, 2014).This chapter presents the research design adopted to achieve the main aim of this thesis;

> *'To develop a framework to assist in the airport strategic planning process and related national civil aviation policy development to optimise the positioning of an airport in the aviation network of the East.'*

The chapter details the research approach taken (in theory development) and the 'strategic group theory', on which the research strategy of this study is based. The latter part of the chapter presents the choice of types of data, methods of data collection and approaches to data analysis. Figure 1-14 provided a summary of the design of this research.

3.2 Research approach

The primary task of any research project is to determine the approach that should be taken to achieve the research objectives. "Answers to issues can be found either by the process of deduction or the process of induction or by a combination of the two" (Sekaran, 2006). *Deductive* reasoning (theory to data) adopts a logical approach to theory building/conclusions through a set of known premises. The process involves building theory on a certain premise based on existing academic literature (hypothesis), testing the hypothesis through collection of (specific) data, and based on the conformity (or nonconformity) of the results with the original premise, to arrive at conclusions. *Inductive* reasoning (data to theory) starts with an observed phenomenon, identifies themes and patterns on collected data and builds up theories to reach conclusions (Saunders, Lewis and Thornhill, 2012; Sekaran, 2006). Though these approaches do seem quite the opposite to each other, in reality researchers involve both approaches during the course of a research project (Saunders, Lewis and Thornhill, 2012).

The purpose or nature of investigation in this research is both descriptive and explanatory. Descriptive studies are undertaken when the researcher knows that the subject of investigation exists in some form and the researcher wants to know in-depth its pattern, structure and profile to provide further meaning (Sekaran, 2006). In the first research objective of the study, *‘to propose a methodological approach to comprehend the competitive structure and geography of the network of airports in the East’*, the purpose is to describe (i.e. develop a taxonomy of) the competitive structure of the airports in the East. The second research objective, *‘to identify the factors that shape up the growth of an airport and interpret the causes for the differences in the airport hierarchy’,* aim to explain the drivers of the competitive position of an airport. Explanatory studies elucidate relationships between the variables in a study (Sekaran, 2006). Thus, the study is a “discripto-explanatory” type of research (Saunders, Lewis and Thornhill, 2012).

Thus, this research has mostly adopted a deductive approach to reasoning. However, induction was not completely discounted. Research problem identification used an inductive approach. The researcher’s interest in the role of airports in the development of the aviation industry in the East led to an exploratory study, combining literature and data to identify trends (hubbing as a major trend) and drivers of industry growth. The phenomenon of unevenness in developments and its implications for the region’s airports was identified. Research problem was developed around this phenomenon (section 1.2). Further research was carried out with a deductive approach. A detailed review of literature helped to conceptualise the idea generated through the preliminary investigation to hypothesise two conditions: that there are diverse airport types in a network and different factors contribute to shape up their roles in a network (chapter 2). Based on the conceptual framework, data was collected to identify the competitive structure of the airport network in the East. Though theories from the conceptual framework are tested, the researcher has kept open mind on the emerging patterns and structures from the data as in the case of data reduction methods used in the airport classification study (chapter 4).

3.3 Research strategy

The research strategy informs the plan of actions the researcher should take in order to achieve the research objectives (Saunders, Lewis and Thornhill, 2012). The research strategy was mainly influenced by the first research objective of this study, which is '*to propose a methodological approach to comprehend the competitive structure and geography of the network of airports in the East'*. The competitive structure of the airport industry is viewed as multi-tiered or as a hierarchy. This notion is informed by the modified structuralist view of industry competition and barriers to entry. Hunt (1972) pointed out that in an asymmetric industry where firms are largely heterogeneous (economically, organisational systems and discretionary-strategic choices), symmetry can be achieved or asymmetry can be minimised (for strategic decision purposes) by grouping firms within industries according to what they have in common, to form "Strategic Groups".

3.3.1 Strategic group theory

3.3.1.1 Introduction

Hunt (1972, p.15) stated that "a strategic group is a group of firms within the industry that are highly symmetric. An industry then will be viewed as a number of strategic groups". Heterogeneity among firms is a result of strategic choice (Caves and Porter, 1977; Porter, 1979), competitive scope, and resource commitment (Cool and Schendel, 1987a as cited in Leask and Parker, 2006). Based on the firms' standing across strategic dimensions they can be grouped together for shared similarities to create a framework to analyse industry competition. The theory proposes that firms in an industry compete within groups of similar firms rather than within the wider industry. Strategic groups emerge in industries for a variety of reasons including differences in firm's initial strengths and weaknesses, historical developments in the industry, difference in the point of time a firm entered into a business and technological changes in the industry (Porter, 1979). Porter (1980) says that formulating competitive strategy is about the "choice of which strategic group to compete in".

3.3.1.2 Strategic choices for group formation and mobility barriers

The strategic group theory suggests that the barriers to entry into an industry are mostly barriers to entry into a group of competing firms within an industry. Therefore, a potential entrant can be a completely new firm or a firm already competing in another group. The firms already competing in the industry in different groups face “barriers to mobility” between the groups in the same industry. The barriers to mobility are created when firms make strategic choices on competitive dimensions (Caves and Porter, 1977; McGee and Thomas, 1986; Porter, 1979, 2004). Mobility barriers explain why some firms thrive while others struggle. If a firm makes it difficult for other firms to imitate the chosen strategic path, it will increase the height of the mobility barrier. However, when industries evolve and the technologies change, the mobility barriers will also change. Depending on the strategic choices, the firms can move into different groups over time (Porter, 2004).

Porter (2004) has proposed thirteen strategic dimensions that can be used in strategic group analysis. Using those and the taxonomy of sources of mobility barriers by McGee and Thomas(1986), a sample of strategic dimensions is given in Table 3-1. While some of these strategic choices (e.g. size) are common for any industry, not all these dimensions are commonly applicable to every industry. The type of strategic dimensions and their scope depends on the nature of the industry. On the other hand, strategic choices are related and internally consistent with each other (Porter, 2004). Identification of relevant strategic dimensions has been emphasised as the primary step in any industrial structural analysis exercise (Fiegenbaum, Sudharshan and Thomas, 1990; McGee and Thomas, 1986; Porter, 1979, 2004). Careful selection should focus on the key characteristics of the industry that set it apart from others and most importantly that will affect their performance (Leask and Parker, 2006) and create a meaningful division between firms.

Table 3-1 Dimensions for strategic group analysis/sources of mobility barriers

Market related strategies	Product line/width/scope, Services, Price, Specialisation/Market segmentation(Geographical Coverage/Customer segments) , User technologies, Distribution channels, Brand identification, , Selling strategy (Push vs Pull), Sales
Industry supply characteristics	Economies of scale in production/marketing/ administration, Manufacturing processes capability (technology leadership/cost leadership /product quality), Research and development capability, Marketing and distribution systems, Number of manufacturing plants in a firm
Characteristics of firms	Ownership, Organisation Structure, Control Systems, Management skills, Boundaries of firms (diversification/vertical integration), Firm Size, Relationship with influence groups (governments/parent company), Financial leverage, Age of firms, capital intensity, eight firm-concentration ratio

Source: McGee and Thomas, (1986) with adaptations from (Hatten and Hatten, 1987; Leask and Parker, 2006; Porter, 2004)

The usefulness of strategic group analysis to industrial organisation (Hunt, 1972) is the comprehension it provides of the structure-conduct-performance paradigm. In a different way, the strategic management theorists (Hatten and Hatten, 1987) have developed the theory as a tool for comparing and contrasting competitors for strategic decision making. The approach helps to achieve the following; to identify the most direct competitors and competing bases of firms, opportunities (niche markets) in the industry, relative positioning of a firm to other groups and the potential to move to other groups by overcoming mobility barriers (Leask and Parker, 2006; Porter, 2004).

3.3.2 A strategic group analysis for the airport industry: Classification of airports in the East

Two preliminary conclusions were drawn from the exploratory research (chapter 1) and the literature review conducted (chapter 2) in relation to the subject of this thesis. One is that there is considerable unevenness in the pattern of air transport development in the East. A result of these developments is the shadow-effect on the nearby small airports by the mega-hubs in the region. While this has several market benefits, from a national self-interest perspective, these small airports find themselves in a challenging situation in aspiring to become a hub themselves and attract direct services from international destinations. Policy-makers are pushed to seek defensive strategies to face international competition. In this situation, a better understanding of the current market and distinctive roles played by different airports in the network and different levels of competition becomes useful. The other conclusion is that there is a hierarchy of airports in a network depending on the network role they play and also that airports are not homogeneous in size, market scope, ownership and performance.

In this context, strategic group theory provides a suitable analytical framework to explain the competitive structure of the airport network in the East. From a policy and strategy development perspective, classifying airports into homogeneous groups helps to identify the different airport group profiles in a network, which provides an understanding of the role played by a particular airport in the network and the direct competitors. Thus, an *airport classification* study is proposed as the primary tool of this research. This is also influenced by the previous studies on airport classifications (section 2.5.2) that have been carried out for different purposes.

Once a classification is in place, it assists in achieving the second and third research objectives of this study. The second research objective seek to *'identify the factors that shape up the growth of an airport and interpret the causes for the differences in the airport hierarchy'*. The review of drivers of growth of the aviation market in the East (chapter 1) and the literature review (chapter 2) proposed that an airport's environment and a country's competitiveness factors influence its success or failure. This knowledge is used to compare the differences between the competitiveness of the aviation industry in different countries and the respective positioning of their airports in different groups. A comparison of macro environmental factors within and between groups will help to produce knowledge to inform the corresponding second research objective; which is *'to identify the factors that shape up the growth of an airport and interpret the causes for the differences in the airport hierarchy'.* The third research objective focuses on the *'application of the methodological approach to recommend airport strategy and civil aviation policy measures to improve the status of an International Airport identified to be under the traffic shadow created by developed hubs in the East'.*

A taxonomy of airports will bring similar airports together, which allows them to be benchmarked against best- in-class strategies of each group. It enables the identification of strategic priorities for airports in different groups in order to enable them to move up in the Airport Hierarchy (e.g. from an OD airport to a Hub), thus allowing policy-makers to make informed decisions regarding national civil aviation policies with the best interests of contributing to national economic development.

Thus, this research is a three- phase process guided by the research objectives of this study (Figure 1-14).

1. Classification of airports
2. Comparison of macro environmental factors between airport groups
3. Application of the airport classification to the case study of the International Airport in Sri Lanka.

3.4 Research methods

This section presents the decisions taken regarding the implementation of the research strategy. The main unit of analysis in this research is the 'airports' used in the classification exercise. Data is collected in aggregation for an airport. The classification exercise carried out in this study is a cross-sectional study for data collected for the year 2012, to take a snap-shot of the structure of the airport industry. Quantitative methods dominate this research in data collection and analysis stages. However, qualitative data are also integrated in the study to a higher degree in the interpretation of results in chapters 4, 5 and 6.

3.4.1 Data collection

In an era where big-data[8] analytics is changing the way information is being used for decision making and research (Batarseh and Latif, 2015; Jin et al., 2015; Martínez-Torres and Toral-Marín, 2010), the quantity, quality and reliability of

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[8] Big data is referred to as the large data sets that are generated as a result of the sophisticated information technologies and systems including internet, and cloud computing in place today. They are real time population data beyond the analytical capability of traditional computing software. Analysis of big-data requires advanced algorithms and machine capacity.

secondary data has improved enormously (Saunders, Lewis and Thornhill, 2012). Thus, "secondary data studies" have become an established research method (Sreejesh, Mohapatra and Anusree, 2014). The Air Transport industry is one of the most technologically advanced industries, in addition to being among the most complex networks in the world today. The relationships between passengers, cargo handlers, airlines and airports are multi-faceted, and they generate a vast amount of data available through different stakeholders in the industry, starting from individual airlines/airports, Government Departments up to global agencies like IATA, ACI, ICAO, and Global Distribution Systems (GDS) (Devriendt, Derudder and Witlox, 2006). The phenomenon under investigation in this research - the role of an airport in a network - is a result of this multi-faceted relationships. Data generated by the industry can be used to extract the true nature of the subject being studied. Therefore, secondary data/desk research was selected as the dominant data collection method of this study.

Collection of data began in early 2013, and all possible attempts have been made to use latest available data since then. While the main database of the study is from 2012, progressive analysis used elsewhere in the study uses data from much later periods to keep the discussion up-to-date and current. Some of the data were directly adopted from the original databases. Some of the measurements were calculated by the researcher using the original data in order to meet the objective of each measurement as in the case of calculating flow centrality and traffic generation measures for the airport classification study (chapter 4). Types of data collected are mostly quantitative. Qualitative information is also used as supplementary evidence in the discussion of analytical results. Section 3.4.1.1 introduces the OAG databases, which produced the majority of the data used in the classification exercise in chapter 4. Section 2.7.1.2 introduced the Global Competitiveness Index and the Travel and Tourism Competitiveness Index (WEF, 2012, 2013), which produced the majority of the data used in the ANOVA of chapter 5 for environmental profiling of airports. The key sources of data used in the study are summarised in Table 3-2. Chapters 4, 5 and 6 as standalone presentations make account of the details of the type of data, specific measurement derived and the relevant sources. In-text references are provided when additional sources of information (from the above sources) are used to supplement the discussion of results in these chapters.

Table 3-2 Data Sources

Type	Data Source	Chapters
Secondary aviation databases	Official Airline Guide (OAG) (introduced in section 3.4.1.1)	1,4,5 and 6
	Company profile data - Airline Type and Airport Infrastructure and Ownership by Flightglobal (2013)	4,5 and 6
Aviation industry trade press	Flightglobal	4, 5 and 6
	CAPA*	1,2,4,5 and 6
Analytical reports and websites	CAPA*	1,2,4,5 and 6
	Air Service Agreements Projector by World Trade Organisation (2012)	5 and 6
	Great Circle Mapper (www.gcmap.com)	5 and 6
Country level and global census/ statistics databases and documentary evidence	World Development Indicators Database by World Bank (2012, 2013)	1,5 and 6
	CIA World Factbook (2012)	5 and 6
	United Nations, Department of Economic and Social Affairs, Population Division (2012, 2014)	1, 5 and 6
	ICAO World Air Service Agreement Database (Doc – 9511) (online) (ICAO, 2014)	5 and 6
	Regional / Plurilateral Agreements and Arrangements for Liberalisation (ICAO, 2009)	5 and 6
	Tariffs for Airports and Air Navigation Services (Doc 7110) (ICAO, 2013)	5 and 6
Databases from continuous and regular surveys carried out by international organisations	Travel and Tourism Competitiveness Index and Global Competitiveness Index (WEF,2012) (introduced in section 2.7.1.2)	5 and 6
	Ease of Doing Business (World Bank Group, 2013)	5 and 6
Official Websites	Civil aviation authorities (e.g. Civil Aviation Authority of Sri Lanka), airports (e.g. Dubai Airports), and airlines (e.g. Sri Lankan Airlines)	
Email/telephone communications	Airport officials to obtain data on airport infrastructure (gates)	5 and 6

* 'author, date' reference is provided for each information source used

Source: Own elaboration

Supplementary to the secondary data used, the researcher spent a study week from 31st March to 4th April 2014 at the Economic Analysis and Policy (EAP) Section of the Air Transport Bureau at the ICAO Secretariat in Montreal, Canada. Objectives of the visit were;

- To exchange views on the research and develop a comprehensive understanding of the regulation of international air transport (ICAO policies and activities and the state level developments in the area.
- To develop a joint survey instrument to gather state level aviation policy, investment and expenditure and GDP contribution data[9]

The researcher was introduced to the policies on the economic regulation of international air transport and was given access to the databases of WASA database –Doc 9511, Tariffs for Airports and Air Navigation Service (2013)-Doc 7100) and other databases from the studies carried out by ICAO. An additional benefit that improved the richness of the data gathered was the series of open-ended interviews (Table 3-2) carried out with the key officials involved in economics, policy analysis and regulations at the ICAO secretariat. These interviews were not carried out to gather data for any analytical purpose (in relation to the major analytical tools involved in the research), but were conducted to broaden the researcher's knowledge of the role of economic regulation in shaping up global air transport industry and its impacts on airports. Thus, they played an "informant" role (Yin, 1994) by providing insights into the topics being studied and suggested/shared further sources of information. For example, the discussion on global trends in relation to the recently concluded 6th World Air Transport Conference (ATCONF/6) (then) provided an insight into the working papers related to the different themes of this study. Interviews are a flexible research tool that can be incorporated into different stages of the research design. They can be used at the beginning of a research to refine ideas in relation to the research problem and questions (Saunders, Lewis and Thornhill, 2012) or

[9] The survey Instrument could not be materialised until the data analysis stage of this research began, due to the time involved in the organisational procedures of ICAO secretariat to receive an approval for a "Sate Letter".

to corroborate results from a data analysis. Thus, these inputs have contributed to the interpretation of the results of the research in abstraction.

Table 3-3 Interviews conducted at the economic analysis and policy section, air transport bureau, ICAO secretariat from 31st March-4th April 2014

Key Informants	Interview Topics
Narjess Abdhennebi Chief, Economic Analysis and Policy Section	Global trends and development in relation to ICAO 38th Assembly and ATCONF/6, ICAO Policies and Manuals for Economic Regulation (International air transport, Airports and Air navigation services) and airport charges
Yuanzheng Wang International Commission for Air Navigation (ICAN) Manager	Economic regulation of Airports and Air Navigation Services, Airports and Air navigation Services Ownership Trends, National and International regulation of air transport
Jerome Simon Infrastructure Manager	Economic contribution of air transport and Satellite Accounts, Tourism and air transport
Fredric Malaud Air Transport Development Manager	Regulatory aspects of global air connectivity (bilateral and open skies, Visa regulations, consumer rights regulations
Mara Keller Economic Assistant	World Air Service Agreements (WASA –Doc9511) Aviation Data Analysis Panel ICAO inputs on the development of the joint survey instrument

Source: Own elaboration

3.4.1.1 Official Airline Guide (OAG)

OAG is an independent air travel intelligence database which provides industry with up-to-date market information based on airline schedules and bookings data, through different products they offer. Being able to access data used by the industry in commercial decision making has provided the advantage of arriving at academic conclusions which are readily applicable to the current industry-wide setup. Three OAG data products are used in this study to generate the indicators for research measurements.

1. OAG Schedules Analyser

OAG Schedules Analyser uses published airline schedules to produce capacity introduced to the market by worldwide airlines. Data extracted included seat capacity data by all the airlines operating to and from each airport (both ways), including operating carrier, flight origin, destination, routing, departure and arrival timing, distance, operating days of the week, frequency, and number of seats made available.

2. OAG Connections Analyser

This is a connection building tool, using the published airline schedules and their itineraries which include information on the number of stops and their routings. Connection options made available by airlines to carry traffic between continents (excluding Asia and Middle East) via Asian and Middle Eastern airports for May 2012 were extracted to analyse the nature of competition in directional/continental hub operations in the region.

3. OAG Traffic Analyser (MIDT)

Market Information Data Transfer/ Tapes are real time industry data on airline and travel agency activities giving a true picture of the itineraries of global travel based on bookings made via GDSs (Devriendt, Derudder and Witlox, 2006). OAG traffic analyser data is powered by the Travelport® booking system. Each data point/route observation includes point of origin, point of destination, connecting gateways, seat class type, number of bookings and fare details, all of which provide valuable competitor information which other traditional databases from international agencies like ICAO, IATA, ACI etc. cannot provide. Devriendt, Derudder and Witlox(2006, p.1) refer to them as having “implicit state-centrism in the data, lack of comparability between different data sources, information biased through the use of selected carriers, lack of origin-destination data, and use of proxy variables, such as scheduled flights or services.”

MIDT data provides the actual picture of the market, even though it has the limitation of not covering the bookings made directly with the airline and also details of all low cost carriers that have stayed away from using GDSs to sell their tickets as a strategy to keep costs low. However, OAG has provided for the uncovered part of the market by making adjustments to the dataset using mathematical algorithms. The validity of these adjustments was tested by Suau-Sanchez, Voltes-Dorta and Rodríguez-Déniz (2015), comparing Department of Transport (DOT) data for the USA domestic market against MIDT data and they confirm the usefulness of the MIDT data to build a true market picture. Extracted date included booking details of domestic, regional, and international OD traffic. Data was also extracted for each airport as a connecting gateway, in one-stop flights (as Gateway 1) and two-stop flights (as Gateway 2) of an itinerary booked through the respective airport. The database used for the analysis included all the bookings made for the month of May 2012. Annual data was not used in the study due the complexity it creates in handling details on individual bookings to and from and via a large sample of airports within a year. Therefore, unlike seat capacity data which are annual records, passenger numbers (one booking=one passenger) used to generate connectivity measures are based on monthly figures.

3.4.2 Analytical methods

This research mainly employed three statistical methods namely; Principal Component Analysis, Hierarchical Cluster Analysis, and Analysis of Variance (ANOVA).

3.4.2.1 Cluster Analysis for airport classification

The review of airport classification studies (Section 2.5.2) saw that, while some of the studies have used criteria based judgement/*ad hoc* partitioning techniques(Cranfield University Air Transport Group et al., 2002; FAA, 2012; Graham, 1998; Mason, 2007; Neufville, 1995) others have gone on to adopt comprehensive variables and statistical methods such as cluster analysis (Adikariwattage et al., 2012; Burghouwt and Hakfoort, 2001; Ivy, 1993; Malighetti, Paleari and Redondi, 2009; Rodriguez-Deniz, Suau-Sanchez and Voltes-Dorta, 2013; Rodríguez-Déniz and Voltes-Dorta, 2014; Suau-Sanchez, Voltes-Dorta and Rodríguez-Déniz, 2015; Vogel and Graham, 2013), network analysis (Guimera et al., 2005) and latent class models (Barros, 2009). Cluster analysis is also the commonly used tool in the applications of strategic group theory in different industries (Ketchen and Shook, 1996).

Clustering objects into groups in two dimensional space is mostly straightforward and can be easily attained by visualisation techniques (Everitt, Landau and Leese, 2001). However visualising a structure in an n x p multivariate matrix is a complicated task. Cluster analysis is a useful tool in grouping similar objects together when more than two variables are present (Mooi and Sarstedt, 2011). Numerical cluster analysis techniques allow the *discovery of groups* in data (either object groups or variable groups), and it is different to assigning objects into predefined groups (Everitt, Landau and Leese, 2001).

Figure 3-1 presents a decision diagram by Hair et al.(2006), which has been followed in this study to ensure that maximum objectivity is maintained in deriving clusters. The first step is required to establish the objective of performing a cluster analysis; whether it be taxonomy description, definition of a structure for further analysis or identification of relationships. This is in parallel to the first research objective of this study. Thus, the suitability of the approach could be justified. Selection of cluster variables should be carried out according to the theoretical foundations of the research. The current study uses multiple variables (24 variables introduced at the beginning) in the airport classification exercise. The next step involved choosing the sample, which should be large enough to represent the true nature of the population, so that smaller groups are not left out. Out of the 908 airports in the defined 'Eastern network', the top 450 airports were selected. This ensured that all the airports with a significant commercial importance were included in the sample.

When metric or continuous variables are used, proximity is used as the measure-of-closeness of the objects to each other. It is expressed in terms of the distance or dissimilarity and the most commonly used distance measure is the '*Euclidean Distance'* (Everitt, Landau and Leese, 2001). It is the geometric straight-line distance (Pythagoras formula) between two objects, which can be easily generalised to more than two variable p dimensional space. A variation is 'S*quared Euclidean Distance'* associated with the advantages of assigning greater weight to objects further apart (Hair et al., 2006). When the data are from different measurement scales, standardisation is usually recommended to avoid the problems of unnecessary influence of highly dispersed/larger variables on the cluster solution.

Multicollinearity is another issue that disrupts the final results by acting as a weighting process in the classification. A common solution used to deal with standardisation requirement and multicollinearity is to derive principal components/factor analyse data (Ben-Hur and Guyon, 2003; Budd, Ryley and Ison, 2014; Ding and He, 2004; Everitt, Landau and Leese, 2001; Gan, Ma and Wu, 2007). However, Principal Component Analysis (PCA) should be cautiously deployed to avoid the risk of true discriminatory variables getting under represented (Hair et al., 2006; Mooi and Sarstedt, 2011). Still, extreme multicollinearity (r=.9) or singularity (r=1) cannot be solved with PCA. Thus excluding the variables offers a better solution (Field, 2005; Mooi and Sarstedt, 2011). This study had 24 variables and 4 were eliminated to reduce the impact of extreme multicollinearity and singularity. In addition to this, the research has used a two-step[10] clustering approach; in the first step using one set of variables and in the second using PCA scores of the second set of variables to develop the taxonomy of airport typologies.

The next major decision is the choice of cluster procedure: hierarchical methods, partitioning methods or a combination of both. Hierarchical methods, as the name suggests follow a sequential merging (agglomerative) or dissecting (divisive) process of the objects according to the clustering algorithm chosen. Partitioning methods are one-step procedures where a judgement is made on the number of clusters and an optimisation algorithm is used to minimise the within-cluster variance (k-means algorithm is one of the commonly used) (Gan, Ma and Wu, 2007; Mooi and Sarstedt, 2011).

[10] The term ‘two-step’ means, that the clustering procedure has been conducted in two separate steps. It is different to the ‘stepwise clustering method’.

Hierarchical Cluster Procedure

Agglomerative Hierarchical Clustering (AHC) is the most widely used hierarchical procedure (Everitt, Landau and Leese, 2001) when the observer is interested in the sequence of 'nested-partitions' (Gan, Ma and Wu, 2007). The process starts with each object in its own cluster and sequential fusing of the objects until all are in one group. The researcher relied on hierarchical procedures for choosing the final solution, mainly because of this advantage it gives over k-means clustering in not having to have a predetermined number of clusters. This allowed the researcher to maintain a flexible view on the number and types of airport groups. The criterion for fusion is based on the distance measure (clustering algorithm specified). An algorithm defines distance from one object to another or a newly formed cluster to another object. There are several methods of doing this; Single, Complete or Average Linkage which are graph methods and Centroid, Ward's and Median which are geometric methods (Gan, Ma and Wu, 2007). Hierarchical methods have the additional benefit of being able to represent the agglomeration/division in visual format through dendrograms or icicle plots. It was useful in comprehending the structure of the airport hierarchy. As a method it corresponds very well to the nature of the problem being studied, hierarchical structure of the airports in the network and how airports are nested within groups.

In hierarchical methods, one key issue to deal with is the decision on the optimal number of clusters. There are several rules that help in the decision. The first rule is visual based. The dendrogram provides a rough visual guidance on probable truncation points. There are different computational ruling methods available that one can choose to 'cut the tree'. One simple calculation is the percentage changes in heterogeneity. Using the distance coefficients (or with-in cluster sum of squares for Ward's method) in the agglomeration schedule, percentage change resulting from cluster fusion can be calculated for each cluster solution. Then the solution before the one with the highest heterogeneity change is taken as the tentative solution (Hair et al., 2006). Further validation is carried out by computing the *Variance Ratio Criterion (VRC)* (pseudo-F coefficient) by Calinski and Harabasz (1974). Milligan and Cooper (1985) after evaluating five methods had recommended this as a robust method applicable for different situations. It is calculated as;

$$VRC_k = (SS_B/(K-1)))/(SS_W/(N-K))$$

SS_B = overall between- group variation

SS_W = overall within-group variation

K = number of clusters

N= number of observations

A distinctive cluster solution would be a one where, between-group variance is larger (SS_B) and within-group variance (SS_W) is smaller. Therefore, a good solution can be determined by the comparative size of VRC_k across a *k* number of cluster solutions.

Once the groups are in place, their centroids/ means are examined to characterise each group and name them accordingly. Validation in cluster analysis is another grey area as no single method is available. The solutions *stability* can be assessed by re-running the analysis using different cluster procedures. For this purpose, K-means quick cluster procedure is carried out using the centroids and number of clusters from AHC as a guide. The outcome is compared against the original AHC solution to determine the stability of the solution (Hair et al., 2006; Mooi and Sarstedt, 2011). The solution's *validity* and *reliability* are assessed by testing for the statistical significance of differences between groups means of a predetermined set of *criterion variables*.

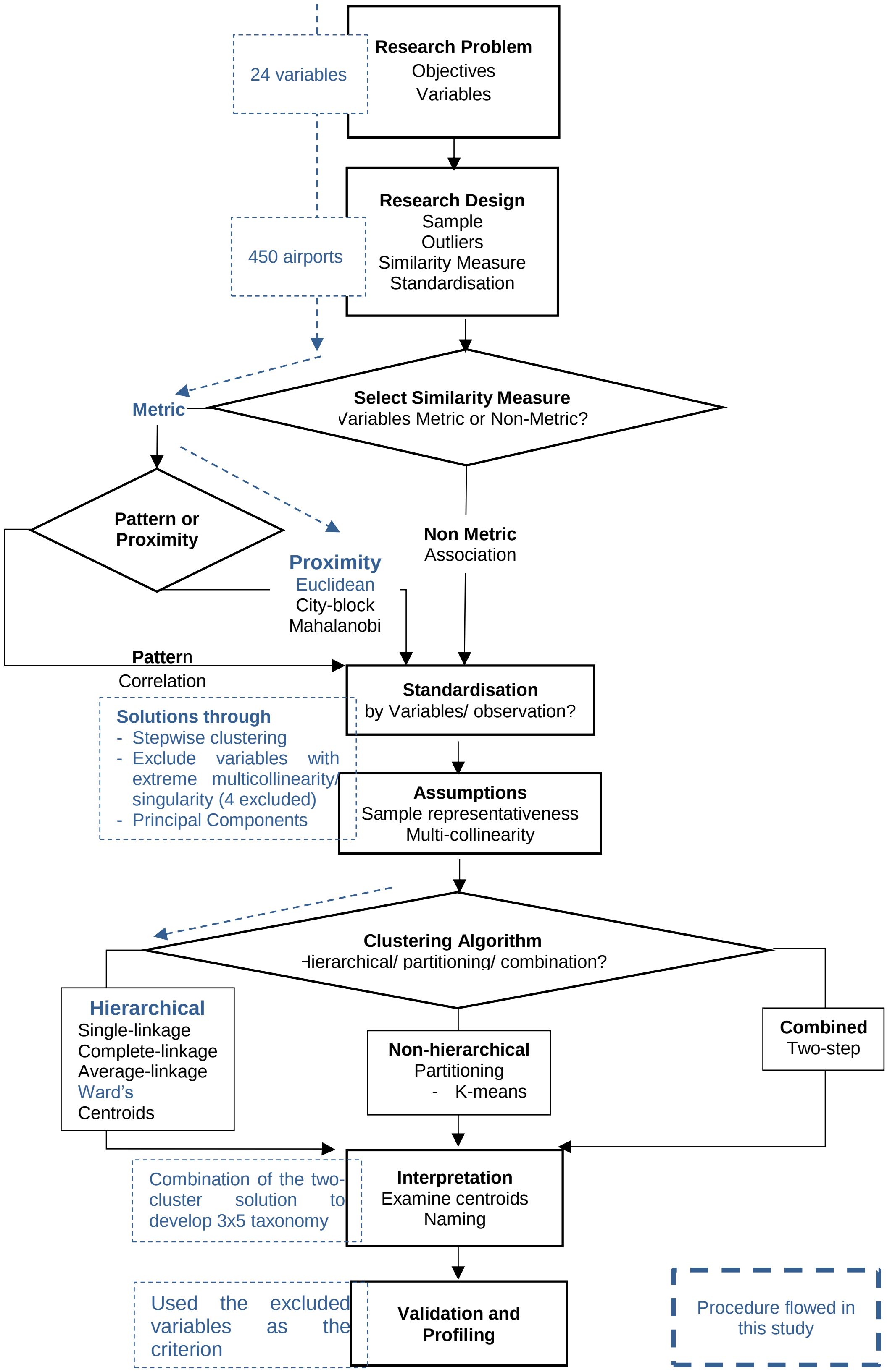

Figure 3-1 Steps in Cluster Analysis

Source: Adopted from Hair et al. (2006) and Mooi and Sarstedt, (2011)

3.4.2.2 Principal Component Analysis as a data reduction tool

In the second classification step, this study initially proposed 17 multiple variables to represent different strategic choices of airports. PCA is employed as a data reduction tool, while retaining the variability within a safe margin (Jolliffe, 2002). Adikariwattage et al.(2012) uses a similar approach in their airport classification, in order to account for multicollinearity between variables. Steps followed in the PCA procedure are given in Figure 3-2. Before the application of PCA in any analysis, a clear distinction between PCA and Factor Analysis (FA) should be known, as they seem quite alike, but very different in their assumptions and purpose of application (Figure 3-3). FA assumes an underlying structure in a set of observed variables and tries to derive a mathematical model to estimate factors (summation). The assumption is that the latent factor drives the observed variables. In PCA, the objective is to decompose the observed variables into a fewer components and the focus is on the contribution of each variable to the linear variate (component). The mathematical difference in the two approaches lies in the analysis of variance. PCA analyses the total variance in the observed variables, while FA only analyses the shared variance. Variance due to error and variance unique to individual observed variables are eliminated in the process (Carlos Martín and Román, 2003; Field, 2005; Jolliffe, 2002; Matsunaga, 2010; Tabachnick and Fidell, 2007). In PCA the original variables are transformed into a new set of variables called Principal Components (PCs). PCs are computed *as;*

$$C_1 = b_{11}X_1 + b_{12}X_2 + \cdots + b_{1p}X_p$$

C_1 - Principal Component 1

b_{1p} -The regression coefficient (or weight) for observed variable p, as used in creating principal component 1

X_p - The subject's score on observed variable p

Likewise, the subsequent PCs ($C_2 \ldots C_n$) are computed as linear combinations of the original variables that account for the (maximum) remaining variance. The uncorrelated property between them makes the PCs useful in substitution to original variables in further statistical analysis, including regression analysis (Jolliffe, 1982) and cluster analysis (Ben-Hur and Guyon, 2003; Ding and He, 2004; Gan, Ma and Wu, 2007).

Once PCA is confirmed as the suitable method for the problem under investigation, the research design should take into consideration the influence of the sample size on the final solution. A sample of 450 is an adequate number (well above the 300 rule by Lee (1992)) and this is further tested by the Kaiser-MEYER-Oklin measure of sampling adequacy (KMO) (values above 0.5 acceptable). For a strong PCA solution, correlation between variables is important. Bartlett's sphericity is a statistical test to confirm the significance of the existence of correlation between variables, and lower values in the *Anti-image correlation* matrix indicate the adequacy of the correlations. At the same time extreme-multicollinearity or singularity happening due to the introduction of composition variables disrupts the component loadings (Aitchison, 1983; Jolliffe, 2002). As explained earlier, component extraction progresses until the components are equal to the number of variables introduced to the procedure and the variance they explain becomes gradually smaller. How many components to retain or extract is a criterion based decision. Several criteria are available; the Eigenvalues, the Percentage variance or the Scree plot. Eigenvalues indicate the amount of variance accounted by a component. Values greater than 1 are acceptable (Field, 2005). Percentage of cumulative variance explained by each component successively extracted should be more than 60%. A scree plot (eigenvalue (*y* axis) and component (*x* axis) provides a visual guideline to decide on the number of components. The points of inflection allow the researcher to judge how many components to retain in the final solution (Hair et al., 2006).

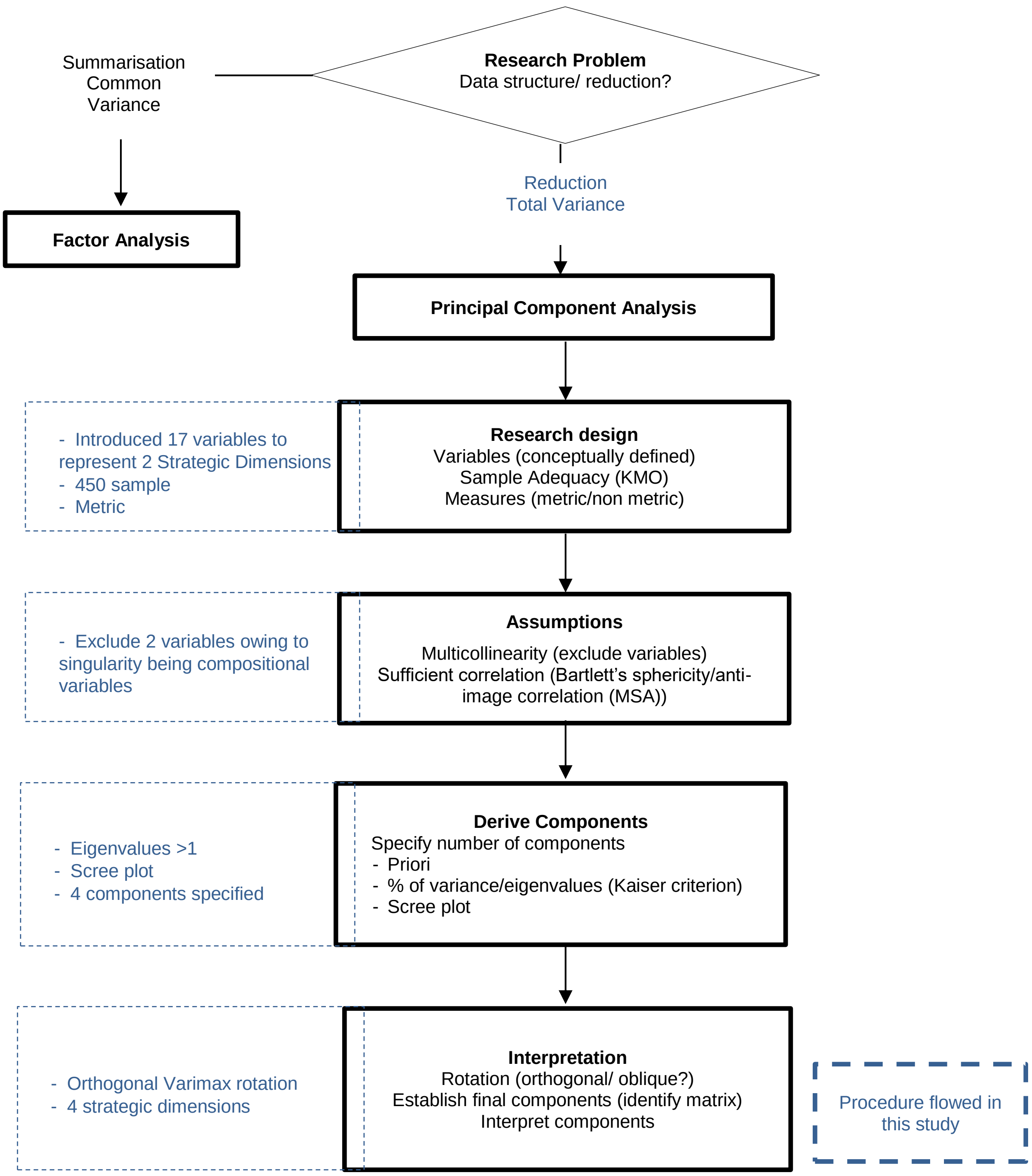

Figure 3-2 Steps in Principal Component Analysis

Source: Adopted from (Field, 2005; Hair et al., 2006; Jolliffe, 2002)

An oval represent a latent (unobserved) factor at the population level, whereas a rectangle represents an observed variable at the sample level. An arrow represent a casual path. Note that the observed tem in the factor analysis are assumed to have been measured with measurement errors (i.e. ε_s), whereas in principal component analysis are

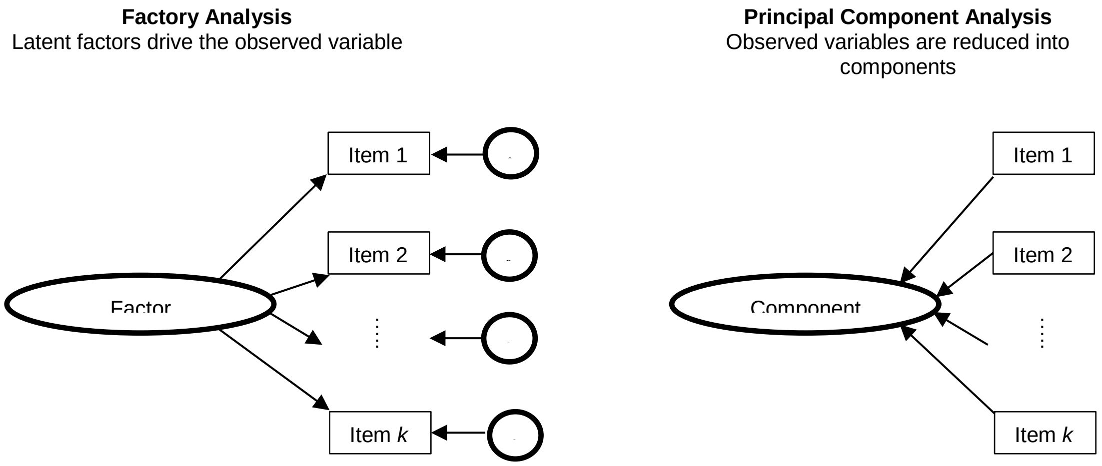

Figure 3-3 Conceptual distinction between Factor Analysis and Principal Component Analysis

Source: Adopted from Matsunaga (2010)

Unlike in FA, interpretation of components in PCA is a challenging task, since the focus is on total variance of all measures (Jolliffe, 2002). Generally, the first PC will have the highest loading and subsequent PCs have smaller loadings. Rotation is one method to improve interpretability. Here, the PC axes are rotated to maximise the loading of the closely related variables to a particular component. Two methods are available; orthogonal rotation (PCs remain uncorrelated) and oblique rotation (PCs are correlated). Out of the three orthogonal rotation methods, *varimax (the* other two are *quartimax, equimax)* rotation is used in this study for its characteristic of dispersing the loading across the PCs which makes it easy to interpret and is thus popular (Jolliffe, 2002). A rule should be applied to decide the degree of loading of a particular variable on a PC, to finalise the variables that makes up a PC. Field (2005) suggests 0.4 (recommended by Steven (2002)) as a cut-off value and Hair et al. (2006) suggest 0.3 as minimally acceptable when sample size is greater than 350. Thus, the rule for this study remained 0.3. Final interpretation of PCs is dealt with by looking at the significant loadings of each variable starting from the first PC. Variables are assigned based on their highest loading on a particular PC. Variables that do not load significantly at least on one PC should be reviewed and decisions should be made whether the model needs respecification. If not, PCs can be named taking the characteristics that is explained by the variables loading highest on to the PC.

3.4.2.3 Analysis of Variance (ANOVA)

ANOVA is used in situations where there is a need to compare differences between the means (of a dependent variable) of more than two groups. It avoids the risk of increasing the Type I error (falsely rejecting null hypothesis) of using multiple *t*-tests to compare pairs of group means (Hair et al., 2006). Central to the ANOVA is the *F*-test (Fisher's test) which compares estimates of variance within groups (SS_w) and between groups (SS_b). It determines whether the variance is attributable to the unique characteristics between groups or the general variability of values of the independent variable within the objects of the same group. Thus, the *F*-ratio is calculated by;

$$F\ Statistic = \frac{SS_b}{SS_w}$$

The *null-hypothesis* is that there are no differences in means between groups. Therefore, if SS_b is larger null-*hypothesis* is rejected (reference to the critical value of the *F*-distribution with (*k-1*) and (*N-k)* degrees of freedom for a specified level of α, i.e. 0.05 or 0.1 or 0.01) (Hair et al., 2006). Though this test provides an overall indication of group differences (at least two of the group means are different for the independent variable), it does not indicate the group-wise differences. *Post-hoc* multiple comparison tests should be used to evaluate the pair-wise comparison for each independent variable.

Though *F*-test is robust for certain violations of assumptions of normality in parametric tests (Field, 2005), it does not provide for unequal group sizes when distributions are highly skewed and homogeneity of variance is violated (Leven's test is used to assess the homogeneity of variance). Therefore, the error rate can be high. Welch's F test addresses the problem by adjusting for residual degrees of freedom. The nature of the research problem of this study is not an ideal (scientific) experimental set-up. The clustering solution is based on an actual industry set-up and unequal group sizes were unavoidable. Simultaneously, with the existence of an apparent hierarchy of airports, the potential for violation of homogeneity of variance is high. The same problem exists with the standard *post-hoc* tests as the sample sizes are unequal and equal variance assumption is violated. Alternatively, Gabriel's, Hochberg's GT2 and Games-Howell *post-hoc* are robust tests when such violations are unavoidable (Field, 2005).

F-test is used in this study for two purposes. One is calculating the VRC as explained above (Section 3.4.2.1) to determine the best cluster solution. The other is to distinguish differences between groups in the final cluster solution. Criterion validity of the solution is established through an ANOVA conducted on the criterion variables introduced at the beginning of the classification procedure (chapter 4). Later in chapter 5, it is used to profile the airport groups based on the macro environmental variables. Here the objective of ANOVA was to identify whether there are significant differences between the airport groups across the macro variables that help shape the success/ evolution of an airport.

3.5 Sample: Selection of the network of competing airports

From the regions of South Asia (AS1), Central Asia (AS2), Southeast Asia (AS3), Northeast Asia (AS4), and the Middles East (ME), 45 countries were drawn into the sample. The selection of airports was limited by the availability of data. Therefore, a criterion was drawn to include all airports with more than 100,000 available seats per year to provide for the purpose of including all the international gateway airports of the countries selected. For example, Paro (PBH) airport, the main international gateway for Bhutan only had 192, 964 seats and Pyongyang (FNJ) the main international gateway for North Korea had even less seats (156,096) for the year 2012. This left the researcher with 450 airports (Table 3-3) out of the 908 airports/aerodromes/heliports which have an official registration with ICAO.   A map of the sample is given in Figure 3-4.

The comparison of airport profiles for the macro environmental variables was limited to those groups that consists of the primary international airport/s (as designated by the respective country as such) of the sample of 45 countries. The main reason for the limitation was the unavailability of airport specific data for the macro variables. Out of the 45 countries, data were unavailable on certain variables for Maldives, Macau, Afghanistan, Iraq, Turkmenistan, Uzbekistan and North Korea. Syria was ruled out on the basis of prevailing market conditions after 2012.

Figure 3-4 Map of the sample of countries and airports

Source: Own elaboration based on www.gcmap.com

Table 3-4 Sample of countries and airports

Region Code	Region Name	Country Name	Number of Airports
AS1	South Asia	Afghanistan	3
AS1	South Asia	Bangladesh	3
AS1	South Asia	Bhutan	1
AS1	South Asia	India	45
AS1	South Asia	Maldives	3
AS1	South Asia	Nepal	3
AS1	South Asia	Pakistan	8
AS1	South Asia	Sri Lanka[a]	1
AS2	Central Asia	Kazakhstan	11
AS2	Central Asia	Kyrgyzstan	2
AS2	Central Asia	Tajikistan	3
AS2	Central Asia	Turkmenistan	1
AS2	Central Asia	Uzbekistan	6
AS3	South East Asia	Brunei Darussalam	1
AS3	South East Asia	Cambodia	2
AS3	South East Asia	Indonesia	43
AS3	South East Asia	Laos	2
AS3	South East Asia	Malaysia	17
AS3	South East Asia	Myanmar	4
AS3	South East Asia	Philippines	20
AS3	South East Asia	Singapore	1
AS3	South East Asia	Thailand	16
AS3	South East Asia	Timor-Leste	1
AS3	South East Asia	Viet Nam	13
AS4	North East Asia	China	112
AS4	North East Asia	Chinese Taipei	9
AS4	North East Asia	Hong Kong	1
AS4	North East Asia	Japan	44
AS4	North East Asia	North Korea	1
AS4	North East Asia	South Korea	11
AS4	North East Asia	Macau	1
AS4	North East Asia	Mongolia	1
ME1	Middle East	Bahrain	1
ME1	Middle East	Iran	20
ME1	Middle East	Iraq	5
ME1	Middle East	Israel	2
ME1	Middle East	Jordan	2
ME1	Middle East	Kuwait	1
ME1	Middle East	Lebanon	1
ME1	Middle East	Oman	2
ME1	Middle East	Qatar[b]	1
ME1	Middle East	Saudi Arabia	17
ME1	Middle East	Syria[c]	2
ME1	Middle East	United Arab Emirates	3
ME1	Middle East	Yemen	3

[a]Only Colombo Bandaranaike International Airport was sampled, since the second International airport was not opened at the time this study began and also for the reason that the airport has not been fully operational after its opening.
[b]Doha International Airport was sampled, since the alternative Hamad International Airport was not in operation at the time this study began
[c]Included in the cluster procedure but excluded from subsequent analysis owing to the prevailing market conditions

Source: Own elaboration

3.6 Contributions of the pilot study

Any research is a learning process, particularly in the development of research designs. In developing data collection instruments, pilot studies are given priority as they contribute to improving the validity and reliability of the research instruments used (particularly in the design of questionnaires /surveys (Saunders, Lewis and Thornhill, 2012)). They are also employed to clarify the researcher's view of the topic and help in deciding the suitability of the analytical methods proposed, study variables introduced, and data types used (Sreejesh, Mohapatra and Anusree, 2014) and in order to refine the research design prior to final data collection and analysis (Yin, 1994). During the research design and data collection stage of this study, a pilot study was conducted to develop the understanding of statistical methods (PCA and AHC) to be employed and the types of data that could be used as proxies for the strategic choices of airports. A global sample of 29 airports was analysed across 13 dimensions that were suggested as proxies for some of the strategic choices proposed in the study. Based on the pilot study, a concept paper, *"Classifying Airports from a Strategic Management Perspective", was presented* at the Air Transport Research Society Annual Research Conference – ATRS 2014 from 17th – 20th July 2014 in Bordeaux, France, with the intention of receiving inputs to improve the final study (Appendix C.1 contains a stand-alone description of the study with results and interpretation to clusters)

Based on the results and comments received at the ATRS conference, the following inputs were derived to finalise variables and analytical procedures.

1. Mixing strategic choice indicators with environmental indicators disrupts the final solution to a certain degree. The market size PC representing GDP and population seemed to have a significant impact on the division of the groups (Large gateways and emerging gateways groups have a similar profile except the market size indicator), which creates noise in the analysis. However, it confirmed the role of external environment in driving the network role of an airport. It was concluded that it was desirable to eliminate macro

environmental indicators from the classification exercise and introduce a separate analysis to determine their impact on the airports.

2. Abu Dhabi, known for its role as a sixth freedom air hub, was put into a group of small gateways, which raised concerns over the variables introduced in the study to measure 'network strategy' of airports. It was concluded that the percentage of transfer traffic alone cannot be used as an indicator to measure the 'hubness' of an airport, as it is an absolute measure. It was proposed to supplement this with a relative measure of the airports centrality and hub coordination role in relation to other airports in the network: flow centrality and traffic generation.
3. It could have observed that the within-group variance of airport size (flights/day and seats/day) to be larger due to a mix of different sizes of airports being classified into the same group. Thus, the definitions for 'large' or 'small' were inconclusive. Memphis was classified as a large gateway but Abu Dhabi which was in the smaller gateway group had more seats/day than Memphis. Similarly, in the emerging gateway group Chennai was nearly six times smaller than Beijing. Since size is a key strategy that determines the relative competitive strength of an airport, it was decided to follow a similar strategy to Adikariwattage et al. (2012) and take a two-step approach to clustering in the final analysis.
4. The study also confirmed the undue influence of (judgement) sampling on the final solution and interpretation. Since, the study objective is to analyse the structure of the network (and a network is a form of hierarchical relationships), it was deemed appropriate to include a larger sample, in order to eliminate the risks of omission of smaller groups and thereby the inherent hierarchical patterns/relationships in the network.

3.7 Conclusion

This chapter presented the research design of this thesis. Discussion on strategic group theory further justified that an airport classification exercise very well serve the research objectives of this study. The chapter explained the appropriateness of secondary data in representing the phenomenon examined in this research and identified the relevant data sources. The statistical techniques of Cluster Analysis, Principal Component Analysis and ANOVA were explained which would be used in the various stages of the data analysis process of this study. According to the geographical scope explained in chapter 1, this chapter detailed out the selection of the primary sample that consists of 450 airports from 45 countries in Asia and Middle East. The chapter finally presented the pilot study, which was conducted using a small sample during the development of the research design of this study. The pilot study helped to finalise the methodological considerations regarding the airport strategic dimensions, macro environmental indicators, statistical techniques and sample choice. According to the research design finalised in this chapter, the next three chapters present the work carried out to achieve the three objectives of this research. The next chapter presents the airport classification exercise carried out in order to achieve the first research objective of this study.

4 ROLE AND FUNCTIONALITY OF AIRPORTS IN THE EASTERN AVIATION NETWORK

4.1 Introduction

Based on the research plan explained in the previous chapter, this chapter details the analysis, interpretation of results and discussion of the work carried out with respect to the first objective of this study. By presenting a strategic group analysis of the network of airports in the East, it achieves the first research objective, which is to *'propose a methodological approach to comprehend the competitive structure and geography of the network of airports in the East.'* The chapter has five main parts to it. The first section is assigned to the identification of the key competitive strategies and the proposal of proxy measurements for each strategic choice based on the literature review carried out in chapter 2 and review on strategic group theory in chapter 3. The next section deals with the details of data and steps of the analytical method. In the exercise to reduce dimensionality of the multivariate data used in the classification, the PCA revealed an underlying pattern to the data. The third section provides an interpretation of the PCs which gave additional meaning to the network strategy choices of airports. The two-step classification procedure is presented next, followed by the proposed taxonomy of airports. The final section of the chapter is assigned to the profiling of airport groups.

4.2 Key competitive strategies of airports/hubs

As reviewed in section 3.3.1 in chapter 3, the strategic dimensions chosen for a structural analysis of an industry should be those that are perceived as the most vital business decisions, and typical and deeply-rooted features of the industry in question (McGee and Thomas, 1986; Pehrsson, 1990; Porter, 2004). Accordingly, the choice of strategic dimensions 'to *comprehend the competitive structure and geography of an airport network'* should cover the vital business strategies to stay competitive within the global network in terms of attracting, generating and transferring passengers (as identified under the forms of airport competition in section 2.3).

Review of literature on network theory (section 2.4), airport classification studies (section 2.5) and hub and spoke systems (section 2.6) identified different strategic features of airports that is helpful in staying competitive in the market. The review highlighted that the associated network of an airport plays a major role in defining the competitive scope of the airport (Table 2-1 summarised the different measures that can be used to assess those network features). Accordingly, network strategy was identified as one of the key success factors for successful hub airports (Table 2 -4). Other key characteristics that differentiate an airport are the non-network features (section 2.5.2) of airport size, airport-airline relationship, market segmentation (Table 2-2). Thus, the literature review deduced that the *'role and functionality of an airport within the global aviation network varies depending on the airport's strategic choice of the scale, scope and intensity of operational activity (size related dimensions), associated network, geographical market focus and service type (airline) orientation'.* These airport specific strategic dimensions correspond with the general strategic dimensions proposed by Hatten and Hatten (1987); Hunt (1972); Leask and Parker (2006); McGee and Thomas (1986); and Porter (1979, 2004) as useful dimension for strategic group analysis in any industry (as summarised in Table 3-1).

In the literature review, service levels and pricing (charges) at airports were also identified as key success factors for hub airports (Table 2-4). However, these two strategic variables are not introduced in the classification procedure for the following reasons. First, introducing too many variables in a classification procedure increase the dimensionality in the procedure that result in a solution not managerially useful (Mooi and Sarstedt, 2011). Second, even though the two variables are important in attracting airlines to the airport; contribution of them in defining the competitive position in terms of the network role played by the airport (which is the focus of this study) is marginal. Accordingly, the following three strategic dimensions were selected to represent the specific features of the airport industry.

1. Size strategy
2. Network Strategy
3. Market Strategy

Each strategy, their importance in competing in the international market and the choice of the respective proxy measures are explained below. When alternative proxy measures were considered, the possibility of obtaining data for a maximum number of airports in the sample was the decision criterion.

4.2.1 Size strategy: Degree of airport activity

4.2.1.1 Size of operational activity

In the pursuit of achieving hub status, size related decisions are crucial to an airport. Size reflects a firm's strategy for relative competitive power in a market (Porter, 1979), since it is a long-term decision when a firm decides to invest in fixed inputs (Butler and Huston, 1999). Airport investments on runways, apron facilities, and terminals are typically very long-term decisions lead by state level policy and strategic Airport Master Planning. Size provides an indication of the firm's motivations to achieve potential for scale of economies, which would create entry barriers for new entrants and mobility barriers for incumbent small firms to compete at the same level. This is evident in the airports industry through the shadow effects (O'Connor, 1995) created by the large hubs such as Dubai and Singapore over small surrounding airports. The airport size can be measured using different indicators such as capacity, volume of output, relative market share, and scope, all of which represent different choices by a firm depending on the time scale (Butler and Huston, 1999). The studies reviewed on airport classification (section 2.5.2), hub and spoke system (section 2.6), and strategic group theory (section 3.3.1) have all used 'size' as a key indicator that differentiate airports (firms) from one another. They have measured size using different indicators as outlined above. This study uses three dimensions of size; capacity, volume of output, and scope to define the degree of airport operations. Relative market share is not used here, because it is captured by the measures used to assess network strategy as explained in section 4.2.2.

a. Airport capacity - Number of boarding gates

Capacity can be measured in terms of the aircraft handling capacity of the runway, annual passenger handling capacity of the terminals, the handling capacity of annual aircraft movements and the number of gates at the airport. These measurements are interrelated. The decision on the number of boarding gates is influenced by the number of aircraft to be handled over a time period (a design hour) and gate occupancy time of an aircraft. This, in turn, is a function of expected traffic volume at the airport, which again, is controlled by the capacity of the runways to handle a certain number of aircraft during a time period (Horonjeff et al., 2010). The number of boarding gates is used as a key determinant of facility size in design studies of airport terminals (de Barros and Wirasinghe, 2003; de Neufville, de Barros and Belin, 2002) and is subsequently used by Adikariwattage et al., (2012), in their airport classification study as a measure of overall capacity of terminal systems. In an attempt to define airline hub size, Butler and Huston (1999) suggested that airline hub competition exists mostly at the gate (capacity) level because changing the number of gates is a slow, costly and long term decision. Therefore, they have used boarding gates as a long-term entry, exit and scale related decision in measuring hub size. In fact, the number of boarding gates available at an airport determines to what degree the other infrastructure facilities (runways, terminals) at the airport can be utilised. This is because at times, full runway capacity may not be utilised due to the limitations of the number of gates to handle aircraft. Hence, in this study, the number of boarding gates is taken as the most suitable indicator of an airport's operational capacity.

b. Volume of output

Airline capacity (flights or seats) and resulting passenger throughput are often used interchangeably in different studies to represent the size of operations (in terms of output). Burghouwt and Hakfoort (2001), and Malighetti, Paleari and Redondi, (2009) use capacity data in their airport classification studies and Graham (1998) uses passenger throughput as a measurement of size. Passenger throughput data are not used in the study mainly because of the inconsistencies and unavailability of data for all the airports in the sample. In this study flights and seats[11] are used as measures of volume of operations. This data can be collected consistently from OAG capacity reports (Table 1-4).

i. Flights per day

$$Average\ flights\ per\ day = \frac{\substack{Total\ annual\ flight\ frequency \\ at\ the\ airport}}{365}$$

Flights handled per day represent the total aircraft movements (arrival and departure) during 24 hours and is an indicator of an airport's runway and taxiway related infrastructure (Doganis, 1992). The decision to use the average figure over a day was to develop a further understanding on the density of operations (Malighetti, Paleari and Redondi, 2009) at the airport on a daily basis rather than using the annual total flight numbers. The figure also provides an indication of the level of daily traffic at the airport.

ii. Seats per day

$$Average\ seats\ per\ day = \frac{\substack{Total\ annual\ seats\ made \\ available\ at\ the\ airport}}{365}$$

Total number of seats made available by all the airlines represents the expected traffic volume at an airport (although the load factors will reduce this volume). The designs and sizes of airport passenger terminal facilities are influenced by the expected total traffic volumes to be handled by the airport (Doganis, 1992). While the number of flights indicates the magnitude of air traffic operations at the airport, flights alone cannot provide a clear indication of the volume since the type and size of aircraft operated at the airport will decide the amount of passenger traffic. Some airports have a higher frequency of flights, but handle very small aircraft. Therefore, the total passenger volumes are lower than at those airports with comparatively lower frequency on averagely larger aircraft. Rodríguez-Déniz and

[11]The primary aim of this research is to analyse the airports in terms of their role in the passenger air transport market. Airports' freight handling output is not used in the classification for this reason. Hence, only flights and seats data are considered.

Voltes-Dorta (2014) has taken hedonically adjusted air traffic movements to account for the influence of differences in aircraft size on the volume of output. However, for the purpose of this study, using both flights and seats data provides a descriptive picture of the volume dimensions. Available seats are also calculated as an average figure per day to develop an understanding of the intensity (Malighetti, Paleari and Redondi, 2009) of the services offered by the airlines at the airport.

c. Geographical scope

Measures of scope look at the distinctiveness of the services offered. In the aviation industry scope can be divided into two elements, geographical and product or service scope (Holloway, 2008). Geographical scope is the number of markets or destinations served by the airlines operating at an airport. This provides a measure of the size of the network being served and the geographical coverage by the airport. Number of destinations (degree of node) is also a simple connectivity measure. Burghouwt and Hakfoort (2001) have used average number of destinations as a measure of connectiivty in their classification study of European airports. On the other hand, Malighetti, Paleari and Redondi, (2009) have used it as a measure of scope of services offered. This study use total number of direct destinations as a measure of geographical scope. The aim is to capture the magnitude of the network facilitated by the airport in question.

4.2.1.2 Intensity of competition

The strength of a hub is determined by the size and competitive power of the hub carrier/s at the airport (Button and Lall, 1999; Irandu and Rhoades, 2006; Kraus and Koch, 2006). Malighetti, Paleari and Redondi, (2009) have also used the number of airlines using the airport as a base in their classification study of European airports. Nevertheless, Mason (2007) has found out that airline dominance does not necessarily influence the hub role of an airport. He points out that Amsterdam and Dubai have promoted hub development by encouraging foreign carriers to fly to the airports through a liberal market approach. Presumably, a balance of both would ensure that the airport has a primary carrier driving the hub waves while the presence of different airlines will increase the choice available to passengers and the degree of competition between airlines, which will enhance the quality of services. Taking both views into consideration, this study proposes to measure the intensity of competition using three indicators.

a. Number of airlines – this is a simple indicator of the scale of competition and variety of airline services (choices) available at the airport.
b. HHI – the degree of competition is measured using the Herfindhal–Hirschman Index which is widely used to estimate the level of concentration in a market (Button, 2002; Holloway, 2008). The total of seats offered by each airline at the airport is taken as the market share measurement. Each airline's fraction of market share (percentage of seats offered) is then squared (s_i^2) and aggregated to arrive at the degree of concentration ranging from 0 to 1. Zero represents perfect competition and one represents pure monopoly. As the level of concentration increases the degree of competition is weakened.

$$HHI\ at\ airport = \sum_{i=1}^{n} s_i^2$$

c. Percentage of seats by the dominant carrier/s – Even though both measures have a significant correlation to each other, while HHI provides an idea of the intensity of competition, the dominant carrier's market share is used as a measure of the power of the hub carrier at the airport.

While the above three measures would explain the competitive intensity between airlines, they would also provide an indication on the nature of airline-airport relationship of different types of airports.

4.2.2 Network strategy

The network strategy and structure is central to the business strategy of the key players in the air transport industry. Airports enable the creation of the network by providing key infrastructure for airline network operations. Thus, the associated network defines the role played by an airport (Cranfield University Air Transport Group et al., 2002) in the global network, which typically falls somewhere between the continuum of OD airports (non-hubs) and transfer airports (hubs). The associated network determines the degree or volume of airport activities and plays an important role in determining the types of infrastructure and services required at the airport. For example, a hub airport will require higher-level terminal configurations than a simple node or spoke airport in a network (Adikariwattage et al., 2012). Due to the significance of the impact of a network on an airport, network strategy is used as a key strategic dimension in this study to classify airports. Following Rodriguez-Deniz, Suau-Sanchez and Voltes-Dorta (2013), two indicators are selected in this study to assess the degree of hubbing at an airport taking a spatial approach: traffic generation and flow centrality (connectivity). The choice of the above two indicators among the other spatial and temporal network measures (section 2.4 and 2.5), is influenced by several factors.

First, several studies indicate the importance of both OD and transfer traffic generation for successful hub operations (Button, 2002; Doganis, 2002; Fleming and Hayuth, 1994). Fleming and Hayuth, (1994) defined c*entrality* as the feature of a hub airport that has the ability to drive true OD traffic, and *intermediacy or in-betweenness* as the locational attribute of being situated *en route* between important places. The two measures: traffic generation and flow centrality, capture the above two features very well. The spatial measures used in the other airport classification studies such as gross vertex connectivity index (Ivy, 1993), and betweenness-centrality (Guimera et al., 2005; Malighetti, Paleari and Redondi, 2009) do not capture both dimensions accurately. In addition, the study by Guimera et al. (2005) highlight the shortcoming of betweenness-centrality as a measure of connectivity. They have found that the most central (high betweenness) cities are not always the most connected (high degree of node) cities in the worldwide air transportation network. Therefore, it fails to capture both features of traffic generation and connection. Second, unlike other measures, traffic generation and flow centrality can be easily computed for differrent tiers of the network; domestic, regional or international. This helps to further identify the network strategy of the airport at the different levels of the network. Third, both measures indicate the *relative* contribution by the airport for generation and connection of traffic. Thus, the measurements indicate *relative competition*, which is in line with the first research objective.

Inclusion of temporal connectivity measures were discounted on the basis that costs (time and complexity involved in handling schedules of 450 airports) outweigh the benefits (a measurement on schedule coordination efficiency). On the other hand, the data (Table 4-1) used to calculate the traffic generation and flow centrality measures are real-time booking data from OAG Traffic Analyser (section 3.4.1.1), which is the final outcome of the schedule coordination at airports. Adoption of the two measures to the context of this study are explained below.

4.2.2.1 Traffic Generation

The main purpose of any airport is to facilitate the OD traffic to and from the airport's catchment area (except for Wayports, which are primarily aimed at facilitating transfer traffic (Huston and Butler, 1991)). A hub airport capitalises on this direct OD traffic by consolidating it into complexes which increasess the city-pair markets served by the airport and allows the generation of more traffic at the airport (Doganis, 2002; Ivy, 1993). Hence, a hub should be a central place generating true OD traffic and needs to be located closer to larger markets (Hensher, 2002; Liu, Debbage and Blackburn, 2006). The centrality feature is assessed using the traffic generation ratio. Rodriguez-Deniz, Suau-Sanchez and Voltes-Dorta (2013) defines generated traffic (ODi)as the direct traffic between airport H(Hub) and airport A which is calculated by taking the ratio between the OD traffic (od_i) at the airport and the total traffic of the network (P) under consideration. Thus,

$$Traffic\ Generation\ (ODi) = \left(\frac{od_i}{P}\right)$$

The traffic generation ratio indicates a particular airport's contribution to the total traffic in the network which in turn is an indicator of the degree of centrality of the airport. In this study the central role of the airport is measured at four different levels by calculating traffic generation ratios as explained below.

a. Global traffic generation

For this study, the global network is defined as all the airports in the Eastern aviation network under consideration. Global traffic generation (TG_g) for each airport *i* is calculated by taking the ratio between total traffic of all the airports(P_g) in the global network and total OD passengers at airport *i* (od_{it}).

$$Global\ Traffic\ Generation\ (TG_g) = \frac{od_{it}}{P_g}$$

The figure represents the importance of the airport as a true traffic generator within the Eastern network. Thus it indicates the competitive ability of the airport's network to attract traffic to and from the country/region it is serving.

b. Domestic traffic generation

Domestic traffic generation (TG_d) is calculated by taking the ratio between the domestic OD passengers of the airport under consideration(od_{id}) and total domestic traffic (P_d) of all the airports within the domestic network (country).

$$Domestic\ Traffic\ Generation\ (TG_d) = \frac{od_{id}}{P_d}$$

The reason for using this indicator is to capture the unique qualities of certain airports that could not be represented by only using passenger type proportions. For example, while being the main international airport of Sri Lanka, Colombo airport also acts as the main airport for domestic traffic (mainly for domestic tourism purposes). However, the proportion of the domestic traffic is insignificant compared to international passengers. Hence, the airport's domestic role is not highlighted by purely using passenger proportion types.

c. Regional traffic generation

Regional traffic generation (TG_r) is calculated by comparing the proportion of regional OD passengers ($od_{i,r}$) at the airport to the total regional traffic (P_r) between all the airports within the region in concern. This measure provides an indication of the central role of the airport within the region it belongs to.

$$Regional\ Traffic\ Generation\ (TG_r) = \frac{od_{i,r}}{P_r}$$

The ‘respective region’ for each airport is one of the five *sub-regions* explained the geographical scope of this research (section, 1.4).

d. International traffic generation

To calculate international traffic generation(TG_t), only those journeys going out to or coming from international destinations and transferring via the airport heading for international destinations are considered. The reason for this measure is to estimate the importance of the airport in the international market. Hence, all the journeys having an international itinerary at either end (origin or destination) are considered here. In calculating the international market(P_t), the following journeys are included for all airports;

- International OD traffic
- Transfers coming from and going out to international destinations (international to international transfers). The ‘international destination’ here means any port of call outside of the *sub-region* which the particular airport under consideration belongs to.
- Transfers coming from international origins and going out to domestic destinations and vice versa (international to domestic transfers)
- Transfers coming from international origins and going out to regional destinations and vice versa (international to regional transfers)

The ratio is taken as the figure for international OD traffic at the airport $(od_{i,t})$ compared to the figure for the total international market(P_t).

$$International\ Traffic\ Generation\ (TG_t) = \frac{od_{i,t}}{P_t}$$

4.2.2.2 Hub centrality and connectivity

Besides generated traffic, connected traffic plays an important role in hub and spoke operations. The hub connectivity measures the potential of an airport’s network to facilitate transfer traffic (Burghouwt and Redondi, 2013). This study measures intermediacy or the hubbing potential of an airport within its associated network by measuring the degree of flow centrality proposed by Rodriguez-Deniz, Suau-Sanchez and Voltes-Dorta (2013). Degree of flow centrality (FC) is the ratio of connecting traffic (c_i) at the airport to the total traffic of the network (P) under consideration, excluding the OD traffic (od_i) of that airport. The

$$Flow\ Centrality\ (FC) = \frac{c_i}{P - od_i}$$

This measure indicates the contribution of the airport as a centrally co-ordinated airport to facilitate connectivity. In this study, the betweenness or hub centrality of the airport is measured at five different network levels by calculating flow centrality ratios as explained below.

a. Global flow centrality

Global flow centrality (FC_g) covers the entire Eastern aviation network. The aim is to construct a measure to evaluate the competitive position of an airport against the other 450 airports within the network. For each airport it is calculated by taking the ratio of total connecting traffic (c_{it}) at each airport to total network passengers (P_g) excluding the OD traffic(od_i) at each airport being studied.

$$Global\ Flow\ Centrality\ (FC_g) = \frac{c_{it}}{P_g - od_i}$$

b. Domestic flow centrality

This measure evaluates the contribution of an airport as a hub within the domestic network. Domestic flow centrality $(FC_d)$is calculated by taking the ratio of domestic transfer traffic (c_{id}) to the total domestic network traffic (P_d) excluding the domestic OD traffic (od_{id}) at the airport in question.

$$Domestic\ Flow\ Centrality\ (FC_d) = \frac{c_{id}}{P_d - od_{id}}$$

c. Regional flow centrality

For each airport, a regional flow centrality measure is calculated using traffic data within each sub-regional network to which the airport belongs. By doing this, each airport's role as a regional hub could be identified. To derive the numbers for regional flow centrality(FC_r), only the total traffic directed to and from the airports within the region was considered. The ratio of transfer traffic (c_{ir}) at each airport to the total traffic (P_r) excluding regional OD traffic (od_{ir}) provides an indication of the contribution of a particular airport in coordinating regional traffic flows.

$$Regional\ Flow\ Centrality\ (FC_r) = \frac{c_{ir}}{P_r - od_{ir}}$$

d. International flow centrality

The international transfer market was further examined under three network types in order to broaden the dimensions of betweenness of a particular airport in coordinating international transfer traffic (Section 4.2.2.1, defined the international market for this study). The three network types and the measures are explained below.

i. International to international flow centrality

This is the network which generates international transfer traffic at the airport. All through traffic from the journeys originating from and terminating at airports outside the region which the airport belongs to is considered here (Figure 4.1). This measure helps to identify airports with an intercontinental hub status, operating as a traffic coordinator between geographically separated continents and long haul travel markets.

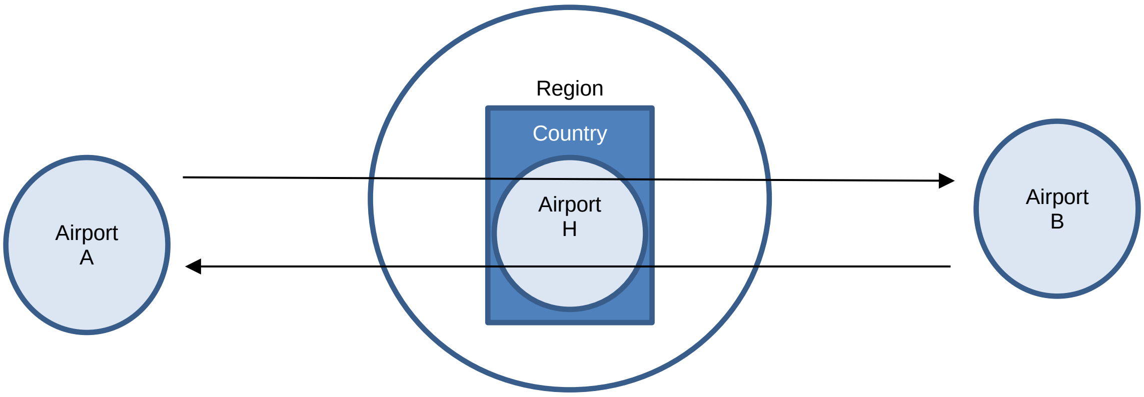

Figure 4-1 Definition of international-international transfer market

Source: Own elaboration

International to international flow centrality (FC_{tt}) is calculated by taking the ratio of international to international transfers (c_{it}) to the total international network traffic (P_t) excluding the international OD traffic (od_{it}) at the airport *i*.

$$Internatiol\ to\ International\ Flow\ Centrality\ (FC_{tt}) = \frac{c_{it}}{P_t - od_{it}}$$

ii. International to domestic flow centrality

This is the network of journeys originating or ending at an international airport outside the region under consideration, transferring via the airport in question to another domestic airport within the country (Figure 4.2). The aim of separating this flow of traffic from the rest of the international transfers at the airport is to identify the hub role played by the airport in connecting domestic airports to the international markets. It highlights the ‘international gateway’ status of the airport in the international-domestic market.

For each airport, international to domestic flow centrality (FC_{td}) is calculated by taking the ratio of international to domestic (vice versa) traffic to the total international traffic (P_t)at all the airports in the respective region excluding the particular airports international OD traffic (od_{it}).

$$Internatiol\ to\ Domestic\ \ Flow\ Centrality\ (FC_{td}) = \frac{c_{itd}}{P_t - od_{it}}$$

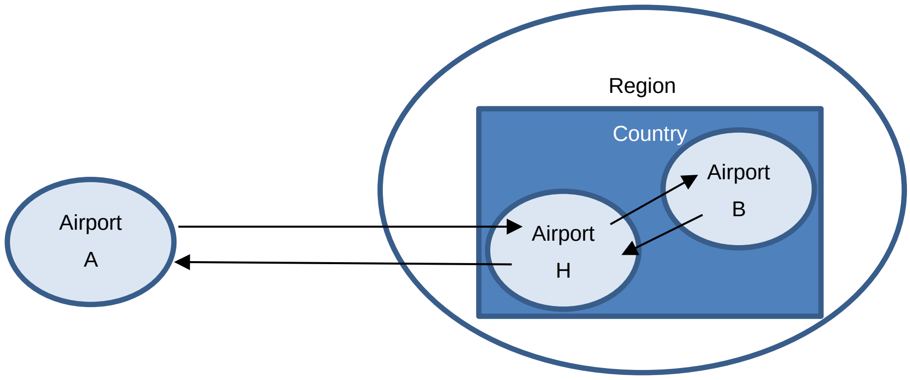

Figure 4-2 Definition of international-domestic transfer market

Source: Own elaboration

iii. International to regional flow centrality

Similar to the above measure, the international to regional flow centrality measure helps to identify the 'regional gateway' airports. The network here includes all the journeys transferring at the airport with an international airport at one end of the journey and a regional airport at the other end of the journey (Figure 4.3). The ratio of international to regional transfers (c_{itr}) to the total international market (P_t) excluding international OD traffic at the airport is taken as the international to regional flow centrality measure (FC_{tr}).

$$Internatiol\ to\ Regional\ \ Flow\ Centrality\ (FC_{tr}) = \frac{c_{itr}}{P_t - od_{itr}}$$

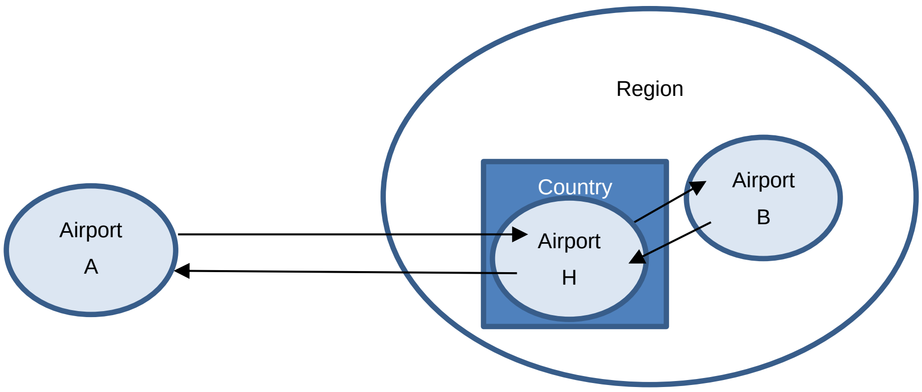

Figure 4-3 Definition of international-regional transfer market

Source: Own elaboration

4.2.3 Market related strategies

The business strategy of a firm provides the long-term direction for its products and the markets that the firm has chosen to compete in (Pehrsson, 1990). Market segmentation is a key strategic dimension, where firms decide on which markets to target their efforts. Market segmentation is based on the assumptions that customers have different needs and these differences can be used to identify specific groups who will respond similarly to any marketing activities targeted at them (Kotler, 2015). Accordingly, firms will decide on the degree of specialisation or differentiation aimed at each selected market depending on the nature of the customer group. At the same time, it helps to identify specific direct competitors in those markets (Holloway, 2008). Consumer markets can be segmented using bases such as geographic, demographic, psychographic and, behavioural (Kotler, 2015) depending on the industry characteristics and the purpose of the specific exercise.

Market segmentation in the airport industry is not as simple and straightforward as in the consumer goods markets since airports have a complex mix of customers (Graham, 2008a). Holloway (2008) suggests two bases for segmenting the global air transport industry as a whole (a large region or a carrier’s network): geography and aeropolitics. Geographically markets are contrasted as short-haul, medium-haul, or long-haul flows and alternatively, intra-regional or inter-regional flows. Aeropolitically they are contrasted as domestic, regional or international flows. Apart from geographic segmentation, airports also focus their efforts on servicing different types of airlines and passengers (Graham, 2008a). Existing airport classification studies have also used all these three approaches (geographic, passenger, airline) (Table 2-2 and 2-3) in segmenting airport markets. Accordingly, the current study uses information on flight destinations, airline types, and passenger/seat class types and adopts a two dimensional approach to airport market segmentation: geographic and service type orientation as explained below.

4.2.3.1 Geographical orientation

In order to identify the geographical orientation of the airport, both destination of flight and passenger/seat class types are used, for the reasons explained below.

Destination

While airports generally have a catchment area (a region or a country) defined with geographical boundaries where they get their primary mix of passengers, airlines link them to other destinations expanding the geographies. Hence an airport will have domestic (short-haul), regional (medium-haul) and international (long-haul) passenger flows created by airlines. Similar measures are used in other airport classification studies by Adikariwattage et al. (2012); Burghouwt and Hakfoort (2001); and Malighetti, Paleari and Redondi (2009) to differentiate the geographical orientation of the airport (Table 2-3).

Passenger /seat class type

This study is advancing the previous classification studies (Table 2-2 and 2-3) by including passenger/seat class types. It is included on the basis that there is a relationship between the choice of seat class types and distance travelled or trip purpose of passengers. These have implications on airport infrastructure decisions. People travel by air to be at different places for different reasons and they have different travel needs. While all such trip purposes cannot be individually identified and catered for, the industry generally classifies trip purposes as business and leisure with the intention of meeting as many of those differing travel needs as possible (Doganis, 2002; Shaw, 2011). Airlines primarily offer two or three different seat class types for these markets. They are first, business and economy classes that offer varying levels of services and facilities. Although not at the same level as airlines, airports are also required to serve these travellers by facilitating airlines and to offer varied services to different customer segments. For example, business travellers may require late check-in through a separate check-in desk, to save time. Hence, airports nowadays make an attempt to cater for the different travel classes and sometimes specialise in servicing certain segments, like the London City airport specialising in business travel (Graham 2008a) or Singapore Changi Airport's JetQuay terminal serving commercially important people. Most of the airports cater for all types of passengers and certain small tourist destinations purely focus on leisure travellers. These strategic choices influence airports' decisions on infrastructure investments.

On the other hand, passengers on short-haul routes (mainly domestic or regional) tend to travel in economy class from a local airport rather than a distant hub (Shaw, 2011) and those on a longer journey would seek greater comforts. This is the case with some of the short haul business passengers as well who also fly no-frills to a certain degree (Mason, 2001, 2002). Therefore, small airports serving local/regional travellers or tourist attractions will have basic facilities compared to major international airports that handle both types of travellers.

Considering these facts, an airport's geographical orientation is assessed using the following variables;

a. Percentage of total domestic passengers - OD and transfer passengers at the airport flying to and from domestic destinations.
b. Percentage of total regional passengers – for each airport, regional OD and transfer passengers were counted from those journeys that took place within each defined sub-region (AS1, AS2, AS3, AS4 and ME1)
c. Percentage of total international passengers- OD and transfer passengers having at least one end of their journey outside the country and region the particular airport belongs.
d. Percentage of first and business class seats. Both first and business class seats are aggregated since they cater for high profile customers and have a similar service orientation.
e. Percentage of economy class seats

Data on flight destination is derived from the OAG schedules for each airport and seat type data are derived from the passenger booking data from OAG traffic analyser (Table 1-4).

4.2.3.2 Airline service orientation

The types of airlines operating at the airports create a significant impact on the airport's infrastructure costs, services provided, and revenue generation. There are two distinct airline business models; Full Service Carriers (FSCs) (also called, traditional or network or hub or legacy or flag carriers) and Low Cost Carriers (LCCs (also called, point-to-point or no-frills carriers). FSCs operate scheduled flights and target all types of passengers including business, leisure, and other miscellaneous types and offer different seat class types such as first, business and economy. Large network carriers aim to optimise schedule convenience and transfer opportunities for passengers by operating one or more hub and spoke network systems, generally consisting of a mix of domestic, regional and international services (Belobaba, Odoni and Barnhart, 2009; Doganis, 2002). Hence, they have a diverse fleet of aircraft types to suit the length of flight legs they fly. Airports serving hub carriers are required to facilitate them by providing both airside and landside infrastructure that support HS operations. Airports capitalise on the opportunity to build a hub status within the catchment area of the airport by investing in infrastructure such as terminal systems, to provide convenient passenger waiting and transfer facilities. Not all traditional carriers are essentially hub carriers. Certain flag carriers operate OD services from their base airport (country of origin) following the traditional business model of providing the full service (a bundled product).

On the other hand, LCCs operate point-to-point services to secondary airports mainly on short to medium haul routes. They offer a single cabin class (economy) and an unbundled product targeting budget travellers. They operate a single type of aircraft fleet in order to minimise costs. The low cost focus of their business model obliges airports to facilitate them by lowering the airport charges, creating consequences for the airport revenue generation (Francis, Humphreys and Ison, 2004). However, airports too have come up with strategies to cater for these requirements. Even major international airports have gone the length of developing low cost terminals such as 'klia2', the purpose built mega terminal dedicated for low cost airlines at the Kuala Lumpur International Airport in Malaysia (Malaysia Airports, 2011). In addition, certain secondary airports have changed their strategies to become purely low cost oriented, especially in Malaysia, Thailand and Philippines that have a mature low cost carrier markets.

Likewise, airports have taken it as one of their strategic priorities to collaborate with airlines in order to improve their businesses through different target market strategies to develop as mega hubs, secondary LCC airports, or hybrid airports facilitating both types of carriers. Therefore, to capture the service orientation of an airport three variables are used.

a. Percentage of seats by carrier type

Percentage of seats by FSCs and LCCs provide the primary distinction between the carrier types catered for by the airport. Nowadays airlines have embraced a combination of characteristics from each business model type. Hence, categorising airlines following clear-cut features for differentiation based on a universal definition of each business model is challenging. To avoid ambiguity, the list of airlines by business model type is drawn from the 'Flightglobal Dashboard' for 2013. Percentage of seats offered by each airline is taken from OAG data on supply of seats by each airline for the year 2012 (Table 4-1).

b. Average size of aircraft served at the airport

Legacy carriers operating on international routes tend to have large wide-body aircraft (Belobaba, Odoni and Barnhart, 2009), such as Airbus A380, A350, A340, and A330 or Boeing B747, B767, B777, and B787. Other traditional carriers flying medium to short haul flights (with a regional or domestic focus) usually have mixed fleets of narrow-body jets. They can range from Airbus A319/320/321, Boeing B737/727/757, MD 80, and DC 9 to Turboprops such as Embraer EMB 110/120, Bombardier (de Havilland) DHC 8, Antonov, ATR and Jetstream. LCCs generally use a single aircraft type or single family of aircraft; the most popular being Airbus A320 and Boeing B737 with a seat capacity between120-150. Average seat capacity per aircraft is calculated from OAG schedules data for each airport as below (Table 1-4).

$$Average\ seats\ per\ aircraft = \frac{Total\ Annual\ Seats\ offered\ at\ the\ airport}{Total\ annaul\ flights\ at\ the\ airport}$$

c. Average frequency per route

Long-haul routes take more travel time. Hence, the ability to achieve higher frequency on a route is less than that of a short- haul route. However, large hub airports have achieved this through traditional hub carriers with bigger fleets introducing more frequency. Another way is to encourage competition on thick routes to attract several airlines, increasing frequencies and choices available to passengers. While large hub airports with strong hub carriers can achieve this, smaller traditional airlines with a limited fleet cannot achieve daily frequencies to far-away destinations. Hence, small international airports will have lesser frequencies per route. On the other hand, low cost airlines fly medium or short flight sectors. The focus of their business model is to increase aircraft utilisation per day by reducing the time that the aircraft is on ground. Hence, one of their major airport requirements is fast turnaround time. This, in turn, creates opportunities for airports to have increased frequencies per day to the destinations they serve and more passengers frequenting the airport. This is an important competitive weapon against traditional carriers flying those routes. Therefore, the higher the frequency, the greater is the tendency for the airport to be servicing low cost carriers or mega hub carriers. This is calculated from schedules data from OAG for each airport as below.

$$Average\ \ frequency\ per\ route = \frac{Average\ flights\ per\ day}{Number\ of\ destinations\ served}$$

4.3 Data and Analysis

As explained above, for the three broad strategic areas chosen, 24 proxy measures were proposed. The respective measures, sources, and the timing of the data gathered are given in Table 4 -1. As introduced in section 3.4.1.1, majority of the data comes from the OAG databases. The advantage is that it provides consistent data on all the airports in the sample, rather than compiling data from different data sources (e.g. ICAO, national civil aviation statistics, ACI) which are being collected using different approaches. All are continuous or metric data and has a meaning to its scale. First, correlation between variables and the descriptive statistics were examined to get a feel of the data.

Table 4-1 Measures and data sources of the airport classification exercise

Strategic Area	Features	Measure	Data Source
Size of Airport Activity	Operational Intensity	Seats per day	OAG Schedules Analyser (Annual 2012)
		Flights per day	OAG Schedules Analyser (Annual 2012)
		Number of direct destinations	OAG Schedules Analyser (Annual 2012)
		No of gates	FlightGlobal Dashboard (January 2014), individual airport websites, and email/telephone communications
	Competitive Intensity	HHI	OAG Schedules Analyser (Annual 2012)
		% of seats by the dominant carrier	OAG Schedules Analyser (Annual 2012)
		Number of Airlines	OAG Schedules Analyser (Annual 2012)
Network	Centrality	Traffic generation (domestic)	OAG Traffic Analyser (May 2012)
		Traffic generation (regional)	OAG Traffic Analyser (May 2012)
		Traffic generation(international)	OAG Traffic Analyser (May 2012)
	Intermediacy /connectivity	Flow centrality (domestic)	OAG Traffic Analyser (May 2012)
		Flow centrality (regional)	OAG Traffic Analyser (May 2012)
		Flow centrality (International to domestic)	OAG Traffic Analyser (May 2012)
		Flow centrality (International to regional)	OAG Traffic Analyser (May 2012)
		Flow centrality (international to international)	OAG Traffic Analyser (May 2012)
Segmentation	Geographic	% Domestic traffic	OAG Traffic Analyser (May 2012)
		% International traffic	OAG Traffic Analyser (May 2012)
		% Regional traffic	OAG Traffic Analyser (May 2012)
		% of First/ Business seats	OAG Traffic Analyser (May 2012)
		% Economy seats	
	Service	Average size of aircraft	OAG Schedules Analyser (Annual 2012)
		Average frequency per route	OAG Schedules Analyser (Annual 2012)
		% FSC seats	OAG Schedules Analyser (Annual 2012) List of airline type from 'FlightGlobal Dashboard' (May 2013)
		% LCC seats	OAG Schedules Analyser (Annual 2012) List of airline type from 'FlightGlobal Dashboard' (May 2013)

Source: Own elaboration

4.3.1.1 Preliminary data exploration

Descriptive statistics of the study sample are given in Table 4-2. From the minimum and maximum values, and standard deviation values it can be observed that the sample data has a higher degree of variability. Histograms (Figure D-1 and Figure D-2) are used as a basic visualisation technique of clusters to see how objects were falling into 'bins' (Everitt, Landau and Leese, 2001). Most of the variables have positively skewed distributions owing to the nature of the industry. A network of airports has tiers of nodes including (few) primary nodes which take a central role and subsequently (more) secondary and tertiary nodes taking minor roles. The variables representing the degree of airport activity dimensions revealed a possible three or four cluster solution. The majority of the airports fall into one or two bins that correspond to smaller values. This could be identified as a single cluster or two clusters representing the small and very small airports. At the extreme end of the skewed distribution, there was a small cluster of big airports like Beijing Capital, Tokyo Haneda, Singapore, Dubai, Jakarta and Bangkok. In addition, there were a few bins in the middle where airports like Riyadh, Abu Dhabi, Ho Chi Minh City, Bahrain etc. were included. A similar pattern is observed in the network variable values (traffic generation and flow centrality). Two clusters are visible across the service related market segmentation variables and three on the geographical orientation. Some airports had highly distinctive values for some of the variables, but they were not eliminated as outliers, since they represent unique features of the market.

Theoretically, firms are consistent in their strategic choices (Porter, 2004). For example, if an airport has invested in more capacity (represented by gates in this study), it should be generally expected to attract more airlines leading to more flight movements being handled. Therefore, a certain degree of correlation was present between the variables used to represent airport strategies (Table D-1). The problem was the extreme multicollinearity (r>0.9) between the *flights/day* with the *seats/day* and *gates*. The *percentage of seats by dominant carrier* and the *HHI* were also highly correlated. Two other couples of variables had the problem of singularity (r=1), and it was learnt that the problem is associated with the 'composition' nature of those variables. The *percentage of FSC and LCC* *seats* and the *percentage of first/business and economy seats* is a situation where one variable represents the identical opposite of the other since they are expressed as vectors of proportions of the same unit (Aitchison, 1983). These issues were addressed at each stage of the analysis (next section).

Table 4-2 Descriptive statistics for the airport classification variables

Variable	Min	Max	Mean	Std. Dev.	Skew ness
Flights/day	3	1507	96.7	181.2	3.623
Seats/day	288	287529	16124.7	35405.9	4.113
No of gates	1	135	9.74	16.811	3.767
No of destinations served	2	216	22.01	30.761	2.841
No of Airlines	1	114	12.85	15.313	2.793
% of seats by the dominant carrier	12%	100%	49%	22%	.849
HHI	.05	1.00	.36	.23	1.325
Seats/aircraft	34	255	138.26	34.455	-.061
Average frequency per route	1	25	4	3	1.852
% of First and Business seats	0%	16%	4%	3%	.889
% of Economy seats	84%	100%	96%	3%	-.889
% seats by FSCs	0%	100%	81%	28%	-1.421
% seats by LCCs	0%	100%	18%	27%	1.481
Traffic generation(international)	.0000	.1908	.0095	.0275	4.271
Traffic generation (domestic)	.0000	1	.0629	.1255	3.009
Traffic generation (regional)	.0000	.2879	.0109	.0340	5.047
Flow centrality (domestic)	.0000	.0485	.0013	.0049	6.225
Flow centrality (regional)	.0000	.0114	.0002	.0010	7.699
Flow centrality (International to domestic)	.0000	.0218	.0005	.0023	6.578
Flow centrality (International to regional)	.0000	.0368	.0006	.0032	8.111
Flow centrality (international to international)	.0000	.0840	.0006	.0047	13.634
%Domestic traffic	0%	100%	78%	30%	-1.551
% Regional traffic	0%	93%	9%	15%	2.544
% International traffic	0%	100%	13%	21%	2.035

Source: Own elaboration from SPSS22 output

4.3.1.2 Outline of the classification procedure

Based on the findings from the pilot study, a two-step cluster procedure was proposed to solve the issues of multivariate data and a higher degree of correlation between some of them. The objective was to minimise the unnecessary weighting placed on the dimension of correlated variables (Adikariwattage et al., 2012; Hair et al., 2006).

Step 1

In the first step, airports were classified based on the size related airport strategies and intensity of competition. Out of the seven variables proposed (Table 4-1), to solve for extreme multicollinearity, the *flights/day* and the *HHI* were excluded. The two were introduced as criterion variables to assess the validity and reliability of the cluster solution. In addition, the *passengers for the month of May 2012*[12] was also introduced as a criterion variable.

Step 2

Before the second classification step, the seventeen network and segmentation variables (Table 4-1) were Principal-Component analysed, to reduce the impact of collinearity issues of using multivariate data (Ding and He, 2004; Everitt, Landau and Leese, 2001; Gan, Ma and Wu, 2007; Jolliffe, 2002). The second step classified airports based on the scores of these PCs. *The percentage of FSC seats* and *the percentage of Economy seats* variables eliminated were to solve the singularity problem (fifteen variables remained). As in the first step, the two excluded variables were introduced as criterion variables along with, the *global traffic generation and the global flow centrality* and *average distance of a route/flight.*

Step 3

The two classifications were combined to produce a matrix of airport typologies. Profiling of the groups was carried out based on the new matrix and values of original variables.

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[12] Since passenger data extraction from MIDT was only for May 2012, **annual** seats were preferred over **monthly** passenger figures to represent volume in the classification procedure

4.4 Principal component analysis on the network strategies and segmentation strategies of airports

4.4.1 Procedure

In this study, PCA was only suggested as a supportive tool for conducting a cluster analysis to derive a taxonomy of airports that will provide a structure to understand the competition in the eastern aviation network. The researcher was more interested in extracting a set of components that will represent the variability present in the data to a degree that it will help in the generation of a set of distinctive clusters. Therefore, the extraction of PCs and clustering of airports was reiterated several times to compare the solutions until a final cluster solution was reached. In the preliminary solution derived, the KMO test for sample adequacy stood at 0.667 (>0.5) satisfactory levels and highly significant Bartlett's test of sphericity confirmed the adequacy of correlations between variables for a robust PCA solution (Table D-2). The 15 variables were initially loaded into five PCs, that met the Kaiser's eigenvalue criterion (>1). The original varimax rotated five PCs solution (Table 4-3) explained 75% of the total variance (Table D-4).

Table 4-3 Rotated component matrix for the five-PC solution

Variable	Component				
	1	2	3	4	5
Flow centrality (International to regional)	.943				
Flow centrality (international to international)	.879				
Flow centrality (regional)	.834				
Traffic generation (regional)	.653	.311	.487		
Total Domestic traffic		-.928			
Total Regional traffic		.767			
Total International traffic		.749	.365		
% of First /Business seats		.527	.330		
Flow centrality (International to domestic)			.862		
Traffic generation(international)	.562		.705		
Flow centrality (domestic)				.768	
average frequency per route		-.350		.608	.394
Traffic generation (domestic)		.534		.601	
% LCC seats					.760
seats/aircraft		.339			.647

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.[a]
a. Rotation converged in 10 iterations. Degree of Loading Cut-off 0.3

Source: Own elaboration from SPSS 22 output

Though interpretability of the PCs was not a primary concern; a certain consistency in the loadings of variables on to PCs could be observed. This is in line with Porter's (2004) suggestion that strategic choices of firms have an underlying consistency with each other. The variables introduced under the two strategic themes of network and segmentation did not load (as expected) exclusively onto the same PC as they were originally listed, but (unsurprisingly) loaded in combination to five PCs providing additional insight into an airports' strategic behaviour. International and regional traffic generation and flow centrality variables load highly on the first PC. The second PC has the highest loading from domestic passenger share and subsequently regional and international shares. This PC more or less explains the geographical orientation. The third PC has the highest loading from international to domestic flow centrality, which indicates the 'gateway to the country' role of an airport. Domestic flow centrality loads high on the fourth PC and the fifth PC is dominated by the percentage of LCC seats, indicating carrier patronage by the airport. While this seemed to be an acceptable solution both statistically and in terms of interpretability, the subsequent cluster solution derived, using these PC scores was associated with the problem of seemingly dissimilar airports being clustered together.

An account of one such problem is as follows: Tokyo Narita (with only 4% domestic traffic share, 0.87% domestic traffic generation and 0.016% domestic flow centrality) was assigned to a group which Beijing Capital (with a 72% of total domestic traffic share, 6.30% domestic traffic generation and 0.25% domestic flow centrality) was also assigned to. Corresponding to these figures are the insights gained from the review of the region's aviation industry (chapter 1). Tokyo-Haneda plays a bigger domestic role (also promoted as an international airport (Wenkan, Miyoshi and Pagliari, 2012)) and Tokyo Narita mainly focuses on international traffic. The component scores (Table D-6), of the relevant second PC were also seemingly different; Tokyo Narita scoring 1.7 and Beijing Capital scoring -0.36. However, it could be observed that the two airports have close values for the third PC, which is dominated by the 'international to domestic flow centrality' variable (Tokyo Narita 3.89 and Beijing Capital 4.11). The examination of the original variable values revealed that both airports play a similar domestic gateway role by connecting international traffic with domestic airports (Tokyo Narita 1.021% and Beijing Capital 1.24%). The coefficient of this variable (Table D-5) that is used in the computation of the mathematical model to derive the component score is significantly high. It accounts for (+) 0.56 of the total variation. But in the 2nd PC, total domestic traffic only explains (-) 0.35 of variation. The weightings on these variables influence the PC scores. While this is statistically correct, assigning an airport that plays a minor domestic hub role into the same group as an airport that plays a major domestic hub role is conceptually against the objectives of this classification.

One reason for this classification may be that, when the percentage of variance explained decreases progressively from the first PC to the last, the importance of the dimension explained by the progressive PCs becomes under represented. Then those variables that load high on them are understated. In this solution domestic hubbing indicators load on to the fourth PC which only explains 10% of the variance. Having noted this, the scree plot for the solution was further examined (Figure 4-4) to identify the relative importance of the factors and decide how many components to retain.

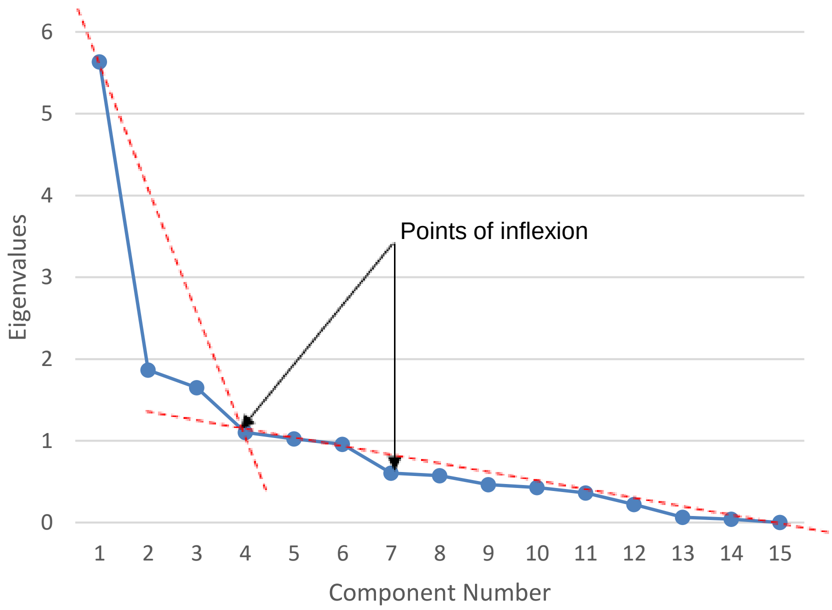

Figure 4-4 The Scree plot of the PCA solution

Source: Own elaboration from SPSS 22 output

A typical scree plot will have a sharp descent and an elbow where the curve starts flattening when the importance of PCs starts dropping. This point of inflexion is the decision criteria for the number of PCs to retain. Generally, PCs to the left of the inflexion point are retained (Field, 2005). However, Cattel (1966) originally suggested keeping the PCs (factors) up to the inflexion point, which is more applicable to PCA conducted for data reduction purposes (Jolliffe, 2002). This scree plot has two points of inflexion before tailing off. In such situations taking the upper point of turn (first to the left) has been suggested as appropriate by Cattel (1966), given that the relative importance of the subsequent couple of PCs: $l_{k-1} - l_k$ (l_k is the eigenvalue of k^{th} PC) stay fairly constant (before it drops again). In this scree plot, after the fourth PC, the relative changes in the fifth and the sixth PCs are small and almost equal (0.08 and 0.07 respectively). Therefore, the solution was respecified to extract four PCs (Table 4-4). KMO and Bartlett's stood at the same levels, but the percentage of variance explained dropped to 68.36% (Table D-7). The components extracted represented more or less the same dimensions as in the previous solution. Variables that loaded onto third and fourth PCs of the previous solution combined onto the third PC of the new solution. The cluster solution generated from using new PC scores provided a satisfactory (in term of manageability and homogeneity) result.

Table 4-4 The rotated component matrix for the Four-PC solution

Variable	**Component**			
	1	**2**	**3**	**4**
Flow centrality (International to regional)	.925			
Flow centrality (international to international)	.852			
Flow centrality (regional)	.827			
Traffic generation (regional)	.730	.303	.427	
Traffic generation(international)	.721		.481	
% of Domestic traffic		-.923		
% International traffic		.755		
% Regional traffic		.749		
% of First/Business seats	.366	.541		
Flow centrality (domestic)			.767	
Flow centrality (International to domestic)	.325		.705	
Traffic generation (domestic)		.508	.597	
% LCC seats				.762
Seats/aircraft	.344	.358		.637
Average frequency per route		-.368	.416	.442

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.[a]
[a.] Rotation converged in 5 iterations. Degree of Loading Cut-off 0.3

Source: Own elaboration from SPSS 22 output

4.4.2 Interpretation of the principal components: Network and segmentation strategies of airports

Interpretation of the PCs is based on the rotated component (loading) matrix (Table 4-4) and the component score coefficient matrix (Table 4-5) for the Four-PC solution. The component score coefficient values are used in the calculation of the PC scores. Therefore, it is important to examine the correlation coefficient values of the variables to each PC. It gives an understanding of the direction of the PC score (negative or positive and the associated meanings to it).

Table 4-5 The component score coefficient matrix of the Four-PC solution

	Component			
	1	2	3	4
Seats/aircraft	-.003	.141	-.063	.530
% of First/Business seats	.027	.185	-.080	.107
% seats by LCCs	-.079	.036	-.061	.650
Traffic generation(international)	.162	-.036	.168	-.028
Flow centrality (international to international)	.300	-.085	-.153	-.025
Traffic generation (domestic)	-.140	.157	.296	-.124
Traffic generation (regional)	.177	-.035	.141	-.089
Flow centrality (domestic)	-.105	-.032	.425	-.001
Flow centrality (regional)	.262	-.079	-.028	-.066
Flow centrality (International to domestic)	.043	-.114	.361	-.033
Flow centrality (International to regional)	.303	-.073	-.113	-.027
% of Domestic traffic	.077	-.355	.043	-.023
% Regional traffic	-.100	.318	-.074	.012
% International traffic	-.037	.269	-.009	.024
Average frequency per route	-.009	-.179	.244	.318

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Component Scores.

Source: Own elaboration from SPSS 22 output

1. Component 1 – International and regional network

The first PC clearly measures the international and regional network strategy of airports. All the international and regional traffic generation and flow centrality variables have their highest loadings on this PC (loadings are above 0.7) (Table 4-4). This PC contrasts the international and regional hubs with non-hubs. For example, Dubai (11.867), Singapore (9.175) and Hong Kong (5.884) rank top.

This is because; the flow centrality variables have the highest positive correlation coefficient values for this PC (Table 4-5). This will increase the scores of the first components for the airports that are both central and intermediate in the region's international and regional network flow. It should be noted that the domestic flow centrality and traffic generation (indicators of domestic hub role) have negative coefficients and will drive the PC scores lower for those airports that have higher values for those measures. International to domestic flow centrality variables also load fairly on this PC. If the airport is a gateway to the country's other airports, it will further increase the score. On the other hand, the size of aircraft also has a strong correlation with hubbing, particularly with international hubs. One key advantage of HS systems is the traffic consolidation and the ability to operate bigger jets to carry higher passenger loads resulting in increased economies of scale. Seats/aircraft represent this relationship in the first PC.

2. Component 2 – Geographical orientation

This component represents the geographical orientation of the airport. The three percentage by type of traffic variables have their highest loading on this component. A higher positive score for the component should indicate the international or regional orientation of the airport. Share of domestic seats load very high with a negative coefficient (-0.923) (Table 4-4), which drives the score negative. However, the component score coefficient of the variable is -0.35 (Table 4-5), which is not very large when compared with the 0.318 (Table 4-5) component score coefficient of the regional traffic percentage (in terms of absolute value). Nevertheless, as it is a negative coefficient, it will drive the component score smaller when the percentage of domestic traffic is high for the airport. The average frequency per route also loads negatively, which will drive the score negative. This corresponds with the theory that the higher the frequency on a route, the higher is the probability of the airport serving short-haul routes. This is because when flight distance is short; several trips can be made which increases the average aircraft utilisation. The Biratnagar (-1.9) and Pokhara (-1.8) airports in Nepal that have 100% of domestic traffic with frequencies as high as 15-16 per route scores the lowest on this PC. The airports, Bandar Seri

Begawan (4) of Brunei Darussalam and Paro (3.5) of Bhutan that have a higher regional focus with more than 50% of traffic, score highest on this PC. These airports have no domestic traffic.

The percentage of first/business class seats also has its highest positive loading on this factor. Unlike in short-haul travel, where business passengers also fly no-frills to a certain degree (Mason, 2001, 2002), in the long-haul business journeys, business passengers prefer comfort over money. Therefore, airlines operating at international airports offer first/business class seats. The percentage of first/business class seats indicates the airport's importance in these aspects. It can be easily interpreted as the more the airport is internationally or regionally focused, the higher will be the number of first/business class seats offered at the airport. Domestic traffic generation has a fair load on this PC. This is a specific feature of this sample of airports. In most of the countries (e.g. UAE -Abu Dhabi, Sri Lanka- Colombo, Brunei- Bandar Seri Begawan, Jordan – Amman, Oman-Muscat), even if they have very small domestic markets, all or most of those domestic operations take place at the international airport. The seats/aircraft variable also explains the aircraft size and length of the journey. Long-haul routes need longer-range aircraft, which is a feature of bigger jets in the market today. The airlines' objective is also to operate a profitable leg on long-haul routes by carrying a load that allows them to benefit from economies of scale. Therefore, international hub oriented airports score positive on this PC while domestic hub oriented airports score negative.

3. Component 3 – Domestic network

This component is more or less a combination of the third and the fourth PC of the previous solution. It explains the 'domestic hub' role of the airport in three ways; domestic traffic generation, domestic flow centrality and the international to domestic flow centrality. Flow centrality indicators dominate the PC loading (above 0.7) (Table 4-4) which indicates that the PCs explain the connectivity levels of the airport in the domestic market. Unlike in the second PC, the average frequency per route loads positively on this PC (0.45) (Table 4-4). This clearly explains the rationale that short-haul routes have a higher frequency. In addition, the international and regional traffic generation variables also explain a certain variability on this PC. This again is associated with those airports that play both international and regional roles while being the central airport in the domestic network. For example, Tokyo Haneda (6.1), Delhi (5.6) Jakarta (5.3), Mumbai (5.2) and Bangkok (4.7), which are the primary domestic airports in the respective countries and also play the primary or secondary international airport role, rank top on this PC.

4. Component 4 –Service orientation

This PC contrasts the airports by the type of carriers; whether it is a LCC oriented airport or not. The PC score is dominated by the percentage of seats by LCC (0.76) variable, of which the component score coefficient is 0.65. Therefore, the higher the LCC seats the higher the component score. The frequency on a route and aircraft size also load positively on the PC. A key characteristic of the LCCs is the high level of aircraft utilisation. If the average frequency is high, it will increase the component score. The LCCs usually operate aircraft with an average seat capacity of 150. Therefore, airports with a LCC orientation score high on this PC. Examples are; Nakhon (2.5), Trang (2.3) and Hat Yai (2.2) in Thailand, and General Santos (2.4) in Philippines, that are ranked top for the fourth PC. They have more than 60% of seats by LCCs.

The PC also indicates the service orientation of large (possibly hub) airports. As previously explained, large airports that have the presence of hub carriers and multiple foreign airlines will also have higher per route frequencies. Similarly, the aircraft sizes (seats/aircraft) are also larger for these airports because of the big jets using them. Therefore, the two variables can drive the PC scores up even if the LCC presence is not as high as a typical LCC airport. Thus, these airports score around zero (0) positive or negatively. The airports that have a significant LCC presence will score above zero and those airports that have a very small LCC share will score below zero. Examples are Delhi that has 44% of LCC share and scores 0.4 on the PC, and Abu Dhabi that only has 3% of LCC share and scores -0.04 on the PC.

4.5 A two-step hierarchical cluster analysis of the network of airports in the East

4.5.1 Clusters by degree of airport activity (size)

4.5.1.1 Initial solutions

Three of the five retained variables - seats/day, number of destinations and number of gates represent the size of operations at an airport. The other two variables - the number of airlines and the percentage of seats by dominant carrier represent the degree of competition at an airport. Both AHC and K-means clustering solutions were compared to determine the best classification solution. First, AHC procedure was performed, using a Euclidean distance matrix that gives the pair-wise geometric distance between two airports for all the variables used. The fusion of two clusters (airports) was sequenced using the Ward-linkage algorithm, which has the objective function of minimising the increase in the total within-cluster variance (sum of squares of errors).

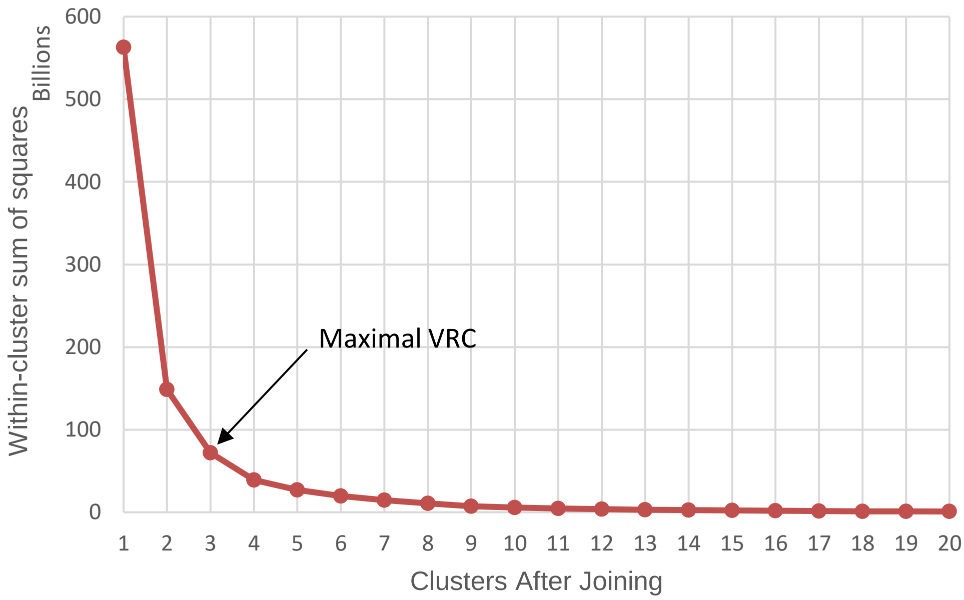

Figure 4-5 Scree Plot* of the within-cluster sum of squares

* For the last 20 agglomeration steps

Source: Own elaboration based on SPSS 22 output

The dendrogram (Figure D-3) was examined to obtain a preliminary idea of cluster formation. Arranged horizontally are the clustering objects (airports) and vertical lines show how the objects or clusters are merged upward. The distances over which the merging takes place are rescaled from 0-25 (SPSS 22 output provides rescaled distances). A distinctive cluster of nineteen airports could be observed to the right of the dendrogram. They were the group that were lying furthest on the positively skewed distribution observed in the initial exploration of histograms. They merged (449^{th} step) with the other cluster with a very high degree of heterogeneity which is usual for the last merging step of an agglomeration schedule (Hair et al., 2006). Therefore, the two-cluster solution was excluded as an option. The merger (448^{th} step) prior to the last step (three into two clusters) happens further down at a rescaled distance of five. Then the merger (447^{th}step) before (four into three clusters) occurs at a distance of approximately two. Heterogeneity is lowest in this merging step and the gap between the 447^{th} step and the 448^{th} step is smaller than that between 448^{th} step and the 449^{th} step. Therefore, truncation of the dendrogram after the 447^{th} merger was deemed appropriate to form a three-cluster solution. The increase of the coefficient from three into two cluster merging is 107%, which is markedly higher than other mergers. This could be further justified by the scree-pot of the coefficients of distances (Figure 4-5) created from the agglomeration schedule in Table D-10. As the final ruling criterion, VRC was calculated and the maximal *Pseudo-F* statistic corresponded with the three-cluster solution (Table 4-6 4-6).

Table 4-6 VRC for the cluster solutions by degree of airport activity

Number of clusters	VRC
2	2618.055
3	**3269.083**
4	3223.986
5	3177.322
6	3254.923

Source: Own elaboration based on SPSS 22 ANOVA output

Since a three-cluster solution seemed an appropriate number, a K-means cluster procedure was conducted by specifying the number of clusters as three and the cluster centres from the mean values for each variable of the new clusters formed by AHC. There was a slight change in the final cluster centres from the initial cluster centres (Table D-21), because of a five-iteration partitioning (Table D-23) to reduce the overall within cluster variance. Cluster compositions have changed slightly, and the ANOVA of the cluster centres returned that the means differ significantly across the three groups formed, as the null hypothesis was rejected for every case (sig<0.01) (Table D-22).

4.5.1.2 Comparison of solutions

Since the two procedures generated quite similar clusters (except for a few changes in the group membership), both AHC and K-means solutions were compared for the cluster centroids (Table 4-7) to determine a final solution. The mean values for each variable across the three clusters are different and can be organised in the ascending order for first, second and third clusters. The Welch's F test confirmed that these differences are statistically significantly for at least two of the three clusters (Sig <0.005) for the AHC solution. Further, to identify the typical cut-offs or border values for each variable, the minimum and maximum values for each variable within each cluster were examined. A key observation is that seats/day has clear borders between clusters but values for the other variables are blurred. Therefore, seats/day for the three clusters across the two solutions were compared to define borders. The AHC values are more practical in terms of defining borders than the K-means values. The third airport cluster of the AHC solution has seats above 100,000 per day and draws a clear cut-off from the upper boundary of the second cluster which is 82,840. This is a round number that provides a clear cut-off than the K-means solution where the lower boundary of the third cluster is 113,549 and the upper boundary of the second cluster is 102,558. Similarly, between the second and first clusters the boundary could be drawn as 20,000 for the AHC solution. As it provides a better rule for breaking clusters, the AHC cluster solution was adopted as the final solution.

Table 4-7 The centroids for the AHC and K-means solutions by degree of airport activity

Method	Variable	Cluster Number /Name									Welch's F- test			
		1			2			3						
		Small			Medium			Large						
		Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Statistic	df1	df2	Sig.
AHC	Seats/day	288	**4335**	20536	21548	**42630**	82840	101279	**160611**	287529	235.474	2	37.140	.000
	No of destinations	2	**11**	60	13	**57**	145	73	**123**	216	168.703	2	37.690	.000
	No of gates	1	**4**	32	6	**24**	66	24	**71**	135	108.596	2	37.196	.000
	No of Airlines	1	**8**	41	7	**30**	75	23	**60**	114	132.267	2	37.768	.000
	% of seats by the dominant carrier	12%	**51%**	100%	13%	**39%**	78%	19%	**35%**	59%	29.825	2	54.701	.000
	Cluster membership		***370***			***61***			***19***					
K-means	Seats/day	288	**5012**	26828	27589	**49776**	102558	113549	**167516**	287529	F tests in the K-means procedure returns significant values, because the clusters have been chosen to maximize the differences among cases in different clusters (Table D-22).			
	No of destinations	2	**12**	79	14	**61**	145	73	**127**	216				
	No of gates	1	**5**	36	7	**27**	77	35	**73**	135				
	No of Airlines	1	**8**	46	7	**31**	75	23	**63**	114				
	% of seats by the dominant carrier	12%	**51%**	100%	13%	**37%**	77%	19%	**35%**	59%				
	Cluster membership		***383***			***50***			***17***					

Source: Own elaboration from SPSS 22 output

Table 4-8 The centroids and Welch's F-Test (ANOVA) for the criterion variables of the AHC solution

Variable	Cluster Number /Name									Welch's F- test			
	1			2			3						
	Small			Medium			Large						
	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Statistic	df1	df2	Sig.
Passengers/day	329	**2884**	15255	12833	**25731**	55054	67827	**96953**	177881	252.406	2	37.193	.000
Flights/day	3	**32**	224	132	**268**	573	447	**799**	1507	246.185	2	37.238	.000
HHI	0.07	**0.40**	1.00	0.05	**0.22**	0.62	0.07	**0.19**	0.36	68.537	2	69.353	.000

Source: Own elaboration from SPSS 22 output

4.5.1.3 Testing for criterion validity

K-means results, not being drastically different to AHC, ensured the *stability* of the solution. Prior to establishing AHC as the final solution, *validity* was tested using the three criterion variables introduced at the beginning of the procedure to identify whether there are significant differences between the clusters formed. Welch's F-ratios confirmed that mean values of the passengers/day, the flights/day and the HHI variables are significantly different across the three groups (Table 4-8).

4.5.1.4 Profiling of clusters by degree of airport activity

The centroid values for the three distinctive clusters are given in Table 4-7 and Table 4-7. For the purpose of visual comparison, the standardised values of the seven variables used to distinguish the clusters are mapped in the radar chart in Figure 4-6 below. It is clear that the values are distinctive enough to identify the three clusters uniquely as confirmed in the ANOVA tests. However, the percentage of seats by the dominant carrier and the HHI are not very different between the third cluster and the second cluster. The *post-hoc* tests (Games-Howell) further confirmed that the above two variables are not significantly different between second and third clusters (Table D-11). Therefore, competitive intensity at airports can only be used to distinguish the first cluster from the others. The bigger the airport, the more intense is the competition at the airport, since the airport attracts more airlines.

Post hoc multiple comparisons confirmed that for the other variables all three groups are significantly different to each other. Looking at the magnitude of the numbers involved, labelling of the clusters according to their size was deemed appropriate. Thus, the clusters are named as *small airports* (first cluster), *medium airports* (second cluster) and *large airports* (third cluster). The small airports cluster consists of 370 airports which represents the largest membership. The medium airports cluster and the large airport cluster consist of 61 and 19 airports respectively.

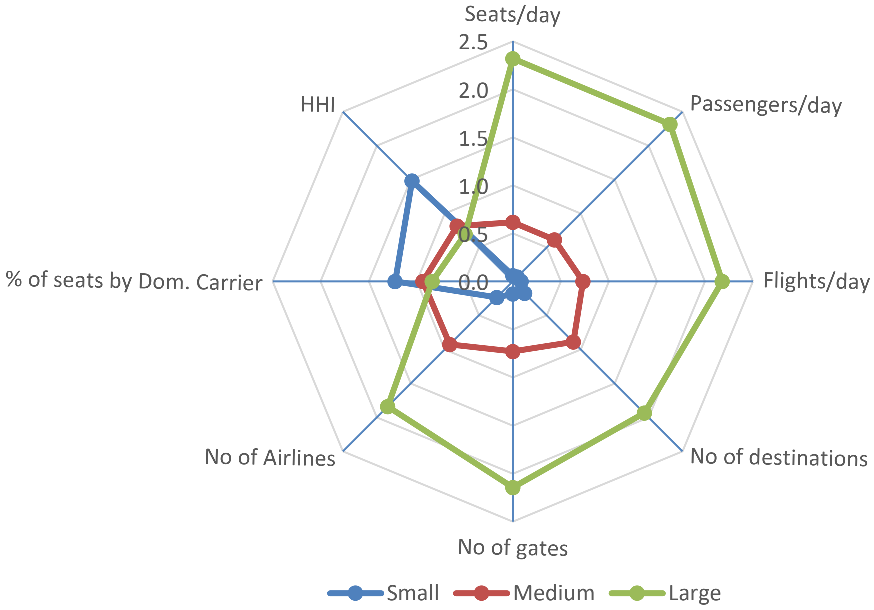

Figure 4-6 Profile analysis of the standardized clustering variables of the degree of airport activity for the three-cluster AHC solution

Source: Own elaboration

4.5.2 Clusters based on network and segmentation strategy

4.5.2.1 Initial solutions

As the first step, three AHC solutions based on; (i) the original fifteen variables proposed under network and segmentation strategy, (ii) the five PCs extracted from those fifteen variables, and (iii) the four PCs extracted from the same variables (section 4.4.1), were screened using the dendrogram and the percentage of change in heterogeneity values. As heterogeneity is always the highest in the last fusing stage (two into one cluster), candidacy of the two cluster solutions as final solutions was discounted at the beginning for all three AHC procedures.

Prior to the PC-based solutions, an AHC was performed using the original fifteen variables that were proposed to represent network and segmentation strategies. The best solution appeared to be three, six and four clusters in the descending order of the change in heterogeneity (Table D-12). When examined for the profiles of members (airports) in each group, noticeable dissimilarities were present between airports within the same group. For example, in the three-cluster solution, the third cluster has grouped Dubai, Singapore, Hong Kong, and Doha airports with Mumbai, Delhi, Kuala Lampur, Tashkent, and Bangkok airports. The former group of airports are far from being domestic hubs (0% domestic seats) and the latter group of airports play a significant domestic hub role (average 42% domestic seats, 30% domestic traffic generation, 1.23% flow centrality and 1.6% international to domestic flow centrality). The same problem was present in the two-cluster solution. Though the six-cluster solution solved the problem to a certain level (only for the third cluster), when combined with the ‘degree of airport activity (size)’ cluster, it resulted in single member groups, which is not helpful in identifying competition in the market. Therefore, the solution was not carried forward for further evaluation.

The reasons for the irregularities in the cluster solution may be the higher degree of dimensionality in the data and the high collinearity between some of the variables (e.g. regional traffic generation and international traffic generation r = 0.875). Hence, PCA was introduced to reduce the dimensionality and collinearity. As explained in section 4.4.1, the PCA initially derived five PCs. An AHC was first performed using these five PCS. In the five PC cluster procedure, the best solution was a five-cluster categorisation, which had the highest percentage change in heterogeneity (Table D-12). However, due to the issues related to confusions in cluster composition as explained in section 4.4.1 this solution was also subsequently excluded.

As the Five-PC solution did not give a satisfactory outcome, a Four-PC solution was tested. A combination of two-dimensional plots of the four PCs observed formation of clusters along the four strategic dimensions (Figure 4-7). It is clearly visible that there is a distinctive cluster of a few airports scoring high on the international hub dimension. A majority of the airports fall into a non-hub cluster. In addition, there are a few airports having strong scores on the domestic hub dimension, some of them strong in the international hub dimension as well. Geographical and service orientation plot has a dispersion of the airports on all four quadrants of the graph. When examined, on the domestic side, it is a clear LCC and non-LCC split. On the international side, it is more of a higher frequency and aircraft size influenced split. The graphs confirmed the existence of distinctive groups and the ability of the PCs to represent the unique features without losing the variability in the data.

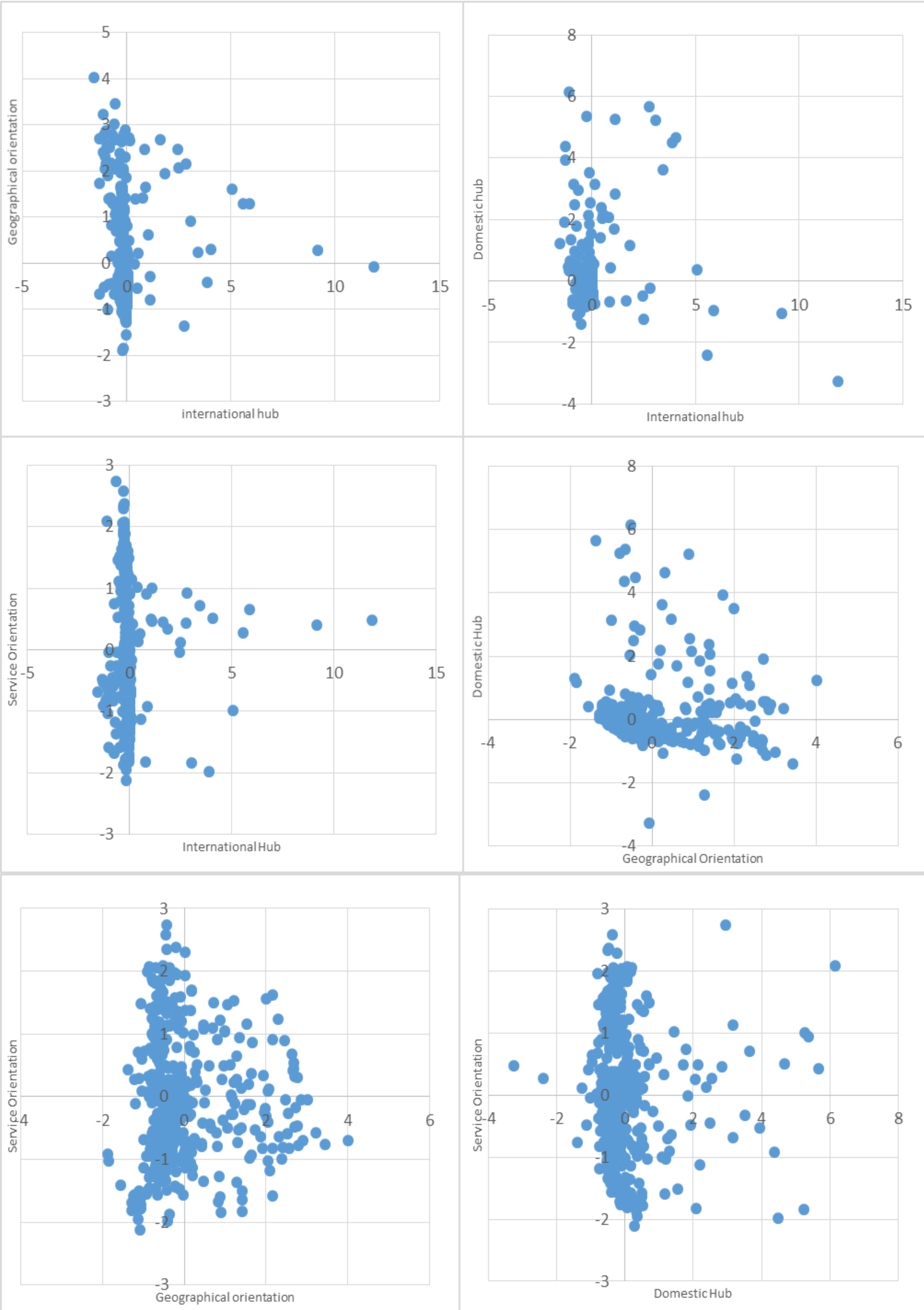

Figure 4-7 Scatter plots of the airports with respect to the scores of the four PCs of network and segmentation strategies

Source: Own elaboration

Next, the AHC was performed using the Ward-linkage algorithm on Euclidean distance. Initial stopping rules were applied to choose a few solutions for final evaluation. The dendrogram (Figure D-4) displayed a breaking point at five-clusters. Besides, in the agglomeration schedule (Table D-13), the change in the within-cluster sum of squares (SS_W) in merging the 445th solution with the 446th solution (five into four cluster merger) was 36.7%, which is the largest change in heterogeneity. The corresponding scree plot in Figure 4-8 clearly shows a change in the slope at five-cluster solution as well. Four-cluster and three-cluster solutions account for the next largest percentage change in SS_W (heterogeneity) with 27.8% and 24.9% respectively. This suggests that after the 445th step, the clusters that are merged are more distinctive than in the steps before that and stopping at any of the three stages will deliver a distinctive cluster solution. Therefore, the three cluster solutions were carried forward for further evaluation.

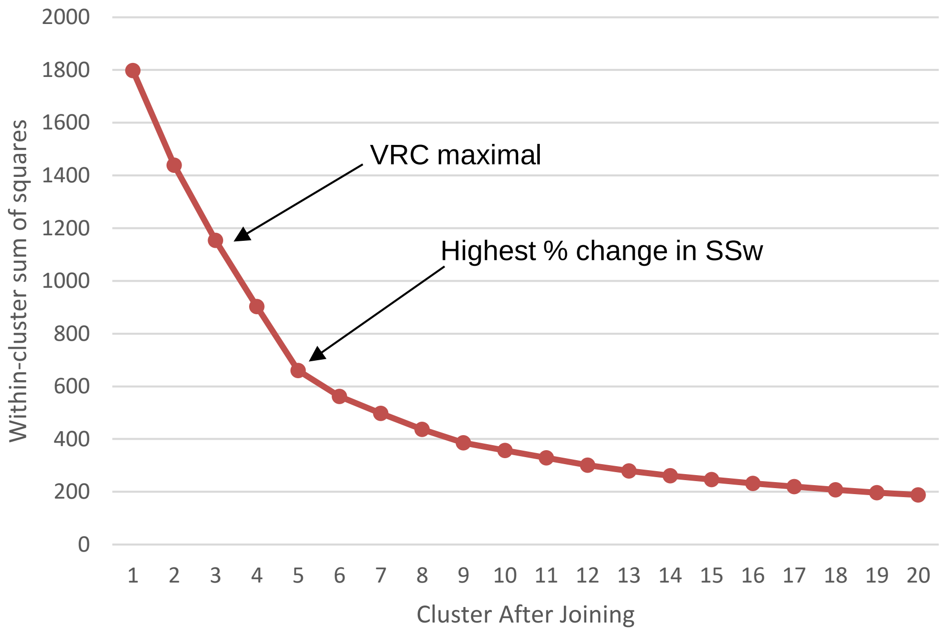

Figure 4-8 Scree plot* of the within-cluster sum of squares for the Four-PC based cluster solution

*for the last 20 agglomeration steps

Source: Own elaboration based on SPSS 22 output

4.5.2.2 Comparison of solutions

As a stringent measure to determine the best number of clusters, VRC was calculated for the last ten cluster solutions in the agglomeration procedure (Table 4-9). The VRC was maximal at the three-cluster solution, indicating that it is superior to the other two solutions in terms of both minimising within-cluster heterogeneity and maximising between cluster heterogeneity.

Table 4-9 VRC for the Four-PC cluster solution

Cluster No	VRC
2	773.093
3	**1040.025**
4	878.231
5	817.536
6	837.180
7	977.853
8	910.116
9	890.381
10	849.502

Source: Own elaboration based on SPSS 22 ANOVA output

The solution suggested by the VRC was different to the order of superiority that was suggested by the preliminary screening of the dendogram and the percentage of change in heterogeneity. Therefore, all three cluster solutions were profiled on the PCs as given in Figure 4-9, to see whether there are significant differences between the clusters in each solution that make them distinctive enough to be considered as a final solution. The profile maps clearly show that the group that consists of international airports such as Dubai that are hubs, merges with the group that consists of international airports such as Kathmandu that are non-hubs, when the five-cluster solution is merged to form the four-cluster solution (446th step). Then going from four to three clusters (447th step), the group of LCC airports such as Bangkok Don Meuang are merged with the group of non-LCC airports such as Beijing Nanyuan. Under each cluster solution, the clusters can be uniquely profiled, as they are discernible at least across one strategic dimension (PC). The merging steps provide an interesting overview of the agglomeration of airports in the hierarchy.

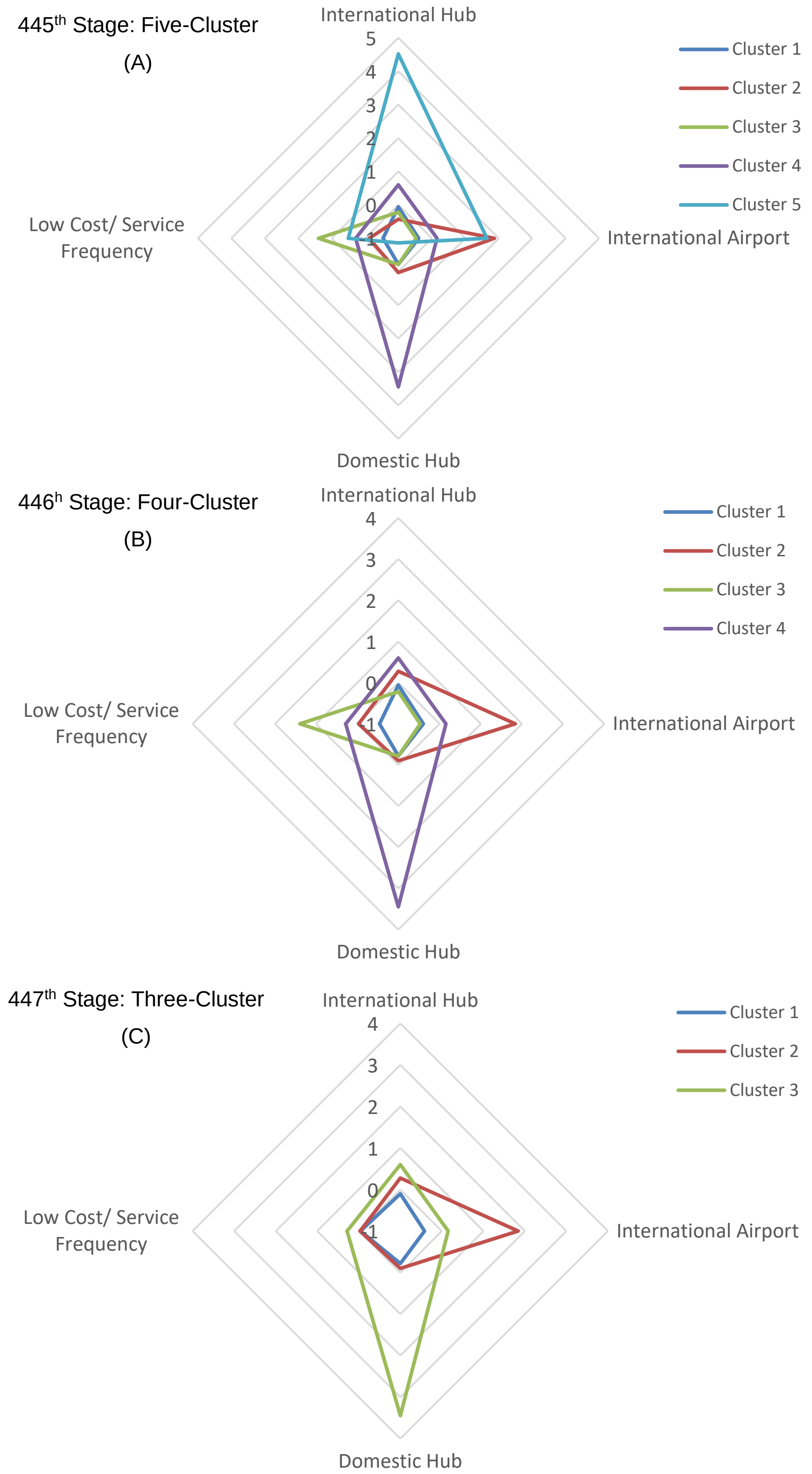

Figure 4-9 Profile analysis of the Four-PC based AHC solutions

Source: Own elaboration based on SPSS 22 output

Based on the dendrogram, the framework given in Figure 4-10 was derived as a guide to study the cluster formation. At the 447th stage, airports are placed on an 'international-domestic' continuum. Cluster 2 can be termed as '*international airports'* and Cluster 1 as *'domestic airports'.* The term *'hybrid'* is used here to represent those airports that play roles of an international hub or a traffic generator and a domestic hub or traffic generator. The term has previously been used by Mason (2007) to identify those airports that play a hub and as well a gateway airport role. His focus has not been on identifying the role of the airport in the international and domestic networks separately. This study extends the investigation by separately identifying the international and domestic network roles and as well as differentiating hubs from non-hubs (gateways or traffic generators). The type of airport profiles in the hybrid group are international hub or gateway airports like Beijing Capital, Kuala Lampur, Bangkok, Almaty, Tashkent, Dhaka, Ryadh, Ho Chi Minh City that play a significant domestic hub role or purely domestic hub airports like Tehran Mehrabad, Kinmen, and Makung.

Stage	**Agglomeration**				
447th Stage	**International** (cluster 2)		**Hybrid** (cluster 3)	**Domestic** (cluster 1)	
446th Stage	**International**		**Hybrid**	**Domestic LCC**	**Domestic Non-LCC**
445th Stage	**International Hubs** (cluster 5)	**International Non-hubs** (cluster 2)	**Hybrid** (cluster 4)	**Domestic LCC** (cluster 3)	**Domestic Non-LCC** (cluster 1)

Figure 4-10 Framework to study the airports in the East based on the network and segmentation strategies

Source: Own elaboration based on SPSS 22 output

In the 446th stage, domestic airports are separated as *'domestic LCC airports'* and '*domestic non-LCC airports',* based on their patronage of LCCs. At the 445th stage international airports are separated as *'international hub airports'* and *'international non-hub airports',* based on their hubbing role. Both solutions were retained as a framework for studying the competitive structure of the airport network, because the three-cluster solution provides a simplified structure of the market, and within that, the five-cluster solution provides a comprehensive picture of the divisions. Welch's F-test was significant at <0.05 for all of the four PCs for the five-cluster solution. However, the three-cluster solution was not significantly different across the fourth PC which represents Low Cost/Service Frequency feature (Sig>0.05, p=0.314) (Table D-14). This is due to the loss in variation because of the convergence of clusters.

4.5.2.3 Testing for criterion validity

The two solutions were first K-means analysed to examine the *stability* of the solution. The results did not have a drastic difference, except a few cluster membership changes. The profile charts of the five-cluster (Figure D-5) and three-cluster (Figure D-6) of K-means solutions largely correspond with the respective AHC profile charts in Figure 4-9. For the three-cluster solution, the maximal partitioning was achieved in two iterations (Table D-28) and for the five-cluster solution, the iteration stopped at three steps (Table D-26).

Next, ANOVA for the criterion variables were performed for the both cluster solutions in order to assess the *validity* of the solutions. For the five-cluster solution, the Welch's F-test confirmed that there is a significant difference at least across two clusters between the mean values of the average distance of a route, global traffic generation, global flow centrality, the percentage of seats by FSCs, and the percentage of economy seats (Sig<0.05). The test results are given in Table D-16. Further examination of differences between pairs of groups through *post hoc* tests (Games-Howell Procedure) given in Table D-20, revealed that cluster 2 (international non-hubs) and cluster 4 (hybrid) are not significantly different on average distance of a route, the percentage of economy seats, and the percentage of seats by FSCs. This may be because airports in both clusters play a significant international role in the market. Clusters 1 (domestic non-LCC) and 2 (international non-hubs), clusters 1(domestic non-LCC) and 3 (domestic LCC), and clusters 2 (international non-hubs) and 3 (domestic non-LCC) are not significantly different on global flow centrality and global traffic generation. The reason is that those airports are not significant hubs in the market. Therefore, centrality and intermediacy are low. Global flow centrality and global traffic generation are not significantly different between cluster 4 (hybrid) and cluster 5 (international hubs) as both groups play significant hub roles in the market. Clusters 1 (domestic non-LCC), 2 (international non-hubs) and 4 (hybrid) are not significantly different to cluster 5 (international hubs) for the percentage of seats by FSCs. This is explained by the facts that cluster 1 consists of domestic non-LCC airports, clusters 2 and 4 are groups with an international orientation and cluster 5 is the international hub group. All the airport groups serve more traditional carriers than LCCs.

Except for the percentage of seats by FSCs (Sig >0.05, p=0.67), all the other variables were significantly different across the three groups in the three-cluster solution (Table D-19). It is because all three types of airports serve more FSCs than LCCs. International airports certainly have more FSCs. The hybrid airports also having an international orientation have more FSCs flying from different destinations compared to few LCCs. In the domestic airport group, there are more non-LCC airports than LCC airports, which influence the average values for the respective variables.

4.5.2.4 Profiling of clusters by network and segmentation strategies

The *post hoc* comparisons supported the conclusions made by the VRC that in the three-cluster solution, SS_B is larger (while minimising SS_W), so that groups are distinctive to each other, and in the five-cluster solution $SS_{W\ is}$ minimised (while groups share similarities between them along certain strategic dimensions). Thus, the superiority of one solution to the other is subjective to the researcher's judgement on how best each solution is meeting the research requirements.

Table 4-10 provides cluster centroids of the original variables used to extract PCs on which the clusters were formed. It also includes the values of the variables used in the criterion validity testing. A typical *domestic airport* has on average of more than 90% of domestic traffic. The *international airports* (both hubs and non-hubs) have approximately a ratio of 2:1:1 of international, regional, and domestic traffic respectively. However, when separately taken, the *international hubs* in the region do not have significant domestic markets. Therefore, they have a 3:2 ratio of international and regional traffic. Owing to the bigger domestic role they play, *hybrid* airports have a larger share of domestic traffic (on average 57%). Thus, the traffic ratio of international, regional and domestic is 6:1:3, respectively. In terms of traffic generation, on average, *domestic airports* generate a very small share (below 2.2%) in the market. The *hybrid* airports have the highest traffic generation ratios for all three markets, indicating the central role they play in all three markets. Even though *international hub* airports do not have significant traffic shares in the domestic markets, their domestic traffic generation ratios (9%) are higher than a typical *domestic airport*. Because there are only few airports within the domestic networks in some of the countries that have *international hubs*, those hub airports have to cater for those domestic traffic, even though it is very small in numbers. This raise the traffic generation ratios since they are the only airports serving domestic traffic. Contrary to this is the situation of typical *domestic airports*, which are usually part of a larger domestic network. Therefore, they only contribute a minor share to the total market.

Domestic airports and *international non-hub airports* have no or very low values for average flow centrality indicators, while *international hubs* play leading roles in the intercontinental transfer markets (average international to international flow centrality is 2%), and regional transfer markets (average regional flow centrality is 0.43%). *International hubs* are also the international gateways to their respective regions (average international to regional flow centrality is 1.6%). The *hybrid* airports are key transfer points for domestic traffic and international traffic continuing the journey forward to another domestic destination. Thus, the average domestic flow centrality and international to domestic flow centrality are 1.6% and 0.7% respectively. The *hybrid* airports are only secondary to *international hubs* in connecting continents and their respective regions. A typical *LCC airport* in the region will have on average 63% of seats offered by LCCs. However, LCCs in the region also operate from international airports.

Table 4-10 Profiles of clusters by network and segmentation strategies

Variables	Domestic	International	Hybrid
% Domestic traffic	92.0%	21.9%	56.9%
% Regional traffic	3.9%	30.5%	12.5%
% International traffic	4.1%	47.6%	30.6%
Seats/aircraft	132	156	169
Average frequency per route	5	3	8
% of First and Business seats	3.1%	6.0%	5.3%
% seats by LCCs	18.5%	15.4%	15.8%
Traffic generation (domestic)	2.2662%	17.8556%	27.7753%
Traffic generation (regional)	0.1305%	3.5172%	7.2752%
Traffic generation(international)	0.1168%	2.9203%	6.8293%
Flow centrality (domestic)	0.0277%	0.1175%	1.6080%
Flow centrality (regional)	0.0002%	0.0685%	0.0936%
Flow centrality (International to domestic)	0.0044%	0.0453%	0.7049%
Flow centrality (International to regional)	0.0001%	0.2530%	0.2459%
Flow centrality (international to international)	0.0001%	0.2900%	0.1785%
Traffic generation (Global)	*0.1145%*	*0.2762%*	*1.1177%*
Flow centrality (Global)	*0.0028%*	*0.0321%*	*0.0864%*
Average distance of a route	*778*	*1641*	*1511*
% of Economy seats	*96.9%*	*94.0%*	*94.8%*
% seats by FSC	*80.7%*	*82.8%*	*83.2%*

	Domestic Non-LCC	**Domestic LCC**	**International Non-hubs**	**International Hubs**	**Hybrid**
% Domestic traffic	91.3%	94.0%	25.4%	0.5%	56.9%
% Regional traffic	4.6%	1.8%	29.0%	39.5%	12.5%
% International traffic	4.1%	4.2%	45.6%	59.9%	30.6%
Seats/aircraft	129	142	145	218	169
Average frequency per route	4	5	3	5	8
% of First and Business seats	3.3%	2.7%	5.3%	10.1%	5.3%
% seats by LCCs	2.9%	63.4%	16.2%	10.5%	15.8%
Traffic generation (domestic)	2.2368%	2.3509%	19.3393%	8.9535%	27.7753%
Traffic generation (regional)	0.1259%	0.1440%	2.0600%	12.2605%	7.2752%
Traffic generation(international)	0.0933%	0.1843%	1.9017%	9.0315%	6.8293%
Flow centrality (domestic)	0.0243%	0.0374%	0.1368%	0.0018%	1.6080%
Flow centrality (regional)	0.0001%	0.0004%	0.0067%	0.4394%	0.0936%
Flow centrality (International to domestic)	0.0046%	0.0038%	0.0325%	0.1220%	0.7049%
Flow centrality (International to regional)	0.0002%	0.0001%	0.0258%	1.6168%	0.2459%
Flow centrality (international to international)	0.0002%	0.0000%	0.0110%	1.9639%	0.1785%
Traffic generation (Global)	*0.1259%*	*0.0818%*	*0.1447%*	*1.0654%*	*1.1177%*
Flow centrality (Global)	*0.0033%*	*0.0015%*	*0.0031%*	*0.2058%*	*0.0864%*
Average distance of a route	*817*	*664*	*1506*	*2446*	*1511*
% of Economy seats	*96.7%*	*97.3%*	*94.7%*	*89.9%*	*94.8%*
% seats by FSC	*96.5%*	*35.4%*	*81.8%*	*88.9%*	*83.2%*

Source: own elaboration based on SPSS 22 output

4.5.3 The proposed taxonomy of airport typologies

As the third step of the classification procedure, the two cluster solutions by the ‘degree of airport activity’ and the ‘network and segmentation strategies’ were amalgamated to arrive at a combined taxonomy of airports based on the three strategic dimensions. The criterion objective of the amalgamation is to arrive at a manageable number of distinctive clusters.

As the first step a 3x3 matrix is formed by integrating the three-cluster solutions of ‘degree of airport activity’ and the ‘network and segmentation strategies’. As shown in Figure 4-11, each airport type under the network and segmentation strategies were divided into three corresponding sizes as large, medium and small. This provided an overview to the structure of the airport hierarchy in the region. When the *international airport* cluster was divided into small, medium and large categories, the quadrant of the large international airports consists of six airports which qualify for the status of mega-hubs. These were named as *primary international hubs*. This is one of the key outcomes of this integration. This result corresponds very well with the international hub cluster identified in the five-cluster solution by ‘network and segmentation strategies’. It also proved that ‘size’ is a key strategic determinant of successful hubbing. When the newly identified cluster of *primary international hubs* profiled in Figure 4-12 (A) is compared with the profile of *international airports* cluster in the three-cluster solution by ‘network and segmentation strategies’ in Figure 4-9 (C), a significant difference is observable in the international hub dimension.

When the statistical significance of the differences were examined, the nine airport groups proved to be significantly different across the variables used to classify them (Welch’s F-test significant at <0.05 level) (Table D-30). Because, each group is a part of a parent-group either by size or network and segmentation strategies, p*ost hoc* tests showed that the groups share certain similarities across some variables. However, each group is different to others across at least one dimension. As shown in Figure 4-11, the nine airports were named based on the size dimension and the key network or segmentation strategic dimension that make them distinct from other airports.

Network and segmentation Strategy

Degree of Airport Activity

<table>
<tr><th></th><th colspan="2">International/Regional</th><th>Hybrid</th><th colspan="2">Domestic</th></tr>
<tr><th>Large</th><td colspan="2">Primary international hubs & gateways to regions</td><td>Large international/ regional hubs & gateways to country/ region & Primary domestic hubs</td><td colspan="2">Large domestic od airports</td></tr>
<tr><th rowspan="2">Medium</th><td colspan="2">Medium international airport</td><td rowspan="2">Medium international/ regional hubs & gateways to country/ region & Primary domestic hubs</td><td colspan="2">Medium domestic OD</td></tr>
<tr><td>Secondary internation al hubs & gateways to regions</td><td>Medium international / regional airports</td><td>Medium domestic OD airports</td><td>Medium domestic LCC airports</td></tr>
<tr><th rowspan="2">Small</th><td colspan="2" rowspan="2">Small international /regional airports</td><td rowspan="2">Small international/ regional gateways to country & Primary domestic hubs</td><td colspan="2">Small domestic OD</td></tr>
<tr><td>Small domestic OD airports</td><td>Small domestic LCC airports</td></tr>
</table>

Figure 4-11 The proposed taxonomy of airports in the East

Source: Own elaboration

The 3x3 taxonomy seems to represent the diversity in the airport network mainly in terms of size and destination orientation. The next step was to introduce the five-cluster solution of the ‘network and segmentation strategies’ to determine whether it contributes to a better comprehension of the structure of the airport network. Theoretically, if the three size clusters and five network and segmentation strategies clusters were to put together, it would create a 3x5 matrix and a taxonomy of fifteen airport groups. However, owing to the strategic features of the airport industry, it produced a twelve-cluster solution that sits well within the main 3x3 matrix (Figure 4-11). The medium international airport group was partitioned into hubs and non-hubs. Medium and small domestic airports were further partitioned as LCC airports and Non- LCC airports. These two partitioning happened along the ‘international hub’ and ‘LCC airport’ strategic dimensions. Thus, the twelve-group taxonomy differentiates airports across all the strategic dimensions that were introduced in the analysis. It also highlighted two strategic features of the airport industry. First, the larger and intense is the international airport, the higher is the probability of it being an international hub. Secondly, the smaller/secondary is the airport, the more likely it is for LCCs to choose the airport as a destination.

4.6 The profiles of airport groups

The following information and individual data of airports are used in elaborating the profiles of each airport group in the taxonomy.

1. Cluster centroids/mean values and standard deviations for the original variables and PCs used in the classification process given in Table 4-11.
2. Criterion variables and other key totals given in Table D-32.
3. Nine- and Twelve-cluster profile charts given in Figure 4-12.
4. A sample of the airport taxonomy given in Figure 4-13, with the complete list of airport group memberships given in Table D-13.

Table 4-11 Cluster profiles by degree of airport activity and network and segmentation strategies

Strategic Dimensions	*Indicators*		Primary International Hubs	Secondary International hubs	Medium International Airports	Small International Airports	Primary Hybrid Airports	Medium Hybrid Airports	Small Hybrid Airports	Large Domestic Airports	Medium Domestic OD Airports	Small Domestic OD Airports	Medium Domestic LCC Airports	Small Domestic LCC Airports
Degree of Airport Activity	Seats/day		162270	48171	33609	6289	175271	53076	11221	108423	43981	3545	33646	4699
		std.dev	*42290*	*21524*	*10717*	*5516*	*55026*	*19536*	*5552*	*11284*	*17276*	*4127*	*9594*	*4008*
	No of gates		74	25	23	6	75	21	9	52	26	4	18	4
		std.dev	*24*	*22*	*15*	*5*	*32*	*11*	*3*	*27*	*14*	*4*	*12*	*3*
	No of destinations		142	78	60	22	123	60	32	88	54	10	38	7
		std.dev	*39*	*24*	*14*	*13*	*47*	*40*	*22*	*16*	*21*	*9*	*4*	*6*
	No of Airlines		76	38	39	14	60	32	18	29	26	6	21	6
		std.dev	*23*	*7*	*15*	*9*	*21*	*20*	*13*	*8*	*8*	*5*	*6*	*4*
	% of seats by dom carrier		37%	56%	42%	42%	35%	43%	45%	32%	34%	56%	35%	45%
		std.dev	*13%*	*20%*	*19%*	*21%*	*9%*	*15%*	*20%*	*2%*	*9%*	*24%*	*12%*	*15%*
Network: International Hub	Traffic generation(international)		13.43%	3.75%	3.13%	1.63%	9.29%	3.42%	7.27%	0.44%	0.27%	0.06%	2.06%	0.07%
		std.dev	*4.72%*	*1.14%*	*2.10%*	*2.26%*	*4.98%*	*3.13%*	*8.30%*	*0.26%*	*0.23%*	*0.23%*	*1.24%*	*0.18%*
	Traffic generation (regional)		14.54%	9.53%	3.02%	1.85%	7.14%	4.12%	11.71%	0.91%	0.54%	0.06%	1.56%	0.06%
		std.dev	*6.89%*	*6.69%*	*1.65%*	*3.41%*	*4.62%*	*3.26%*	*13.18%*	*0.49%*	*0.49%*	*0.10%*	*1.75%*	*0.14%*
	FC (international to international)		2.68%	1.10%	0.03%	0.01%	0.28%	0.02%	0.22%	0.00%	0.00%	0.00%	0.00%	0.00%
		std.dev	*2.94%*	*1.31%*	*0.07%*	*0.02%*	*0.42%*	*0.02%*	*0.41%*	*0.00%*	*0.01%*	*0.00%*	*0.00%*	*0.00%*
	FC (international to regional)		1.81%	1.39%	0.10%	0.01%	0.44%	0.09%	0.13%	0.00%	0.00%	0.00%	0.00%	0.00%
		std.dev	*1.43%*	*0.67%*	*0.19%*	*0.02%*	*0.58%*	*0.12%*	*0.17%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*
	FC (regional)		0.41%	0.48%	0.02%	0.00%	0.14%	0.01%	0.12%	0.00%	0.00%	0.00%	0.01%	0.00%
		std.dev	*0.32%*	*0.41%*	*0.03%*	*0.01%*	*0.22%*	*0.02%*	*0.17%*	*0.00%*	*0.00%*	*0.00%*	*0.01%*	*0.00%*
Network: Domestic Hub	TG (domestic)		0.66%	18.91%	16.97%	19.87%	21.65%	30.70%	34.09%	5.10%	3.11%	2.08%	8.86%	1.97%
		std.dev	*0.82%*	*25.96%*	*18.84%*	*21.94%*	*12.80%*	*10.49%*	*14.45%*	*0.42%*	*2.42%*	*4.60%*	*3.13%*	*2.16%*
	TG (domestic)		0.00%	0.00%	0.06%	0.15%	1.54%	1.32%	2.10%	0.21%	0.11%	0.01%	0.43%	0.01%
		std.dev	*0.01%*	*0.00%*	*0.09%*	*0.41%*	*1.46%*	*1.23%*	*1.18%*	*0.01%*	*0.11%*	*0.04%*	*0.09%*	*0.03%*
	FC (international to domestic)		0.22%	0.00%	0.05%	0.03%	1.19%	0.27%	0.47%	0.05%	0.02%	0.00%	0.05%	0.00%
		std.dev	*0.40%*	*0.01%*	*0.06%*	*0.10%*	*0.65%*	*0.25%*	*0.66%*	*0.04%*	*0.06%*	*0.01%*	*0.02%*	*0.00%*

Table 4-11 continued…

Strategic Dimensions	***Indicators***	**Primary International Hubs**	**Secondary International hubs**	**Medium International Airports**	**Small International Airports**	**Primary Hybrid Airports**	**Medium Hybrid Airports**	**Small Hybrid Airports**	**Large Domestic Airports**	**Medium Domestic OD Airports**	**Small Domestic OD Airports**	**Medium Domestic LCC Airports**	**Small Domestic LCC Airports**
Geographical Orientation: International/ Domestic Airport	% Domestic seats	0.8%	0.2%	25.1%	25.5%	59.4%	62.3%	45.5%	93.0%	90.0%	91.5%	78.2%	94.9%
	std.dev	1.6%	0.4%	22.0%	20.9%	20.4%	21.7%	31.3%	1.7%	6.4%	11.1%	2.6%	5.8%
	% Regional seats	43.7%	34.6%	28.6%	29.0%	12.1%	13.0%	12.5%	4.7%	6.6%	4.4%	3.8%	1.6%
	std.dev	*15.2%*	*13.0%*	*15.8%*	*27.1%*	*9.7%*	*8.6%*	*7.8%*	*2.1%*	*5.0%*	*7.0%*	*4.3%*	*2.9%*
	% International seats	55.7%	65.0%	46.5%	45.4%	28.4%	24.9%	41.8%	2.3%	3.5%	4.2%	18.0%	3.4%
	std.dev	*14.6%*	*12.6%*	*21.6%*	*27.1%*	*15.0%*	*21.0%*	*35.0%*	*1.5%*	*2.2%*	*8.6%*	*4.2%*	*4.9%*
	% of First/ Business seats	10.5%	9.6%	6.9%	4.9%	6.2%	4.4%	4.8%	5.3%	3.7%	3.2%	3.2%	2.7%
	std.dev	*1.6%*	*1.7%*	*2.7%*	*3.0%*	*1.6%*	*1.9%*	*3.3%*	*0.6%*	*1.1%*	*2.3%*	*0.8%*	*1.8%*
Service Orientation: LCC/Service Frequency	% seats by LCCs	9.5%	11.6%	20.4%	15.2%	22.1%	16.9%	3.7%	4.0%	6.1%	2.5%	61.2%	63.5%
	std.dev	*8.6%*	*9.2%*	*22.1%*	*21.5%*	*19.6%*	*15.4%*	*5.3%*	*4.4%*	*5.3%*	*5.9%*	*6.7%*	*22.0%*
	Seats/aircraft	243	189	171	139	190	172	132	168	150	126	146	141
	std.dev	*11*	*20*	*17*	*27*	*22*	*23*	*36*	*12*	*13*	*33*	*8*	*25*
	Average frequency per route	5	4	4	2	9	8	6	8	6	4	6	5
	std.dev	*1*	*1*	*1*	*1*	*3*	*7*	*5*	*1*	*2*	*3*	*1*	*2*
Principal Components	International Hub	5.54	3.29	-0.14	-0.49	1.29	-0.28	0.62	-0.05	-0.08	-0.06	-0.24	-0.22
	std.dev	*4.23*	*1.98*	*0.16*	*0.47*	*1.65*	*0.59*	*2.25*	*0.02*	*0.06*	*0.10*	*0.19*	*0.08*
	International Airport	1.38	1.98	1.93	1.85	-0.26	0.43	0.46	-0.38	-0.36	-0.40	-0.09	-0.49
	std.dev	*1.09*	*0.53*	*0.74*	*0.80*	*0.64*	*0.78*	*1.25*	*0.09*	*0.27*	*0.48*	*0.18*	*0.26*
	Domestic Hub	-0.83	-0.90	0.02	0.03	4.05	2.43	3.80	0.32	0.04	-0.26	0.55	-0.26
	std.dev	*1.44*	*1.02*	*0.50*	*0.84*	*1.58*	*0.92*	*0.98*	*0.03*	*0.34*	*0.31*	*0.11*	*0.23*
	Low Cost/ Service Frequency	0.87	0.05	0.56	-0.27	0.81	0.56	-0.96	0.42	0.00	-0.63	1.32	1.40
	std.dev	*0.44*	*0.68*	*0.65*	*0.91*	*0.53*	*1.05*	*0.74*	*0.13*	*0.33*	*0.58*	*0.31*	*0.50*

Source: Own elaboration based on SPSS 22 output

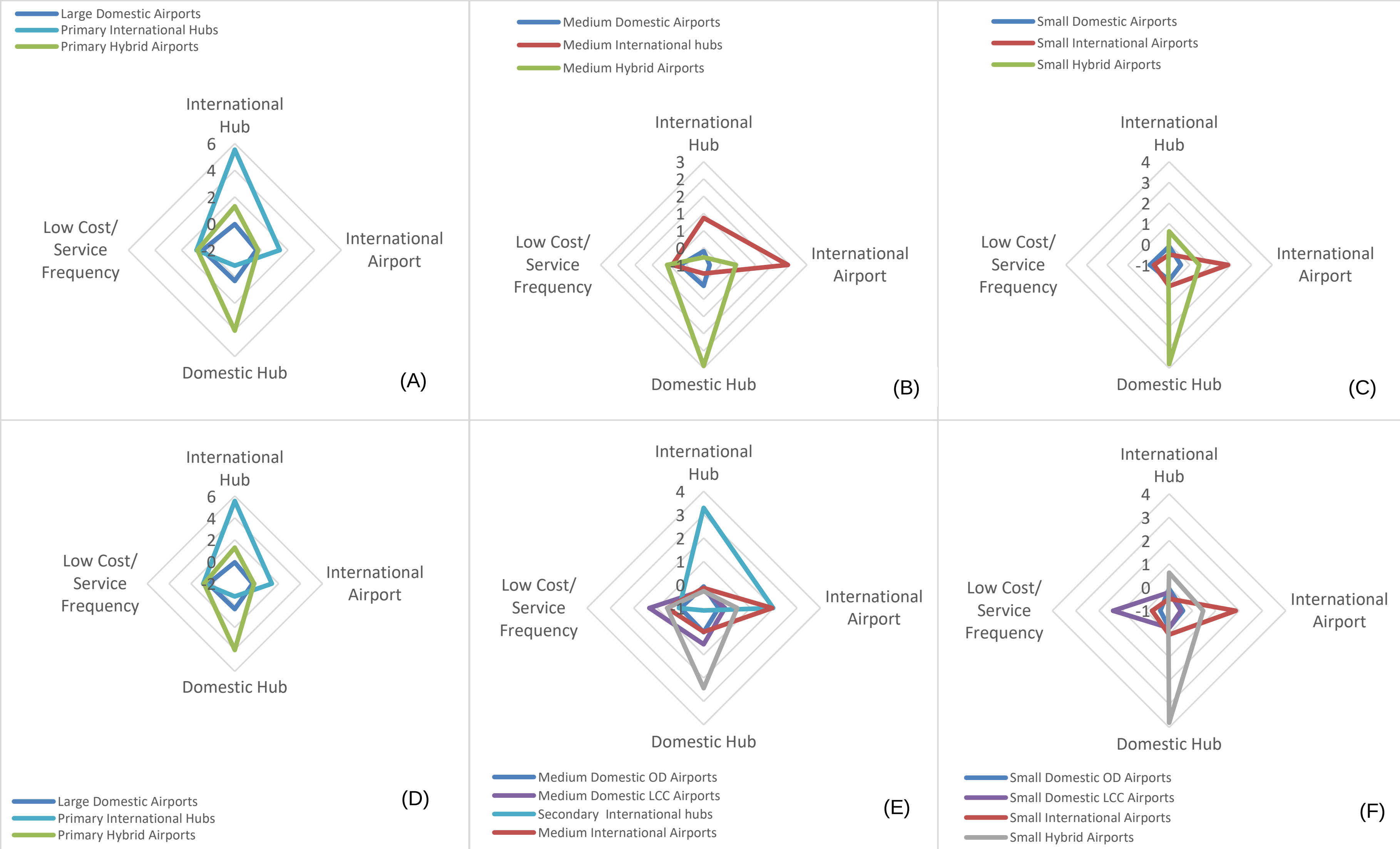

Figure 4-12 The radar charts* for the profiles of the proposed taxonomy of airports

*A, B, and C - 3x3 taxonomy profiles and D, E, and F – 3x5 taxonomy profiles
Source: Own elaboration

Network and segmentation Strategy

Degree of Airport Activity

<table>
<tr><th></th><th colspan="2">International/ Regional (77)</th><th>Hybrid (24)</th><th colspan="2">Domestic (349)</th></tr>
<tr><td>Large (19)</td><td colspan="2">Primary International Hubs
Dubai
Singapore Changi
Hong Kong
Tokyo Narita
Seoul Incheon
Taipei Taiwan Taoyuan

(6)</td><td>Primary Hybrid
Bangkok Suvarnabhumi
Mumbai
Jakarta Soekarno-Hatta
Delhi
Kuala Lumpur
Manila Ninoy Aquino
Beijing Capital

<u>Domestic Hubs</u>
Shanghai Pudong
Tokyo Haneda
Guangzhou

(10)</td><td colspan="2">Large Domestic OD Airports
Shanghai Hongqiao
Shenzhen
Chengdu

(3)</td></tr>
<tr><td rowspan="2">Medium (61)</td><td colspan="2">Medium International Airport</td><td rowspan="2">Medium Hybrid
Jeddah
Riyadh
Ho Chi Minh City
Karachi

<u>Domestic Hubs</u>
Jeju
Chennai
Tehran Mehrabad
Seoul Gimpo

(8)</td><td colspan="2">Medium Domestic OD Airports</td></tr>
<tr><td>Secondary International Hubs
Abu Dhabi
Colombo
Doha
Kuwait
Bahrain

(5)</td><td>Medium International Airports
Muscat
Tel Aviv
Amman
Beirut
Dammam
Phuket
Denpasar Bali

(12)</td><td>Medium Domestic OD Airports
Balikpapan
Surabaya
Dalian
Kunming
Osaka Itami
Okinawa
Naha

(31)</td><td>Medium Domestic LCC Airports
Kota Kinabalu
Bengaluru
Kolkata
Cebu
Hyderabad

(5)</td></tr>
<tr><td rowspan="2">Small (370)</td><td colspan="2" rowspan="2">Small International Airports
Ashgabat
Dushanbe
Tehran Imam Khomeini
Male
Kathmandu
Phnom Penh
Dili (TL)
Siem Reap
Bandar Seri Begawan
Baghdad
Damascus

(54)</td><td rowspan="2">Small Hybrid
Almaty
Dhaka
Kabul
Tashkent

<u>Domestic Hubs</u>
Kinmen
Makung

(6)</td><td colspan="2">Small Domestic OD Airports</td></tr>
<tr><td>Small Domestic OD Airports
Herat
Beijing
Nanyuan
Osaka Kobe
Pekanbaru
Mashhad
Eilat

(225)</td><td>Small Domestic LCC Airports
Nakhon Phanom
Nanded
Pagadian
Butuan
Johor Bahru
Langkawi
Vinh City
Kita Kyushu

(85)</td></tr>
</table>

Figure 4-13 A sample taxonomy of airports

Source: Own elaboration

4.6.1 Primary international hubs and gateways to regions

Six large airports, namely, Dubai (DXB), Singapore (SIN), Hong Kong (HKG), Tokyo-Narita (NRT), Seoul-Incheon (ICN), and Taiwan-Taoyuan (TPE) fall into this category. These airports are from the mature aviation markets of Middle East, Southeast Asia and Northeast Asia. These airports on average offer 162,270 seats per day and operate 673 flights. On average, they are directly connected to 142 destinations (airports). More than one third of the seats are offered by the main hub carrier/s. However, competition is intense (HHI at 0.19) since as many as 76 airlines fly to and from these airports. These airports are well known for their investment in massive infrastructure developments. Their operational capacity stands at on average 74 boarding gates. This means that at any given time they can service, on average, 74 aircrafts.

These airports rank highest in terms of centrality and intermediacy among other airports in the region. Thus, as can be seen from the profile charts, these airports stand out from the rest on their international hub role. They satisfy three elements to become an international hub. One is the intercontinental connections that they provide. On average a primary hub airport accounts for 14% of the international OD traffic generated within the sub-region to which it belongs. Their average intercontinental connectivity is the highest at 2.7%. Secondly, they play a significant gateway role to the sub-region to which they belong. The average international to regional connectivity stands at 1.8%. Thirdly, they are major regional hubs as well, generating on average 14% of OD traffic and connecting 0.41% traffic within the region.

The individual traffic profiles of the six airports are unique, because their domestic markets are either zero or very small, while they have established international and regional OD markets. This brings out a further division within the group. Dubai, Singapore and Hong Kong share similar characteristics. Tokyo-Narita, Seoul-Incheon and Taiwan-Taoyuan are different as they play a minor domestic hub role as well. At Tokyo-Narita, 4% of passengers from international flights transfer to domestic airports. The difference in the traffic profiles of Tokyo-Narita, Seoul-Incheon and Taiwan-Taoyuan is because they are a part of a network of airports within their respective countries, unlike Dubai, Singapore and Hong Kong where no such big network of airports exists. They play the major 'international gateway to the country' role and in doing that generate significant intercontinental transfer traffic owing to the city-pair markets created by serving diverse destinations. There are separate major domestic airport/s taking the central domestic hubb role in each country, namely, Tokyo-Haneda (HND), Seoul-Gimpo (GMP), Kinmen (KMN) and Makung(MZG). If not for these airports, it can be assumed that, Tokyo-Narita, Seoul-Incheon and Taiwan-Taoyuan would also take up the domestic hub role which will make them more of a 'hybrid' nature. This is not surprising, as Tokyo-Narita, Seoul-Incheon and Taiwan-Taoyuan were built as alternatives to overcome the capacity restrictions at Tokyo-Haneda (Japan), Seoul-Gimpo (South Korea) and Songshan (TSA) (Taiwan) to expand as international hubs. Therefore, subsequently, the international role played by them was taken up by the newly built international airports. These airports took a secondary international role, while serving as the primary domestic hub for the larger domestic market of the three countries.

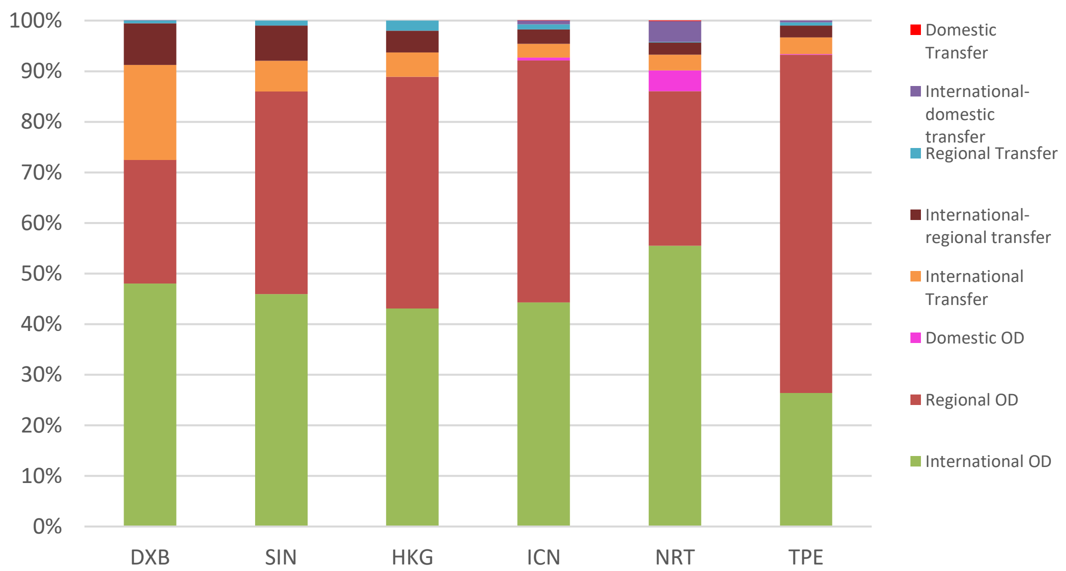

Figure 4-14 Traffic profiles of primary international hubs

Source: Own elaboration based on OAG (2012)

In terms of hub competitiveness, Dubai, Singapore and Hong Kong are leaders in the intercontinental hub market and Tokyo-Narita, Seoul-Incheon and TPE are followers (Figure 4-15). Dubai carries more than 8% of intercontinental transfer traffic out of the total international transfer traffic carried via Middle Eastern airports and rank as first (0.6%) on its connectivity in the Eastern aviation network. The three leading airports' contribution to regional connectivity is also comparatively higher in their respective regional markets as well. They can be upgraded to 'super-hub' status, within the primary hub cluster, profiled as airports that generate more than 15% share of the total international traffic generated by all the airports in the region, and score more than 2% on intercontinental connectivity. Though the hub connectivity measures and timing of the study is different, Ivy (1993) identified Atlanta, Chicago and Dallas as 'super hubs' for the higher degree of connectivity provided at those airports. Mason (2007) found the same based on absolute connecting traffic figures. A much later study by Suau-Sanchez, Voltes-Dorta and Rodríguez-Déniz (2015) is similar in terms of measures and timing to the current study[13]. Their classification proposed 'super hub' status for airports with more than 3% flow centrality (connectivity), into which Atlanta falls. Dubai is similar or even superior to the connectivity profile of Atlanta. Dallas and Chicago are termed as second tier hubs, which has similar connectivity levels to Singapore and Hong Kong. However, the USA airports does not have traffic generation ratios as high as the Eastern airports.

Compared to other groups of international airports and hybrid airports, LCC presence at these airports is comparatively lower. This value is similar to the 'Worldwide hubs' category named by Malighetti, Paleari and Redondi (2009) in their classification study of airports in Europe. Airports like London- Heathrow, Amsterdam-Schiphol are in this group. Dubai and Singapore have contributed to increase the average value with 14% and 25% shares of LCCs respectively. The

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[13] However, it should be noted that the definitions of the 'networks' on which these measures are based on is different. Suau-Sanchez, Voltes-Dorta and Rodríguez-Déniz (2015) calculate the measures for the USA network (country) and the above classification is based on the total market figures. The current study calculates the measures for the network of the respective sub-region of the airport and the measure used above is only for the international-to-international market.

other airports have less than 6% of LCC seats. This is explained by the greater regional role played by these two airports. Both airports are dedicated to serve respective LCCs owned by their governments (fly Dubai at Dubai) or the national flag carrier (hub) (Scoot and Tigerair at Singapore).

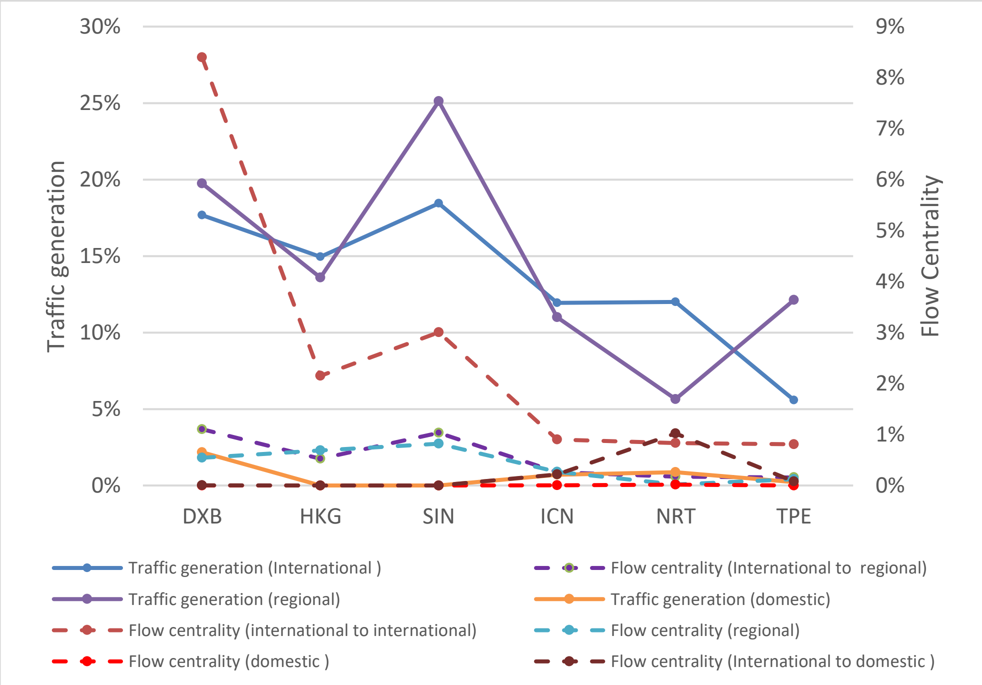

Figure 4-15 Centrality and Connectivity of Primary International Hubs

Source: Own elaboration Source: Own elaboration based on OAG (2012)

4.6.2 Secondary international hubs and gateways to regions

Secondary international hubs share a similar profile to the primary international hubs, but their degree of airport activity and hub connectivity is subordinate to that of primary hubs. Five airports; Abu Dhabi (AUH), Doha (DOH), Bahrain (BAH), Kuwait (KWT), and Colombo (CMB); break away as a separate group from the medium international airports cluster, owing to their unique characteristics of negligible domestic market shares (Figure 4-16) and higher degree of connectivity (Table 4-11and Figure 4-17), compared to the rest of the group . On average, a secondary hub's intercontinental connectivity is 1.1% and they generate an average 4% share of the total international OD markets in their respective regions. The average regional connectivity that they provide is slightly higher than primary hubs. However, this is influenced by the primary regional hub role played by Colombo in the South Asian region. In the Middle East, where the other four hubs are based, they take a secondary regional hub role to Dubai. But comparing individual traffic profiles of the five airports (Figure 4-16), it can be observed that Bahrain and Kuwait are more regionally oriented than the Abu Dhabi and Doha.

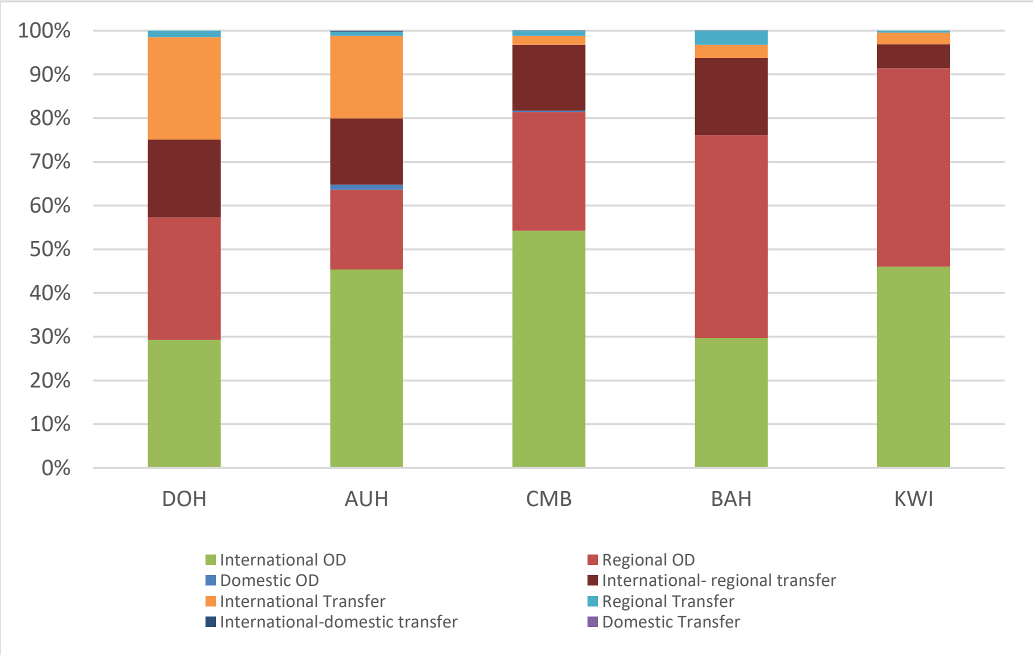

Figure 4-16 traffic profile of secondary international hubs

Source: Own elaboration based on OAG (2012)

A typical secondary hub on average offers 48,171 seats/day. The capacity of these airports is 25 boarding gates on average. Hub carriers dominate more than 50% share of seats at the airport, therefore competition is less intense (HHI=0.36) to primary hubs. On average, they are connected to 78 destinations directly with 38 airlines operating 256 flights per day. These group averages are mostly influenced by Abu Dhabi and Doha, which stand out as leading secondary hubs. When ranked, they come on top in terms of international-international and international-regional connectivity. With respect to regional centrality and connectivity, Colombo plays a relatively bigger role within South Asia than the roles played by Abu Dhabi and Doha in Middle East. Bahrain and Kuwait score low on both aspects.

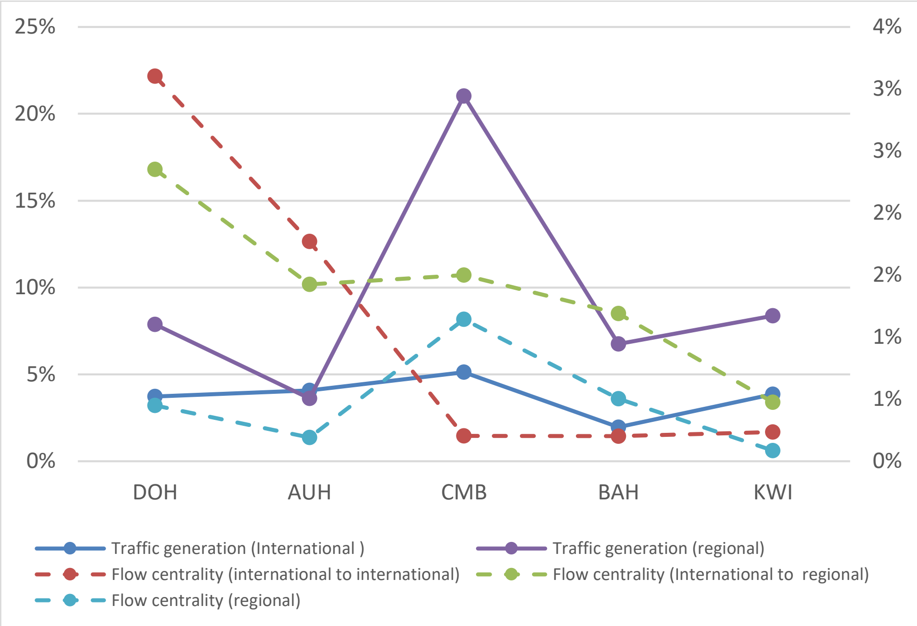

Figure 4-17 Centrality and connectivity of secondary international hubs

Source: Own elaboration based on OAG (2012)

4.6.3 Medium international airports

Twelve airports from the Middle East, Southeast and Northeast Asia belong to this group. They are either the major international airport of the respective country; such as Muscat (MCT) in Oman, Amman (AMM) in Jordan, Beirut (BEY) in Lebanon or a secondary international airport serving a larger metropolitan or a city or an island such as Sharjah (SHJ) in the UAE, Phuket (HKT) in Thailand, and Osaka Kansai (KIX) in Japan. The degree of airport activity of an average medium international airport is smaller than an average primary international hub, but is not different to secondary hubs. The average number of airlines (39), gates (23), and destinations (60) are not very much different to secondary hubs. As these airports serve primary or secondary cities, they also occupy a similar central role to that of the role played by secondary hubs in generating international traffic (3.1%) in their respective regions. However, compared to secondary hubs, their connectivity levels are minuscule in the international and regional transfer markets (<0.1%) when compared with secondary hubs, which draws the major boundary between the two groups.

The profile of geographical orientation is also different to the profile of a typical primary or secondary hub airport in the region. On average, nearly half (47%) of the seats offered at these airports are for international markets. Apart from Beirut and Sharjah, these airports offer 25% of seats to the domestic market. Therefore, even though not as high as hybrid or domestic hub airports, they generate a significant portion of traffic in the domestic markets (17%). On average, 29% of seats are offered to the regional markets and on average, they generate 3% of the total regional OD traffic in their respective regions. Therefore, these airports are 'traffic generators' rather than 'traffic connectors' (see, Figure 4-18). One other feature is the significance LCCs presence at these airports compared to other international airport categories (20% of seats).

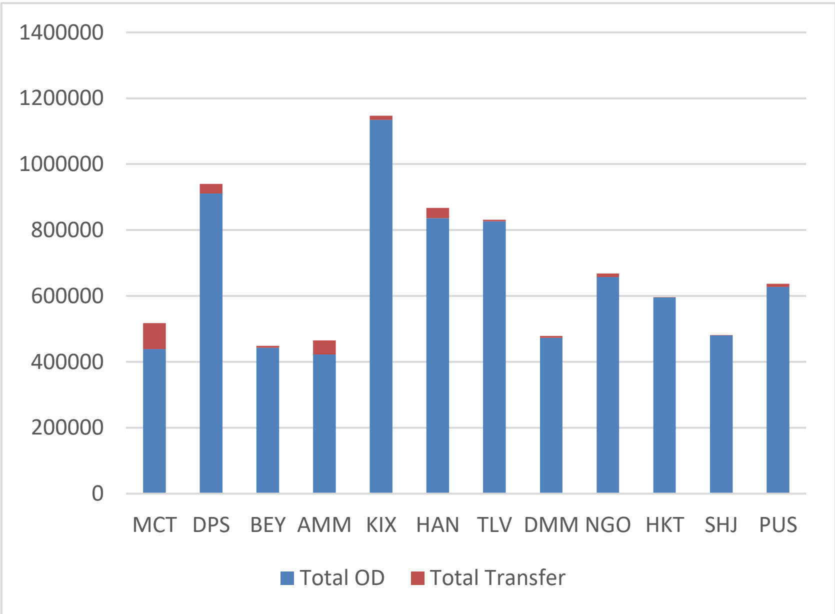

Figure 4-18 OD and transfer traffic at medium international airports

Source: Own elaboration based on OAG (2012)

4.6.4 Small international airports

This is the group with the largest membership (54) among the four internationally oriented airport groups. Nineteen airports of this group are the primary international airport of the respective country they serve, such as, Kathmandu (KTM) in Nepal from South Asia, Yangon (YGN) in Myanmar from Southeast Asia, Tehran Imam Khomeini (IKA) in Iran from the Middle East, Ulaanbaatar

(ULN) in Mongolia from Northeast Asia, and Dushanbe (DYU) in Tajikistan from Central Asia. The other airports are international airports serving capital cities or provinces and secondary populous cities such as Chittagong (CGP) in Bangladesh, Thiruvananthapuram (TRV) in India, Islamabad (ISB) in Pakistan, Khudzhand (LBD) in Tajikistan, and Samarkand (SKD) in Uzbekistan. Some airports are tourist destinations and regional airports like Krabi (KBV) in Thailand, Penang (PEN) in Malaysia, Bandung (BDO) in Indonesia, Taipei Song Shan (TSA) in Taiwan, and Madinah (MED) in Saudi Arabia.

The profile of this group is very similar to medium international airports in terms of their network strategy and geographical orientation. The primary difference is in the size of airport operations. Small international airports offer less than 20,000 seats per day and on average is connected to 22 direct destinations with 14 airlines operating 46 flights per day. In terms of service levels they have the lowest frequency per route (2 flights per day) among all types of airport groups.

4.6.5 Primary hybrid airports

This group comprises ten of the largest and most intense airports in terms in operations. They are Mumbai (BOM) and Delhi (DEL) from India, Beijing Capital (PEK),Shanghai Pudong (PVG), and Guangzhou (CAN) from China, Manila Ninoy Aquino (MNL) from The Philippines, Jakarta Soekarno-Hatta (CGK) from Indonesia, Bangkok Suvarnabhumi (BKK) from Thailand, Kuala Lumpur (KUL) from Malaysia, and Tokyo Haneda (HND) from Japan.

This group is termed hybrid, since they play diverse network roles as international hubs, international gateways to the region and country and as well as being primary domestic hubs in the respective country. In the preliminary PC plots (Figure 4-7), hybrid airport group could be distinctively identified from the international primary hub group because of the significant domestic hub role they play in the domestic market. In terms of the share of traffic, the percentage of domestic traffic is higher than other traffic types. But on absolute terms they carry a large amount of international traffic and are only second to primary international hubs(on average 28,000 international passengers per day compared to 52,500 by primary hubs). In the international markets, their connectivity levels are only second to primary and secondary hubs (<0.5% flow centrality in international to international, international to regional and regional transfer markets). However, the standard deviations suggest that variation in flow centrality is large. Bangkok and Kuala Lampur provide significant connectivity, which is greater than some of the secondary hubs such as, Colombo, Bahrain, and Kuwait. Tokyo-Haneda, Jakarta, Manila, Guangzhou and Shanghai-Pudong play a marginal role in connecting international and regional markets (Figure 4-19). While these differences exist, what groups these airports together is their strong presence in the domestic market as both a traffic generator and a connector.

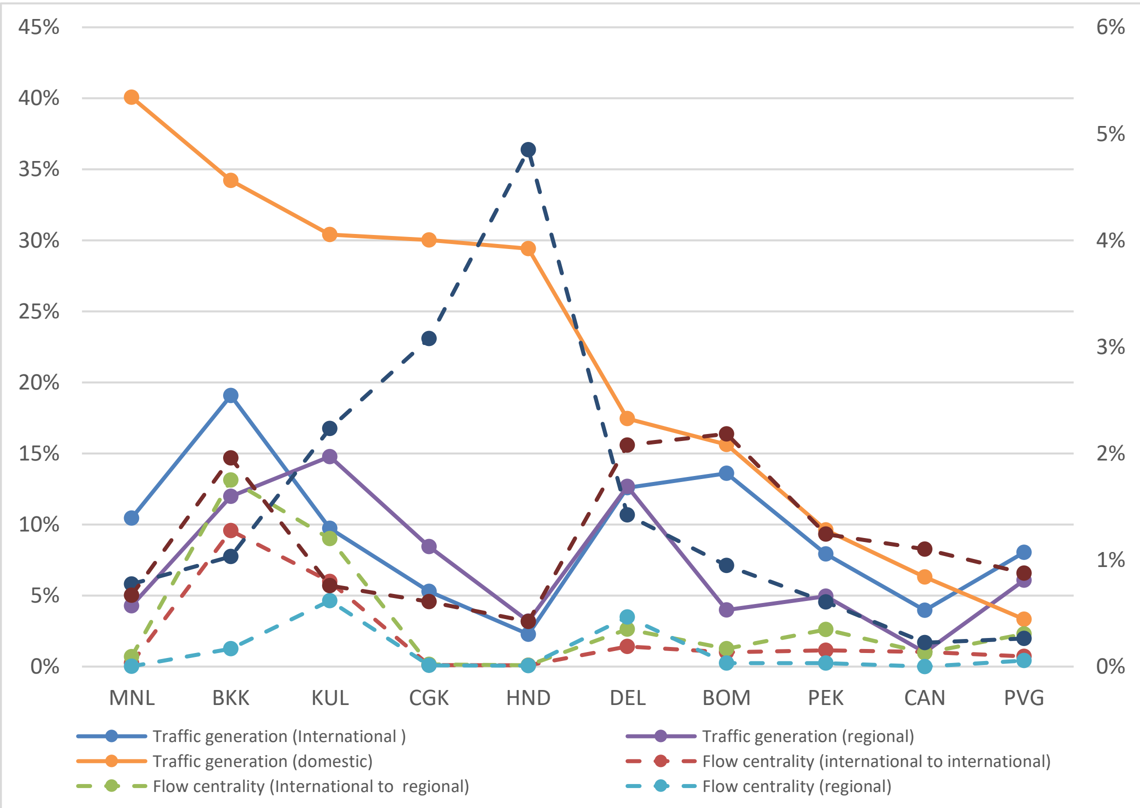

Figure 4-19 Centrality and connectivity of primary hybrid airports

Source: Own elaboration based on OAG (2012)

Owing to the presence of both international and domestic carriers, service frequency per route is higher than other airport groups (9 per route). Average seats by LCCs amount for 22%, however this varies with a standard deviation as high as the average (20%). On average, 44% of seats are offered by LCCs at

Mumbai, Delhi, Kuala Lampur and Manila airports. Other airports are not significant LCC bases.

4.6.6 Medium hybrid airports and domestic hubs

This group is secondary to primary hybrid airports in their degree of airport activity and the level of traffic generation and centrality in traffic flows. The degree of airport activity is very much similar to medium international airports as they are from the same parent- cluster (medium airport group). The group consists of 8 airports. Four of those are designated as the main international airport of the country they serve. These are Jeddah (JED) and Riyadh (RUH) from Saudi Arabia, Ho Chi Minh City (SGH) from Vietnam, and Karachi (KHI) from Pakistan. Chennai (MAA) is the capital of the Indian State of Tamil Nadu. The other three airports are Jeju (CJU) and Seoul-Gimpo (GMP) in South Korea and Tehran Mehrabad (THR) in Iran. These three airports have somewhat different traffic profile to the other airports (Figure 4-20). Their international presence (1%) is very much lower than that of other airports in the group. However, they strongly correspond with the other airports on the domestic hubbing role, which has made them closer to a hybrid group. Once in history they had been the primary international airport in their countries, but the role has been taken up by the purpose built new international airports. Examples are Seoul-Incheon for Seoul-Gimpo and Tehran Khomeini for Tehran Mehrabad. Jeju is the main airport for the island of Jeju in South Korea. Therefore, it needs to keep connected to the mainland as well as to the regional and international destinations. Though these three are more domestic and regionally oriented airports, they represent international interest as well.

On average, a medium hybrid airport generates 4% of OD traffic in the international and regional markets of the regions to which they belong. However, international hubbing is minimal at these airports. The average flow centrality in the international markets is below 0.1% and they play a secondary (or even below) regional gateway role to the international traffic of the respective regions. Similar to primary hybrid airports, the three domestic hub indicators are strong for these airports (Figure 4-21). On average, an airport generates 31% of the total domestic OD traffic and transfer 1.3% out of the traffic transferring within the domestic network.

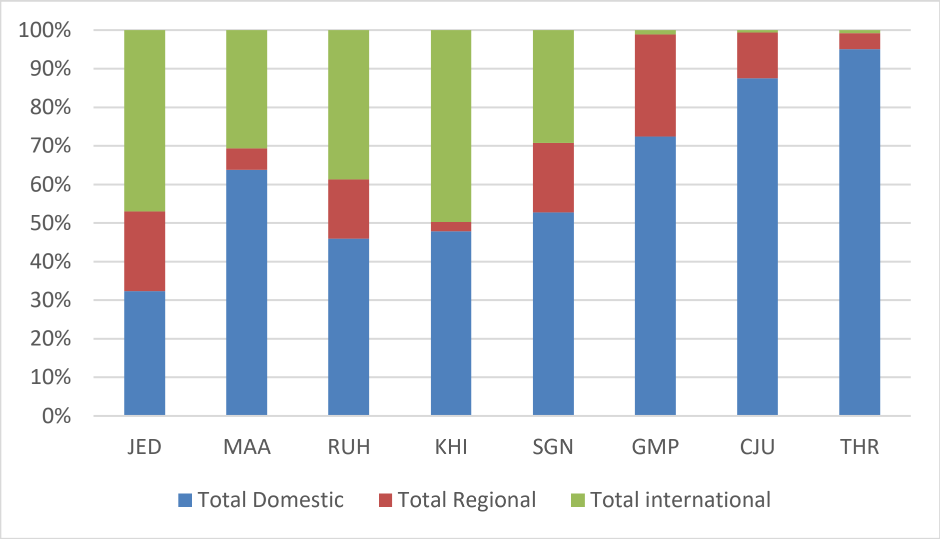

Figure 4-20 Traffic profiles of medium hybrid airports

Source: Own elaboration based on OAG (2012)

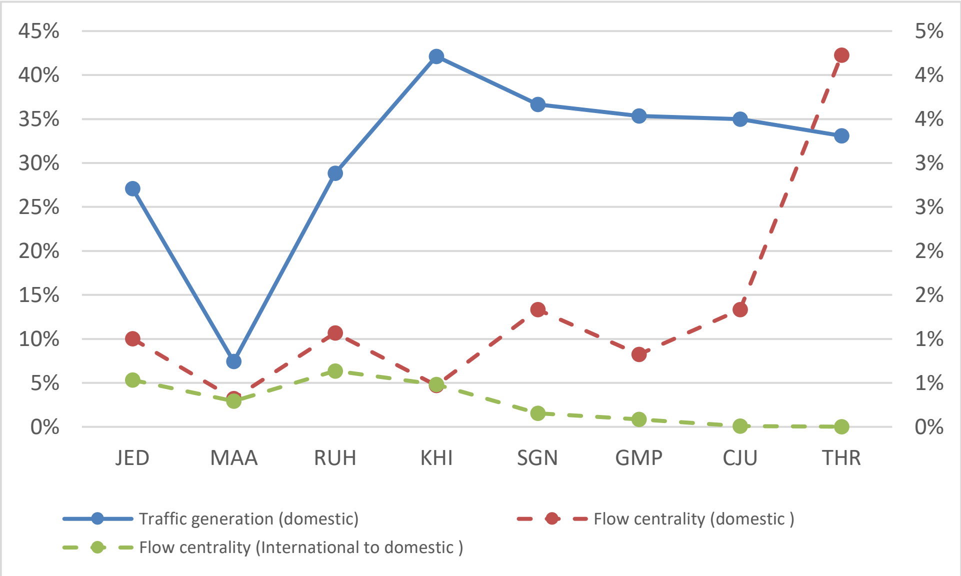

Figure 4-21 Domestic hub indicators for medium hybrid airports

Source: Own elaboration based on OAG (2012)

4.6.7 Small hybrid airports and domestic hubs

Six airports fall into this group and four of them are designated as the main international airport of the respective country. They are Kabul (KBL) from Afghanistan, Tashkent (TAS) from Uzbekistan, Dhaka (DAC) from Bangladesh and Almaty (ALA) from Kazakhstan. The other two airports Kinmen (KNH) and Makung (MZG) are mainly domestic airports from Taiwan that connect the island with mainland China and other regional airports.

This group of airports are not different to small international airports in terms of degree of airport activity. On average, they play a significant role in the international and regional markets, generating 7% and 12% OD traffic respectively. Connectivity levels in the international and regional markets are higher than the average medium hybrid airport. It could be observed that Almaty and Tashkent are more central within the Central Asia than Dhaka and Kabul within the South Asian Region (Figure 4-22). The average aircraft size is small with 132 seats per aircraft and LCC presence is only 4.7%. Frequency per route is six, which is influenced by the shorter average route length of domestic services.

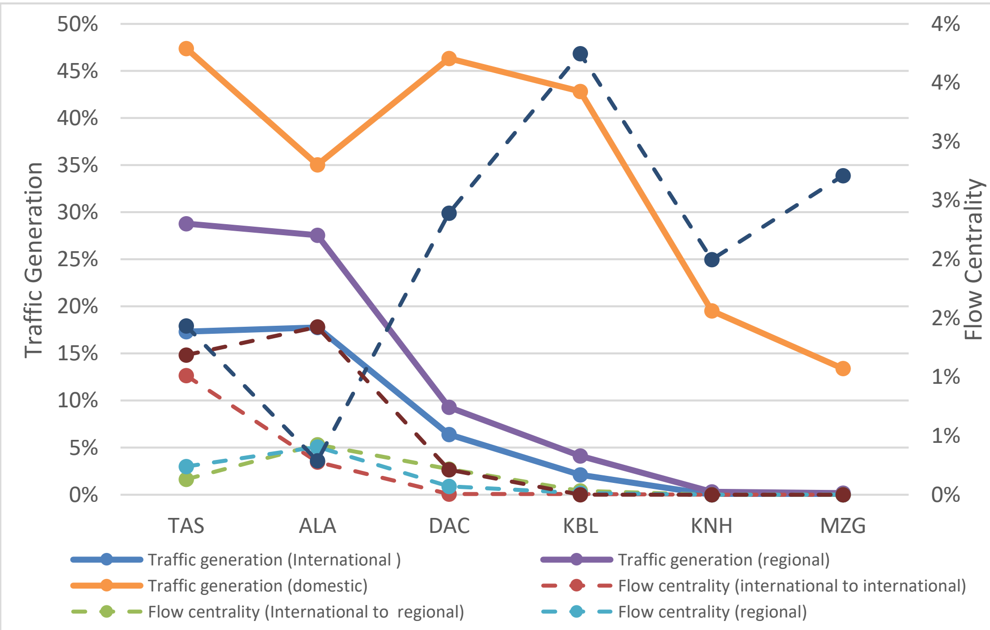

Figure 4-22 Centrality and connectivity of small hybrid airports

Source: Own elaboration based on OAG (2012)

4.6.8 Large domestic OD airports

Three large Chinese airports; namely, Chengdu (CTU), Shenzhen (SZX) and Shanghai Hongqiao (SHA) are separated from the other airports owing to the large-scale operations at these airports and pure domestic orientation. More than 92% of traffic at these airports is domestic and, on average, they handle 108,423 seats per day. These three airports serve the capitals of Sichuan, Guangdong and Shanghai provinces. Together, the three airports generate 15% of the OD traffic in the Chinese domestic market. Domestic connectivity levels are on average 0.2%. Since the international traffic is less than 4%, their 'international gateway to the country role' is also not as high as that of Beijing Capital, Guangzhou or Shanghai-Pudong, which are large hybrid airports. LCC presence is low (6%) at these airports. These airports are bases for major regional airlines like Sichuan, or traditional domestic carriers like Chengdu Airlines and Shenzhen Airlines.

4.6.9 Medium domestic OD airports

On average, 90% of the traffic at these airports consist of domestic passengers. This group consists of thirty-one (31) airports from three countries; China, Japan and Indonesia. All three countries are geographically dispersed over a large land mass (China) or archipelago (Japan and Indonesia). Hence, the requirement for a strong domestic network of airports is important. Medium sized domestic airports mostly serve secondary cities in those countries. For example, in China, Xi'an Xianyang (XIY)), Kunming (KMN), Urumqi (URC), and Wuhan (WUH) are airports that serve capitals of populous Chinese provinces or Autonomous capitals. In Japan Osaka Itami (ITM) is the second airport that serve Kansai region and the largest port city in the island of Honshu (The other airport, Osaka Kansai is an international airport). Likewise, Sapporo Chitose (CTS) serves Hokkaido island. Okinawa Naha (OKA) serves the Okinawa prefecture, a group of 150 islands. In Indonesia also, airports like Balikpapan (BPN), Ujung Pandang (UPG), and Surabaya (SUB) serve large islands of Borneo, Sulawesi, and Java respectively. Thus, they occupy a central role within the region or the island they serve. On average, the domestic traffic generation is 3%. Connectivity levels stand below 0.1%.

4.6.10 Small domestic OD airports

This is the largest group in terms of airport membership. There are 225 airports mainly from China, Japan, Indonesia, Vietnam, Saudi Arabia, Kazakhstan, Iran and South Korea in this group. Similar to medium domestic airports these airports serve either secondary cities or remoter regions in their respective countries. On average, six airlines operate at a small domestic airport and more than 56% of the traffic is held by the dominant airline. On average, an airport contributes 2% of the total OD traffic in their respective domestic markets. Aircraft that operate to these airports tend to be smaller (126 seats per aircraft).

4.6.11 Medium domestic LCC airports

This group of airports consists of three airports from India; Bengaluru (BLR), Kolkata (CCU), and Hyderabad Rajiv Gandhi (HYD); Cebu (CEB) from The Philippines; and Kota Kinabalu (BKI) from Malaysia. The major difference of this group from the other medium domestic airports is the high LCC presences at these airports. On average, 61% of the seats are offered by LCCs at these airports (Figure 4-23). Compared to other domestic airport groups, the average proportion of domestic traffic is lower at these airports (78%). On average, they handle 18% of international traffic at these airports as well. Therefore, the traffic profile is slightly different to other domestic airports. Domestic flow centrality at these airports averages to 0.4% and international to domestic flow centrality averages to 0.05%, which are the highest connectivity levels among the four domestic airport groups in the taxonomy. This is unlikely for a typical low cost airport. The reasons is that some low cost airlines nowadays offer connecting services for forward domestic or international journeys. For example, when MIDT booking data was examined, it was found that at Hyderabad airport is one of the bases for Indian LCC Spicejet. The airline connected 8,011 domestic passengers in India via the airport for the month of May 2012.

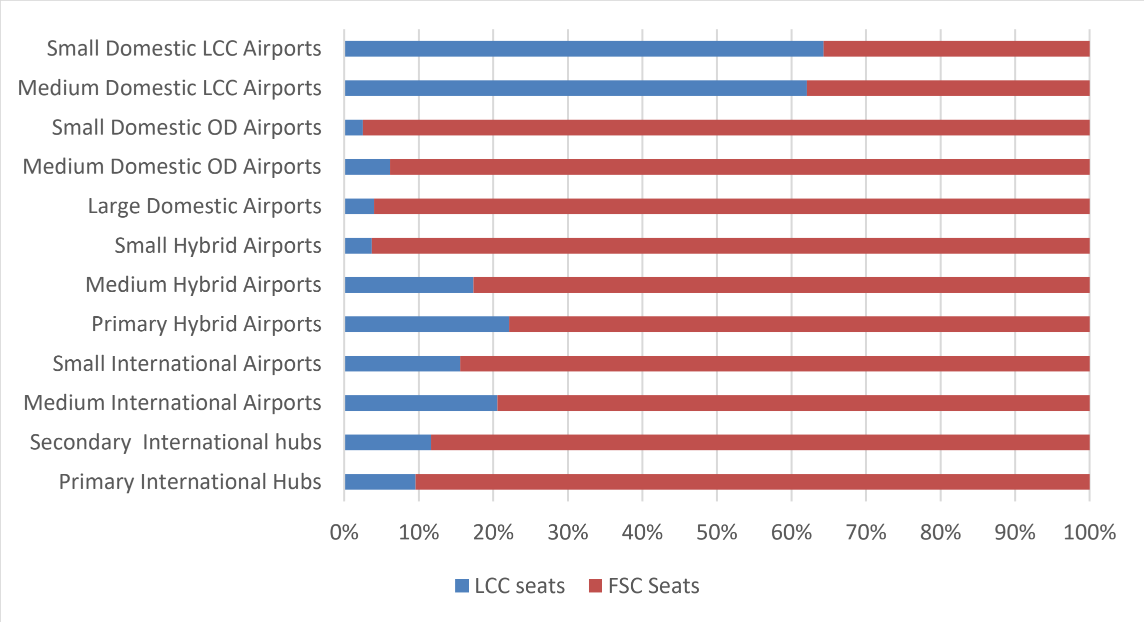

Figure 4-23 Seats by carrier type for the twelve airport clusters

Source: Own elaboration based on OAG (2012)

4.6.12 Small domestic LCC airports

On average, 64% of seats offered at these airports come from LCCs (Figure 4-23). There are 85 airports in this group and the majority of the airports are form India, Malaysia, Thailand, and Philippines where the LCC business model has taken precedence over traditional airlines in the domestic and regional markets.

4.7 Conclusion

In terms of achieving the aim of this research, this chapter met the first research objective of this study, which is *to 'propose a methodological approach to comprehend the competitive structure and geography of the network of airports in the East.'* This chapter presented a methodological approach to airport classification using multivariate data. The study analysed 450 airports in the eastern aviation network using 20 variables across three proposed strategic dimensions of airports. The classification was carried out in two steps using AHC procedures of Ward-Linkage clustering algorithm based on Euclidean distance. First, it grouped airports into three clusters based on the 'degree of airport activity' using five variables. Depending on the size of operations and intensity of competition, the three groups were labelled as *Large, Medium* and *Small* airports.

In the second step, PCA was used to reduce the multivariate data across 15 variables. Four PCs were extracted that seemingly represented four key strategic areas of airports. The first PC differentiated airports based on their 'international hub role'. The second PC explained an airports geographical orientation (international airport or domestic). The third PC differentiated airports based on their 'domestic hub role' and the fourth PC explained the airline service orientation at the airport. Using the PC scores, the airports were again classified into separate groups for the four strategic dimensions. A framework was developed to comprehend the structure of the airport hierarchy based on their network roles and service and geographical orientations. Three primary groups and five secondary groups within them were identified (based on two cluster solutions of the agglomeration schedule). The groups were *International Airport (Hubs and Non-hubs),Hybrid Airports* and *Domestic Airports (LCC and non-LCC)*. As the third step, the classification derived in the first step and the classification derived in the second step were combined to develop a 3x3 matrix. The matrix was further elaborated by incorporating the five-cluster solution which resulted in identifying 12 airport groups.

The outcome of the analysis answered the first research objective of the study. The taxonomy provides a clear distinction between primary and secondary international hubs, international non-hub airports, hybrid airports and domestic LCC airports and non-LCC airports by degree of airport activity in the Eastern aviation network. In addition, the study contributes to the research methodology of airport classification when multivariate data are present. Having identified the competitive position of different types of airports in the network of the East, it is now useful to understand the factors that have influenced their respective network position. This is beneficial for national civil aviation policy makers and governments in drawing up policies to facilitate the development of the airports in a country/region. Next chapter would look at the industry level policy variables and macro environmental factors that shape an airport's growth by addressing the second research objective of this study.

5 AN EVALUATION OF THE FACTORS DRIVING AN AIRPORT'S ROLE IN A NETWORK

5.1 Introduction

The previous chapter presented a structural analysis of the airport network in the East, which met the first objective of this study. This chapter examines the drivers behind the structure of that airport hierarchy to meet the second research objective of the study, which is to *'identify the factors that shape up the growth of an airport and interpret the causes for the differences in the airport hierarchy'.* There are four main parts to the chapter. First section of the chapter explains the methodological considerations involving selection of the variables to represent the macro environmental conditions and the air transport policy and regulatory conditions based on the literature reviewed in chapters 1 and 2. Second section presents the profiles of the airport groups along the selected macro environmental variables based on the analysis of variance (ANOVA) conducted. Third section further profiles the airport groups on the variables chosen to represent the air transport policy and regulatory conditions. Drawing upon the findings of the previous two sections, the fourth section bring forth the role of government in airport development in the East. Final section concludes the chapter by highlighting the important findings.

5.2 Identification of key drivers of an airport's external environment

The review of literature on aviation competitiveness, determinants of hubbing and policy and regulation of air transportation (section 2.7.2) established the hypothesis that *'the role played by an airport in the global aviation network is determined by the conditions of the national aviation industry and the factors that shape up the general macro environment of a country'* (section 2.7.8). Based on this hypothesis; geography, economic development, demographic trends, business attractiveness, tourism attractiveness, intellectual and physical infrastructure, and the political and administrative framework of a country, were identified as key elements that shape up the general operating environment of a country that influence the air transport (in turn airports) industry (section 2.7.2.1

to section 2.7.2.7). The review also highlighted the importance of the air transport industry specific policy and regulatory conditions for the successful operation of airlines and airports. Policies and regulations on market access, taxation, entry and exit, ownership and structure of national regulation were reviewed.

As explained above, based on the literature review and hypothesis generated, the following eight elements are selected in evaluating the macro environmental conditions and the air transport policy and regulatory conditions of the airport groups in the sample. Under each element, several variables are introduced to measure different dimensions.

5.2.1 Geography

a. Relative geographical advantage – Routing Factor

There are several dimensions to relative geographical advantage of an airport. They are relative location against major air traffic flows, population, and competition (section 2.7.2.1). Among these, the desirability of the location of an airport with respect to the major air traffic flows shows the potential of an airport to develop as a hub. Since the focus of this analysis is on identifying the driving factors behind the differences in the airport hierarchy, it is useful to assess the location of an airport in relation to its hubbing potential. This is assessed by using the routing factor (RF) for each airport (Bootsma, 1997; Burghouwt and de Wit, 2005; Redondi, Malighetti and Paleari, 2011; Veldhuis, 1997; Wenkan, Miyoshi and Pagliari, 2012). To recall from section 2.7.2.1, RF is calculated by,

$$Detour\ factor = \frac{(Great\ circle\ distance\ for\ Leg\ 1) + (Great\ circle\ distance\ for\ leg\ 2)}{Great\ circle\ distance\ between\ Origin\ and\ Destination}$$

For this study, RF is taken as an average figure of ten major air traffic flows (pairs of destinations) of the top ten region-pairs (in terms of seat capacity) connected via the Eastern region as of May 2012 (Table E-1). For each region-pair the routes with the highest seat capacity made available were selected as given below.

1. Southwest Pacific-Western Europe: Sydney- London Heathrow (SYD-LHR)
2. Southwest Pacific-North America: Sydney-New York (SYD-JFK)
3. Southwest Pacific-Eastern Europe: Sydney-Moscow (SYD-DME)
4. Southwest Pacific -Western Africa: Sydney-Nairobi (SYD-NBO)
5. Western Europe- Western Africa: London Heathrow-Nairobi (LHR-NBO)
6. Western Europe-North America: Paris- Honolulu (CDG-HNL)
7. Southwest Pacific- Eastern Africa: Sydney-Cairo (SYD-CAI)
8. Western Europe-South Africa: London Heathrow- Johannesburg (LHR-JNB)
9. Western Africa- North America: Nairobi-New York (NBO-JFK)
10. Western Africa- Eastern Europe: Nairobi-Moscow (NBO-DME)

b. Country Size

Additionally, country size (area) is proposed as a variable representing the condition of demand in the domestic market. Itani, O'Connell and Mason (2014) have proposed country size as an essential factor condition that determines the competitiveness of the air transport system at a national level. A larger geographical area creates the barrier of 'distance' to accessibility and mobility. By far air transportation takes a leading role in time-space convergence (Rodrigue, Comtois and Slack, 2006). Thus, need for a domestic network would largely be driven by the geopolitical boundaries of a territory.

5.2.2 Demographic trends

The total population and the percentage of urban population are both used to identify the demographic profiles of the airport groups.

a. Population

In section 2.7.2.3, it was identified that population is an important OD traffic driver, which is a prerequisite for successful hub operations (Button, 2002; Dennis, 1994a; Doganis, 2002; Rodriguez-Deniz, Suau-Sanchez and Voltes-Dorta, 2013). A strong local market attract direct services by international airlines, which increase both the direct and indirect connectivity of the airport through the city-pairs multiplier effect. It also provides opportunities for the learning and growth.

b. Percentage of urban population

Section 1.1.4.2 identified urbanisation as one of the major structural transformation of demographics in Asia. Urbanisation indicates the degree of agglomeration in a society, which creates more opportunities for people to raise their income levels and consumption of goods and services. Agglomeration is the starting point of mega cities. Rise of mega cities is strongly associated with the development of airport cities and aerotropolises. Airbus (2014, pp.50-51) have forecasted that nearly 1/3 aviation mega cities in 2033 will be from the region of Asia and Middle East. Therefore, inclusion of this variable is useful in assessing the degree of demographic structural transformation associated with different airport types.

5.2.3 Level of economic development and stability

a. Level of economic development - Gross Domestic Product (GDP)

The relationship between economic activity and air transportation was central to the discussion of this thesis from the beginning (section 1.1.1, 1.1.4.1, 2.2, and 2.7.2.2). As identified in section 2.7.2.2, both, level of economic development and stability of the economy are used to measure the condition of the economy. GDP per capita (US$) is used as the indicator of the level of economic development, because the rise in income levels has a direct influence on demand for air travel.

b. Economic Stability

A stable economy reduces the risk of economic recession (WEF, 2012), and increase the credibility of a country from a foreign direct investment perspective. Air transportation is a global industry and is very much affected by the condition of the global economy. This could be observed during the 2008/09 economic recession. Therefore, a collective index of economic indicators is introduced to assess the degree of stability of the macroeconomic environment. This index (Pillar 3) by WEF (2012) is the simple average of 1-7 best scores of five macroeconomic variables; government budget balance, gross national savings, inflation, government debt, and country credit rating (see, Table B-1 for details of items).

5.2.4 Business Attractiveness

As indicated in section 2.7.2.4, business travel is one key segment in the global travel market. Attractiveness of a country's business environment is a key driver if airport OD traffic. It is also indicates the potential for business cluster/aerotropolise development, which in turn promote the development of aviation mega cities. The role of the airport catchment area as a business centre has also been used as an explanatory variable in the hub location determinant studies (Butler and Huston, 1999; Huston and Butler, 1991, 1993).To assess attractiveness of the business environment of a country, the Ease of Doing Business (EDB) index by The World Bank is proposed here. The index ranks 185 economies on a scale of desirability of doing business in a country by looking at a number of aspects of regulatory facilitation of business. They are - starting a business, dealing with construction permits, getting electricity, registering property, getting credit, protecting investors, paying taxes, trading across borders, enforcing contracts and resolving insolvency (World bank Group, 2013). EDB is a relative ranking of countries based on the above areas. The World Bank Group also produce a supplementary "Distance-to-Frontier" measure for the EDB which quantifies the absolute quality of the regulatory environment of each country to the frontier score. The frontier score is derived from the most efficient or best practice across all the index components. This measure is used as a proxy for the attractiveness of each airport's business environment. The values range from 0-100, worst to best scale.

5.2.5 Tourism Attractiveness

As identified in section 2.7.2.5, the role of tourism in the airport industry is assessed here from an inbound travel perspective. Attractiveness of a country as a tourist destination would determine the demand for inbound tourism. Studies on hub determinants and aviation competitiveness have used tourism demand as a driving factor of air travel (Bauer, 1987; Butler and Huston, 1999; Huston and Butler, 1991, 1993; Itani, O'Connell and Mason, 2014).

Four pillars from the TTCI by WEF (2013) are proposed here to assess the degree of attractiveness of the destination in attracting inbound tourists. They are;

a. Level of natural and cultural resources and the openness of a country to receive foreign visitors (affinity) (Pillars 12, 13, and 14),
b. The prioritisation of tourism by the government as a key industry (Pillar 5)
c. Price competitiveness of a country in terms of accommodation, fuel, taxation etc.; (Pillar 10) (items measuring airfare and ticket taxes were excluded) and,
d. Level of tourism infrastructure such as hotels, car rental etc. (Pillar 8),

These are measured across a 1-7 best scale, which has been summed up to take the simple average for each index (see, Table B-2 for items of measurement under each pillar).

5.2.6 Intellectual and physical infrastructure

Level of physical infrastructure and human capital were identified as fundamental factor conditions of global competitiveness in section 2.7.2.6. Therefore, following two variables are introduced to assess the level of infrastructure.

a. Intellectual infrastructure

Knowledge is a key efficiency enhancer, which is fundamental to today's innovation driven economies (WEF, 2012). Accordingly, in this study, the quality of human resources is assessed based on the opportunities offered for primary education, higher education, and research and training. GCI (WEF, 2012) have four sub-indexes representing the following items on a 1-7 best scale. Average of the four indexes are taken here to represent the level of intellectual infrastructure (see, Table B-1 items of measurement under each sub-index).

1. Primary education (Sub-index 4.B)
2. Quantity of higher education (Sub-index 5.A)
3. Quality of higher education (Sub-index 5.B)
4. On-the-job training (Sub-index 5.C)

b. Physical infrastructure

A quality transportation system is essential for a sound logistics and transport system. Likewise, access to health, electricity, water, and telecommunication facilities are primary needs of society. Therefore, physical infrastructure is assessed through the level of transportation health, electricity, and information communication technologies (ICT). Similar to the intellectual infrastructure, a common index is calculated by taking the simple average of the following four sub-indexes representing the above elements in the GCI by WEF (2012). The index is on a 1-7 best scale (see, Table B-1 items of measurement under each sub-index).

1. Transport infrastructure (excluding air transportation) (Sub-index 2.A)
2. Electricity and telephony infrastructure (Sub-index 2.B)
3. Health (Sub-index 4.A)
4. ICT use (Sub-index 9.B)

5.2.7 Political and administrative framework

Section 2.7.2.7 showed that the operating framework of the air transport industry of a country is a result of interplay between policies and regulations at three levels. They are; international regulations (ICAO), national political and administrative framework and state-level air transport policy and regulations (Figure 2-10). Section 2.7.2.7.3 identified significance of the elements in the political environment on the air transport industry. Frist, ethical behaviour, accountability, and efficiency of both public and private institutions of a country have a strong influence on the framework governing the air transport industry. It affects the organisational culture, corporate ethics and performance of relevant aviation stakeholder organisations and the formation of policies governing the industry. Second, the degree of safety and security is of primary importance for tourism and air transport industries. Therefore, it is important to have an assessment of the condition of the political environment of a country in the process of identifying external environment factors that have an influence on an airport's growth. Diverse aspects of political and administrative organisations of a country are assessed through the ‘institutions’ pillar in the GCI by WEF (2012). This is proposed as a proxy for assessing an airport’s political environment. It is an index on a 1-7 best scale, which provides a measurement of the following items (see, Table B-1 items of measurement under each sub-index).

1. Public Institutions (Sub-index 1.A)
   i. Property rights
   ii. Ethics and corruption
   iii. Undue influence
   iv. Government efficiency
   v. Security
2. Private Institutions (Sub-index 1.B)
   i. Corporate ethics
   ii. Accountability

5.2.8 Air transport policy and regulatory environment

Section 2.7.2.7.2 identified two components to the national regulatory structure of air transport: the organisational component and the legal component. The following variables are introduced to capture the elements of the national policy and regulatory system, which is important to the operation of airports.

a. Degree of liberalisation (legal component)

A liberal approach to the regulation of air transportation will have an impact on the regulatory system governing air transport. Among them, a government’s attitudes to free trade and liberalisation particularly influence policies on entry into ASAs, taxation of air transport activities and regulations on entry of visitors to a country. These elements have a considerable impact on the operation of airports in terms price competitiveness to attract airlines and traffic generation. Three indexes - openness of BASA, ticket, taxes and airport charges, and visa requirements are used to evaluate the degree of liberalisation.

1. Openness of BASA - Air Liberalisation Index (ALI)

The Air Service Agreement Projector (ASAP) by World Trade Organisation produces the ALI index on a ‘highly restrictive to very open’ scale of zero to fifty (0-50). It is a weighted index on the features of market access agreed in a BASA. They are; grant of traffic rights, tariffs, capacity, designation, withholding (ownership), statistics, and cooperative arrangements. For each BASA entered into by a signatory (country), a score is calculated based on the weights assigned for each feature. It is also weighted by the respective traffic on the routes they cover. This study uses the “Standard ALI”[14].

2. Ticket taxes and airport charges index

This index assesses the ‘relative cost of access to international air transport services’ (WEF, 2012) in a country based on airport charges for narrow-body and wide-body passenger plane arrival and departure[15], ticket taxes[16] and value added taxes[17] on a 0-100 (highest to lowest) scale. WEF (2012) produces the index based on the data from IATA manuals and Schedules Reference Services (SRS) Analyser.

3. Visa requirements

This is a lowest to highest index weighted on the ease of obtaining visa by all United Nations (UN) countries. The weights assigned are; 1= visa exempt, 0.7= visa upon arrival, 0.5=electronic visa, and 0= visa required prior to departure. A count of the number of countries in each category is weighted by the respective

[14] ASAP has four variants of the same index based on different weights for different market access features. In addition to the “standard” system, the other three variants each give comparably more weight to one market access feature, namely fifth freedom traffic rights (5th+), liberal withholding/ownership provisions (OWN+), multiple designation (DES+) They are devised to accommodate different geographical and economic situations (ASAP, 2011). Details on the index are accessible through https://www.wto.org/asap/resource/data/html/methodology_e.htm.

[15] Charges include landing, terminal navigation, and passenger and security charges as listed in the IATA Airport and Air Navigation Charges manual (WEF, 2012).

[16] Ticket taxes applicable to international travel are applied as described in the IATA List of Ticket and Airport Taxes and Fees manual. Per-passenger charges are calculated by applying a 75 percent load factor to a typical seating configuration of each type of aircraft (WEF, 2012).

[17] Value-added taxes (VATs) are calculated based on an average ticket price for each country, applied to half of the departing passengers, because the VAT is normally charged only on itineraries originating in the country concerned (WEF, 2012).

value and summed up to arrive at a figure for each country. This data is produced by the World Tourism Organisation, which is subsequently used in the TTCI by WEF (2013).

b. Ownership and operations models of airports (organisational component)

The organisational component consists of the institute/s vested with authority to regulate every aspect of air transport (economic and technical) within the territory of the state (section 2.7.2.7.2). Thus, the degree of autonomy enjoyed by an airport operator is a result of the approach to deregulation in the air transport industry of the country in question. Section 2.7.2.7.2 identified several approaches to airport ownership and operation (Figure 2-11) that a State can adopt depending on the degree of autonomy sought. Information on ownership and operations models of the sample airports are collated to identify how far the airport industry of each country is allowed to operate as an autonomous industry. This indicates a government's promotion of commercialisation and encouragement of private participation.

5.3 Data and Analysis

In the previous section, eighteen (18) proxy measures were proposed to represent the different dimensions of the macro environmental elements and the air transport policy and regulatory environment. The respective measures, sources, and the timing of the data gathered are given in Table 5 -1. Seventeen of those measurements are metric data that has a meaning to its scale. The information on ownership and operation models are categorical data (the type of ownership model). Majority of the index-based data comes from the GCI (Figure 2-8 and Table B-1) and TTCI (Figure 2-9 and Table B-2) by WEF (2012, 2013) which was explained in section 2.7.1.2. Both indexes are developed using secondary quantitative data available from diverse sources (indicated in Table 5-1 where necessary) and the Executive Opinion Survey carried out by the Institute. Therefore, they have captured a wider perspective on the dimensions addressed above. In addition to the above quantitative data used in the statistical analysis, the discussion is supplemented with information gathered from different sources (indicated earlier in section 3.4.1) and empirical literature related to the themes under discussion. In-text references are provided to the information sources as and when they are used in the discussion of results in section 5.3.Triangulation of results from the statistical analysis and information from these additional sources further validate the researcher's judgement on the findings related to the second objective of this study.

Table 5-1 Measures and data sources used in the macro environmental profiling of airports

Macro environmental element	Measure	Data Source
Geography	Routing factor	Great Circle Mapper (2012)
	Country Size (Km^2)	CIA World Factbook (2012)
Level of economic development and stability	GDP Per capita (US$)	World Development Indicators Database-World Bank (2012)
	Macroeconomic Stability	World Economic Forum (2012)
Demographic trends	Total Population % Urban Population	United Nations, Department of Economic and Social Affairs, Population Division (2014)
Business Attractiveness	Distance-to-Frontier in Ease of Doing Business	World Bank Ease of Doing Business (2013)
Tourism Attractiveness	Cultural and Natural resources and Affinity for Tourism Tourism Infrastructure Government Prioritisation of Travel and Tourism Price Competition	Travel and Tourism Competitiveness Index- World Economic Forum (2013)
Intellectual and Physical Infrastructure	Education (human resources) Physical Infrastructure	Global Competitiveness Index - World Economic Forum (2012)
Political and Administrative Framework	Institutions	Global Competitiveness Index - World Economic Forum (2012)
Air transport policy and regulatory conditions	Openness of BASA	Air service Agreement Projector- World Trade Organisation (2012)
	Ticket taxes and airport charges	Travel and Tourism Competitiveness Index- World Economic Forum (from IATA) (2013)
	Visa Requirements	Travel and Tourism Competitiveness Index- World Economic Forum (from World Tourism Organisation) (2013)
	Ownership/ Operation	CAPA, Flightglobal Dashboard and airport websites (2012/2013)

Source: Own elaboration

The airport taxonomy developed in chapter 4 is evaluated to determine whether there are significant differences between the macro environmental profiles of different airport groups that may have influenced their strategic positioning in the

Eastern aviation network. As explained in section 3.4.2.3, ANOVA is conducted to identify between group differences for the seventeen metric variables. Data on airport ownership and operations models are descriptively compared to assess the differences. The comparison could only be carried out for seven airport groups that included the major designated international airport of each country in the sample, because the national level indicators used in the study were common to all the airports in a particular country. The seven groups were - primary international hubs, secondary international hubs, medium international airports, small international airports, primary hybrid airports, medium hybrid airports and small hybrid airports. Due to the limitation of data availability, small hybrid airports group was not included in the ANOVA for certain variables as indicated in the footnotes to Table 5-2.

5.4 Macro environmental profiles of airport clusters

Table 5-2 and Figure 5-1 present the profiles of the seven clusters on the country level macro environmental variables. At the outset, a key observation is that, while there are certain significantly different features between-clusters, considerable within-cluster variances are also visible when standard deviations are examined. Primary international airports and hybrid airports are significantly different to other clusters for most of the variables. As expected best-in-class values for most of the environmental elements are associated with these two clusters of airports which are at the top of the hierarchy, justifying the relationship of a sound macro environment and size (degree of activity) of airports. Behaviour of each environmental element across the groups are discussed with reference to the results of ANOVA in Table 5-2 and group profile charts in Figure 5-1 below.

Table 5-2 Macro environmental profiles of airport clusters

Variables		Small International Airport (Cluster 2)	Medium International Airport (Cluster 6)	Secondary International Hubs* (Cluster 9)	Primary International Hubs (Cluster 12)	Small Hybrid Airport** (Cluster 4)	Medium Hybrid Airport (Cluster 8)	Primary Hybrid Airports (Cluster 11)	Levene's Statistic (Sig<0.05)	ANOVA *F* (Sig<0.05)	Welch's *F* (Sig<0.05)	Country sample
Average routing factor (intercontinental flights)	*Mean*	1.44	1.18	1.25	1.60[1]	1.34	1.32	1.55	*.074*	*.002*[a]		*44*
	Std. Dev	*0.20*	*0.04*	*0.10*	*0.19*	*0.08*	*0.21*	*0.15*				
Country size	*Mean*	357789	107503	35875	99837	992132	1356671	2745575	*.000*		*.040*[b]	*44*
	Std. Dev	*480274*	*139145*	*36438*	*142299*	*1173894*	*935160*	*3292316*				
GDP per capita (US$)	*Mean*	4235	17700	47349	40000	3468	13248	4464	.000		.011[c]	44
	Std. Dev	*8180*	*12390*	*37417*	*17341*	*4842*	*13668*	*3163*				
Macroeconomic environment	*Mean*	4.47	4.63	5.76	5.66	5.15	5.48	5.23	.741	.231		44
	Std. Dev	*1.01*	*1.41*	*1.27*	*1.02*	*1.29*	*1.66*	*0.73*				
Population (millions)	*Mean*	17	5	7	38[2]	57	81	615[3]	.000		*.056*[d]	*44*
	Std. Dev	*20*	*2*	*8*	*50*	*64*	*71*	*635*				
% of Urban Population	*Mean*	45%	84%	77%[4]	88%	35%	58%	45%	.029		.000[e]	44
	Std. Dev	*23*	*8*	*35*	*11*	*13*	*28*	*15*				
Distance to Frontier of Ease of Doing Business	*Mean*	55.3	65.0	65.5	81.8	48.6	63.8	61.5	.720	.000[f]		42
	Std. Dev	*8.9*	*6.0*	*6.0*	*7.9*	*10.1*	*6.3*	*10.7*				
Cultural /Natural resources and Affinity for Tourism	*Mean*	3.18	3.47	3.35	4.36	2.83	3.44	4.59	.195		.000[g]	34**
	Std. Dev	*0.32*	*0.06*	*0.59*	*0.44*	*0.09*	*0.47*	*0.44*				
Tourism Infrastructure	*Mean*	1.89	4.67	4.26	4.59	2.38	3.37	3.12	*.146*		*.002*[h]	*34***
	Std. Dev	*0.73*	*0.61*	*1.28*	*0.71*	*1.05*	*1.54*	*1.05*				
Government Prioritisation of Travel and Tourism	*Mean*	4.11	4.91	4.14	5.07	3.58	3.79	4.77	.521		.145	34**
	Std. Dev	*0.99*	*0.51*	*1.12*	*0.67*	*0.82*	*0.62*	*0.65*				
Price Competition	*Mean*	4.93	4.38	5.00	4.55	4.85	5.17	5.14	.037	.173		34**
	Std. Dev	*0.67*	*0.67*	*0.22*	*0.58*	*0.44*	*0.02*	*0.18*				
Physical Infrastructure	*Mean*	3.64	4.55	5.03	5.60	4.13	4.16	4.23	.006		.005i	34**
	Std. Dev	*0.63*	*0.81*	*0.28*	*0.58*	*1.17*	*1.03*	*0.36*				
Intellectual Infrastructure	*Mean*	4.09	5.04	5.01	5.43	4.45	4.19	4.76	.035		.031[j]	34**
	Std. Dev	*0.56*	*0.46*	*0.39*	*0.46*	*1.14*	*0.88*	*0.31*				
Institutions	*Mean*	3.64	4.44	4.97	5.20	3.58	4.34	4.03	.106		.001[k]	34**
	Std. Dev	*0.63*	*0.88*	*0.72*	*0.70*	*0.53*	*1.16*	*0.44*				

[a]Cluster 11 and 12 are significantly different to 6 and 9, and cluster 2 is significantly different to 6
[b]Cluster 11 is significantly different to 2,9, and 12
[c]Cluster 12 is significantly different to 2,4 and 11
[d]Cluster 11 is significantly different to all others
[e]Cluster 12 is significantly different to 2,4,11 and cluster 2 significantly different to 6
[f]Cluster 12 is significantly different to all others
[g]Cluster 11and 12 are significantly different to all others
[h]Cluster 2 is significantly different to 6,9, and 12
[i]Clusters 9 and 12 are significantly different to 2and 11
[j]Cluster 2 is significantly different to 9,11, and 12
[k]Cluster 2 is significantly different to 9 and 12
***** ANOVA was conducted both excluding/including Abu Dhabi (since UAE country data are common for both), but did not influence the results of significance and group differences
** ANOVA for these variables were not conducted for Small Hybrid Airports, due to the small group size of 2
[1]Avearge routing factor for Dubai is 1.22
[2]Average population is 7 million for the three 'super hubs'- Dubai, Singapore and Hong Kong
[3]Average population is still the highest at 110 million excluding India and China
[4]Average urban population is the highest at 92% excluding Colombo

Source: own elaboration based on SPSS 22 output

Figure 5-1 The macro environmental profiles of airport clusters

Source: Own elaboration

5.4.1 Geographic advantage

a. Relative geographical advantage – Routing Factor

The average routing factor (1.6) is highest for the primary international hub group. Primary hybrid airports group also record the second highest (1.55) value. The values of these two groups are statistically significantly higher than the values of medium non-hub international airports group and secondary international hub group. The medium non-hub international airports group (Muscat, Tel-Aviv, Amman, and Beirut) enjoys the best routing factor of 1.18. Except for the small international airports group, the values are not significantly higher for other airport groups (Table 5-2).

From the perspective of connecting continents, this result is contradictory to the international connectivity levels (flow centrality measures) displayed by the primary hubs (Table 4-11) in the market. Therefore, it can be argued that this is a subjective measure. The argument stands true since the airports were evaluated across 10 routes only. If circuitry was calculated for each airport based on the top densest routes (flown via the East), instead of the densest route of the top ten region-pairs (flown via the East), the results would have been different. Because, all the densest routes flown via the East (Table 1-3) are in the Southwest Pacific – Europe region-pair. This route group is well served by the primary international hub group for which they record routing factors closer to 1 (almost 1 for Hong Kong). Table E-2 provides individual routing factors for each airport for all the ten routes analysed. Serving multiple destination-pairs along the Southwest-Europe diagonal route have enabled them to offer higher connectivity in the intercontinental markets. However, the objective here was to benchmark the airports against a standard rule to evaluate the geographical positioning to connect multi-directional region pairs. In the primary and secondary international hub categories, airports of Dubai, Abu Dhabi, Doha, Bahrain, and Kuwait have smaller RF (average 1.22) values compared to the other airports in the two groups. In that sense, the evaluation sheds light on the geographical advantage of Middle East and Central Asian airports. Northeast Southeast, and South Asia are relatively disadvantaged (in descending order) to serve multi-directional continent-pairs.

A question that needs answering here is then, ‘why all the Middle East airports are not either primary or secondary hubs and why a single airport in Central Asia is not providing significant continental connections to qualify as a hub?’ The extant literature on the subject provides the answer to this. The studies on hub centrality (Fleming and Hayuth, 1994) and determinants of hubbing (Butler and Huston, 1999; Dennis, 1994a; Huston and Butler, 1991, 1993), state that relative location is only a qualifier for hub status. Benefit of location should be combined with necessary factor endowments to convert it into a sustainable advantage. The results of this analysis further validates the above fact. For example, on the routes between airports in the African region and the airports in the European, Russian, and North American regions, the primary hubs (Tokyo-Narita, Singapore, Hong Kong) and primary hybrid airports (Bangkok and Kuala Lumpur) have higher RFs compared to the RFs of small international airports group. So they are less advantaged in terms of connecting multi-regions. However, these airports have fully exploited their geographical (RF) (Table E-2) advantage on the routes between airports in Southwest Pacific and airports in Europe, Russia, North America, and North Africa, in order to become leading continental hubs in the region.

b. Country Size

Country size is strongly associated with the type of airport. The bigger or the more dispersed the land area is the greater is the tendency for the airport to be a multipurpose hybrid hub. The primary hybrid hub group’s country size is larger than other airport groups and is statistically significantly different to the country sizes of small international airports, secondary international hubs and primary international hub groups (Table 5-2). Both China and India contribute to raise the average land area of this group. However, even without these two countries, the average land area of the groups is larger than the area of countries with international airport clusters. Even though it is not statistically substantiated, medium and small hybrid airport groups also have comparatively larger average land areas. The conclusion is that primary hybrid airport groups are located in those countries that are geographically dispersed, either owing to larger land mass (China and India) or separated by sea (archipelagos of Malaysia, Indonesia and Philippines). These features demand airports to provide multi-level connectivity at domestic, regional and international markets that has shaped their 'hybrid' nature. This is the main feature that has contributed to the network differences of primary hybrid airports group and the Tokyo- Narita airport, which belongs to the primary international hub group. Even though Tokyo-Narita serves a similar geographical entity (Japanese archipelagos), it plays a limited domestic role as highlighted in section 4.6.1. The alternative Tokyo-Haneda has taken up the domestic role.

5.4.2 Demography

Similar to the effect of country size, the population size in the primary hybrid airport cluster is statistically significantly higher than all other airport clusters. The argument in section 5.4.1 is valid here as well (Table 5-2). In order to connect geographically dispersed populations to the international markets, an airport has to take up a 'gateway to the domestic market role'. The percentages of urban population in the primary and small hybrid clusters are statistically significantly lower (below 45%) than the percentages in the primary international hubs (88%). In order to keep populations in remoter regions connected to the primary local markets, the major airports in the country need to operate services to those local points. Therefore, these airports have to play multiple roles in the market that shape their network into a hybrid nature.

The above positive relationship between the percentage of urban population and degree of international hubbing proves that higher the proportion of urban population, the greater is the opportunity to connect the airport to international markets. Urban agglomerations create more demand for international passenger and freight transport, because working populations (e.g. expatriates) have come from different parts of the world and industries require efficient transportation of goods and transfer of knowledge. Some examples of this are; Tokyo which is the world's largest urban agglomeration, and Singapore, Hong Kong, Qatar and

Kuwait, which are among the top ten most urbanised city-states in the world (United Nations, Department of Economic and Social Affairs, 2015). In most of the Middle East countries, the majority of the working population are foreigners (International Labour Organisation, 2016) The other factor that has influenced higher levels of agglomeration in Gulf countries is the natural geography. The desert terrains have limited the dispersion of population in these countries.

On the other hand, lower levels of agglomerations suggest the potential for an airport to drive urbanisation by encouraging an agglomeration of industries and thereby clustering working populations around them. This has been the strategy of the Chinese government, using airport development as a tool for spreading the benefits of Chinese economic reforms (Williams, 2006). China and India are forecasted to become the countries with the greatest number of 'Megacities' (cities with a population of more than 10 million) by 2030 (United Nations, Department of Economic and Social Affairs, 2015). However, there are within-cluster variances that draw different conclusions to the above. Macau is a 100% agglomerated society, but is in the small international airport cluster. On the other hand, Sri Lanka, which is in the secondary hub cluster, has the smallest percentage of urban population in the sample (15%).

5.4.3 Economic environment

The average GDP per capita value associated with primary international hubs (USD 40, 000) is significantly higher than that of small international (USD 4,235) and hybrid (USD 3,468) airports (Table 5-2). This corresponds with the theory of positive relationship between economic development and level of air transport activity. Primary international hub group is also significantly different to the primary hybrid airports, which has a relatively low average GDP per capita (USD 4,464). India strongly influences the averages with a per capita GDP of 1,492 USD, which is the lowest in the group. However, except for Malaysia, all the other countries in the sample have a GDP of less than 6,100 USD per capita (World Bank, 2012). The lower national averages are partly because of the large populations in these countries. For example, the GDP per capita of Bangkok is three times larger than the national average of Thailand (World Bank, 2012).

The leading international hubs and primary hybrid airports belong to newly industrialised countries. Empirical research in the area (Airbus, 2014; Bowen, 2000; Brunner, 2013; O'Connell, 2006; Tsai and Su, 2002; Vespermann, Wald and Gleich, 2008; Williams, 2006) have pointed out that the economies of hub pioneers in East Asia and The Middle East have anchored their growth around the development of manufacturing, business services, industries and tourism. These factors have stimulated the development of HS networks. The establishment of the manufacturing arms of multinational corporations and the growth of native brands into global brands have intensified the requirements of real-time logistics solutions around the mega cities such as Dubai, Singapore, Kuala Lumpur, Bangkok, Hong Kong, Tokyo, Seoul and Taipei. This has promoted the growth of aviation networks in those countries. As a result, the region has become the home for some of the major aerotropolises in the world (Kasarda, 2006, 2008, 2015; Yeo, Wang and Chou, 2013). These are agglomerations of both light and heavy manufacturing industries, high-tech industries such as multimedia and information technology, biotechnology, aviation industries (including manufacturing of aerospace equipment, maintenance, repair and overhaul services) catering and financial services. Dubai World Central, Singapore-Suntec City and Aerospace cluster, Seoul Incheon-Winged City, and Hong Kong-Sky City are a few examples (Kasarda, 2008). The chain of mega cities is expanding with Beijing, Jakarta, Manila, and potentially Mumbai and Delhi, which will provide seamless connections over the East Asian Development corridor and beyond (Brunner, 2013; De and Iyengar, 2014).

Average GDP per capita values between other airport groups are not statistically significantly different (Table 5-2). One major reason for this is the large within group variances. For example, the secondary international hub group records the highest per capita GDP (USD 47,349) owing to the four Middle East countries, especially Qatar, where the GDP is the highest in the world. In the group, Sri Lanka sits at the bottom for per capita GDP. This is because Sri Lanka's population is nearly twenty times larger than that of Kuwait, Qatar, Bahrain and UAE and the total GDP is four times lower than the average of Kuwait, Qatar and

UAE. However, when each airports relative hub-role within their respective regions are compared (Colombo in South Asia and the other four in the Middle East), Colombo takes up a more significant role in South Asia than that of Kuwait and Bahrain in the Middle East. Colombo airport's regional connectivity levels are higher than the other two airports even though their international connectivity levels are quite similar. Abu Dhabi and Doha stand out in terms of connectivity levels and per capita GDP. Macroeconomic stability is not statistically significantly different between any groups. This confirms the contention of the WEF (2013) that, while economic stability reduces the risks associated with economic recession in the long run, it does not necessarily ensure productivity in a country.

A key observation of the analysis is that the level of economic development (GDP per capita) is not significantly different between the medium and large airport groups in the taxonomy (Table 5-2). This concludes that, while wealth is a key differentiator of small airports from large airports (and hubs), wealth alone is not sufficient to achieve hub status. An example is Brunei Darussalam, which is a high-income country in Southeast Asia that is served by a small international airport. Thus, wealth is an essential requirement that raises the potential of a country to develop as a hub, but unless harnessed with correct aviation policy, wealth cannot deliver results alone.

5.4.4 Business attractiveness

The distance-to-frontier for EDB underlines the fact that conducive business environments increase the attractiveness of a country as a business destination. Business attractiveness of the countries with primary international hubs is statistically significantly higher (distance-to-frontier score for EDB is 81.8) than all the other airport clusters (Table 5-2). The profile charts (Figure 5-2) clearly show that the value of the index increases for each airport group, when they are arranged in the ascending order based on the degree of airport activity (size). As explained in the previous section, the level of development of businesses in the countries where the leading primary hubs are located has surely created a conducive environment for aviation industries to grow. This is one key element of airport competition nowadays. In addition to the distance to frontier values, the

EDB indicate the level of regulatory facilitation of businesses across different dimensions. For example, according to EDB data by World Bank Group (2013), in order to start a business in Hong Kong, Singapore, Malaysia, or Taiwan, it requires only three procedural steps compared to the fifteen steps in Brunei Darussalam or fourteen in China. The total tax rates as a percentage of profit are as high as 108% in Sri Lanka while it is only 11% in Qatar (World Bank Group, 2013). These differences explain the degree of industrial development in these countries.

5.4.5 Tourism attractiveness

c. Cultural /Natural resources and Affinity for Tourism

The quality of the natural and cultural resources and affinity for tourism in the primary international hubs and hybrid airports groups are statistically significantly higher than the other airport groups (Table 5-2). This provides an interesting case for further evaluation, given that most of the countries in the primary international hub group are known for their limited natural factor endowments such as cultural attractions and natural sites, factors which normally promote tourism (e.g. Singapore) (Henderson, 2007; Lohman et al., 2009). In terms of the number of world heritage natural sites[18], China (13), India (6), Indonesia (4), Japan (4) Vietnam, Malaysia, Thailand, Philippines, Sri Lanka and Nepal (each having 2) are ranked top in the region. In terms of world heritage cultural sites[19], China (70), Japan (32), India (31), Iran (24), South Korea (23), Vietnam (11), Mongolia (11), Indonesia (10) are ranked top in the region (WEF, 2013). However, not all the countries in the lists above have higher values for tourism attractiveness. Apart from the natural and cultural sites, the WEF (2013) also assesses attractiveness of a country on other factors like the quality of the natural environment, total known species, marine protected areas and policies on terrestrial biome protection, all of which affect the desirability of a region for visitors (these practices are hugely influenced by government policies towards them). For

[18] An item of measurement in ‘natural resources-pillar 13’ of TTCI (Table B-2)
[19] An item of measurement in ‘cultural resources-pillar 14’ of TTCI (Table B-2

example, according to TTCI data (WEF, 2013) while China is in the top of both lists above, it scores low on the affinity for tourism index and environmental sustainability practices.

The scores of tourism attractiveness for primary international hubs and primary hybrid hubs are higher because Japan, South Korea, China, India, Thailand, and The Philippines are rich in both natural and cultural heritage sites. However, other member countries such as Singapore, Dubai, and Hong Kong are not necessarily scored lower for not having natural factor endowments. Instead, they are ranked higher for their popularity as tourist destinations owing to the man-made tourist attractions that give them the modern tourism appeal. For example, Singapore as a tourism brand has surpassed the naturally endowed Southeast Asian countries such as Vietnam and Cambodia (UNWTO, 2016). Singapore has successfully developed a destination brand that carries the message of a ‘cosmopolitan, youthful, vibrant centre of modern Asia’ (Singapore Tourism Board, 2016). The Singapore authorities are involved in a long-term brand campaign with a series of slogans such as, 'Uniquely Singapore', 'Surprising Singapore', 'New Asia-Singapore', and 'Your Singapore' (Henderson, 2007; Morgan, Pritchard and Pride, 2002; Singapore Tourism Board, 2016). All primary hubs and hybrid airport destinations have had more than 60 international fairs and exhibitions[20] in 2012. The highest was 341 in Japan (ICCA, 2012). Likewise, these countries have developed a modern tourism appeal by incorporating MICE, shopping, and sports tourism. For example, Advantage Abu Dhabi, is an initiative to promote MICE tourism in Abu Dhabi (Abu Dhabi Convention Bureau, 2016). Qatar has secured the 2022 FIFA World Cup (CAPA, 2010a), geared to benefit from the presence of a global sports icon to improve the visibility of Qatar as a destination brand, which is an outcome of co-branding destinations with global sports (Xing and Chalip, 2006). Due to the openness maintained towards tourism in these countries, their affinity for tourism is ranked the highest. The results are

[20] An item of measurement in ‘cultural resources-pillar 14’ of TTCI (Table B-2)

in correspondence with WEF (2013, p.45) findings, that, in developed economies, affinity for tourism is 'most effective in driving stable inbound tourism growth'.

d. Government Prioritisation of Travel and Tourism

These initiatives to develop the general appeal of a destination are greatly influenced by the government policies towards tourism in those respective countries. The primary international hub group ranks the highest in government prioritisation of tourism (pillar 5). However, the rankings of government prioritisation of tourism are not statistically different between the airport groups (Table 5-2). The possible explanation to this is that the governments of the countries that are highly dependent on traditional inbound tourism as a major means of income generation, have always given high priority to the sector. On the other hand governments of modern tourist destinations assign high priority to tourism as well, because it is seen as a complementary income source and is developed parallel to other industries (Bowen, 2000). Traditional tourist destinations are more or less traffic generators and modern tourist destinations are more or less development-induced travel destinations. The difference in the definitions by Ivy (1993) and Lohman et al. (2009) of 'destination hubs' further justify this phenomenon.

e. Price competitiveness and Tourism Infrastructure

Degree of price competition is not significantly different between any airport groups (Table 5-2). Being competitive in prices is one key strategy of any tourist destination. However, it is interwoven with purchasing power parity (PPP), exchange rates, demand for exports in foreign markets, and currency differences (undervalue/ depreciation/ appreciation) between countries. Generally, in low-income countries the PPP is low, meaning that the cost of domestic goods is lower, but higher for imported goods. Therefore, it is difficult to say that price levels are different between countries of different airport types (although it may influence a traveller's decision on the holiday destination). An economy that is not strong (a weak economy) may be comparatively lower in costs to travel. However, it may not be conducive to businesses and may not have good infrastructure. For this reason, the country's attractiveness as a destination for diverse travel needs (business and MICE etc.) deteriorates. This is why there is a statistically significant difference in the tourism infrastructure of medium international airports, secondary international hub and primary international hub groups against the small international airport group. This, again, proves that government policy towards creating a conducive environment for business and tourism matters.

5.4.6 Infrastructure

The role of the physical and intellectual infrastructure in the development of a strong air passenger market is proved by the differences observed in the infrastructure indicators between hub airport groups and other airport groups (Table 5.2).

a. Physical infrastructure

Primary and secondary international hub groups have statistically significantly higher levels of transportation, health, electricity, and ICT infrastructure than small international airports and primary hybrid airports (Table 5-2). A good ground transport network and public transport services are beneficial for an airport in two ways. One is that they helps to improve the accessibility and logistics that are essential for both passengers (ease of access through public transport modes) and cargo (improve time to market) markets. For example, Singapore and Hong Kong (countries with primary hubs) rank first and second in the global logistics performance index (World Bank, 2012). The other reason is that a well-connected public transport system will reduce private transport use. It has been viewed as an opportunity for airport managers to reduce the negative environmental impacts of airports (Budd, Ryley and Ison, 2014). Having access to basic needs of health, sanitation and electricity may not differentiate a hub from a non-hub. However, they are essentials on one hand, to maintain the basic quality of life of a society, which in turn influences the quality of the workforce and on the hand to improve the attractiveness of the destination or the country for tourism and business. The rate of technology adoption and ICT use ensures that countries are adopting cutting-edge technologies in manufacturing and service provisions. The added benefit for the airport industry is the improvement of efficiency of service provision across diverse airport activities. The strong association of quality of infrastructure and levels of hubbing validate the importance of parallel development of other infrastructure alongside aviation infrastructure.

b. Intellectual infrastructure

Knowledge is a key gap between advanced and less developed countries. There is a statistically significant gap between the levels of intellectual infrastructure of the countries with medium international airports, secondary international airports and primary hub airports and the countries with other airports (Table 5-2). Examining the data further, globally, Cambodia is ranked 111th in higher education and training, which is served by two small international airports. In the primary hybrid airport group, India and Indonesia are ranked 86th 73rd respectively. On the other hand, Singapore, Japan UAE and Qatar whicha re served by secondary and primary hubs are ranked 2nd, 22nd, 37th, 33rd respectively (WEF, 2012). The two Arab countries provide an interesting example of the importance of knowledge/human capital. In the post-colonial era the main factor that differentiated the oil rich Arab countries from the other developed economies in the world was the low levels of human capital (Zahlan, 2007). This has been counteracted in the short to medium term by using expatriate knowledge. The governments have a long-term strategy of improving the quality of higher education, research and training facilities within the countries and promoting knowledge acquisition abroad (Mohammed bin Rashid Al Maktoum Foundation and The United Nations Development Programme, 2014). For each year governments set targets for replacing expatriates with local experts. For example, under the Abu Dhabi Airport's Emiratisation Programme, recruitment of national talent has increased the Emiratis in the airport group up to 43% in 2014 from 24% in 2011 (Abu Dhabi Airports, 2015).

5.4.7 Institutions

The political and administrative frameworks of countries with small international airports score statistically significantly lower to those with secondary and international hubs. Though not statistically justified, small hybrid airports also score lower for the quality of institutions (Table 5-2). Apart from Malaysia, which scores 4.9 on the index, the other countries in the primary hybrid hubs category have scores below four (WEF, 2012). The results clearly explain the importance of a sound institutional environment in order to be competitive in the industry. When governments are inefficient, corrupted in awarding contracts, bureaucratic, over-regulate industries, and are not transparent, it does not create a conducive environment for industries to operate. Not only does it impose undue costs on businesses but it also slows down economic development. The inefficiencies penetrate into economic and industrial systems and private institutions as well, capturing the entire institutional framework in a downward spiral. The effect is particularly harmful when important industries and business entities are government owned. This is exemp01lified in the structural issues faced by the Indian aviation industry, even though it is one of the largest aviation markets in Asia (CAPA, 2015a). Similarly, Chinese aviation industry has also suffered until the government began restructuring its approach to business in the recent decades (Wang and Heinonen, 2015).

When the governments are focused, efficient and operate to correct failures of market economies or take an active role in directing the economy, the results can be rewarding, as in the cases of Singapore and Dubai, where their governments play an active role in aviation industry investments and direction (Bowen, 2000;Lohman et al., 2009). Changi Airport Group, the holding company of the Changi Airport is a 100% government owned company. Temasek Holdings Private Limited, which is also a government-owned investment company, holds the majority of the shares in Singapore Airlines (SIA). In Dubai, the Al Maktoum family governing the Sheikdom, has provided continuity and assistance to realise the long-term growth objectives of Dubai as an aviation hub (Lohman et al. 2009). The CEO of Dubai airports, Paul Griffiths, once quoted that, “in Dubai aviation is embraced as a strategic imperative” of the pro-aviation government policies (CAPA, 2010b). The ownership of the Emirates airline, Dubai airports and related aviation organisations are held by the sovereign wealth funds held by the Government of Dubai. While this model is questionable when it comes to fair competition in the market, these countries provide a good example of how efficient institutional frameworks promote successful aviation industries.

5.5 Air transport policy and regulatory conditions

The efficiency of the institutional frameworks of the countries in the region are at different levels and this has an impact on the regulatory frameworks of the aviation industries as well. This section assesses the impacts on the deregulation, liberalisation and privatisation policies in the aviation industry that may have influenced the role of an airport in the network.

5.5.1 Degree of liberalisation

Abdennebi (2014) defines connectivity in the context of global air transport "as the movement of passengers, mail, and cargo involving the minimum of transit points, making the trip as short as possible, with optimal user satisfaction, at the minimum price possible". This is a broad definition to the concept of connectivity provided by air transportation as an enabler of global economic activity and highlights the importance of regularity facilitation from different aspects, including air service agreements, border regulations, consumer rights and tax regulations.Table 5-3 and Figure 5-2 provide values and charts for the profiles of airports on the liberalisation indexes.

The average ALI scores increase with the increase in the degree of airport activity (size) of the airport groups (from small (less than 7) to medium/secondary (9-10) to primary (more than 12)). This clearly explains the importance of a more open approach to BASA for the growth of an airport (correlation between ALI and annual seat capacity is 0.463, Sig<0.01). The ALI for the primary international hub airports and hybrid airports are statistically significantly higher to the ALI of small international airports. When the ALI values are compared against the values of the 'Institutions' index above (Table 5-2 and section 5.4.7), even though not very strong, a certain degree of correlation between the two variables exists (0.438, sig<0.01). This shows the importance of positive government attitudes towards free trade and liberalisation, which in turn promotes liberal air transport policies. Both categories of small airports have scored lower in the 'Institutions' and ALI indexes.

Table 5-3 The cluster profiles for the degree of liberalisation variables

Variable	Statistic	Small International Airport	Medium International Airport	Secondary International Hubs	Primary International Hubs	Small Hybrid Airport	Medium Hybrid Airport	Primary Hybrid Airports
Openness of BASA(ALI)[a]	Mean	6.6	9.7	9.4	18.0	7.0	9.4	12.0
	Std. Dev	4.8	1.5	1.7	6.2	2.0	3.2	2.8
	Minimum	0.0	7.8	7.0	11.3	6.0	6.8	7.1
	Maximum	17.6	11.4	11.3	27.5	10.0	13.1	14.6
Ticket taxes and airport charges[b]	Mean	83.9	80.6	85.1	83.9	73.9	88.8	88.5
	Std. Dev	10.3	9.4	16.4	10.1	8.5	4.0	1.8
	Minimum	63.5	72.8	56.1	63.9	68.0	83.1	86.0
	Maximum	97.3	93.7	95.5	91.2	79.9	91.6	91.3
Visa requirement[c]	Mean	62.3	78.3	56.3	104.2	37.0	39.3	66.8
	Std. Dev	50.5	19.6	38.3	46.8	35.4	67.3	66.8
	Minimum	1.0	52.9	23.0	41.0	12.0	5.0	3.0
	Maximum	148.7	96.2	99.0	161.0	62.0	140.3	163.0

[a]Welch's F statistic 3.867 significant at 0.019 for sample of 43 countries in the seven groups. Primary international hubs and primary hybrid airports are significantly different to small international airports.
[b] F-statisctic 0.496 not significant (0.776) for a sample of 29 countries across 6 airport groups. Small hybrid group not included in the test due to lack of data
[c]F-statisctic 0.941 not significant (0.467) for a sample of 25 countries across 6 airport groups. Small hybrid group not included in the test due to lack of data

Source: Own elaboration based on SPSS 22 output

The mean values of the ALI are not significantly different across all the airport groups, because there is higher degree of variability in the scores between airports within each group. In the primary international hub group, the standard deviation is 6.2. The individual country values show that Taiwan and Japan are the most liberal in the group (27.5 and 23.6 respectively) which increases the average score. Singapore, South Korea, Hong Kong, and UAE rank accordingly with scores of 16, 14, 14, and 11.2 respectively. Values for these countries are not very different to those for India, Jakarta, Kuala Lumpur and The Philippines from the primary hybrid airport group that score 14, 14, 12.2 and 11.2 respectively. Vietnam and Pakistan from the medium hybrid group and Jordan from the medium international airport group have scores of 13, 10.9, and 11.9 respectively. The scores for Brunei Darussalam (17.5) and Macau (15) are higher than the average of the rest of the small international airports that stands at 5.4. Sri Lanka (8.3) and Kuwait (7) from the secondary international hub group are below the 50th percentile of the sample of 45 countries. These scores somewhat dispute the general belief held that the more open is the approach to BASA, the more traffic there should be. Likewise, when more liberal traffic rights are granted (5th freedom and beyond), the more transfer traffic there should be. When continental connectivity (international-international flow centrality) is compared with the ALI index, a weak correlation of 0.238 (sig<0.01) exists between the two variables. One interesting explanation to this is the exploitation of the 6th freedom traffic rights by the hub carriers based at these international hubs. Emirates (Dubai), Qatar (Doha), Etihad (Abu Dhabi), Singapore Airlines (Singapore), Cathay Pacific (Hong Kong), and Malaysian Airlines (Malaysia) are known for their strategies of exploiting 6th freedom rights by the use of the 3rd and 4th freedoms (Hooper et al., 2011; Murel and O'Connell, 2011; O'Connell, 2011).

Chapter 1 stated that the degree of liberalisation in the industry is at different stages for different countries in the region. Multilateral regional agreements that promote a free market approach are still fragmented (Cristea, Hillberry and Mattoo, 2014; Fu et al., 2015; Homsombat, Lei and Fu, 2011; Oum and Yu, 2000; Yeo, Wang and Chou, 2013; Zhang et al., 2009). They remain isolated and very restrictive, compared to their western counterparts such as The EU. The most liberal regional agreement to date, ASEAN, is also being cited as restrictive as it does not open up markets beyond 5th freedom rights (CAPA, 2013f). In addition, Brunei, Mongolia and Singapore are parties to the Multilateral Agreement on the Liberalization of International Air Transportation by Asia-Pacific Economic Cooperation Forum (the "Kona Agreement"/MALIAT) (ICAO, 2009). Agreement on the Liberalization of Air Transport of the Arab League States (Damascus Convention) which opened for signature in 2004 is the only other open-skies MALIAT approach to aviation in the region. Though thirteen countries have signed the agreement, only eight countries have ratified it (Directors General of Civil Aviation-Middle East Region, 2011).[21]

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21 The following countries ratified the Convention: Lebanon, Jordan, Syria, Palestine, Oman, Yemen, United Arab Emirates and Morocco. The following countries signed but did not ratify the Convention: Bahrain, Tunisia, Sudan, Iraq, Egypt and Somalia.

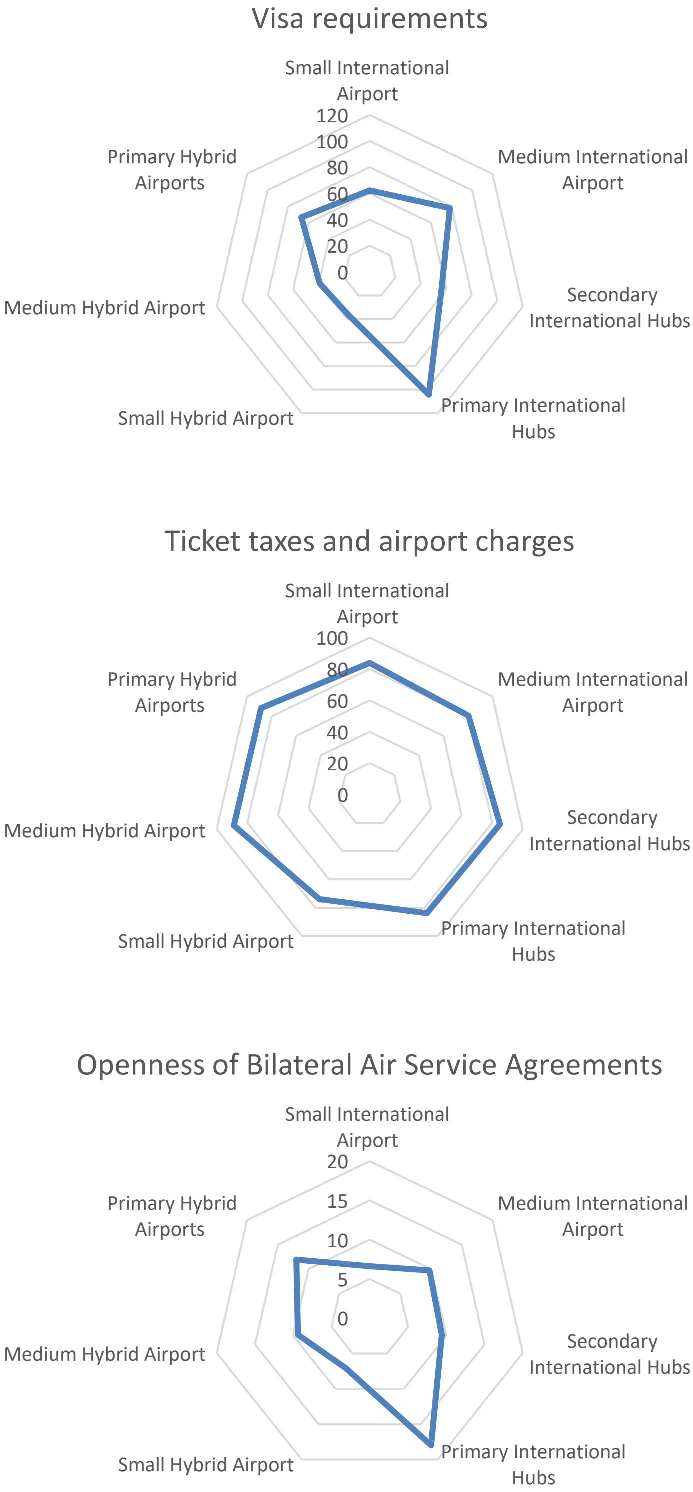

Figure 5-2 The cluster profiles charts for the degree of liberalisation variables

Source: Own elaboration

There are only bilateral open-skies agreements between countries in other sub-regions. In Northeast Asia, most of the bilateral open-skies agreements between Japan, South Korea and China have granted point-to-point access rather than granting multiple-point unlimited access (Kim and Lee, 2011). The Chinese government is very restrictive in fully liberalising its market and favours protecting the major state-owned airlines. Until recently, this has also curbed the growth of its LCCs (Fu et al., 2015). In South Asia, India has recently started liberalising and deregulating its markets to a certain degree, such as allowing up to 49% of foreign investments in Indian carriers (CAPA, 2012b). However, so far, no regional level MALIAT has been approached by the SAARC countries. Central Asia (part of the Commonwealth of Independent States (CIS)) is party to the Interstate Council on Aviation and Use of Airspace between the twelve independent States of the former Soviet Union. The Council is cooperating on safety, security and other issues. Despite being the fastest growing market in the recent years (Figure 1-11), regional liberalisation has not yet received the attention of the Council.

The mean values are not statistically significantly different between the airport groups for ticket, taxes and airport charges. The index scores are above 80 for all of the airport groups (except 74 for medium hybrid airports), on a 0-100, highest to lowest scale. This demonstrates the overall positive attitude of governments to ease the tax burden on air transport activities. The degree of regulation of airport charges is dependent on the government's relationship with the airport ownership and management (privatisation), and the level of competition in the industry (Graham, 2008a). Therefore, it is difficult to assess the degree of influence that governments have on setting airport charges. However, the majority of the airports in the region being under direct government ownership (39 out of 48 airports are either a department, an autonomous regulator or a corporation) (Table 5-4), it could be assumed that the governments' approach to promote airports is represented in the charges levied. The standard deviation of the mean airport charges in the secondary hub group is 16.4, indicating that there is a higher degree of variability within the group. Sri Lanka scores the lowest (56) in the group and is the lowest in the sample.

Although the visa requirements index is not statistically significantly different between groups, a pattern is observable across the scores of the index between international airport groups and hybrid airport groups (Figure 5-2). International airport groups have scored higher than the three hybrid airport groups in their respective size categories. Partly this may be because these countries have larger domestic markets and the domestic aviation industry has overshadowed the importance of international markets. The governments have not realised the damage of restrictive visa regulations in promoting international inbound travel. However, this conclusion should be reached carefully, given the higher degree of within-group variability of scores. For example, the standard deviation is as big as the mean in the primary hybrid airport category. China and India have the most restrictive border regulations (3 and 10 respectively). Malaysia and The Philippines (163 and 151 respectively) have the highest values in the group and in the entire sample as well. This represents the attitude of government towards inbound tourism. The values correspond with the results obtained in assessing tourism attractiveness of the countries discussed in section 5.3.4. This also shows the lack of policy coordination in certain countries in the region. In addition, the results highlight the advantage exploited by 6th freedom hubs. In most cases, passengers transferring between flights (unless crossing the country borders during the transfer) are not required to obtain visas. Therefore, a clear relationship between visa regulations and transfer passengers cannot be established.

5.5.2 Ownership and operations models of airports

It was noted earlier that the majority of the airports in the region come under direct government authority (Table 5-4). Of those, all of the fourteen airports with a department governing structure belong to the small airport category. Fifteen airports come under an autonomous regulator and ten are corporatized. Only nine airports are partly or fully privatised and of those five are concession contracts and four are either listed companies or joint stock companies with the government having a significant shareholding. In the primary hybrid group, India has progressed ahead in transferring operations of the two major international airports to private operators. Mumbai and Delhi were transferred to a consortium led by MGR Corporation for a 30-year concession in 2006. In addition, 100% foreign direct investments are allowed in Greenfield projects (ICAO, 2013c). Privatisation is seen as a step in the development of an airport from a public utility to a commercial enterprise (Graham, 2008a). It can be suggested that India, as an emerging market with huge potential for growth in the future, is in the process of transforming its airports into more commercial enterprises. Cambodia has also moved with awarding concession contracts for the management of Phnom Penh and Siem Reap (Cambodia Airports, 2016), which are in the small international airports group.

However, a contradictory trend is observed in the primary international hub group. All six airports in some way come under direct government ownership. Hong Kong is under an autonomous regulator, The Hong Kong Airport Authority and the other five airports are incorporated as 100% government owned companies. Likewise, in the secondary international hub group, three airports are incorporated and two are under an autonomous regulator. This is different to the scenario observed in Europe, especially in the United Kingdom, where the major hub airports are fully privatised (Graham, 2008a). However, when the hubs are a part of a larger network of airports and there is substantial competition, the effects of privatisation could be more beneficial than in monopolistic situations (Graham, 2011). In most cases, the international hubs in the region are the major international airport or the only airport in the country (except for Japan, South Korea and Taiwan). Therefore, adopting a corporatisation model may have allowed the airport to loosen its ties with the government and operate at a certain degree of autonomy, while being under direct government supervision. This may have been used as a strategy to avoid failures of private monopolies. In 2011 Japan announced its plan to privatise all of its national airports by 2020 (CAPA, 2014b). Graham, Saito and Nomura (2012) also suggest that Japan can benefit from a privatisation move by improving the commercial orientation of the airports. The initiatives towards privatisation by airports in different clusters show that the trends in the East have changed and that governments are actively seeking to reap the benefits of private sector involvement in airport development and operations.

Table 5-4 Ownership and operations models of the airports in the sample

Airport	Ownership/Operations Model	Airport Typology
Ashgabat (ASB)	Government Department	Small International Airports
Baghdad (BGW)	Autonomous Regulator	Small International Airports
Bandar Seri Begawan (BWN)	Government Department	Small International Airports
Dili (TL) (DIL)	Government Department	Small International Airports
Dushanbe (DYU)	Government Department	Small International Airports
Pyongyang (FNJ)	Government Department	Small International Airports
Bishkek (FRU)	Joint Stock Company	Small International Airports
Tehran Imam Khomeini (IKA)	State-owned Public Company	Small International Airports
Kathmandu (KTM)	Government Department	Small International Airports
Macau (MFM)	Government Department	Small International Airports
Male (MLE)	Government Department	Small International Airports
Paro (PBH)	Government Department	Small International Airports
Phnom Penh (PNH)	Concession contract	Small International Airports
Siem Reap (REP)	Concession contract	Small International Airports
Yangon (RGN)	Government Department	Small International Airports
Ulaanbaatar (ULN)	Autonomous Regulator	Small International Airports
Vientiane (VTE)	Government Department	Small International Airports
Amman Queen Alia (AMM)	Concession contract	Medium International Airports
Beirut (BEY)	Autonomous Regulator	Medium International Airports
Muscat (MCT)	Autonomous Regulator	Medium International Airports
Tel Aviv (TLV)	Autonomous Regulator	Medium International Airports
Abu Dhabi (AUH)	State-owned Public Company	Secondary International hubs
Bahrain (BAH)	State-owned Public Company	Secondary International hubs
Colombo (CMB)	State-owned Public Company	Secondary International hubs
Doha (DOH)	Autonomous Regulator	Secondary International hubs
Kuwait (KWI)	Autonomous Regulator	Secondary International hubs
Dubai (DXB)	State-owned Public Company	Primary International Hub
Hong Kong (HKG)	Autonomous Regulator	Primary International Hub
Seoul Incheon (ICN)	State-owned Public Company	Primary International Hub
Tokyo Narita (NRT)	State-owned Public Company	Primary International Hub
Singapore Changi (SIN)	State-owned Public Company	Primary International Hub
Taipei Taiwan (TPE)	State-owned Public Company	Primary International Hub
Almaty (ALA)	Joint Stock Company	Small Hybrid Airports
Dhaka (DAC)	Autonomous Regulator	Small Hybrid Airports
Kabul (KBL)	Government Department	Small Hybrid Airports
Tashkent (TAS)	Government Department	Small Hybrid Airports
Jeddah (JED)	Autonomous Regulator	Medium Hybrid Airports
Karachi (KHI)	Autonomous Regulator	Medium Hybrid Airports
Riyadh (RUH)	Autonomous Regulator	Medium Hybrid Airports
Ho Chi Minh City (SGN)	Autonomous Regulator	Medium Hybrid Airports
Bangkok (BKK)	Public (listed) Company	Primary Hybrid Airports
Mumbai (BOM)	Concession contract	Primary Hybrid Airports
Jakarta (CGK)	Autonomous Regulator	Primary Hybrid Airports
Delhi (DEL)	Concession contract	Primary Hybrid Airports
Kuala Lumpur (KUL)	Public (listed) Company	Primary Hybrid Airports
Manila (MNL)	Autonomous Regulator	Primary Hybrid Airports
Beijing Capital (PEK)	State-owned Public Company	Primary Hybrid Airports

Source: Own elaboration from CAPA, Flightglobal Dashboard, and airport websites and annual reports.

5.6 Government commitment and first mover advantage

Airport development is seen as an evolutionary process from an OD airport serving the needs of a local market to a large base for hub-and-spoke operations connecting multiple destinations and offering indirect connectivity (Kraus and Koch, 2006; Suau-Sanchez, Burghouwt and Pallares-Barbera, 2014). Thus, it will pass different evolutionary stages, being shaped by different macro environmental factors and industry-specific regulations. The above evaluation of such factors across the different typologies in the hierarchy of airports in the East confirmed that, to a certain degree, they create a conducive operating environment for the growth of an airport. Primary international hub airport group was mostly associated with positive values that contribute towards a conducive environment for aviation to grow. However, there were higher within group variances, which contributed to the statistical insignificance of differences between mean values of certain variables for the airport groups compared. For example, there were instances where, airports in countries associated with higher per capita GDP falling into small airport groups (section 5.4.3) or variables such as government prioritization of travel and tourism being statistically insignificant across all the groups (section 5.4.5).

The above observations alter the course of the conclusion of this discussion. The Other than the elements in the operating environment of an airport, there are important forces that shape up the network role of an airport. Study of the historical evolution of the airports in the region over time sheds light on those factors that have intervened in the development of primary hubs. A recurring observation of the analysis and discussions is that, while wealth and government policies have played a determinant role in the success of primary airports, correct timing of such decisions that have made a key difference between the degrees of development between hubs and non-hubs. It is suggested that the success of the primary (leading) hubs in the region today are results of historical, political, economic, social and cultural events and timely decisions by policy makers. The proposition is validated in the preceding discussion based on extant literature and supplementary data.

The strategic and visionary role of governments takes precedence in explaining the competitive structure of airports in the eastern aviation network. The first mover advantage (Lieberman and Montgomery, 1998) has enabled the successful primary hubs and hybrid hubs to take the leading role in the region. As explained in section 1.1.3.1, the historical advantage Asia and the Middle East had in terms of connecting East Asia and Pacific with Europe and the Americas has laid the foundation for the development of air transport industry in the region. The primary hubs today have historically been important stopping points in this West-East trade route (ground, sea and air). When the significance of these stopping points started to decline with the development of longer-range aircraft technology, respective governments had to seek ways of keeping the country open to the global aviation network. Especially markets like Singapore, with very little local demand, were led to establish viable OD services, using their historic gateway status to East Asia and Pacific for the European airlines. This allowed them to build a regime in international air transport connecting East and the West (O'Connor, 1995). Oil rich gulf countries have emulated this in the Middle East (Hooper, 2002). In the case of the UAE, and Qatar, they moved in second, following the path of Bahrain, and Beirut. However, they have exploited the advantage that second movers have in terms of knowledge available from the lessons learnt by first movers. A similar second mover wave is observable in Southeast Asia in Thailand and Malaysia that already had a strong local market and an inbound tourism market. In Northeast Asia, Imperial Japan continued to rise as an economic super power in the post-World War II era. The Japanese aviation industry benefitted from both the local market and its gateway status in the Asian- North American routes (Feldhoff 2002,2003). Imperial Japan had influences on Korea as an annexure and Taiwan as a dependency to the Empire. In the post-World War II era when South Korea and Taiwan emerged as independent entities, the two nations have been ambitious in developing themselves into logistics hubs (Lee and Yang, 2003; Tsai and Su, 2002).

The period after the 1970's/80's witnessed an upsurge in the airport infrastructure investments and national carrier developments in the above countries which is home to primary international hubs today. Similar improvements to infrastructure could be observed in other countries across the region as well. Most of the international airports of these countries were either built or upgraded around the same period (e.g., Colombo airport (newly built in 1967), Amman (newly built in 1983), Dhaka airport (newly built in 1981-83). However, these airports have not been able to reach the same status as the leading hubs. The main reason for the difference is that the countries with leading airports today have continued to invest and keep the development momentum, while the majority of the other countries have lagged behind. The commitment of respective governments has enabled a coordinated policy approach economy-wide. The conclusion is that while conducive macro environmental conditions have created the essential foundation for developing hubs, the advantage is rather gained from moving in first and continuing to grow by exploiting those positive conditions. This can be observed through infrastructure investment commitments by each country.

Table 5-5 Airport infrastructure investments in the East

Country	Projected cost USD (billion)	Country	Projected cost USD (billion)
Abu Dhabi	3	**Laos**	0.86
Afghanistan	0.035	**Malaysia**	1.3
Bangladesh	8	**Myanmar**	1.5
Brunei	0.11	**Oman**	5.2
Cambodia	1	**Pakistan**	2
China	41.2	**Philippine**	12
Dubai	43.2	**Qatar**	15.5
Hong Kong	19.3	**Saudi Arabia**	7.2
India	10.1	**Singapore**	2.2
Indonesia	1.7	**South Korea**	3.5
Iran	2.8	**Sri Lanka**	0.2
Iraq	0.05	**Taiwan**	14
Japan	1.8	**Tajikistan**	0.038
Kuwait	4.8	**Thailand**	3
		Vietnam	7.2

Source: Own elaboration from CAPA (2011, 2014b, 2015b, 2015c)

Table 5-5 summarises airport infrastructure investments committed (actual and planned) by Asian and Middle East countries in the period between 2011 and 2015 published by CAPA (2011, 2014b, 2015b, 2015c). Qatar has invested in a completely new airport, Hamad International Airport, which was completed in 2014. Dubai is aggressively following suit with the ongoing USD 32.3 billion project of Dubai World Central Al Maktoum Airport, which is planned to become the world's largest airport at its completion by offering annual capacity of 160 million passengers and 12 million tonnes of freight, operating on five runways (CAPA, 2014b, Dubai Airports, 2013). Meanwhile, expansion at other pioneering hub airports like Singapore, Malaysia, Thailand, and Korea is on-going. Singapore is going ahead with a 4th terminal and is planning for a potential 5th terminal. These rather ambitious investments are in order to remain current and ahead in the growing Asian market and counter potential threats from emerging competitors like China and India.

China and India have remained dormant for decades (CAPA,2012b, 2015a; O'Connell et al. 2013; Fu et al., 2015; Wang, Mo and Wang 2014), but can bring in real challenges in the coming decades supported by the growing local OD markets, which is a primary condition for hub operations. China is flooding the market with potential capacity through ongoing airport projects across all of its regions in a bid to spread the benefits of its accelerating economy (CAPA 2014b; Williams 2006). According to CAPA (2014b), as of 2013/14, the top three biggest airport projects in the world are in China with the proposed world's largest Greenfield airport construction project; Beijing Daxing, a USD 11 billion investment, planned to come into operation by 2018. As can be seen from Table 5-5, elsewhere in the region also, developments are taking place in the aviation markets (e.g. Sri Lanka (completed in 2013), Pakistan, Myanmar, Vietnam and Bangladesh). However, the analysis of macro environmental factors and aviation policy status revealed the lack of cohesion in policy and planning in the majority of these countries with small and medium airports. Therefore, further analysis on policy coordination is beneficial for these countries to benefit from these infrastructure investments.

5.7 Conclusion

This chapter examined the drivers behind the structure of the airport hierarchy in the East in line with the second research objective of this study, which is to *'identify the factors that shape up the growth of an airport and interpret the causes for the differences in the airport hierarchy'.* The analysis of variance across seven airport groups revealed the following facts with respect to the seven-macro environmental elements and air transport policy and regulatory conditions of respective countries.

- Central Asian and Middle Eastern airports are better positioned to serve multi-directional continental pairs than Southeast and Northeast Asian airports. However, most of the airports (especially Central Asian) have not capitalised on the advantage. Airports with much higher detour factors in East Asia have exploited those limited advantages to establish successful directional hub operations.

- Disparity in economic development is one contributory factor to the differences in the size and network strategy of airports. This has partly contributed to the creation of a hierarchy in the airport network. Countries in the primary hub group - Singapore, Hong Kong, Japan, South Korea, Taiwan and UAE rank as leading edge innovation driven economies, while their neighbours such as Vietnam, Cambodia, India, Pakistan, Nepal, Bangladesh, Yemen, Kyrgyzstan and Tajikistan are still factor driven economies in their first stage of development (World Economic Forum, 2012) (Table E-3)[22]. However, the major international airport in Israel (Tel-

[22] **Factor-driven economies** compete based on their factor endowments—primarily low-skilled labour and natural resources. Companies compete on the basis of price and sell basic products or commodities, with their low productivity reflected in low wages. When countries move into **Efficiency-driven stage** they begin to develop more efficient production processes and wages will rise with advancing development and increase product quality because wages have risen and they cannot increase prices. As countries move into the **Innovation-driven stage**, wages will have risen by so much that they are able to sustain those higher wages and the associated standard of living only if their businesses are able to compete with new and/or unique products, services, models, and processes. At this stage, companies must compete by producing new and different goods through new technologies and/or the most sophisticated production processes or business models"(World Economic Forum, 2012) p.8-9)

Aviv) which is an innovation driven economy and Almaty in Kazakhstan which is in transition to an innovation driven economy, fall into medium international and small hybrid airport groups. Nevertheless, airports in a country whose economy is in the primary stages of economic development have not qualified for primary international hub status in the taxonomy.

- Countries with primary hubs have overtaken countries with natural and cultural heritage advantages in the degree of tourism attractiveness by developing a modern tourism appeal. The opportunity to increase connectivity levels out of tourism-induced travel has not been exploited by countries with such a natural tourism advantage, in the same way and to the same extent as the international hubs have transformed the country or city to have a tourism destination appeal. Price competitiveness and government prioritisation of tourism are basic requirements of any tourist destinations and are not key differentiators. The quality of tourism infrastructure and affinity for tourism, improve a country's tourism appeal and substantially increase the potential for being a hub.
- Infrastructure and institutions play a key role in the primary hub group. Infrastructure and efficient governments are hub qualifiers, but do not differentiate hubs from non-hubs. All primary hubs rank top for their infrastructure quality, but all countries that rank fairly well in the index are not primary airports in both the primary hybrid and hub categories (e.g. Israel, Saudi Arabia).
- Deregulation and liberalisation certainly play a role in defining hub status. Nevertheless, creative exploitation of 3rd and 4th traffic rights plays a higher role than that in determining the degree of hubbing at international airports in the region, especially in the Middle East and Southeast Asia.
- Rather than privatisation, commercialisation raises an airport to a primary international hub status in the region. This is evidenced by the government ownership of primary hubs in the region.

The above findings motivated the further examination of the role of government in facilitating airport development in the East. Section 5.6 highlighted two important facts in relation to government commitment. First, correct timing of policy decisions to promote hubs as an economic development tool. Second, timely and continuous investment in upgrading airport infrastructure in order to maintain competitive status. The analysis revealed that the seven factors; geographical positioning, level of economic development, tourism and business attractiveness, urbanisation, physical and intellectual infrastructure and sound political and administrative framework and liberal aviation policies are prerequisites to establish a successful international hub. However, mere presence of these factors does not guarantee a hub status to an airport. As a part of a holistic strategy, governments should take up an active policy making role in order to facilitate the interplay of the above factors. Section 5.6 brought forward several examples of successful interventions by governments in converting airports into hubs. It also briefly outlined that many governments in the region are investing in their airports with the objective of improving its competitive position to reap the benefits of a growing aviation market.

In chapter 1, the background to the research problem of this study explained the unevenness in the air transport development in the East and the state of the average international airport shadowed by the traffic from developed mega hub regions. The first and the second objectives of this study was aimed at identifying a strategic approach to airport planning and policy making in order to assist an airport in developing its competitive position. Chapter 4 presented an airport taxonomy that helps to identify the competitive position of an airport within a network. This chapter identified the macro/national and industry level policy approaches required to facilitate an airports growth. In the next chapter, the strategic approach developed in the 4th and 5th chapters are applied to the problem identified in chapter 1 through a case study of a selected international airport.

6 AN APPLICATION OF THE PROPOSED TAXONOMY OF AIRPORTS TO EVALUATE THE ROLE OF THE COLOMBO BANDARANAIKE INTERNATIONAL AIRPORT IN THE SOUTH ASIAN REGION

6.1 Introduction

Previous two chapters presented the outcomes of the first two research objectives of this study. The study developed a taxonomy that helps an airport to identify its relative competitive position in the aviation market of the East and the essential macro environmental and aviation policy and regulatory conditions that support the development of a successful airport. The third objective focuses on the application of those research findings to a selected case study, that is,

> *‘Application of the methodological approach to recommend airport strategy and civil aviation policy measures to improve the status of an International Airport identified to be under the traffic shadow created by developed hubs in the East.’*

Section 6.2 of this chapter outlines the approach to the application of the proposed airport taxonomy in order to identify strategic and policy direction of an airport. Section 6.3 presents the justification to the selection of the case study of Colombo Bandaranaike International Airport (CMB, hereinafter referred to as the Colombo airport) in Sri Lanka. Section 6.4 presents application of the taxonomy in benchmarking the Colombo airport to identify its relative position in the network and related strategic issues. Section 6.5 recommends strategy and policy measures at three levels; airport, industry policy and national policy, which is followed by the conclusion to the chapter in, section 6.6.

6.2 Application of the proposed taxonomy of airports

The taxonomy of airports can be applied to derive three types (levels) of strategy and policy recommendations.

1. Airport strategies
2. Industry level policy measures
3. National level policy measures

6.2.1 Airport strategies

Airport strategies are derived from the direct application of the airport taxonomy presented in chapter 4. The taxonomy was developed based on three broad competitive strategies of airports; degree of airport activity, network strategy and market related strategies (section 4.2). The competitive position of an airport is assessed across twenty variables that represent different dimensions of the above three strategies (section 4.3). Therefore, the taxonomy allows a comprehensive view on the strategic issues of the airport in question in relation to competition.

The taxonomy can be applied at three network levels depending on the scope of competition. One is that it classifies airports at a global level against the airports within the entire network of the East. This enable the determination of the positioning of an airport in the airport hierarchy and identify what are the airports with a similar profile, what are the leading airports in each category, and what are the airports that have a potential to move up the hierarchy. In terms of competitor analysis, it assists in evaluating the hub competition at a macro-network-scale. The airport also benefits from being able to benchmark itself against airports with similar strategic profiles.

Secondly, the measures used in the classification also support the identification of the role of an airport at a meso-network-scale. The same taxonomy can be further focused-in at the sub-region level, per se, South Asia, to derive a clear picture of the immediate competition within the regional network. This enable the identification of hub competitors, catchment area competitors and the immediate destination competitors. Thirdly, the taxonomy also can also be used to evaluate a domestic network (micro-network-scale). This is particularly helpful for countries with large domestic networks. A country can then identify the different roles played by airports in the country. This helps in setting up strategies and plans for the airport-system. It also helps to determine new airport projects (if at all required) and the directions they should take. Governments can decide the respective roles they want the airports to take, in order to improve the overall connectivity of the airport-system in the country.

6.2.2 Industry level policies

In chapter 5, the airport groups were cross compared on liberalisation and ownership policies in the aviation industry of the respective country the airport in question belong (section 5.5). The key measurement indicators were; ALI index, ticket taxes and charges, visa requirements and ownership and operations models of airports. Benchmarking these indicators within the airport group (countries of the airports that have similar profiles)) and between competitor groups (countries belonging to a geographical sub-region) in the taxonomy will allow policy makers to take informed decisions that will create a conducive (micro) environment for the development of the aviation sector.

6.2.3 National level policies

Mean values of fourteen variables representing the seven-macro-environmental elements proposed (section 5.2 and 5.3) were compared across the airport groups (section 5.4). These variables represent important policy dimensions to support the growth of a successful aviation industry, which in turn would result in a competitive airport/ airport system in a country. These variables are used to derive the national level policy recommendations for the airport in question.

6.3 The case study: South Asia and Colombo airport

Chapter 1 provided the background to the research problem of this study, with reference to the mega hub regions and unevenness in the development of airports in the East (section 1.1.5). The preliminary investigations suggested that the sub regions of South Asia and Central Asia are comparatively underdeveloped to the rest of the airports in the region and are under a traffic-shadow casted by the developing multi-hub regions of Middle East and Southeast Asia (section 1.1.6). Accordingly the third research objective focuses on the application of the research findings from the first two research objectives to an airport operating under the above conditions. Thus, Colombo airport from the South Asian region has been selected as the case study of this research for the following reasons (elaborated in the sub section to this discussion as indicated below).

1. South Asia is a fast growing economy with a huge potential for aviation growth. However, the region has recorded volatile growth rates in the recent years and its airports have not yet been able to emerge as global hubs (section 6.3.1).
2. Colombo airport is the only (secondary) international hub that serve the South Asian region, which has a similar profile to the leading secondary and primary international hubs in the aviation network of the East (section 6.3.2).
3. There is substantial evidence to validate that Colombo airport is under a traffic shadow from the neighbouring hub regions (section 6.3.3).

6.3.1 Air transport in South Asia

South Asia consists of a group of eight countries; Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka (Figure 6-2). It is bordered by the Himalayas (Tibet) to the North, the Indian Ocean to the South, the Hindu Kush Mountains (Iran, Turkmenistan, Uzbekistan and Tajikistan) to the West and the Chin Hills (Myanmar) to the East. The region is undergoing robust economic growth and has been the fastest growing region in the world for more than a decade (Figure 6-1). South Asia’s air transport market has more than doubled in the last decade and it is speculated that it will lead the next wave of air transport development in the East. The growth is expected to come from India, the largest aviation market dominating the region (Table 6-1). The average annual 14-year growth rate stood at 10% in 2012. Given the size of its population, improvements in per capita income, geographical diversity and global Indian diaspora, India has a huge potential for OD traffic generation both domestically and internationally. This is one key ingredient for establishing a traditional hub. The remaining markets in South Asia are very small compared to the Indian market, which is more than 1000 times bigger than Bhutan, the smallest aviation market in the region.

Over recent years, the South Asian aviation market has experienced mixed results, recording the lowest growth rates (in terms of available seat capacity) compared to the rest of the sub-regions (Figure 1-11). Even though the untapped markets have been providing the region with a huge growth potential for many years, it is still struggling, partly owing to weak regulatory and fiscal frameworks, nationality oriented civil aviation policies and state-owned struggling flag carriers (CAPA, 2013d). The Indian market is also enveloped in the same set of problems of bureaucratic policy environment, high taxes, low productivity and overcapacity in the market (CAPA, 2013e; O'Connell et al., 2013; Saraswati, 2001).

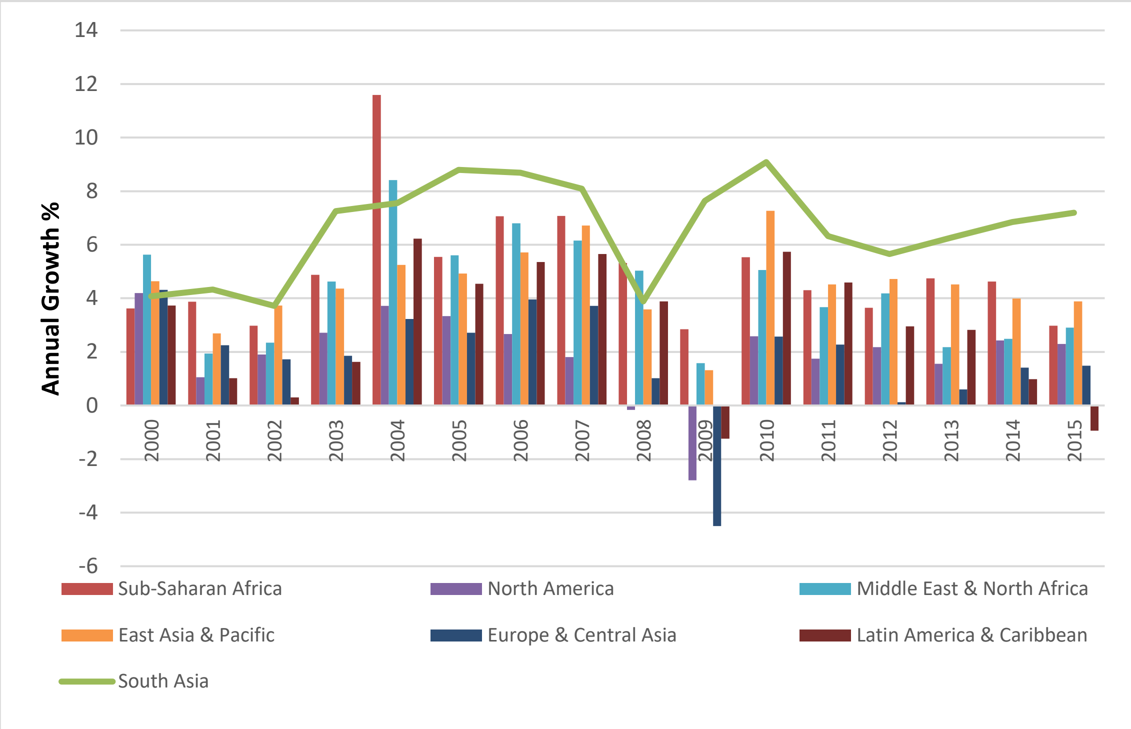

Figure 6-1 Economic Growth* of World Regions

Source: World Development Indicators Database, the World Bank (2015).

*Annual percentage growth rate of GDP at market prices based on constant 2010 U.S. dollars

Apart from the influence of aircraft technology and shifts in travel demand, Bowen (2002) highlights the role played by 'The State' in changing the structure of aviation networks in favour of a country's/city's development. He contends that the State holds the power to set the favourable conditions for transport operations as the provider of airport/navigation infrastructure (in most cases) and regulation of the markets. For these reasons, the Indian government has been criticised for its lack of direction and a sectoral policy for the backwardness demonstrated by the market (CAPA, 2012b; O'Connell et al., 2013). On the other hand, national airlines in Bhutan, Nepal, Bangladesh and The Maldives are very small and these countries are heavily dependent on international airlines to keep connected with the global market. Sri Lanka could see a positive post-war trend. However, it is handicapped by the loss making Sri Lankan Airlines (CAPA, 2012b). In Afghanistan traffic has improved (Table 6-1), but is at a very low level due to the political instability and terrorism prevailing in the country. In Pakistan too, despite the fact that it is the second largest market in the region, capacity has remained stagnant over the last decade, the main reason being the disruption caused by terrorist incidents. While all the other markets have improved on capacity it still has more or less the same level of capacity that it had back in 1999 (Table 6-1).

Table 6-1 Available Seat Capacity (Millions) Growth in the South Asia 1999-2012

Year	Afghanistan	Bangladesh	Bhutan	India	Maldives	Nepal	Pakistan	Sri Lanka
1999	0.05	5.29	0.04	63.23	1.66	2.89	21.51	3.86
2000	0.04	6.03	0.04	67.39	1.49	2.78	19.64	4.70
2001	0.00	6.02	0.05	71.42	1.76	3.28	18.24	4.46
2002	0.05	5.77	0.04	75.86	1.92	3.16	15.42	4.14
2003	0.39	6.18	0.07	80.10	1.93	3.06	16.09	4.95
2004	0.73	6.65	0.05	87.79	2.10	2.55	19.08	6.31
2005	1.15	6.18	0.07	98.43	2.01	4.07	20.04	6.18
2006	1.04	6.79	0.11	132.67	2.19	4.88	22.61	6.57
2007	1.23	7.79	0.13	175.86	2.80	3.75	20.28	7.06
2008	1.42	9.45	0.13	192.66	3.19	3.74	18.23	7.38
2009	2.05	8.93	0.13	192.16	3.26	4.26	17.91	6.30
2010	4.02	9.29	0.16	199.62	4.10	7.12	18.84	7.28
2011	5.22	10.19	0.24	227.97	4.49	7.81	22.05	8.87
2012	5.07	9.83	0.19	227.15	4.83	7.55	22.95	9.86
AARG	38.3%	4.5%	11.9%	9.6%	7.9%	7.1%	0.5%	6.9%

Source: OAG (2013)

On a macro scale, despite the surging individual economies, unevenness in development is widely experienced in South Asia. The region still has extreme forms of social exclusion, widening inequality, higher levels of poverty, and infrastructure gaps (De, 2005, 2013; World Bank, 2015). This is preventing the lower stratas of the population getting involved in aviation. Although regional integration has been pursued through the South Asian Association for Regional Co-operation (SAARC), which was formed in 1985 to promote integration among many areas, including trade (for which they have South Asian Free Trade Agreement); the region remains the world's least integrated with intra-regional trade below 5% of total trade(World Bank, 2016). Lack of connectivity (De, 2013) has been cited as the key primary reason for poor intra-regional integration, in which air transport has a key role to play. For instance, South Asia has the lowest airport per million inhabitants ratio of 0.08 (Airbus, 2014) in the world.

The Government of India has invested over US$ 4 billions in new terminal developments and the upgrade of Mumbai and Delhi airports. A further US$ 1.6 billion projects are under way to develop a network of up to 100 low cost airports. Pakistan's New Islamabad International Airport construction is under way with the expectation of completion in 2016. China is heavily investing in the regions' airports, including Nepal, The Maldives and Bangladesh. Sri Lanka saw the completion of its second international airport in 2013, again financed by China. However, the region still does not see a hub emerging, as had happened in the development process in the neighbouring regions. Thus, the role of the region's airports in the international aviation network are yet undefined.

6.3.2 Structure of the network of airports in South Asia

In chapter 4, sixty- seven airports in South Asia were analysed to develop the airport taxonomy (see, table D-33 for complete classification). As can be seen from Figure 6-2, majority of the airports are from India, which is the largest market in South Asia. India is geographically centred on the cross roads of routes between the other seven countries; Afghanistan, Pakistan, Nepal, Bhutan, Bangladesh to the north and Sri Lanka and Maldives to the south. The airports are presented in the proposed taxonomy in Figure 6-3, according to their degree of airport activity and network and segmentation strategies. Table F-1 presents values for the airport clustering variables for South Asia.

Figure 6-2 The map of South Asian airports (2012)

Source: Own elaboration based on www.gcmap.com

Network and segmentation Strategy

Degree of Airport Activity	International/ Regional (15)		Hybrid (6)	Domestic (46)	
Large (2)	**Primary International Hubs**		**Primary Hybrid** *Mumbai (BOM)* *Delhi (DEL)*	**Large Domestic Airports**	
Medium (6)	**Medium International Airport**		**Medium Hybrid** *Chennai (MAA)* *Karachi (KHI)* **(2)**	**Medium Domestic OD Airports**	
	Secondary International Hubs *Colombo (CMB)* **(1)**	**Medium International Airports**		**Medium Domestic OD Airports**	**Medium Domestic LCC Airports** *Kolkata (CCU)* *Bengaluru (BLR)* *Hyderabad (HYD)* **(3)**
Small (59)	**Small International Airports** *Kathmandu (KTM)* *Male (MLE)* *Paro(PBH)* *Peshawar* *Sialkot* *Lahore* *Islamabad* *Kozhikode* *Amritsar* *Tiruchirappalli* *Thiruvananthapuram* *Kochi (IN)* *Mangalore* *Chittagong* **(14)**		**Small Hybrid** *Dhaka (DAC)* *Kabul (KBL)* **(2)**	**Small Domestic OD Airports**	
				Small Domestic OD Airports *Jodhpur* *Quetta* *Faisalabad* *Sylhet* *Kandahar* *Kaadedhdhoo* *Gan Island* *Herat* *Pokhara* *Multan* *Biratnagar* **(11)**	**Small Domestic LCC Airports** *Nanded* *Nagpur* *Jaipur* *Agartala* *Raipur* *Indore* *Dibrugarh* *Patna* *Coimbatore* *Guwahati* *Jammu* *Ahmedabad* *Srinagar* *Lucknow* *Madurai* *Bhopal* *Bhubaneswar* *Vishakhapatnam* *Tirupati* *Pune* *Bag Dogra* *Vadodara* *Aurangabad* *Leh* *Ranchi* *Chandigarh* *Vijayawada* *Imphal* *Goa* *Udaipur* *Port Blair* *Varanasi* **(32)**

Figure 6-3 The taxonomy of airports in South Asia

Source: Own elaboration

The two primary hybrid airports in South Asia, Delhi (DEL) and Mumbai (BOM) are from India. They are the only two airports of that size in the South Asian region that offer seat capacity in excess of 100,000 per day. All the other airports are either medium or smaller and offer less than 50,000 seats per day. The only airport that qualify for a hub status other than the hub roles played by the two primary hybrid airports is the Colombo airport in Sri Lanka. International gateways of other countries fall into the small international airports cluster and small hybrid airport cluster. Figure 6-4 presents the daily demand and supply at the major international gateways to each country. This clearly display that the size of the aviation markets in the region are below average (except India) that makes them less competitive in the international markets.

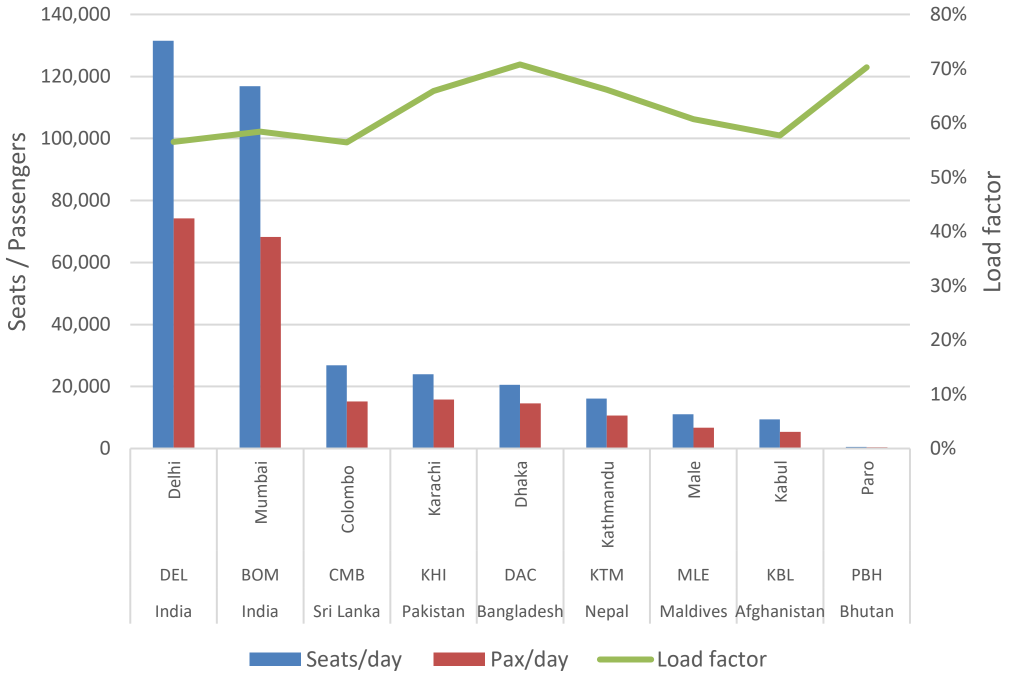

Figure 6-4 Daily supply and demand at major international gateways to the Country - South Asia, May 2012

Source: Own elaboration based on OAG (2012)

Hybrid type airports of Karachi (KHI), Dhaka (DAC), and Kabul (KBL) respectively serve as the major gateways to Pakistan, Bangladesh and Afghanistan. They take up a significant domestic role as well. As shown in Figure 6-5, small and medium hybrid airports generate a significant portion of traffic in their respective domestic markets. Domestic traffic generation is indicated by the size of the bubble. Delhi and Mumbai play a larger international gateway to the country role owing to the large network of domestic airports in India. Kabul and Dhaka scores higher on the domestic flow centrality. Average connectivity levels at Mumbai and Delhi may be a result of LCC developments in India. As a result, PP networks that bypass hubs are replacing the traditional domestic HS networks.

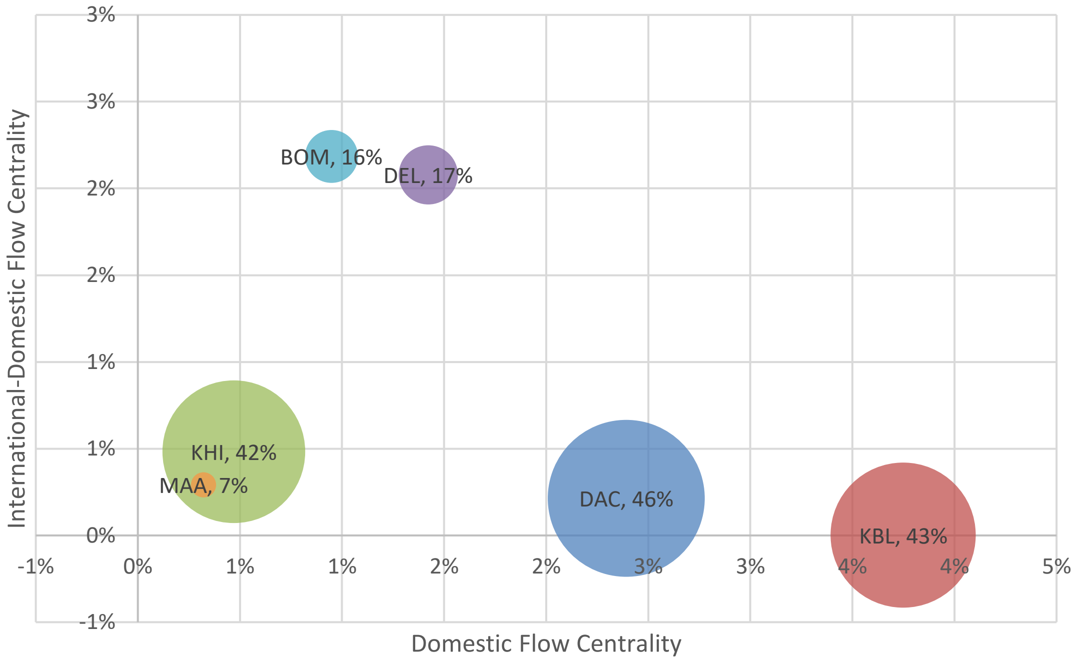

Figure 6-5 Hybrid airports in South Asia, May 2012

Source: Own elaboration based on OAG (2012)

The three airports in the capital cities of States of West Bengal (Kolkata-CCU), Telangana (Hyderabad-HYD), and Karnataka (Bengaluru-BLR) in India are categorised as medium LCC domestic airports as they offer more than 75% of seats to the domestic market. Above 60% of the seats at these airports are by LCCs. Though the three airports are designated as international airports, they only offer on average 20% of seats to the international market. Likewise, they do not take up any hub role in the international markets as well. Chennai (MAA) airport in the capital city of the state of Tamil Nadu is also in a similar status to the above three airports, as it is also the designated international airport for the state. However, it is classified as a hybrid airport because of the minor role it plays as an international hub airport (International to International flow centrality is 0.007% and International to Regional flow centrality is 0.011%).

All of the 32 small domestic LCC airports are from India, which is one market that LCC growth has taken its heights in the Asian and Middle East Region. At these airports, on average 69% of the seats are offered by LCCs and on average 94% of seats are for the domestic market. Spicejet, Jet Lite (now under Jet Airways), and Go Air are the major LCCs based at these airports (Figure 6-6). Air India Express mainly operate from international airports. Except the Indian airport of Jodhpur, the other 11 non-LCC airports are from Pakistan, Bangladesh, Maldives, Nepal, and Afghanistan. At these airports, 100% of seats are offered by traditional airlines. Except for the two Nepalese airports, Pokhara (PKR) (15) and Birtanagar (BIR) (16), average frequency per route is three flights. These two Nepalese airports represent the typical nature of the airports in Nepal, shorter runways, small aircrafts (mostly propeller with less than 50 seats), and higher frequency owing to the climatology and topography of the country.

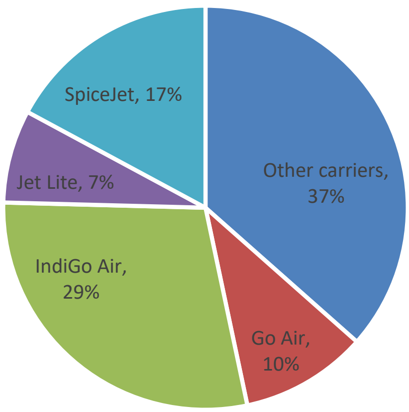

Figure 6-6 Share by major LCCs at small domestic LCC airports in South Asia, 2012

Source: Own elaboration based on OAG (2012) and Flightglobal (2013)

The investigation of the structure of airports in South Asia highlight the unique position of Colombo airport from Sri Lanka as the only airport with a similar profile to the leading primary and secondary international hubs in the region. Thus, it is important to evaluate the potential of this airport to develop as a major hub by emulating the leading hubs of similar profile in the region.

6.3.3 Sri Lanka: A case study for a traffic-shadow effect

6.3.3.1 Air transport industry in Sri Lanka

Sri Lanka is one of the island states in South Asia (the other is The Maldives) which is almost entirely dependent (99.8%) on air transport to connect its economy and people with the rest of the world (Sri Lanka Tourism Development Authority, 2013). It is identified as a country in the transitional stage from a factor-driven economy to an efficiency-driven economy (WEF, 2012).Sri Lanka's Gross Domestic Product (GDP) stood at US$ 60 billion in 2012, to which the service sector makes the largest contribution (58.5%). The growth of the aviation industry was significantly hindered by the civil unrest that prevailed in the country for nearly 30 years (1980-2009), dampening the country's economic growth and, most importantly, the tourism sector, one of the key income generators. The cessation of the civil war has given the country a promising economic growth rate of 6-8% (Central Bank of Sri Lanka, 2012). The aviation industry has annually grown by an average of 13% in the in the post-war era (2009-2012) and total number of passengers passed 7 million in 2012 (Figure 6-7). The growth has been supported by the thriving tourist industry reaching 1 million passengers in 2012, which has doubled during the period.

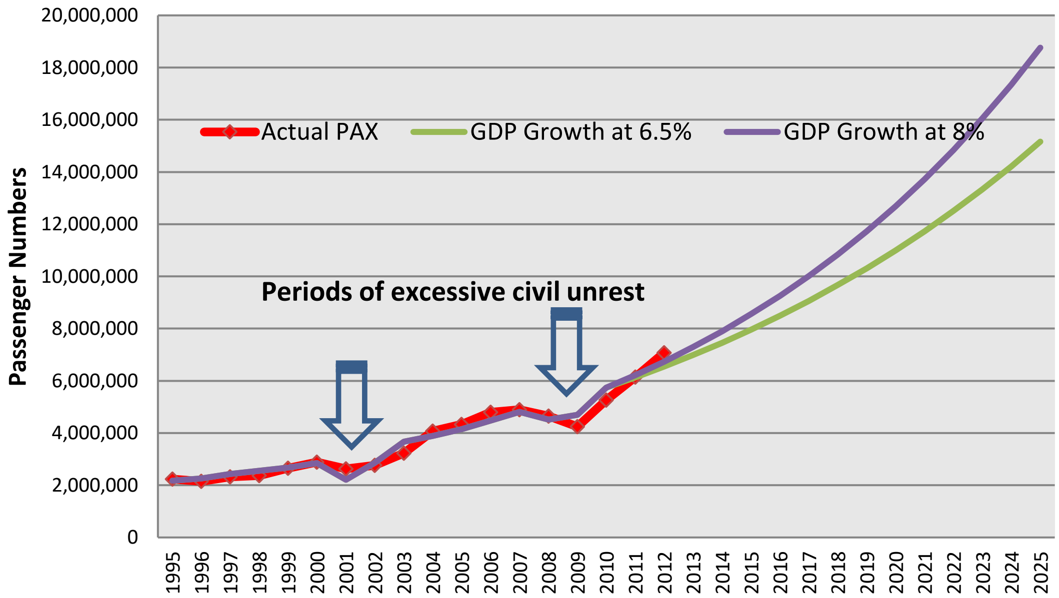

Figure 6-7 Passengers Growth Forecasts at Colombo Bandaranaike International Airport, Sri Lanka

Source: (Piyathilake et al., 2011)

Colombo airport is the primary international gateway[23] to the country. The airport has a single runway of 3,340 m long and 45 m wide with a 7.5 m shoulder either side and the capacity for 45 movements per any given hour. It has four parking aprons and 13 boarding gates at present. However, the actual handling revolves around 25 flights in any given hour (Airport and Aviation Services (Sri Lanka) Ltd. , 2014). The state owned Sri Lankan Airlines (UL) and Mihin Lanka (MJ) are the two registered international operators in the country, mainly operating out of Colombo airport. Sri Lankan Airlines dominate the airport as the national hub carrier with 52% of capacity share (Figure 6-8).

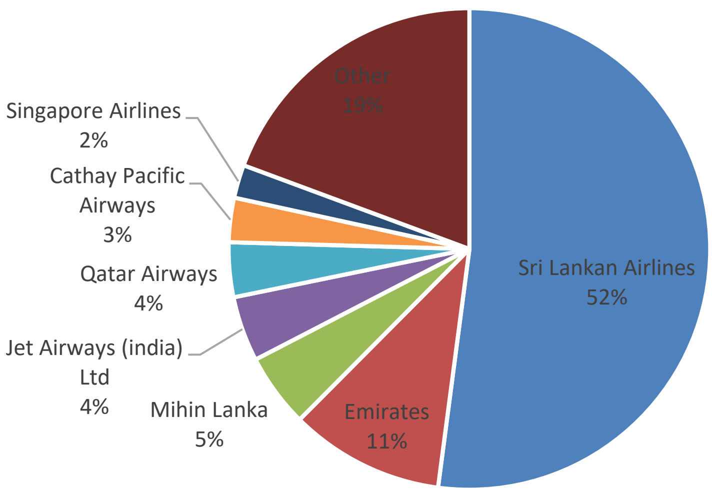

Figure 6-8 Capacity Share by Airlines at Colombo Bandaranaike International Airport, Sri Lanka, 2012

Source: OAG (2012)

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[23] The incumbent government in the period from 2005 to 2014 promoted an aviation hub strategy through accelerating investments on a second international airport. Phase I of the new Mattala Rajapaksha International Airport (HRI) was completed in 2013 with a 3500 m long 75 m wide runway, capacity of 1 million passengers and 45,000Mt cargo, per annum. To promote the new airport for international flights, government declared an open skies policy for the new airport. However, according to the airport operator, Airport and Aviation Services (Sri Lanka) Ltd. (2014), the airport has not come to realise its goal yet. Thus, maintain the role of an alternative aerodrome to the Colombo airport.

6.3.3.2 Is Colombo airport under a traffic shadow? To what extent?

Historically, Sri Lanka too was a strategic location on the East-West trade routes given its position at the southern tip of the Indian subcontinent making the island an ideal transit point for servicing the international Maritime Silk Route[24]. Even today, the world's top trade routes in terms of TEUs[25] fall on this line (World Shipping Council, 2016) and Sri Lanka is on the crossroads of Asia to North America, Europe, and Middle East trade routes (Figure F-1). Owing to the position of the country on the route, its significance as a potential maritime hub has grown overtime. A similar geographic advantage is present in the Asia/Pacific to Europe air routes across the continent as well, which has promoted the development of directional hubs in the region. Thus, Sri Lanka has also been determined to develop itself as an air transport hub by capitalising on this geographical advantage and the growing Asian market. In a study evaluating the potential of Colombo airport to emerge as a hub, Jayalath and Bandara (2001) confirmed that it is better positioned to operate a directional hub on the cross roads between Europe and Southwest-Pacific (Northwest-Southeast) and between Northeast Asia and Africa (Northeast-Southwest).

However, a simple graphical comparison between the OD network structure facilitated by the CMB airport in 2000 and 2012 (Figure 6-9) reveals that such an expansion of operations on the said directions has not occurred. Colombo airport does not have any direct services to destinations in the Southwest Pacific. From the current network map, it is clear that the airports' links with the regional destinations in India and China have improved recently at the expense of the long-haul destinations. Even though the airport is linked with China and Japan (Northeast) it does not have services to any African destinations. Again, a

[24] The Silk Route is an ancient corridor of land (silk road) and sea (silk route) that stretched mainly from east to west connecting all Asian and European civilizations to each other in the past, which was driven by the trade flows of silk from China and Spices from Asia (UNESCO, 2013)
[25] Twenty Foot Equivalent Unit – the measurement unit of container ships

directional operation connecting Northeast (Asia) with Southwest (Africa) is not possible.

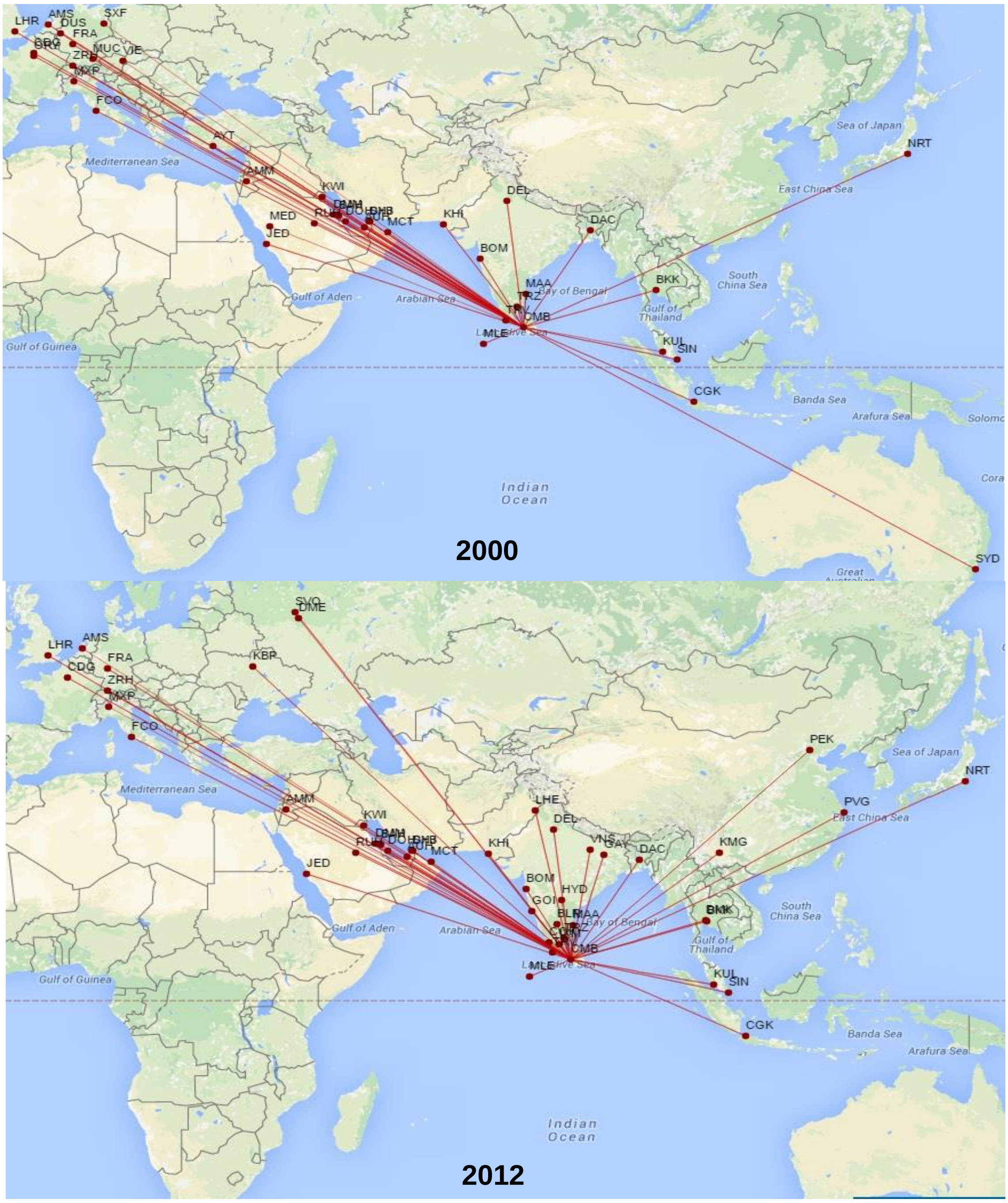

Figure 6-9 Route Map of Colombo Bandaranaike International Airport 2000-2012

Source: OAG (2012)

When airports are closely located, their catchment areas overlap for both OD and transfer traffic. Intensity of competition is higher particularly if there are large hub airports closely located as in the case of the Eastern region. Competitive consequences of this on Colombo airport are twofold. One is the competition to grab a share of the transfer traffic flown via the Eastern region, between continents of Asia/Pacific, Europe, Africa and Americas which also include the world's top four ultra-long-haul routes between Australia and UK (Airbus, 2014). London Heathrow-Sydney is the number one densest route flown over the region (Table 1-3). The routing factor analysis in section 5.4.1, confirmed that Colombo and other airports in the region have an equal advantage over serving this route (Table E-2).

Colombo airport served through traffic of this route until year 2002. The national carrier Sri Lankan Airlines' flight UL 678 to Sydney airport operated thrice a week that offered approximately 1872 seats per week. This could have been used to build up a connection with the airline's daily services to London Heathrow airport (OAG, 2012) but was abandoned a decade ago in 2002 after the carrier suffered severe damage to its fleet in a terrorist attack at the Colombo airport. The current major gateways on this route are the primary international hubs and primary hybrid hubs in the region. According to Figure 6-10, eleven gateways served the route in May 2012. The three super-hubs of Singapore, Hong Kong and Dubai were leading the market carrying more than two thirds of the total transfer traffic. Likewise, the major players in the Europe to Southwest-Pacific market are Dubai, Singapore and Hong Kong airports accounting for nearly 70% of the seats offered in May 2012 (Figure 6-11).

The traffic and seat capacity analysis demonstrate how Colombo's position as a gateway point between major air traffic flows in the world have disappeared over the years. The airport is dependent upon Middle East and South East Asia's primary and secondary hubs, and primary hybrid airports to keep itself connected to continents, as this is the only way to increase overall connectivity of smaller/regional airports (Suau-Sanchez and Burghouwt, 2012). When the route maps of Dubai and Singapore is examined (Figure 6-12) between the years 2000 and 2012, it is clear that during the period Dubai had introduced new services (through Emirates) to number of destinations in Australia. During this period, Colombo was held back from improving its connections when Sri Lankan airlines discontinued the services to Sydney. Colombo airport eventually lost its role as a gateway on the route, while Dubai airport emerged as a new gateway on the route.

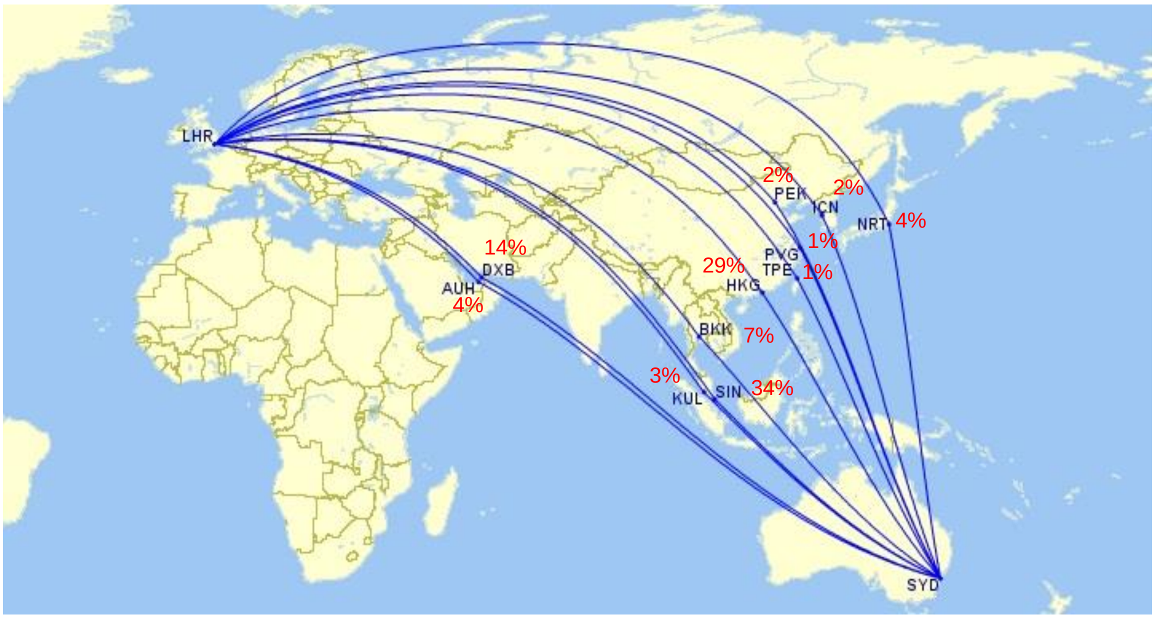

Figure 6-10 Gateways serving London Heathrow-Sydney route

Source: Own elaboration based on OAG (2012) and www.gcmap.com

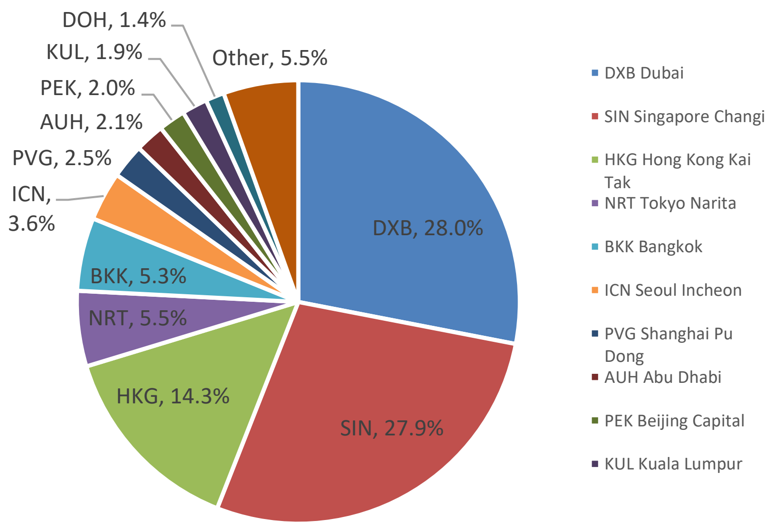

Figure 6-11 Share of seats by airport in the Europe to Southwest-Pacific transfer market, May 2012

Source: Own elaboration based on OAG (2012)

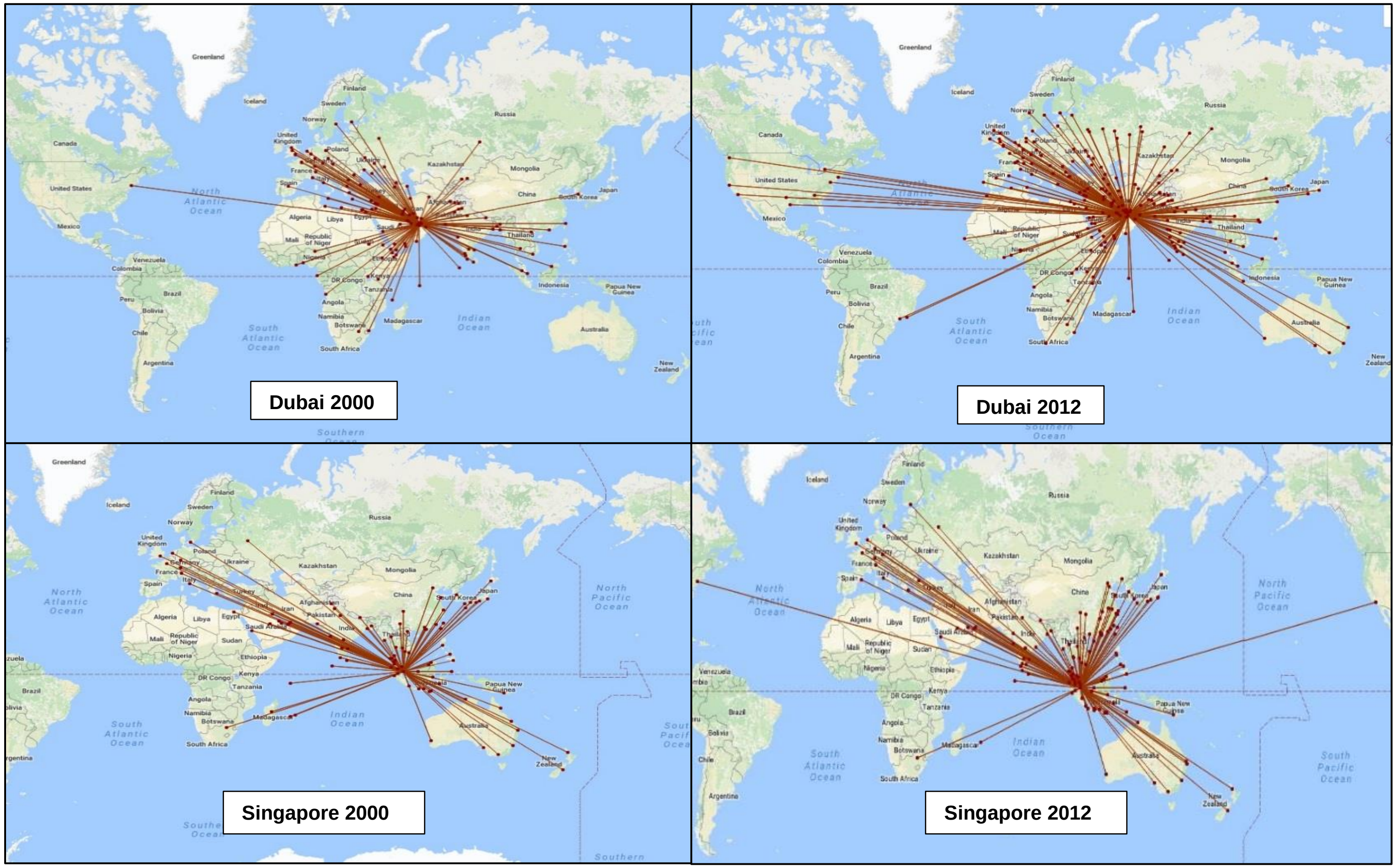

Figure 6-12 Route Maps of Dubai and Singapore Airports 2000-2012

Source: OAG (2012)

When hubs emerged in Souhteast Asia, O' Connor (1995) explained how the need of direct service to international destinations from small airports surrounding Singapore, Hong Kong, and Bangkok diminished over the years. The proximity effect forces small national airlines to cut capacity on the direct routes they are operating from the small airport, because there are large hubs nearby that provide indirect connections. National flag carriers struggle to attract passengers for a direct service for a higher price against a journey with a detour for a lesser price. On the other hand, international airlines get attracted to hubs because of the volumes of traffic pooled at the airport through feeder traffic from different destinations. This allows them to use big jets and introduce more daily frequency rather than operating less frequent direct international services to small airports.

Colombo airport is one such example of capacity cuts and discontinuation of services by the National Carrier Sri Lankan Airlines and International Airlines. The current capacity on the Colombo-Sydney route is shared by the four primary hubs/hybrid airports; Singapore, Hong Kong, Kuala Lampur, and Bangkok (Table 6-2). This demonstrates how mega-hubs attract feeder services from the nearby airports, reducing the need of direct services to those airports over time. This in turn exert pressure on small national airlines to cut capacity on the direct routes(O'Connor, 1995). Similarly, on the Colombo-London Heathrow route, Sri Lankan Airline's direct service only has a 7% share of the market (Table 6-2). Dubai dominates this route by offering 47% of the seats. Colombo airport has diminished itself to take a peripheral role in the network by providing feeder traffic to the main hubs.

It is clear that the Colombo airport and the national carrier Sri Lankan airlines is struggling to keep long haul services continuously, even to Europe, which is the only continent that it has had connections with, outside of the Eastern region. The connections to London Heathrow, Paris Charles de Gaulle, Rome Fiumicino, Munich, Sydney, Zurich and Moscow serve the countries where majority of the Sri Lankan Sinhala and Tamil Diasporas live. However, the services had not been sustained throughout. For example, between 1999-2012, Colombo - Fiumicino service by Sri Lankan airlines has been suspended on two occasions until they were back again on the market in 2012. Similar is the services to Zurich which was abandoned twice in 2006 and 2013 (according to schedule changes data by OAG for 1999-2013 period). Airport and the Airline have been opening up routes to regional airports lately. Comparison of route maps for year 2000 and 2012 (Figure 6-9) shows that regional destinations have increased with more services to China, Korea, and India while international destinations have not changed much.

Table 6-2 Capacity of connecting gateways on the Colombo-London Heathrow and Colombo-Sydney route, May 2012

Departure Airport	Gateway	Arrival Airport	Monthly Frequency	Seats	% seats offered
Colombo (CMB)	Dubai (DXB)	London Heathrow (LHR)	186	63674	47%
	Doha (DOH)		154	23826	17%
	Direct		**31**	**9001**	**7%**
	Bombay (BOM)		31	5859	4%
	Delhi (DEL)		31	5859	4%
	Kuala Lampur (KUL)		31	5146	4%
	Abu Dhabi (AUH)		36	5040	4%
	Kuwait (KWI)		19	4408	3%
	Amman (AMM)		13	4165	3%
	Bahrain (BAH)		27	3672	3%
	Bangkok (BKK)		13	3471	3%
	Oman (MCT)		17	2618	2%
	Singapore (SIN)	Sydney (SYD)	31	10292	39%
	Hong Kong (HKG)		31	8308	31%
	Kuala Lampur (KUL)		31	5146	19%
	Bangkok (BKK)		9	2703	10%

Source: Own elaboration based on OAG (2012)

Several factors have hindered the development of Colombo airport as a hub. One condition that held back Colombo from developing as a hub is the political situation that prevailed in the country since the beginning of 1970's. Sri Lanka experienced an ethnic conflict and a continuous civil war between the government of Sri Lanka and the Liberation Tigers of Tamil Eelam (LTTE) for nearly thirty years (1980-2009). On top of that, the country also experienced two youth-rebellious attempts led by People's Liberation Front in 1970's and late 1980's. This was a major hindrance to the promotion of the country as a safe and secure tourist destination. It also interrupted the flow of foreign direct investments to the country. The LTTE terrorists have attacked the airport several times. In 1986, an

Air Lanka flight was bombed by the terrorists that killed 14 people on board(Civil Aviation Authority of Sri Lanka, 2016). The major attack on the airport was on 24th July 2001, which destroyed half of the Sri Lankan airlines fleet. The carrier was forced to stop services to several international destinations including Australia and Germany and resume operations to certain international destinations from Male (Wijayasiri, Malalasekara and Dunusinghe, 2004). The impact of the incident was doubled with the 9/11 attack in the same year. The safety and security further deteriorated with two more attempts to bomb the airport in 2007 and 2008. The country was declared a state of emergency. The insurance premium on aircrafts passing Colombo was very high and many international airlines pulled out of the airport including KLM and British Airways or others reduced the frequencies (Wijayasiri, Malalasekara and Dunusinghe, 2004).

Another is the insufficient airport infrastructure (Airport and Aviation Services (Sri Lanka) Ltd., 2014). The period after 1970's is the time that the global aviation industry witnessed rapid airport infrastructure developments around the world. Colombo airport was also built around the period (1967/68) and subsequent upgrades with a new runway and a terminal in 1986, and a finger pier in 2005. In addition, the national carrier was also inaugurated in 1979. When an airport's or an airline's opportunities for growth are impeded by external forces, it limits their ability to plan. Because of the political conditions prevailed in the country, the (then) new airport and the airline could not realise their potential to grow as a hub carrier or a hub airport. Thus, the infrastructure upgrades and developments were delayed. While other airports in the region moved forward, Colombo to a certain degree was held back on one hand with an uncertain future. On the other hand, since the government resources were divided between establishing peace in the country and fuelling economic growth, the aviation industry did not receive the much-needed timely intervention to exploit the first mover advantage over the developing Asian aviation market. For example, the current terminal only has capacity to handle 6 million passengers, which is around 1/10th of the capacity of Singapore Changi airport. For a country that has four times larger population than Singapore, the airport infrastructure does seem highly inadequate. However, the airport only exceeded its capacity in the recent years (2012).

The above reveals another constraint the airport faces in terms of traffic generation. The local market has remained stagnant over the years. Seats per head of population stood at 0.45 in 2012 (calculations based on available seat capacity (OAG, 2012) and population (United Nations, Department of Economic and Social Affairs, Population Division, 2014), which indicate the low propensity to fly. Lower income levels (GDP per capita of 2872 US$) may have influenced the outbound travel by citizens. Until recently, outbound leisure travel was not part of the life style of the middle class. People mainly travelled for employment, education, VFR and professional/business reasons. The political situation also influenced inbound tourism, which is one of the key industries that is necessary to support the development of the aviation industry in Sri Lanka. Therefore, one opportunity that the airport could exploit in order to grow beyond its local market was again barricaded.

The analysis reveals that the developments that have taken place over the last decade in the airport industry of Middle East, South East Asia and Northeast Asia and the giant networks of their respective hub carriers have eroded key markets Sri Lanka had been vying for. The fact that the South Asian region is sandwiched between two big aviation markets of Southeast Asia and Middle East that enjoy the 'first-mover advantage' over the continental routes has gradually dampened the competitive edge of the Colombo's geographical positioning to develop a directional hub operation. It can be deduced that Colombo airport's importance as a hub has diminished under the shadow of Southeast Asian and Middle Eastern mega- hubs. Thus, Colombo airport is a pertinent case to study the application of the proposed airport taxonomy.

6.4 Evaluation of the competitive position of Colombo airport

As explained in section 6.2.1, to identify the competitive position of the Colombo airport, the taxonomy is applied at two network levels; macro-network-scale and meso-network-scale. At the macro level Colombo airport is benchmarked against the other airports secondary international hub group (section 6.4.1). Then the airport's role as the only secondary hub in the South Asia region is evaluated against the other airports in the South Asian airport network (section 6.4.2).

6.4.1 Benchmarking strategic performance of the Colombo airport

Colombo airport was classified into the secondary international hub group (section 4.6.2). Secondary international hubs share a similar profile with medium international airports in terms of the degree of airport activity. In terms of their international and regional network strategies, secondary hubs subordinate to primary international hubs. To identify the standing of the Colombo airport, it is compared with the group averages for the strategic performance indicators (used in classification) of the secondary international hub group (Table 6-3).

Colombo airport is the smallest in terms of the size of operations in the secondary hub group. Group averages are strongly influenced by the two leading hubs in the group, Doha and Abu Dhabi. Colombo stands way below (twice as smaller) the group average for number of flights, and seats. Doha records the highest values, which are more than three times bigger than the size of Colombo. Number of passengers are also the lowest, but, in terms of airline load factors Colombo performs better than the average. Kuwait has the highest airline load factors in the group. Abu Dhabi and Doha have the lowest airline load factors. A possible reason for this may be the rapid introduction of capacity by the respective hub carriers at these airports. Middle Eastern hubs and airlines are well-known for the organic growth strategies (Favaro, Meer and Sharma, 2012) pursued by them through heavy airport infrastructure investments and the introduction of airline capacity(Grimme, 2011; Murel and O'Connell, 2011). The strategy is to stimulate market demand by offering low prices, which in turn creates entry barriers to new comers. Again, Colombo has lower than average number of airlines, destinations, and gates. HHI at Colombo is intense than the group average and hub carrier dominance is closer to the average. Their respective hub carriers, Qatar and Etihad, significantly dominate the two leading hubs. Therefore, competition is less intense at the two airports.

Table 6-3 Data for strategic performance indicators of secondary international hubs (2012)

Strategic Variable	Doha (DOH)	Abu Dhabi (AUH)	Bahrain (BAH)	Kuwait (KWT)	Colombo (CMB)	Average
Flights/day	413	274	250	211	132	**256**
Seats/day	82,482	54,302	39,012	38,231	26,828	**48171**
Passengers/day	35,782	25,254	18,555	23,546	15,136	**23,655**
Load factors	43%	47%	48%	62%	56%	**51%**
No of Airlines	32	47	35	44	34	**38.4**
No of destinations served	107	100	64	70	51	**78.4**
No of gates	33	61	10	10	12	**25.2**
% of seats by dominant carrier	77%	69%	55%	26%	52%	**56%**
HHI	0.60	0.48	0.32	0.10	0.29	**0.36**
Traffic generation (Global)	0.42%	0.34%	0.29%	0.45%	0.26%	**0.35%**
Flow centrality (Global)	0.32%	0.18%	0.09%	0.04%	0.06%	**0.14%**
Traffic generation (International)	3.73%	4.08%	1.96%	3.86%	5.12%	**3.75%**
Flow centrality (international to international)	3.10%	1.77%	0.20%	0.23%	0.20%	**1.10%**
Flow centrality (International to regional)	2.35%	1.42%	1.19%	0.48%	1.50%	**1.39%**
Traffic generation (regional)	7.88%	3.61%	6.75%	8.38%	21.03%	**9.53%**
Flow centrality (regional)	0.45%	0.19%	0.50%	0.09%	1.14%	**0.48%**
% of First/Business seats	11%	10%	11%	9%	7%	**10%**
Total Domestic	0.00%	1.17%	0.00%	0.00%	0.34%	**0.30%**
Total Regional	30%	19%	50%	46%	28%	**34%**
Total international	70%	80%	50%	54%	71%	**65%**
Traffic generation (domestic)	0.00%	50.00%	0.00%	0.00%	44.53%	**18.91%**
Flow centrality (domestic)	0.00%	0.00%	0.00%	0.00%	0.00%	**0.00%**
Flow centrality (International to domestic)	0.00%	0.02%	0.00%	0.00%	0.00%	**0.00%**
Seats/aircraft	201	199	157	182	204	**189**
Average frequency per route	4	3	4	4	3	**4**
% seats by LCCs	6%	3%	17%	25%	7%	**12%**

Source: Own elaboration based on OAG (2012) and Flightglobal (2013), and airport websites

The comparison reveals the relatively weak position of Colombo airport within the secondary international hub group. The possibility to emulate the leading hubs are restricted by the capacity limitations at the Colombo airport as it is already operating over the designed capacity of 6 million passengers (7.8 million passengers in 2014). The second terminal building project is at its early stages. It is planned to commence operations in 2019/20 with the capacity to handle 15 million passengers (Airport and Aviation Services (Sri Lanka) Ltd., 2014). This is a delayed project in comparison to the developments at Doha and Abu Dhabi. Doha airport moved its operations to the new Hamad International Airport in 2014 and the Midfield Terminal at Abu Dhabi will be opened in 2017. Each airport will then have the capacity to handle 28-30 million passengers per annum (Flightglobal, 2016). Being capacity restricted limit the attractiveness of the airport to airlines. There is also the threat of its hub status being deteriorated against the primary and the secondary hubs, and being surpassed by other medium international airports. The dominant hub carrier Sri Lankan Airlines is smaller (13876 seats/day)[26] compared to the two major hub carriers Qatar (63, 511 seats/day) and Etihad (37,468 seats/day) at Doha and Abu Dhabi respectively. This hints the weak position of the airline in terms of primary hub carriers like Emirates, Singapore, and Malaysian as well.

Traffic contribution of Colombo airport to the Eastern network (global traffic generation) is the lowest in the secondary hub group. Connectivity (global flow centrality) is the second lowest. This means that within the hub category airports (primary and secondary) competitive position of Colombo is not very strong. The other traffic generation measures and flow centrality measures given in Table 6-3, evaluate the airport's traffic contribution and connectivity role at a regional level (e.g. for Colombo-South Asia, for Abu Dhabi- Middle East). Colombo's position within South Asia in terms of traffic generation is stronger than the average and it is the highest within the secondary hub group. This means that Colombo plays a central role in generating international traffic within South Asia than the other four airports within the Middle East. However, international-to-international flow centrality is below average and is significantly lower compared to the connectivity levels of Doha and Abu Dhabi. Colombo has the second highest connectivity levels in connecting South Asian airports to other international destinations. Similarly, it plays a larger regional hub role within South Asia than the other secondary airports are doing in the Middle East market.

[26] % of seats by dominant carrier x Seats per day (e.g. for Sri Lankan Airlines 56% of 26, 828)

Even though Colombo airport's connectivity role is more regionally oriented, the traffic profile is otherwise, and is more similar to Doha and Abu Dhabi. International traffic accounts for a share of 71% at the airport. This indicate that the airport is more or less a traffic generator in the international markets (international traffic generation is also highest in the group), but has not converted it to improve the connectivity status. The reasons may be that the major hub carrier Sri Lankan Airlines is a small airline and was not part of any alliance until 2014, since when it became a member of 'oneworld'. This may have limited the carrier's potential to offer more connectivity at the airport. Colombo airports domestic traffic share is only 0.34%, which is similar to the other primary and secondary hubs in the region. However, as it is the primary airport that handles (even) the small number of domestic traffic (less than 1791for May 2012), the role of the airport as a domestic traffic generator is somewhat inflated (domestic traffic generation is 44%). It is similar to Abu Dhabi, which is one of the two main airports handling domestic traffic within UAE (the other is Ras al Khaimah (RKT). The domestic traffic at Colombo are mostly the tourist traffic (85% economy and 15% business and first class seats) carried by the Sri Lankan Air Taxi; the domestic carrier of Sri Lankan Airlines (operated by codeshare partner Cinnamon Air).

In terms of service levels, the airport has three flights per route, one flight less than the average. The seats per aircraft is the average size of a medium to long haul jet aircraft. LCC presence is below average at the Colombo airport. The seats were mainly carried by the national budget carrier-Mihin Lanka (47%), Spicejet (22%) and Air India Express (31%). Given the regional role played by the airport, the degree of LCC presence is not adequate at the airport. Bahrain and Kuwait, that are more regionally oriented airports in the Middle East has more LCC presence, 17% and 25% respectively. Another feature of LCCs in the region is the facilitation of connections to onward journeys. In this respect, Colombo airport still has the potential to develop its LCC base.

6.4.2 Role of the Colombo airport in the South Asian aviation market and beyond

According to Figure 6-13, only, the airports of Colombo, Delhi and Mumbai play a significant role of an international hub in the region. However, international connectivity means here, any passenger that is transferring at the airport, whose journey originate and end at a point outside South Asia, *not* points outside the entire Eastern region (therefore not intercontinental connectivity). The size of the bubbles represent the international traffic generation ratios of each airport, and the values are indicated next to each bubble. Delhi and Mumbai are the largest traffic generators in the region. Colombo plays the leading role in connecting the region to international markets. Its international to regional flow centrality is 1.5%, which is the highest in the region.

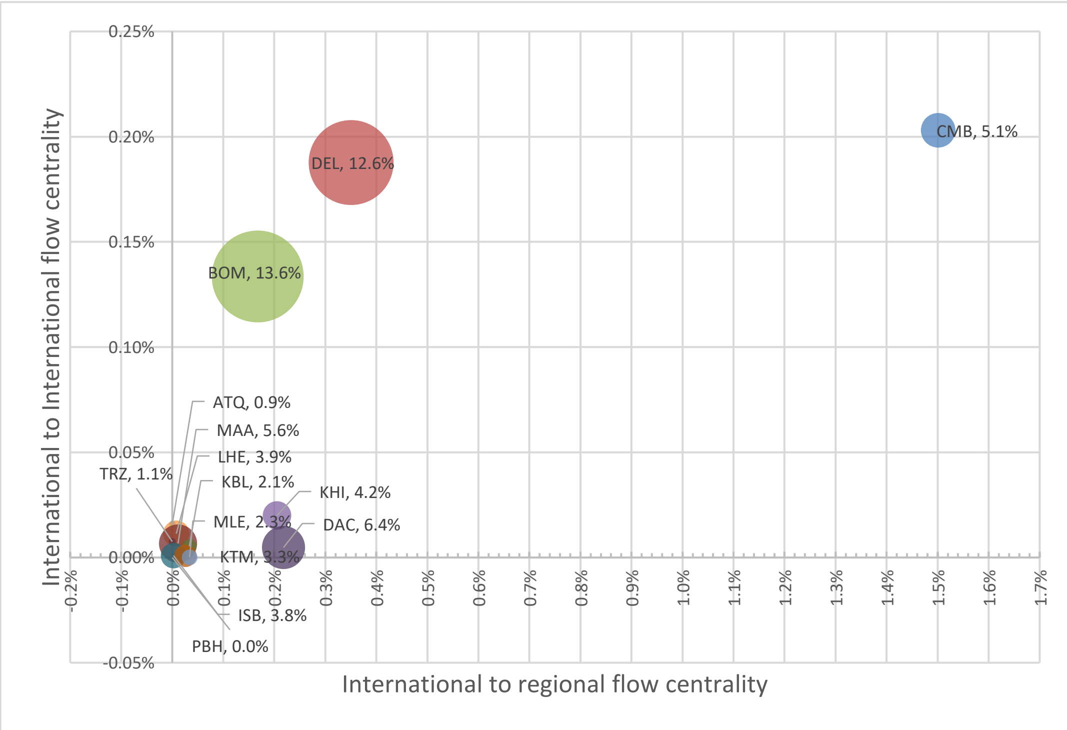

Figure 6-13 Hub roles played by the international and hybrid airports in South Asia, May 2012

Source: Own elaboration based on OAG (2012)

However, the comparatively lower international traffic generation at the airport demonstrate the limitations it faces in developing as a hub. Ability to generate traffic is a major requirement for successful hubs (Rodriguez-Deniz, Suau-

Sanchez and Voltes-Dorta, 2013). As the only (operational) international gateway to the country, Colombo demonstrates the problem Sri Lanka face as country as well. The 5.1% contribution to the total international traffic generated by the airports in South Asia clearly show the limitations of international links. It is directly connected to 51 destinations only, which is also the lowest within the secondary hub category (Table 6-3). Without increasing the city-pairs served, which will eventually increase traffic contribution, Colombo will face challenges in developing its hub status further. In addition, the Indian primary hybrid hubs that have a significant local market to generate enough OD traffic are potential threats to Colombo's status. Colombo is the main regional hub in South Asia as well (Figure 6-14). Regional flow centrality provided by the airport stands at 1.1%. The airport generates 21% of the regional traffic, demonstrating the relationships the airport and the country is having with regional markets.

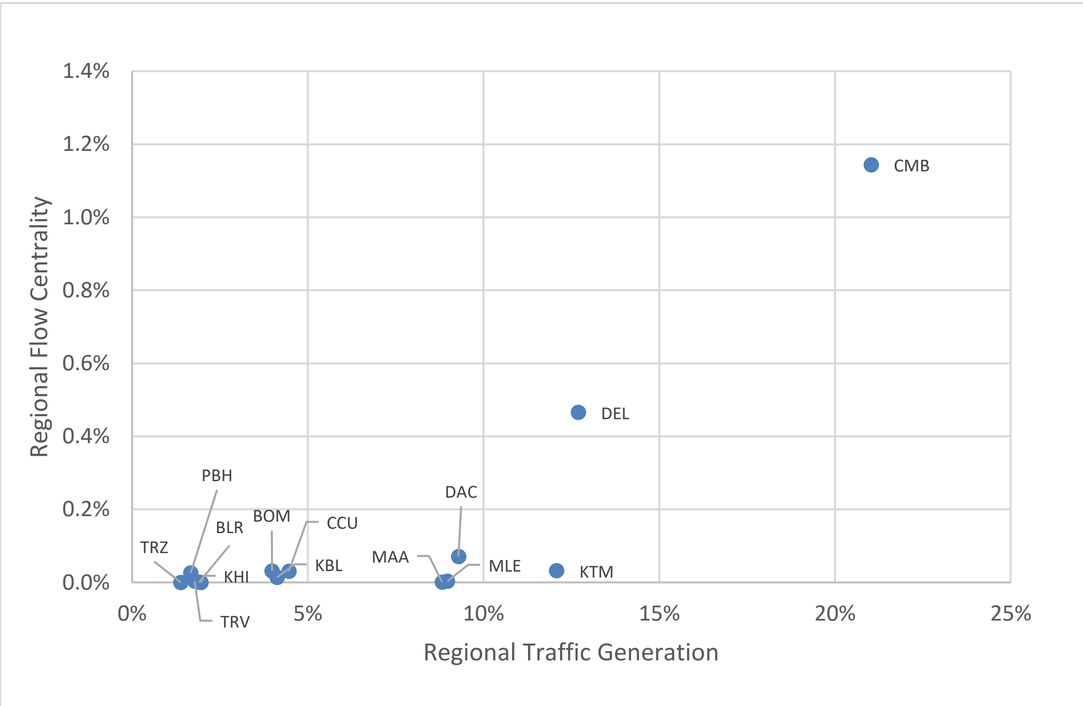

Figure 6-14 Regional hubs in South Asia, May 2012

Source: Own elaboration based on OAG (2012)

While Colombo seems to be taking up a larger connecting role within the network of airports in South Asia, it should be further evaluated what markets it is dependent upon and possible implications. In addition, the regional 'betweenness' role of Colombo is contradictory to the geographic positioning of the airport as could be seen in Figure 6-2. According to the topography of the Indian sub-continent, India is more centrally located between all the countries. Sri Lanka is in the southern tip of the continent.

International/intercontinental hub role

The international connectivity levels of Colombo airport are evaluated by examining the market pairs served by the airport (Figure 6-15). In the month of May 2012, Colombo carried 9572 international transfer passengers. Out of that majority of the international transfer traffic carried are within the Eastern aviation network. The key markets are Middle East, Southeast and Northeast Asia to which the national hub carrier operate direct flights (Figure 6-16). The only continent connected with direct flights is the Western Europe, to which again Sri Lankan Airlines operates direct flights to Frankfurt, London-Heathrow, Milan Malpensa, Moscow Domodedovo, Paris Charles de Gaulle, and Rome Fiumicino. Figure 6-15 shows the dependency of the airport on the Middle East and Southeast Asian hubs in connecting to Southwest Pacific, Africa and America and also the Europe. This reveals that Colombo airport's position is not very strong in terms of connecting intercontinental market pairs.

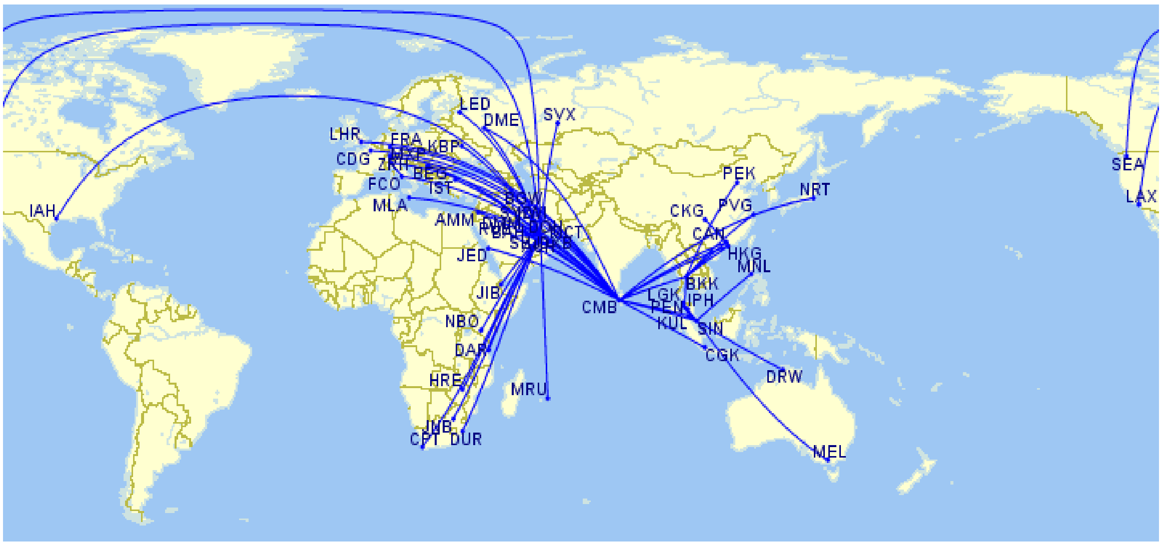

Figure 6-15 International connections facilitated at the Colombo airport, May 2012

Source: Own elaboration based on OAG (2012) and www.gcmap.com

Comparatively Delhi and Mumbai, carried 8152 and 5734 transfer passengers respectively. The airports are directly connected to more continental destinations than Colombo (United States, Mauritius, Kenya, South Africa etc., as points outside of the Eastern region). Owing to the size of the local market, growing Indian economy, and the international Indian Diaspora increase the potential of these airports to grow further as hubs. This presents considerable challenges to Colombo in developing as a hub. On the one hand, the low international traffic generation levels are a hindrance to improve on the city pair markets. On the other hand, dependency on a single continent (Europe) further limit the potential to create multiple intercontinental connections.

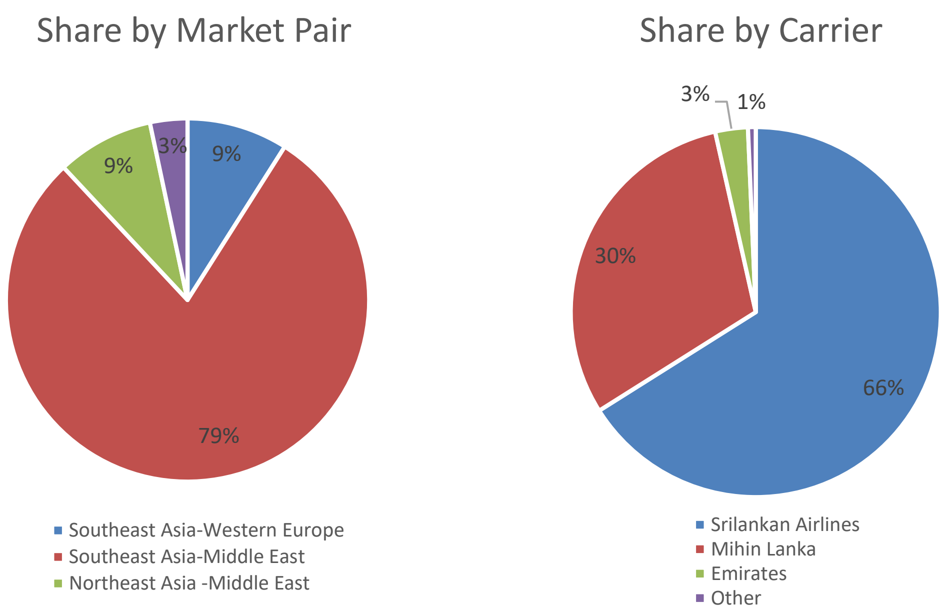

Figure 6-16 International transfer market pairs and carriers for Colombo Airport

Source: Own elaboration based on OAG (2012)

Regional hub role

In the month of May 2012, according to MIDT booking data 5,468 passenger transferred via Colombo to travel to another airport within South Asia. The regional connectivity provided by Colombo airport is highly dependent on the Maldives market (Figure 6-17). Out of the total transfer traffic, 74% is carried between Maldives and Indian destinations. Likewise, 10% and 3% are carried between Maldives-Bangladesh and Maldives-Pakistan routes respectively. The other 13% is carried between India-Bangladesh and India-Pakistan[27]. When the topographic centrality is concerned, this dependency hints the vulnerability of Colombo airport, for being dependent on a single market. Though Colombo is better positioned to connect Maldives to other South Asian destinations, being at the centre, Indian airports are better advantaged to connect the North-South regional traffic. The development of the LCCs in India also increase the potential threats to the position of Colombo in two ways. One is the introduction of PP services between the destinations that is now served by Colombo. The other is providing connections between Maldives and other South Asian destinations. Indian LCCs currently offer connecting services at some of the airports such as Spicejet at Hyderabad airport. Another threat is the possible airline start-ups in Maldives. In addition, regional transfers market in South Asia is a very small. Out of the total intra-regional traffic of 604,863 only 9,113 connected at a regional airport before flying to the final destination. Therefore, the above discussed potential risks can jeopardise the position of Colombo further.

Colombo is also the leading international gateway to the region (Figure 6-13). International to regional connectivity levels stood at 5.1%. For May 2012, the main airports that were connected with an international destination via Colombo were; Chennai (14,988), Tiruchirappalli (12,940) Kochi (IN) (11,399), Male (7,665), Thiruvananthapuram (6,254), Mumbai (4,408), Karachi (3,431), Delhi (3,189), Bengaluru (2,578), and Dhaka (1,551). Figure 6-18 clearly shows that Colombo is a gateway to South Asia mainly for origins or destinations in Northeast Asia, Southeast Asia, Middle East, and Europe. It shows that for some of the connections, Colombo depends on a second gateway as well.

[27] Being a transfer point for traffic between India and other destinations (except Maldives) is theoretically unlikely. The journeys have higher detours, given the geographical position of Colombo. The connections have been made between Karachi or Dhaka and South Indian airports like Chennai, Kochi (IN), Tiruchirappalli and Bengaluru to which Sri Lankan airlines have direct services. In addition, during the time (May 2012), there were no direct flights between some of these airports or only one airline was flying direct.

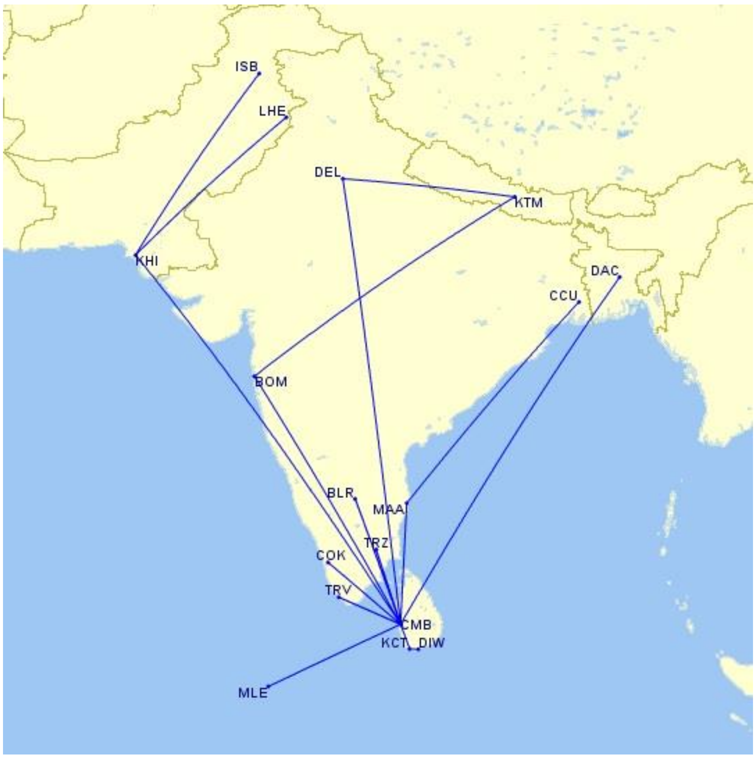

Figure 6-17 Regional market pairs connected via Colombo airport, May 2012

Source: Own elaboration based on OAG (2012) and www.gcmap.com

Though the profile of the Colombo airport qualifies to be a secondary hub and does seem to have an advantage over its position as the only one of such kind in the South Asian region, the above analysis on its hubbing role reveals its vulnerability to potential competition and market dynamics in the future. This analysis corresponds with the results of the benchmarking exercise of the airport against the secondary hub group as well. The facts support the deduction made at the beginning of the study of a possible effect of a traffic shadow on the airport that has weakened its position overtime.

Figure 6-18 South Asian airports connected to the international destinations via Colombo airport, May 2012

Source: Own elaboration based on OAG (2012) and www.gcmap.com

6.5 Policy Recommendations

Following the approach specified in section 6.2, to improve the current position of the Colombo airport, strategic and policy recommendations are provided at three levels; airport strategy, industry level policy and national level policy.

6.5.1 Airport level strategy: Network and route development

Airport strategy recommendations are based on the evaluations carried out in section 6.4 above.

1. *Capitalise on overlapping catchment areas in the Indian subcontinent to maintain regional gateway status and improve regional hub status*

In section 6.4.2, it was shown that Colombo airport acts as the major regional gateway and regional hub to South Asia. However, further evaluation revealed that the airport depends on few markets to maintain its current role, which increases the risks associated with potential competition. Therefore, it is recommended that the Colombo airport focus on strengthening its current position, both as the regional gateway to international markets and as the regional hub. The following discussion explain how the airport can accomplish this by following different strategies.

Airports compete for traffic when they have overlapping catchment areas/hinterlands or are located within the same metropolis. Size of catchments areas/hinterlands vary depending on the type of traffic as well. For short-haul flights, passengers choose nearby airports. Therefore, catchment boundary would be closer to the airport. But for long-haul flights passengers may choose comfort over travel distance to the airport, which expand the catchment areas of international airports(Graham, 2008). Being an island airport[28], Colombo may seem to have no competition from overlapping hinterland traffic at first glance (second international airport was not in operation at the time of the study). However, Colombo scored high on international to regional flow centrality and it could be seen that the airport draws feeder traffic from airports in Southern part of India (Chennai, Tiruchirappalli, Kochi (IN), and Thiruvananthapuram), Male and even Mumbai, Delhi, Bengaluru, Karachi, and Dhaka (section 6.4.2). Thus, Colombo's regional hinterland expand up to South Asian borders to the north.

To assess the competitive position of the airport in the overlapping catchment areas, four South Indian airports and Male which are less than 1:30 hours flight time was selected. Table 6-4 summarises seats offered on the routes (by non-stop and one-stop flights) that a direct flight was available from the origin/destination airport. The figures show that Colombo is well positioned to provide a good alternative to those nearby Indian airports for long-haul flights. Especially for Tiruchirappalli, it is the major competitor carrying the largest share of indirect traffic (4332 out of the total 5602 indirect traffic, which is 77%); to those destinations that a direct flight was available from the airport. Colombo carries the highest number of transfer traffic originating from the four Indian airports compared to Mumbai Delhi and other Middle Eastern airports. However, for Male, Dubai has surpassed Colombo. This threatens Colombo's position as a regional

[28] "If airports are located on small islands or remote regions, there will be very little competition"(Graham, 2008) p.230

gateway as it is highly dependent upon the Maldivian market to generate transfer traffic at the airport (both regional and international).

Table 6-4 Hinterland analysis of Colombo airport for airports within 1:30 hours block time, May 2012)

Origin/Destination Airport	Average block time (Hours)	Total traffic on routes with a direct flight	Traffic carried by direct flights	Traffic carried by one-stop flights to destinations with a direct flight	Traffic carried via Colombo	Traffic carried via other South Asian airports	Largest share of traffic carried via an airport outside South Asia
Chennai	1.21	204762	145650	59112	14176	10616	10491 (Dubai)
Share of total traffic			*71%*	*29%*	*7%*	*5%*	*5%*
Share of indirect traffic					*24%*	*18%*	*18%*
Thiruvananthapuram	1:00	112035	89820	22215	5002	3885	4203 (Dubai)
Share of total traffic			*80%*	*20%*	*4%*	*3%*	*4%*
Share of indirect traffic					*23%*	*17%*	*19%*
Tiruchirappalli	1:00	41684	36082	5602	4322	955	288 (Singapore)
Share of total traffic			*87%*	*13%*	*10%*	*2%*	*1%*
Share of indirect traffic					*77%*	*17%*	*5%*
Kochi	1:20	159069	125474	33595	9530	6119	5085 (Bahrain)
Share of total traffic			*79%*	*21%*	*6%*	*4%*	*3%*
Share of indirect traffic					*28%*	*18%*	*15%*
Male	1:26	60538	39937	20601	3260	3	6700 (Dubai)
Share of total traffic			*66%*	*34%*	*5%*	*.005%*	*11%*
Share of indirect traffic					*16%*	*.02%*	*33%*

Source: Own elaboration based on OAG (2012)

Competition consequences of the above for Colombo are twofold. One is the competition between Colombo and these South Indian airports and Male in attracting long-haul traffic and international airlines, and the other is the competition between Colombo and other airports competing for feeder traffic originating from South Indian and Male airports. Therefore, Colombo should focus on strengthening its position to make it an attractive gateway to the region and maintain its regional hub status. One option is to promote Colombo as the primary gateway to diverse destinations in South Asia. Colombo should reduce its high-dependency on the Maldivian market to maintain its regional hub and gateway status. For this, the airport should focus on developing regional routes working together with national carrier and promoting other regional airlines to choose Colombo as the transfer point. This will ensure that a fair base of feeder traffic is generated at the airport to encourage main international airlines to fly to the airport.

Colombo should capitalise on its current strength as the central airport in the region (ranked first in terms of regional traffic generation- 20%, regional flow centrality -1.14%, and international to regional flow centrality- 5.1%). A possibility to sustain its status is to evaluate the costs and benefits of developing the airport's position as a base for region's LCCs. In section 6.4.1, it was identified that Colombo airport's LCC presence is below the average level of a secondary international airport. This weakness can be converted into an opportunity for the airport to increase regional traffic at the airport. Since Colombo already has a significant regional OD base from FSC airlines, it is easier to promote the airport to LCCs. It will also reduce the risk of introduction of potential threats from point to point services between key markets that Colombo serves as a connecting point.

The current regional demand for international transfers at the Colombo airport (section 6.4.2), the popularity of LCCs in South Asia (section 1.1.4.7, 4.6.1.1. and 4.6.1.2) , and the growing middle class in the South Asian region provide good grounds for the Colombo airport to consider promotion of self-help hubbing as a network growth strategy. The fact that some South Asian LCCs are already offering connecting options (section 4.6.1.1) is an opportunity for the airport to seek airline support in venturing into self-connecting platform. Self- connecting passengers or self-help hubbing is a situation where passengers travel with a combination of tickets on the same or different airlines by organising transfers between flights by themselves without the involvement of the airline/s (Fageda, Suau-Sanchez and Mason, 2015; Malighetti, Paleari and Redondi, 2008; Suau-Sanchez, Voltes-Dorta and Rodríguez-Déniz, 2016). This is popular among the price sensitive travellers on the short-to-medium-haul journeys and as well among passengers transferring to long-haul flights after a short-haul journey. This is a growing travel segment in the Europe and some airports like Gatwick are involved in providing a new platforms to help passengers to organise their travel through self-connection (Fageda, Suau-Sanchez and Mason, 2015; Suau-Sanchez, Voltes-Dorta and Rodríguez-Déniz, 2016)..

2. *International route development*

The analysis in section 6.3.3.2 disclosed the deteriorated secondary hub status of the Colombo Airport against the traffic shadows of primary and leading secondary hubs in the region. Therefore, the airport need to focus on staying competitive in the intercontinental markets. It is recommended that the Colombo airport adopt a strategic route development process (Halpern and Graham, 2015, 2016) in order to improve the international hub status. Given the dilemmas faced by the national carrier[29], Colombo airport should not entirely depend on Sri Lankan Airlines to expand the network associated with the airport. While working closely with Sri Lankan Airlines, the airport management should address following as useful objectives in international route development.

- Promote the hub carrier Sri Lankan to strengthen the international network by considering the potential demand for OD traffic from the regional hinterlands. Section 6.4.2 and the previous discussion in this section identified that Colombo has a strong presence as a gateway to South Indian and Maldivian airports. Thus, introducing services to international destinations that are attractive to regional catchment area population as well, without limiting to the Sri Lankan local market. This will allow the airport and the airline to retain its regional status.

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[29] The hub carrier Sri Lankan airlines is financially struggling (a recorded loss of 16,329 LKR Mn.)(Sri Lanakan Airlines, 2015), which is one reason among several others that has limited the carrier's capacity to pursue an organic growth strategy as mentioned in section 6.3.3.2).

- Section 6.3.3.2 pointed out the case of Colombo airport losing its gateway status in the London Heathrow- Sydney route. The airport should clearly benefit from being able to regain its gateway status in the London Heathrow- Sydney route. Currently 86,413 Sri Lankan origin people are living in Australia(Department of Immigration Citizenship, 2014). Australia is one of the top ten source markets for tourist arrivals to Sri Lanka. In 2015, 61,864 Australian tourists arrived in the country (Sri Lanka Tourism Development Authority, 2015). Airport can promote this as a potential route for new airlines. Likewise, the airport should evaluate the destinations with potential demand and promote new airlines to start up new services.
- Route structure analysis in section 6.3.3.2 revealed that the airport and the airline had been increasing its focus on the Chinese and Indian markets recently, by introducing services to more destinations within the countries (Figure 6-9). India and China are the first and third largest source markets with 316,247 and 161,845 tourist arrivals in 2015 (Sri Lanka Tourism Development Authority, 2015). Given the strong cultural, political and economic ties, Colombo airport should focus on building strong connections to more destinations within the two countries. The growing middle class and increased levels of outbound travel in both countries have the potential to improve the OD base of the airport. The previously mentioned self-connecting platforms would be ideal to promote the airport also as a waypoint for price sensitive Chinese and Indian travellers.

6.5.2 Industry level policy development: Promoting liberal aviation policies

Based on the variables used in chapter 5 for air transport policy and regulatory environment profiling of the airport groups (section 5.5) , this section reviews the conditions of Sri Lanka against the countries of the airports in the secondary international hub group and countries in South Asia in order to provide developmental policy recommendations.

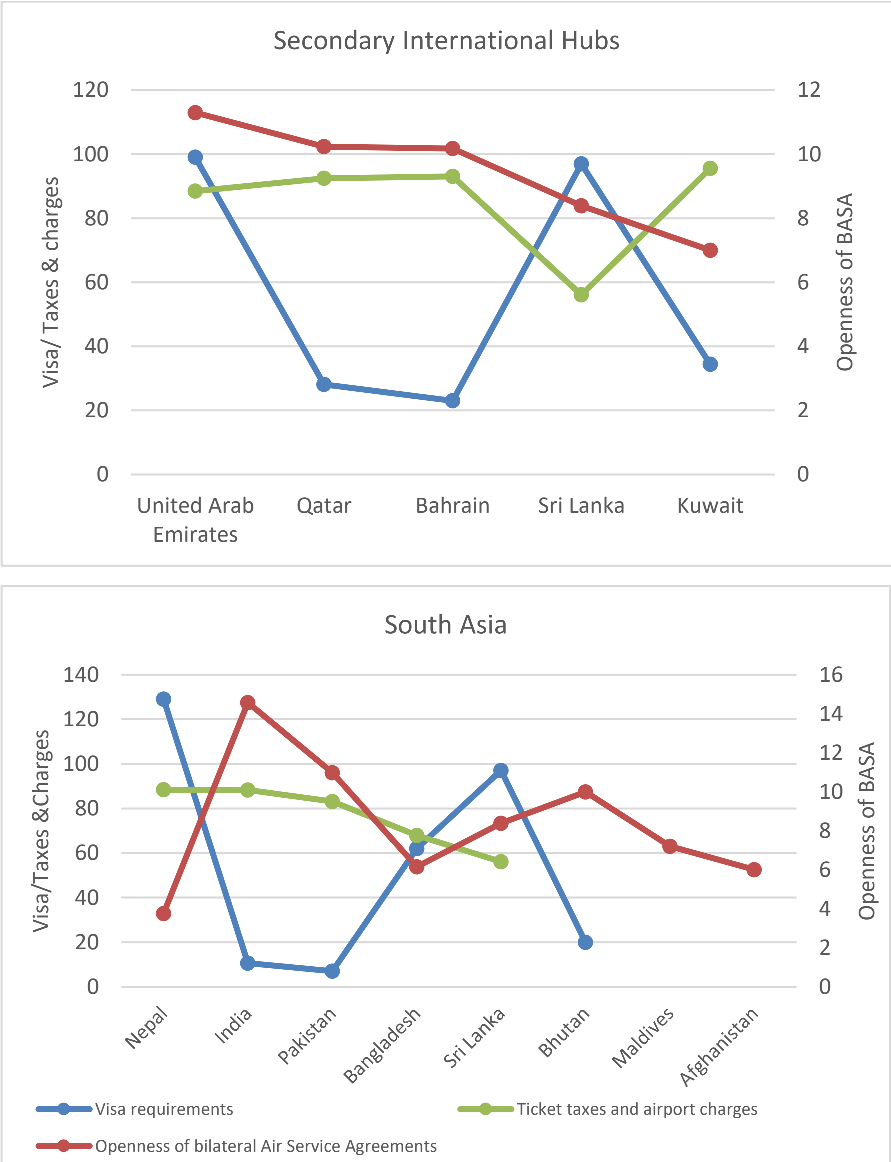

Figure 6-19 Indicators of the degree of liberalisation in the aviation industry, 2012

Source: Own elaboration based on WTO (2012) and WEF (2013)

1. Liberalisation of air services agreements

Among the 45 countries sampled Sri Lanka ranks 25th in terms of openness of BASA. It scored 8.4 on a 0-50 'closed - liberal' scale. Sri Lanka is below the sample average of 9.5. When compared with the countries of secondary international hubs (Figure 6-19), except for Kuwait Sri Lanka is less open than the other countries. Qatar and UAE, which is home to the two leading secondary international hubs of Doha and Abu Dhabi (section 4.6.2 and 6.4.1), are the most liberal. In section 5.5, it was established that the degree of airport activity (size) has a positive relationship with the degree of liberalisation. However, it was also revealed that the leading primary and secondary hubs have exploited the 6th freedom rights to overcome the regulatory barriers in air service agreements. In South Asia also, Sri Lanka is not open as much as India, Pakistan and Bhutan. India and Pakistan are the first and the second largest markets in South Asia. Given the size of their local markets that can support a strong OD market (section 6.3); if they move towards a more liberal approach, there is huge potential to increase the connectivity levels at those airports that will elevate those airports in the airport hierarchy surpassing the current gateway role enjoyed by Colombo airport.

According to the records in the World Air Services Agreements Database (ICAO,2014), Sri Lanka is party to twenty eight BASA, out of which twenty one agreements have clauses on exchange of 3rd, 4th and 5th freedoms of traffic. However, only ten of them are multiple designating and out of that, nine agreements require dual approval for tariff determination. Out of the nine, five of them are predetermined capacity restricted. Most of the agreements that grant 5th freedom is not fully open. There are capacity and points restrictions on routes. The only fully liberal agreement is with USA, the most distanced destination in the list of BASA, which has not been utilised by the national carrier. The protective approach to BASA may be in the interest of defending the national carrier Sri Lankan Airlines, but is not in the best interest of the airport. The evaluation above clearly indicates that Sri Lanka's approach to air service liberalisation is below the best-in class standards of secondary international airports and leading South Asian airports. Thus, it is recommended that the regulators should take a more liberal approach to BASA at least within South Asia, which would improve the status of the airport as a regional hub.

2. An open approach to entry and exit regulations

Sri Lanka scores second best in both secondary international hub group and South Asian airports in the visa requirements index (Figure 6-19). Prior to 2012, visitor visa was granted on-arrival, but since then both electronic and on-arrival applications are entertained (Sri Lanka Tourism Development Authority, 2013) which is a significant improvement to border control in terms of promoting tourism and business. The country should aim to move forward in opening up borders progressively.

3. Ticket, taxes and airport charges

Section 5.5.1 identified that Sri Lanka is the most restrictive country in the sample in terms of ticket, taxes and airport charges. It scores 56 on a 0-100, highest-lowest index (Figure 6-19). There is an overseas sales surcharge of 60US$ on each ticket sold outside Sri Lanka for flights originating from Colombo airport (or any other airport in the country), which is collected at the point of sale by the respective airline(IATA, 2009; Ministry of Finance and Planning, 2008). South Asian countries except Afghanistan is exempted from this tax. Though the South Asian countries are exempted, this form of taxation discourage overseas sales for flights originating at Colombo and are not in support of the previously proposed self-connectivity strategies for the Colombo airport. Thus, the implications of such regulations should be carefully evaluated.

According to the published Tariffs for Airports and Air Navigation Services (Doc 7100) (ICAO, 2013), a blanket rate of 4US$ per metric tonne of maximum take-off weight of aircraft is applied as the airport landing charges. This is different to leading South Asian airports and international hubs that differentiate charges by aircraft type or weight categories (ICAO, 2013). While most of the airports in the two groups (secondary hubs and South Asia) have separate charging mechanism for international and domestic flights, Colombo airport does not differentiate domestic and international aircraft. Though it is justifiable on the basis that the origin of the aircraft does not have an impact on its weight, the implications should be carefully evaluated. A fixed charge is said to favour smaller aircrafts and those airlines that have high load factors and seat capacities(Graham, 2008). It may be prudent to review the impact of this on the small domestic operators that carry out their operations primarily for scenic flights for tourists and in terms of the types of aircrafts that frequent the airport.

6.5.3 National level policy development: Improving destination status

National level policy recommendations are based on the variables of the framework used in chapter 5 to profile airport groups on their macro environmental conditions. Table 6-4 provide benchmarking data for Sri Lanka against the countries of the leading secondary hubs and the countries in South Asia.

Table 6-5 Macro environmental elements of South Asia and leading secondary hubs, 2012

Macro environment element	India	Pakistan	Sri Lanka	Bangladesh	Nepal	Bhutan	Maldives	Afghanistan	UAE	Qatar
Population (millions)	1250	178	21	152	31	0.7	0.3	31	8	2
Seats per head of metropolitan population	2	10	14	0.5	6	2	31	1	35.9	53.1
% of Urban Population	31	36	15	28	17	35	40	23	84	99
GDP per capita (US$)	1492	1296	2873	818	626	2954	6675	622	64840	99731
Government prioritization of the T&T industry (1-7 best)	4.8	3.3	6.4	4.3	5.6	6.1	n/a	n/a	6.5	5.5
Tourism infrastructure (1-7 best)	2.6	1.9	2.3	1.6	1.5	2.6	n/a	n/a	5.7	5.0
Price competitiveness in the T&T industry (1-7 best)	5.1	5.2	4.9	5.2	5.4	5.2	n/a	n/a	4.9	4.9
Cultural and Natural Resources and Affinity for Tourism (1-7 best)	4.8	3.1	3.6	2.9	3.4	3.1	n/a	n/a	4.1	3.2
EDB score (0-100)	52.5	57.3	57.1	48.0	59.6	58.9	66.5	39.5	72	69
Institutions (1-7 best)	3.9	3.3	4.2	3.2	3.3	4.4	n/a	n/a	5.5	5.8
Physical Infrastructure (1-7 best)	4.0	3.2	5.0	3.3	2.8	4.2	n/a	n/a	5.7	5.2
Intellectual Infrastructure (1-7 best)	4.6	3.3	5.1	3.6	3.1	4.2	n/a	n/a	5.0	5.4

Source: Own elaboration

The traffic generation potential is the primary determinant of an airline's choice of a destination to fly. Section 4.2.2 identified that from an airport's perspective traffic generation is also one key dimension of strategic hub development. Local market is the primary source of demand for OD traffic at Colombo airport. Another is the potential of the destination in generating inbound business and tourist traffic. Analysis in chapter 5 showed that the degree of hubbing is strongly associated with the degree of attractiveness of a country as a tourist and an economic or business centre. In addition, chapter 5 also showed that the effectiveness of government administrative frameworks, level of infrastructure and availability of human capital are essentials to develop the brand identity of a country as a destination for tourism and business.

While the requirements to develop as a hub is as indicated above, in section 6.4.2, it was identified that lower traffic generation ratios at Colombo airport (within South Asia) is limiting its growth potential as a hub. Given the Colombo airport's current position as a weak secondary hub (section 6.4.1), the policy makers should look into emulating the best practices of countries with similar hub profiles (Table 6-4) (secondary hubs or primary hubs for even best standards). A coordinated policy approach would be required in the following areas.

1. Stimulate local market growth

Sri Lanka is still a country in transition from a factor-driven economy to an efficiency-driven economy (WEF, 2012). It is has the third highest GDP per capita in South Asia. However, it is far below the levels of secondary international hubs (Table 6-4). Local market demand is very much influenced by income of people, which eventually influence the propensity to travel. It should focus on stimulating economic growth, which is of primary importance to stimulate demand for travel by citizens. Outbound travel for reasons other than employment, education, and professional/business will only be promoted when income levels rise and outbound holidays become a life-style of the general population. One feature of international hubs in the region (East) is the urbanised location and higher number of seats per head of metropolitan population (section 5.4.2). In this respect, degree of urbanisation is very low in Sri Lanka. However, seats per head of metropolitan populations is the highest in the region. It indicates that as a country, the government's approach should be to develop industries and employment opportunities that stimulate urban agglomerations, which eventually bring in more traffic to the country that will also stimulate local OD demand.

2. Development of conducive tourism policies

The coordination of tourism and aviation policies with general economic policies is essential. Even though the government is giving high priority to tourism industry, it does seem that its intervention in ensuring quality tourism infrastructure is insufficient to promote Sri Lanka as a state-of- the-art tourist destination (Table 6-4). Sri Lanka is also a comparatively expensive destination within South Asia. Most of the South Asian countries are alternative travel destination for traditional tourism (mostly natural, cultural, or historical). Therefore, Sri Lanka is at a disadvantage of being relatively expensive to travel for a traditional tourist destination. In places like UAE and Qatar, tourism is based around leisure/ theme parks and shopping and dining. Therefore, prices may not influence tourists travelling to such destinations, since the purpose of the trip itself has a spending element to it. Sri Lanka would be better placed if it can deliver a unique tourism experience that blends traditional (given the natural and cultural heritage it has) and modern tourism which compensate for the higher prices. This will increase the competitiveness of the country. Thus, the policy-makers should focus on strategies to develop the brand 'Sri Lanka' as a 'total-experience' destination.

3. Development of a conducive business environment

Sri Lanka is less competitive within South Asia, in terms of the business regulations that promote investors. It scores lower than Maldives, Bhutan and Nepal in the distance to frontier of EDB (Table 6-4).Therefore, the popularity of the country as a business destination within South Asia should be improved by addressing regulatory barriers to doing business. International hubs in the region have anchored their growth around industry development. EDB scores of UAE and Qatar are very much higher than Sri Lanka, which indicate that the country should address the regulatory barriers in order to improve the ‘business-destination’ identify of Sri Lanka in the long-term.

4. *Institute efficiency across political and administrative frameworks governing industries and public services*

Politics, governments and administrative frameworks in South Asian countries are generally known to be inefficient, bureaucratic and corrupted which is also represented by the scores for the ‘institutions’ pillar by all the countries (Table 6-4). Sri Lanka can be perceived as doing better, but compared to countries of leading secondary hubs of Doha and Abu Dhabi, it is behind the degree of efficiency that needs to be demonstrated by a country that want to develop a typical secondary hub in the region. Therefore, it is recommended that the government look beyond South Asia and improve its efficiency in institutional frameworks to facilitate a flexible and transparent approach to regulation.

5. *Enhance physical infrastructure and maintain quality of human capital development*

Sri Lanka is in the lead on the levels of physical and intellectual infrastructure in South Asia (Table 6-4). Development of physical infrastructure has received considerable attention during the last decade in Sri Lanka. Three expressways came into public use during the last five years and one connects the Colombo airport to the capital city of Colombo (Road Development Authority-Sri Lanka, 2017). Maritime and shipping is a successful industry Sri Lanka. The country is developing its ports to stay competitive in the region and is seen as an emerging logistics hub in the South Asian region, even ahead of ports in India (Chan, 2015). Cargo transhipment is a key business in Sri Lanka, both at the port of Colombo and the newly built port of Hambantota. It is recommended that interventions should be made to promote the development of the country as an air to sea transhipment hub as was expected by the investments in developing seaports and airports in Colombo and Hambantota (CAPA, 2010c). It is also recommended that the policy-makers continue to uphold the standards of infrastructure that has contributed to the quality of intellectual capital.

6.6 Conclusion

This chapter fulfilled the third and the final objective of this study by applying the airport taxonomy developed in chapter 4 (first objective) and environmental forces that drives and airport's growth identified in chapter 5 (second objective) to a case study on Colombo airport in Sri Lanka from the South Asian region that has been identified as an airport affected by the traffic shadow casted by the multi-hub regions of Southeast Asia and Middle East (section 6.3). The chapter detailed out the steps that can be taken in applying the taxonomy at different levels in order to derive strategy and policy recommendations at three levels; airport, industry and national (section 6.2). Accordingly, Colombo airport was benchmarked against the secondary international hubs and airports in South Asia (section 6.4). Section 6.5 derived strategy and policy recommendations based on the strategic benchmarking exercise and comparison of environmental profiles of airports. The application exercise validated the usefulness of the devised airport taxonomy in assisting airport strategic planning and national civil aviation policy making which fulfil the overall aim of this thesis – *'to develop a framework to assist in the airport strategic planning process and related national civil aviation policy development to optimise the positioning of an airport in the aviation network of the East'.*

7 CONCLUSION TO THE THESIS

7.1 Introduction

This chapter concludes this thesis, which was carried out to achieve the main aim of 'developing *a framework to assist in the airport strategic planning process and related national civil aviation policy development to optimise the positioning of an airport in the aviation network of the East.'* The first chapter provided the background to the research problem that derived the research aim and objectives of this thesis. It also introduced the reader to the empirical focus of this thesis, which is on the air transport markets of the East. Second chapter reviewed the literature on two themes mainly; identification of the role of an airport in a network and factors driving competitiveness in the aviation industry. The review supported the development of the conceptual framework to address the first and second research objectives of this study. Third chapter presented the research design of this study. Strategic group theory was adopted as the main research strategy of this study. Accordingly, an airport classification study based on statistical analysis was identified as the primary research tool of the study.

Chapter 4 dealt with the first research objective and presented the analysis, results and discussion of the proposed new taxonomy of airports in the East. Chapter 5 profiled the airport groups of the new taxonomy based on the macro environmental conditions and the air transport policy and regulatory conditions that helps to shape up the growth of an airport. The chapter fulfilled the second research objective of the study. Chapter 6 fulfilled the third research objective of the study by applying the proposed taxonomy to the Colombo airport in Sri Lanka, which was identified to be shadowed by the multi-hub regions of Southeast Asia and Middle East. This chapter summarises the findings under each research objective, discusses limitation and avenues for further research.

7.2 Review of the research objectives

This thesis began with the hypothesis that airports take up a larger role in the national economy than a mere infrastructure provider for airline operations. It investigated this phenomenon with respect to the aviation industry in the East, the fastest developing aviation market in the world. The extant literature on the subject substantiated the important role airports have taken up in promoting economic growth in Southeast and Northeast Asia and the Middle East. Differences in degree of development were observed in Central and South Asia, which lead to the deduction that the region is a potential case study for a traffic shadow effect of mega hub-regions. The research problem highlighted the importance of a tool that assist in identifying the competitive position of a country's airport/s in the global air transport network in the process of airport strategic planning and national level policymaking. Thus, the main aim of this thesis was *'to develop a framework to assist in the airport strategic planning process and related national civil aviation policy development to optimise the positioning of an airport in the aviation network of the East.'* The research achieved its main aim through the findings to the following objectives that were developed around the case of 'airport industry in the East'. The findings of this research are summarised under each research objective below.

7.2.1 Objective 1

Propose a methodological approach to comprehend the competitive structure and geography of the network of airports in the East.

The major contribution of this thesis is the development of a methodological approach to airport classification. The study analysed 450 airports in the eastern aviation network using 20 variables across three proposed strategic dimensions of airports; degree of airport activity, network strategy, and market strategy (segmentation). The classification was carried out in two steps. Using five variables, the airports were first grouped into three clusters based on the degree of 'airport activity' as *Large, Medium* and *Small* airports. In the second step, 15 variables representing the other two strategic dimensions were investigated using Principal Component Analysis to extract four factors; international hub/not, international airport/domestic, domestic hub/not, and LCC base (higher frequency)/not. Using the PC scores, the airports were again cluster analysed. Three primary groups (and within them a secondary five group classification) were identified, namely; *International Airport (Hubs and Non-hubs), Hybrid*

Airports and *Domestic Airports (LCC and non-LCC)*. The two solutions were amalgamated to a combined matrix. The key outcome of the analysis was a taxonomy of 12 airports-types to evaluate the positioning of an airport in the Eastern aviation network, which fulfilled the first research objective of this study. The findings validated the facts that;

1. Six primary international hubs dominate the air transport market in the East. They are Dubai, Singapore, Hong Kong, Tokyo Narita, Seoul Incheon and Taiwan Taoyuan, which are geographically placed like links of a chain spreading from West to the East in the region.
2. The strategy of a typical international hub in the region is extensively focused on connecting continents to exploit the 6th Freedom rights. Thus, they can be alternatively named as 6th Freedom hubs as well. However, an interesting observation on the traffic profiles of these airports is that they have successfully converted the ‘waypoint’ status to a ‘hub’ that has a good balance of OD and transfer traffic. Expanding the catchment area beyond the local market and promotion of the destination to build a strong OD market are strategies pursued by these airports. Therefore, the traffic profiles are somewhat different to a typical transfer airport in the US. On average Dubai, Singapore and Hong Kong transferred about 20% of the total traffic, which is comparatively lower to the proportions connecting at Atlanta or Chicago (Mason, 2007). The averages were also less than average of the secondary hubs of Abu Dhabi and Qatar (39%). This again validates the prepositions made by Button (2002); Doganis (2002); Fleming and Hayuth (1994); Jian, Huiyun and Ting (2011); and Rodriguez-Deniz, Suau-Sanchez and Voltes-Dorta (2013) that a successful hub needs a strong OD market that improve the possibilities of connections.
3. The best airport development strategy for countries with larger populations in dispersed land areas is to combine the large domestic market with international operations to develop as hybrid airports (hubs) by taking up a hubbing role in both domestic and international markets. Bangkok and Kuala Lumpur in the primary hybrid group are successful examples for Beijing Capital, Delhi, Mumbai, Manila and Jakarta to follow in developing their

connectivity levels to improve the international hub role. Nevertheless, airports from primary hub groups like Tokyo Narita and Seoul Incheon hint that, if an airport wishes to improve its international hubbing role in the long-run, separation of the domestic hub role is a potential strategy for hybrid airports. However, they still need to keep connected to domestic airports to maintain the international gateway status. One strategy can be to support a strong domestic network to be established at the airport, like at Tokyo-Narita or to develop a strong ground transport link with the primary domestic hub in the country.

4. Except for the two Indian airports Delhi and Mumbai, all other South Asian and Central Asian airports are medium and smaller airports. The two regions have not been able to witness the growth of a large international hub yet. Colombo is the only airport that portray the profile of a secondary international hub group. However, it is faces developmental challenges being the smallest airport in the secondary hub group. The structure of the hierarchy of airports shed light on the proposition made at the beginning of the thesis, that the mega-hub regions supress the growth of nearby airports.
5. 'Size' is a dominant strategy in an airports path to establish as a global hub. However, size alone without a network strategy will not ensure hub a hub status. There are very large airports in china that focus purely on domestic operations. Size is a qualifier and network strategy is the key differentiator.

7.2.2 Objective 2

Identify the factors that shape up the growth of an airport and interpret the causes for the differences in the airport hierarchy.

Seven macro environmental elements and air transport industry regulations were compared across the seven airport groups in the international and hybrid airport cluster. The major findings are that;

1. Size of country and population is a key differentiator of hybrid and international hubs. It supports the proposal made in the finding of the first objective that airport development strategies of large countries with a network of airports can focus on a hybrid model for their international

airport. However, this should be further evaluated in terms of performance efficiency of the airport.

2. The seven factors; geographical positioning, level of economic development, tourism and business attractiveness, urbanisation, physical and intellectual infrastructure and sound political and administrative framework are prerequisites to establish a successful international hub. Similarly, a liberalised approach to air transport supports an airport to convert itself into a hub. Nevertheless, presence of these factors alone does not guarantee hub status to an airport. For smaller aviation markets, the development of these elements would support the airports to move up in the hierarchy. But, there are other factors, which determine the degree of contribution of these elements to the success of a mega hub.
3. The above conclusion leads to an interesting review of the role of history, government commitment, timely decision-making, and first mover advantage in determining the success of hubs in the region. In the sub regions of Middle East, Southeast Asia and Northeast Asia, there is one super hub for each region, namely, Dubai, Hong Kong and Singapore. Then the three other primary hubs, Tokyo Narita, Seoul Incheon, and Taiwan Taoyuan are followers of the super hubs. Historical evolution of these airports ascertain the fact that foresighted visionary planning and government commitment to promote timely infrastructure investments has allowed these airports to enjoy the benefits of 'moving-in-first' to the growing air transport industry of the east. These airports had grown with the increase in travel demand (and partly had stimulated the growth), rather than waiting for the industry to grow and provide opportunities for airports to invest.

7.2.3 Objective 3

Application of the methodological approach to recommend airport strategy and civil aviation policy measures to improve the status of an International Airport identified to be under the traffic shadow created by developed hubs in the East.

The Colombo Airport was identified as a secondary hub in the devised taxonomy of airports in the East. Application of the taxonomy to the South Asian region revealed the status of the airport as the only airport with an 'international hub' profile within the region apart from the Delhi and Mumbai airports, whose profiles takes a hybrid form (they do play an international hub role at the same level). Even though this position is seemingly advantageous to the Colombo airport, further evaluation of its strategic positioning against the best practices of secondary international hubs uncovered the vulnerable position of the airport, especially in terms of its 'international hub status'. The ability to connect continents at the Colombo airport is minimal and it is only connected to Europe as a continent. The rest of its international connections are within the larger Eastern aviation network (Southeast, Middle East and Northeast Asia). The airport also plays a significant 'regional gateway to South Asia' role and a 'regional hub role'. Its regional hub status is mainly dependent on connecting Male airport with Indian destinations, Karachi and Dhaka. Similarly, the regional gateway role is also dependent on South Indian Subcontinent, Karachi and Dhaka. The airport is not connected to Afghanistan, Nepal and Bhutan. This highlighted the fact that the airport does not have a geographical advantage to connect all South Asian countries.

However, over the years, mainly owing to the good diplomatic relationships of the country with other countries in the region and the geographical separation of the island from the mainland subcontinent, intra-regional air travel at the Colombo airport has remained high. It has been beneficial for the airport to grow into a regional hub. Three strategy and policy development areas were suggested for the airport. In terms of the airport and airline level strategy, strengthening the regional hub and gateway status is recommended. Authorities should focus on a liberalised approach to ASA's in order to promote Colombo as a hub airport. A coordinated policy development approach is necessary across related industries to improve the destination status of 'Sri Lanka', both for tourism and business. This will allow Colombo to establish a strong OD market as the first step to emulate successful international hubs in the region. Unless, the airport would further deteriorate its status under the shadow of Middle Eastern and Southeast Asian hub regions.

7.3 Limitations to the thesis

There are several limitations to this study in terms of methodology and empirical scope. Methodological limitations are four fold. First, the data limitations with respect to the variables studied under the second objective of this research limited the scope of the analysis of external factors that shape up the growth of an airport. At the beginning of this study, the aim was to evaluate effect of diverse external environmental factors on shaping up the business model (network role) of an airport. However, airport catchment area specific data for the external environmental elements were not available for all the nine/twelve groups identified in the new airport taxonomy proposed. One reason is that most of the variables are national level indicators that is common to all the airports within a country (in the cases of multi-airport systems). The other is that, even if it was decided to reduce the diversity of variables and continue the study with collecting data for few variables, the magnitude of the project of data collection was beyond the time frame of this study. This led to the second methodological limitation. Since data were only available at the national/country level, the analysis of macro environmental elements was limited to the airport groups that consisted the designated international airport of each country sampled. Thus, the size of the sample for the second research objective had to be reduced from 450 airports to 45 airports (the designated airport in each country). Further reduction of sample size took place owing to data unavailability for some of the variables for some countries as indicated in Table 5-2.

Reduction of sample size led to the other two methodological limitations. Thus, the third limitation is on the choice of statistical tools for the second objective.

Researcher's intentions at the beginning of this study was to assess the likelihood of an airport developing into a specific typology (e.g. hub or a hybrid or a domestic airport) by the application of a likelihood analysis (logistic regression/discriminant analysis). However, as the sample size got smaller and group memberships had to be limited, the proposals had to be discounted, as it did not meet the methodological assumptions of advanced multivariate analysis. Instead, ANOVA was used to profile the airports on the macro environmental elements. Fourth methodological limitation is the problems faced in conducting the ANOVA. Since, the airports for macro environmental profiling were selected based on the rule of 'designated international airport of the respective country', the number of airports in some of the airport groups had to be reduced. The small hybrid airport group had to be excluded in the ANOVA for some of the variables as indicated in Table 5-2.

The other limitation is the empirical scope of this research. The researcher's interest was to analyse the structure of the changing geography of airports in the East. In this way, it fulfilled the research aim as expected. However, since the geographical application of the thesis is confined to air transport markets of the East that is shaped by a set of environmental forces (section 1.1.4) unique to the aviation development in the region, a direct application of the proposed taxonomy into another geographical region is limited. However, the methodological guidelines are universally applicable that provide room to carry out a similar analysis for a group of airports from another region. Finally, the cluster analysis was a cross-sectional study based on data from 2012. Therefore, it is limited in terms of the scope of timing of the study. The analysis and subsequent strategy and policy recommendations would further benefit if the classification wwas repeated for different points in time, since airports strategic behaviour evolves over time. For example, Doha airport was relocated to the new Doha Hamad International airport with expanded facilities in 2014. The result of the strategic move on the positon of the airport in the hierarchy could be evaluated if the analysis can be repeated for a later point in time.

7.4 Application of the research findings and areas for further research

Section 6.2 in chapter 6 explained application of the taxonomy at macro (Eastern network), meso (sub-region), and micro (country) levels to determine the competitive position of an airport and its role in the network. As demonstrated in the case study of Colombo airport in Sri Lanka, the taxonomy can be applied to any airport or a system of airports in a country by respective authorities to identify strategy and policy options to the future. It is a potential tool that can be used to evaluate the current position and as well the future prospects. Likewise, the taxonomy is helpful in answering different research questions. A fundamental contribution is the characterisation of different airport types that provide a framework for efficiency and financial performance benchmarking of airports. Since the classification is based on airport strategies, an airport's productivity can be assessed against another that follow similar strategies. A geographic map of the taxonomy of airports for a certain network also assist in identifying traffic-shadow effects. A likely argument is that a simple plot of airports on a map within a certain distance would provide the same results without the need of a taxonomy. Nevertheless, the usefulness of the taxonomy is that it characterise each airport in the map. The profiles provide a meaningful analysis of catchment areas and effects of proximity of airports. For example, the effect of a domestic airport in the vicinity is different to the effect of a hub airport being nearby. Likewise, the taxonomy is a versatile tool that can be applied to address different research questions.

The researcher aims for two publications from this research. They are;

1. The competitive position of airports in Asia and Middle East – The paper would come from analysis and findings under the first and second research objective of this study. Expectations are threefold; first, to present the methodological contribution, second, to present a view of the hierarchy of airports in the East, and third, to present a view on the forces driving airport growth in the East.

2. A case study on the potential of Colombo airport to develop as a hub in the South Asian region – The discussion would be based on the traffic shadow analysis, benchmarking exercise and policy recommendations from the 6th chapter.

The following areas are proposed as extensions to the current study.

1. Evaluation of the temporal change in the strategic groups

Section 7.3 indicated that the cross sectional nature of this study is a limitation to this research. The classification is based on data from 2012. A review to the proposed airport taxonomy can be carried out by repeating the classification for different points in time. This would provide an insight into the temporal change in the hierarchy of airports in the East. By repeating the classification, a deeper understanding on the important competitive strategies for airports can be gained which would highlight mobility barriers for different airport groups. Further analysis of macro environmental profiles would provide a comprehensive understanding on the direction of the drivers of airport growth in the East.

2. Evaluation of financial/operational performance of different types of airports

The current classification was limited in its scope to competitive strategies of airports that define their network role. An interesting extension to the current classification is to evaluate the financial and operational performance of different airport groups. From a structure-conduct-performance paradigm, this will deepen the comprehension on the above classification as to how different airport characteristics/strategic differences influence the financial and operational performance of airports.

3. Expand the geographical scope

The current classification was limited to the airport network of the East. Section 7.3 highlighted that this limits the potential direct application of the research to another geographical region. A new study can be carried out to overcome this limitation by applying the proposed methodology to a global sample of airports that represent different geographical regions. This would contribute towards understanding the diversity in the global airport network.

4. A study on drivers of different airport typologies

Section 7.3 detailed out the limitations of this study in terms of the analysis carried out under the second research objective of this study. They were related to data, sample size and methodology. A new study can be designed with an extended time frame to gather data on a selected number of variables at the airport catchment area level. Suggestion for variables at catchment level are, GDP, population/degree of urbanisation, number of tourist attractions, number of multinational businesses located within the catchment area/tax free industrial zones, time to key markets from the airport that represent quality of transport infrastructure. However, variables like political and administrative frameworks, air service agreements, taxes etc., are only available at national level. Therefore, the analytical tools can consider using multilevel analysis to identify the influence of national and local parameters separately. This can be developed as one comprehensive study in the future.

7.5 Conclusion

This chapter concluded the research carried out under the theme of 'role of airports in national civil aviation policies'. The thesis proposed a new tool to assist airport strategic planning in an era where airport competition has become intensive. The analysis of 450 airports in the East developed a taxonomy of airports that profiled twelve different airport typologies. The study also contributed to national level policy making by identifying the factors that shape up the growth of an airport. The usefulness of the proposed taxonomy was validated through a case study on the Colombo airport in Sri Lanka. A revisit of the research objectives in this chapter confirmed the achievement of the research aim of this thesis – '*To develop a framework to assist in the airport strategic planning process and related national civil aviation policy development to optimise the positioning of an airport in the aviation network of the East.'*

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APPENDICES

Appendix A Chapter 1 Appendices

Table A-1 Ownership and Operation of International Airports by Region

Region	No. of reporting States	No. of airports	Governmental entity						Autonomous entity				Concession or leasing arrangement		Other	
			national government (ministry or other)		regional or municipal government		Civil Aviation Authority		State-owned		privately-owned					
			2007	Plan	2007	Plan	2007	Plan	2007	Plan	2007	Plan	2007	Plan	2007	Plan
Africa	23	62	5	0	1	0	4	0	33	3	11	3	6	3	2	0
Asia/ Pacific	20	84	2	0	26	0	9	0	32	3	8	0	40	0	1	0
Caribbean, Central and South America	14	143	16	0	10	0	8	0	42	0	4	0	67	1	0	0
Europe	36	242	24	0	50	0	8	0	99	0	27	0	39	11	29	0
Middle East	3	5	4	0	0	0	1	0	0	2	0	0	2	0	0	0
North America	2	42	0	0	32	0	0	0	0	0	0	0	10	0	0	0
Total	**98**	**578**	**51**	**0**	**119**	**0**	**30**	**0**	**206**	**8**	**50**	**3**	**164**	**15**	**32**	**0**

Source: (ICAO, 2008b)

Table A-2 GDP (PPP), ASKs, Total Seats and LCC Seats for the Eastern Region 1999-2013

		1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
GDP (PPP)	International Dollar Billion	18,313	19,375	20,133	21,078	22,328	23,951	25,628	27,633	29,956	31,508	32,842	35,515	37,620	39,757	41,891
	YoY growth		5.80%	3.91%	4.69%	5.93%	7.27%	7.00%	7.83%	8.40%	5.18%	4.23%	8.14%	5.92%	5.68%	5.37%
ASKs	Billion	1,380	1,462	1,513	1,519	1,562	1,774	1,922	2,071	2,235	2,387	2,427	2,649	2,902	3,057	3,279
	YoY growth		5.94%	3.50%	0.41%	2.82%	13.59%	8.30%	7.79%	7.92%	6.78%	1.67%	9.16%	9.54%	5.37%	7.25%
South Asia	Total Seats	62,769,444	65,370,685	67,894,260	68,393,598	72,994,223	81,311,086	89,901,140	112,212,786	135,352,358	148,698,659	148,993,332	160,103,438	181,214,033	182,442,199	188,888,173
	YoY growth		4%	4%	1%	7%	11%	11%	25%	21%	10%	0%	7%	13%	1%	4%
	LCC seats	6,056	9,636	13,140	13,578	36,330	430,044	2,030,726	10,644,097	26,484,816	33,377,438	30,209,660	34,562,797	44,988,714	51,562,643	61,508,448
Central Asia	Total Seats	6,167,313	6,765,481	6,387,197	6,450,037	7,824,572	8,670,551	8,715,033	9,867,627	12,211,291	13,661,274	13,268,737	14,420,351	16,983,641	18,645,154	20,834,860
	YoY growth		10%	-6%	1%	21%	11%	1%	13%	24%	12%	-3%	9%	18%	10%	12%
	LCC seats	-	-	-	-	-	-	-	18,798	25,110	31,752	30,420	38,070	75,807	144,594	385,654
Southeast Asia	Total Seats	142,422,231	151,916,179	165,640,714	168,450,831	172,737,605	205,355,875	225,472,874	236,088,075	250,553,419	261,755,053	262,128,110	305,330,943	344,567,507	375,847,501	422,387,022
	YoY growth		7%	9%	2%	3%	19%	10%	5%	6%	4%	0%	16%	13%	9%	12%
	LCC seats	3,398,452	3,628,181	3,589,946	4,530,015	3,967,388	10,679,308	17,234,534	22,823,844	37,046,394	50,895,363	60,439,836	78,420,585	93,293,581	125,151,167	149,433,279
Northeast Asia	Total Seats	412,520,295	433,355,337	452,831,995	473,621,714	481,586,120	517,525,690	549,709,273	589,195,319	623,840,476	644,809,363	676,700,384	730,019,577	772,278,501	826,778,709	907,130,078
	YoY growth		5%	4%	5%	2%	7%	6%	7%	6%	3%	5%	8%	6%	7%	10%
	LCC seats	2,728,992	2,919,238	3,279,866	3,196,161	2,972,785	4,366,192	5,731,837	7,358,336	10,370,124	11,624,491	18,458,840	26,254,831	34,764,343	41,595,355	51,206,774
Middle East	Total Seats	90,281,149	97,247,709	99,731,639	101,906,143	108,253,915	117,656,311	126,612,559	142,590,509	155,798,705	169,216,352	192,120,767	215,079,430	232,192,025	246,381,395	261,201,469
	YoY growth		8%	3%	2%	6%	9%	8%	13%	9%	9%	14%	12%	8%	6%	6%
	LCC seats	100,818	319,961	245,333	245,754	256,527	941,773	1,787,256	2,830,693	3,078,884	4,536,805	6,470,507	12,644,185	15,159,407	19,074,002	24,425,056
Region Totals	Total Seats	714,160,432	754,655,391	792,485,805	818,822,323	843,396,435	930,519,513	1,000,410,879	1,089,954,316	1,177,756,249	1,238,140,701	1,293,211,330	1,424,953,739	1,547,235,707	1,650,094,958	1,800,441,602
	Total LCC seats	6,234,318	6,877,016	7,128,285	7,985,508	7,233,030	16,417,317	26,784,353	43,675,768	77,005,328	100,465,849	115,609,263	151,920,468	188,281,852	237,527,761	286,959,211

Source: OAG

Appendix B Chapter 2 Appendices

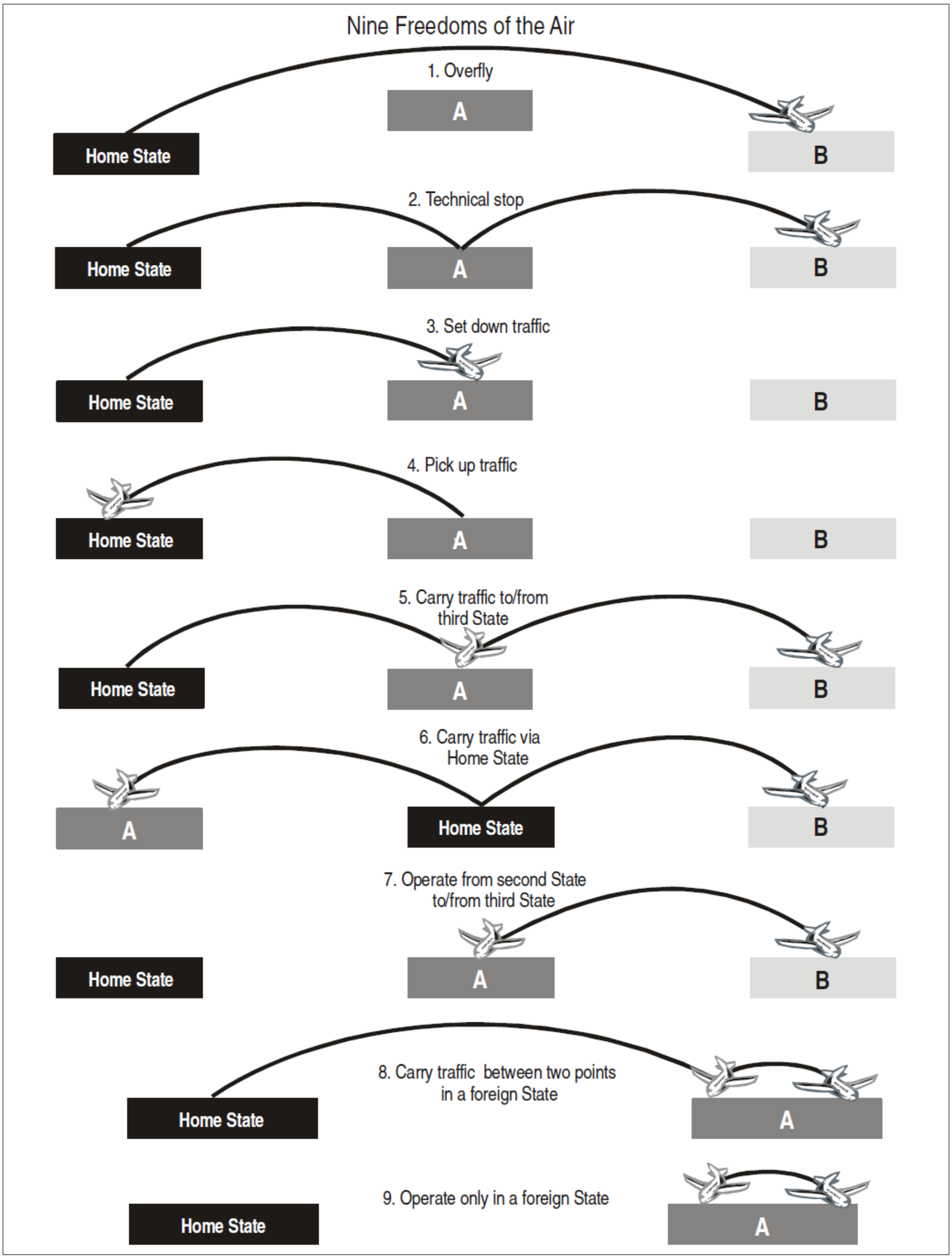

Figure B-1 The Nine Freedoms of the Air

Source: ICAO (2004)

Table B-1 Composition of the Global Competitiveness Index

Pillars	Sub-Indexes	Series
1st pillar: Institutions, 1-7 (best)	1.A Public institutions, 1-7 (best)	1.01 Property rights, 1-7 (best)
		1.02 Intellectual property protection, 1-7 (best)
		1.03 Diversion of public funds, 1-7 (best)
		1.04 Public trust in politicians, 1-7 (best)
		1.05 Irregular payments and bribes, 1-7 (best)
		1.06 Judicial independence, 1-7 (best)
		1.07 Favoritism in decisions of government officials, 1-7 (best)
		1.08 Wastefulness of government spending, 1-7 (best)
		1.09 Burden of government regulation, 1-7 (best)
		1.10 Efficiency of legal framework in settling disputes, 1-7 (best)
		1.11 Efficiency of legal framework in challenging regs., 1-7 (best)
		1.12 Transparency of government policymaking, 1-7 (best)
		1.13 Gov't services for improved business performance, 1-7 (best)
		1.14 Business costs of terrorism, 1-7 (best)
		1.15 Business costs of crime and violence, 1-7 (best)
		1.16 Organized crime, 1-7 (best)
		1.17 Reliability of police services, 1-7 (best)
	1.B Private institutions, 1-7 (best)	1.18 Ethical behavior of firms, 1-7 (best)
		1.19 Strength of auditing and reporting standards, 1-7 (best)
		1.20 Efficacy of corporate boards, 1-7 (best)
		1.21 Protection of minority shareholders' interests, 1-7 (best)
		1.22 Strength of investor protection, 0–10 (best)
2nd pillar: Infrastructure, 1-7 (best)	2.A Transport infrastructure, 1-7 (best)	2.01 Quality of overall infrastructure, 1-7 (best)
		2.02 Quality of roads, 1-7 (best)
		2.03 Quality of railroad infrastructure, 1-7 (best)
		2.04 Quality of port infrastructure, 1-7 (best)
		2.05 Quality of air transport infrastructure, 1-7 (best)
		2.06 Available airline seat kms/week, millions
	2.B Electricity and telephony infrastructure, 1-7 (best)	2.07 Quality of electricity supply, 1-7 (best)
		2.09 Fixed telephone lines/100 pop.
		2.08 Mobile telephone subscriptions/100 pop.
3rd pillar: Macroeconomic environment, 1-7 (best)		3.01 Government budget balance, %
		3.02 Gross national savings, %
		3.03 Inflation, annual %
		3.04 General government debt, %
		3.05 Country credit rating, 0–100 (best)
4th pillar: Health and primary education, 1-7 (best)	4.A Health, 1-7 (best)	4.01 Business impact of malaria, 1-7 (best)
		4.02 Malaria cases/100,000 pop.
		4.03 Business impact of tuberculosis, 1-7 (best)
		4.04 Tuberculosis cases/100,000 pop.
		4.05 Business impact of HIV/AIDS, 1-7 (best)
		4.06 HIV prevalence, %
		4.07 Infant mortality, deaths/1,000 live births
		4.08 Life expectancy, years*
	4.B Primary education, 1-7 (best)	4.09 Quality of primary education, 1-7 (best)
		4.10 Primary education enrollment, net %
5th pillar: Higher education and training, 1-7 (best)	5.A Quantity of education, 1-7 (best)	5.01 Secondary education enrollment, gross %
		5.02 Tertiary education enrollment, gross %
	5.B Quality of education, 1-7 (best)	5.03 Quality of the educational system, 1-7 (best)
		5.04 Quality of math and science education, 1-7 (best)
		5.05 Quality of management schools, 1-7 (best)
		5.06 Internet access in schools, 1-7 (best)
	5.C On-the-job training, 1-7 (best)	5.07 Availability of research and training services, 1-7 (best)
		5.08 Extent of staff training, 1-7 (best)

Table B-1 Continued…

6th pillar: Goods market efficiency, 1-7 (best)		6.01 Intensity of local competition, 1-7 (best) 6.02 Extent of market dominance, 1-7 (best)
		6.03 Effectiveness of anti-monopoly policy, 1-7 (best)
		6.04 Extent and effect of taxation, 1-7 (best)
		6.05 Total tax rate, % profits
		6.06 No. procedures to start a business
		6.07 No. days to start a business
		6.08 Agricultural policy costs, 1-7 (best)
		6.09 Prevalence of trade barriers, 1-7 (best)
		6.10 Trade tariffs, %
		6.11 Prevalence of foreign ownership, 1-7 (best)
		6.12 Business impact of rules on FDI, 1-7 (best)
		6.13 Burden of customs procedures, 1-7 (best)
		6.14 Imports as a percentage of GDP
	6.B Quality of demand conditions, 1-7 (best)	6.15 Degree of customer orientation, 1-7 (best)
		6.16 Buyer sophistication, 1-7 (best)
7th pillar: Labor market efficiency, 1-7 (best)	7.A Flexibility, 1-7 (best)	7.01 Cooperation in labor-employer relations, 1-7 (best)
		7.03 Hiring and firing practices, 1-7 (best)
		7.02 Flexibility of wage determination, 1-7 (best)
		7.04 Redundancy costs, weeks of salary
	7.B Efficient use of talent, 1-7 (best)	7.05 Pay and productivity, 1-7 (best)
		7.06 Reliance on professional management, 1-7 (best)
		7.07 Brain drain, 1-7 (best)
		7.08 Women in labor force, ratio to men
8th pillar: Financial market development, 1-7 (best)	8.A Efficiency, 1-7 (best)	8.02 Affordability of financial services, 1-7 (best)
		8.01 Availability of financial services, 1-7 (best)
		8.03 Financing through local equity market, 1-7 (best)
		8.04 Ease of access to loans, 1-7 (best)
		8.05 Venture capital availability, 1-7 (best)
	8.B Trustworthiness and confidence, 1-7 (best)	8.06 Soundness of banks, 1-7 (best)
		8.07 Regulation of securities exchanges, 1-7 (best)
		8.08 Legal rights index, 0–10 (best)
9th pillar: Technological readiness, 1-7 (best)	9.A Technological adoption, 1-7 (best)	9.01 Availability of latest technologies, 1-7 (best)
		9.02 Firm-level technology absorption, 1-7 (best)
		9.03 FDI and technology transfer, 1-7 (best)
	9.B ICT use, 1-7 (best)	9.04 Individuals using Internet, %
		9.05 Broadband Internet subscriptions/100 pop.
		9.06 Int'l Internet bandwidth, kb/s per user
		9.07 Mobile broadband subscriptions/100 pop.
10th pillar: Market size, 1-7 (best)	10.A Domestic market size, 1-7 (best)	10.03 GDP (PPP)
		10.04 Exports as a percentage of GDP
		10.01 Domestic market size index, 1–7 (best)
	10.B Foreign market size, 1-7 (best)	10.02 Foreign market size index, 1–7 (best)
11th pillar: Business sophistication, 1-7 (best)		11.01 Local supplier quantity, 1-7 (best)
		11.02 Local supplier quality, 1-7 (best)
		11.03 State of cluster development, 1-7 (best)
		11.04 Nature of competitive advantage, 1-7 (best)
		11.05 Value chain breadth, 1-7 (best)
		11.06 Control of international distribution, 1-7 (best)
		11.07 Production process sophistication, 1-7 (best)
		11.08 Extent of marketing, 1-7 (best)
		11.09 Willingness to delegate authority, 1-7 (best)
12th pillar: Innovation, 1-7 (best)		12.01 Capacity for innovation, 1-7 (best)
		12.02 Quality of scientific research institutions, 1-7 (best)
		12.03 Company spending on R&D, 1-7 (best)
		12.04 University-industry collaboration in R&D, 1-7 (best)
		12.05 Gov't procurement of advanced tech products, 1-7 (best)
		12.06 Availability of scientists and engineers, 1-7 (best)
		12.07 PCT patents, applications/million pop.

Source: WEF (2013)

Table B-2 Composition of the Travel and Tourism Competitiveness Index

SUBINDEX A T&T REGULATORY FRAMEWORK	SUBINDEX B T&T BUSINESS ENVIRONMENT AND INFRASTRUCTURE	SUBINDEX C T&T HUMAN, CULTURAL, AND NATURAL RESOURCES
Pillar 1: Policy rules and regulations 1.01 Prevalence of foreign ownership 1.02 Property rights 1.03 Business impact of rules on FDI 1.04 Visa requirements 1.05 Openness of bilateral Air Service Agreements 1.06 Transparency of government policymaking 1.07 Time required to start a business 1.08 Cost to start a business 1.09 GATS commitments restrictiveness index of T&T services	**Pillar 6: Air transport infrastructure** 6.01 Quality of air transport infrastructure 6.02 Available seat kilometers, domestic3 6.03 Available seat kilometers, international3 6.04 Departures per 1,000 population 6.05 Airport density 6.06 Number of operating airlines 6.07 International air transport network	**Pillar 11: Human resources** Education and training 11.01 Primary education enrollment 11.02 Secondary education enrollment 11.03 Quality of the educational system 11.04 Local availability of specialized research and training services 11.05 Extent of staff training Availability of qualified labor 11.06 Hiring and firing practices 11.07 Ease of hiring foreign labor 11.08 HIV prevalence 11.09 Business impact of HIV/AIDS 11.10 Life expectancy
Pillar 2: Environmental sustainability 2.01 Stringency of environmental regulation 2.02 Enforcement of environmental regulation 2.03 Sustainability of T&T industry development 2.04 Carbon dioxide emissions 2.05 Particulate matter concentration 2.06 Threatened species 2.07 Environmental treaty ratification	**Pillar 7: Ground transport infrastructure** 7.01 Quality of roads 7.02 Quality of railroad infrastructure 7.03 Quality of port infrastructure 7.04 Quality of domestic transport network 7.05 Road density	**Pillar 12: Affinity for Travel & Tourism** 12.01 Tourism openness 12.02 Attitude of population toward foreign visitors 12.03 Extension of business trips recommended 12.04 Degree of customer orientation
Pillar 3: Safety and security 3.01 Business costs of terrorism 3.02 Reliability of police services 3.03 Business costs of crime and violence 3.04 Road traffic accidents	**Pillar 8: Tourism infrastructure** 8.01 Hotel rooms 8.02 Presence of major car rental companies 8.03 ATMs accepting Visa cards	**Pillar 13: Natural resources** 13.01 Number of World Heritage natural sites 13.02 Quality of the natural environment 13.03 Total known species 13.04 Terrestrial biome protection 13.05 Marine protected areas
Pillar 4: Health and hygiene 4.01 Physician density 4.02 Access to improved sanitation 4.03 Access to improved drinking water 4.04 Hospital beds	**Pillar 9: ICT infrastructure** 9.01 ICT use for business-to-business transactions 9.02 ICT use for business-to-consumers transactions 9.03 Individuals using the Internet 9.04 Telephone lines 9.05 Broadband Internet subscribers 9.06 Mobile telephone subscriptions 9.07 Mobile broadband subscriptions	**Pillar 14: Cultural resources** 14.01 Number of World Heritage cultural sites 14.02 Sports stadiums 14.03 Number of international fairs and exhibitions 14.04 Creative industries exports
Pillar 5: Prioritization of Travel & Tourism 5.01 Government prioritization of the T&T industry 5.02 T&T government expenditure 5.03 Effectiveness of marketing and branding to attract tourists 5.04 Comprehensiveness of annual T&T data 5.05 Timeliness of providing monthly/quarterly T&T data	**Pillar 10: Price competitiveness in the T&T industry** 10.01 Ticket taxes and airport charges 10.02 Purchasing power parity 10.03 Extent and effect of taxation 10.04 Fuel price levels 10.05 Hotel price index	

Source: WEF (2013)

Table B-3 Table of contents of template bilateral air services agreement by ICAO

BILATERAL TEMPLATE AIR SERVICES AGREEMENT

Table of Contents

Source: ICAO (2008a)

Appendix C Chapter 3 Appendices

C.1 The pilot study

A Classification Exercise on a Sample of 29 Global Airports

Based on convenience of data availability, a sample of 29 airports were drawn from a range of a priori seemed to represent a range of different types of airports in the world. Only 13 of the proposed variables were used in the analysis. Initially all 13 variables were introduced in the analysis, but the results generated a mixed solution of airports. Principal component analysis reduced the data to three constructs which seems to represent the dimensions of destination orientation, airport size, and market size. K-means clustering is performed on the data to arrive at the final solution.

Table 1: Component matrix on global airport strategic dimensions

Variables	Destination orientation	Size	Market Size
Average departing frequency on a route	-.728		
Seats per flight	.676		
% domestic	-.876		
% intraregional	.620		
%international	.809		
% domestic and intraregional transfer	-.653		
%international transfer	.566		
Seats per day		.959	
Number of direct destinations		.821	
Number of airlines serving		.648	
Flight density (Departure Flights per day)		.881	
GDP per capita (US$)			.686
Population (millions)			-.879

Using the constructs, a five cluster solution was generated which could be interpreted as large gateways, small gateways, large domestic hub airports, emerging gateways and intercontinental hubs (Table 3 provides descriptive statistics on the clustering variables for each group).

Table 2: Global Airport Classification

Large Gateways	Small Gateways	Large Domestic hubs	Emerging Gateways	Intercontinental Hubs
Auckland	Abu Dhabi	Atlanta	Chennai	Moscow
Johannesburg	Colombo	Chicago O'hare	New Delhi	Narita
Memphis	Cyprus		Beijing Capital	London Heathrow
Rio	Kenya			Amsterdam - Schiphol
Melbourne	Romania			Changi
Boston Logan				Bangkok
Sydney				Charles De Gaulle
				Frankfurt
				Hong Kong
				John F. Kennedy
				Madrid–Barajas
				Dubai

Strategic Group Profiles

1. Large Gateways

These airports serve countries with larger populations (average 44 million) and has a significant portion (60%) of domestic OD traffic and international traffic (21%). The airports have very low international transfer traffic but serve as domestic and intra-regional hubs to a certain degree owing to the geographical size of the country (e.g. Australia). Problem airport in the group is Memphis International airport which has the highest variance from the mean values of airport size variables. The reason is that the airport is the cargo hub for FedEx which has a significantly different profile from other airports. Since there are no closer match in the sample and the passenger breakdown is similar to other airports it has been allocated for this group.

2. Small Gateways

Conversely, small gateways serve small countries in terms of population (18 million) economy (USD 20,602 GDP per capita - second lowest in the five groups). Very low frequency on routes (1 per route) and low supply of seats owing to the small number of small national carriers serving at these airports. These airports have very low domestic traffic (1%), but equal portions of regional (48%) and international traffic (42%). Abu Dhabi airport is significantly different in transfer traffic profile from the rest of the airports in this group, hence affect the mean values. Though it has a similar profile to intercontinental hub like Dubai, in size it is very small compared to the intercontinental hubs (in terms of seat capacity per day Abu Dhabi is ¼ of the size compared to the average of the intercontinental hub group).

3. Large Domestic airports

These two airports serve a large geographical scope in USA having a very large portion of domestic OD (49%) and transfer traffic (32%). Play a very small regional and international role. High frequencies per route (5) and intensity of flights per day (1204) owing to the shorter domestic routes.

4. Emerging Gateways

Serve emerging economies of China and India bigger in geographical scope and population but still smaller in GDP per capita (India). These airports has a profile similar to large gateways group.

5. Intercontinental hubs

Serving developed economies, these airports play a bigger international hubbing role in the global network (Dubai). These airports are the base for large hub carriers such as British Airways at London Heathrow, Singapore Airlines at Singapore, and Emirates Airline at Dubai. Large supply of seats but lower frequency per route owing to longer routes served. Size, and the significant portion of transfer traffic at each airport has grouped these airports together while there are significant differences in other traffic profiles. John F. Kennedy (JFK) International is significantly different to other airports having very low transfer traffic.

Table 3: Descriptive statistics of the clustering variables used for global airport clustering

Group	Large Gateways	Small Gateways	Large Domestic	Emerging Gateways	Intercontinental Hubs
Flights per day	297	94	1204	436	474
Average frequency on a route	4	1	5	4	2
Seats per flight	140	159	109	169	194
Seats per day	43101	14851	131889	77978	89971
Number of direct destinations	83	80	232	123	203
Number of airlines serving	39	44	49	86	98
% domestic	62%	1%	49%	63%	9%
% intra-region	10%	48%	1%	6%	31%
%international	21%	42%	17%	26%	51%
% domestic and intra-region transfer	6%	3%	32%	4%	3%
%international transfer	0.05%	6%	1%	0.26%	6%
GDP per capita (US$)	41870	20602	49922	3019	38827
Population (millions)	44	18	3.5	1289	55

Appendix D Chapter 4 Appendices

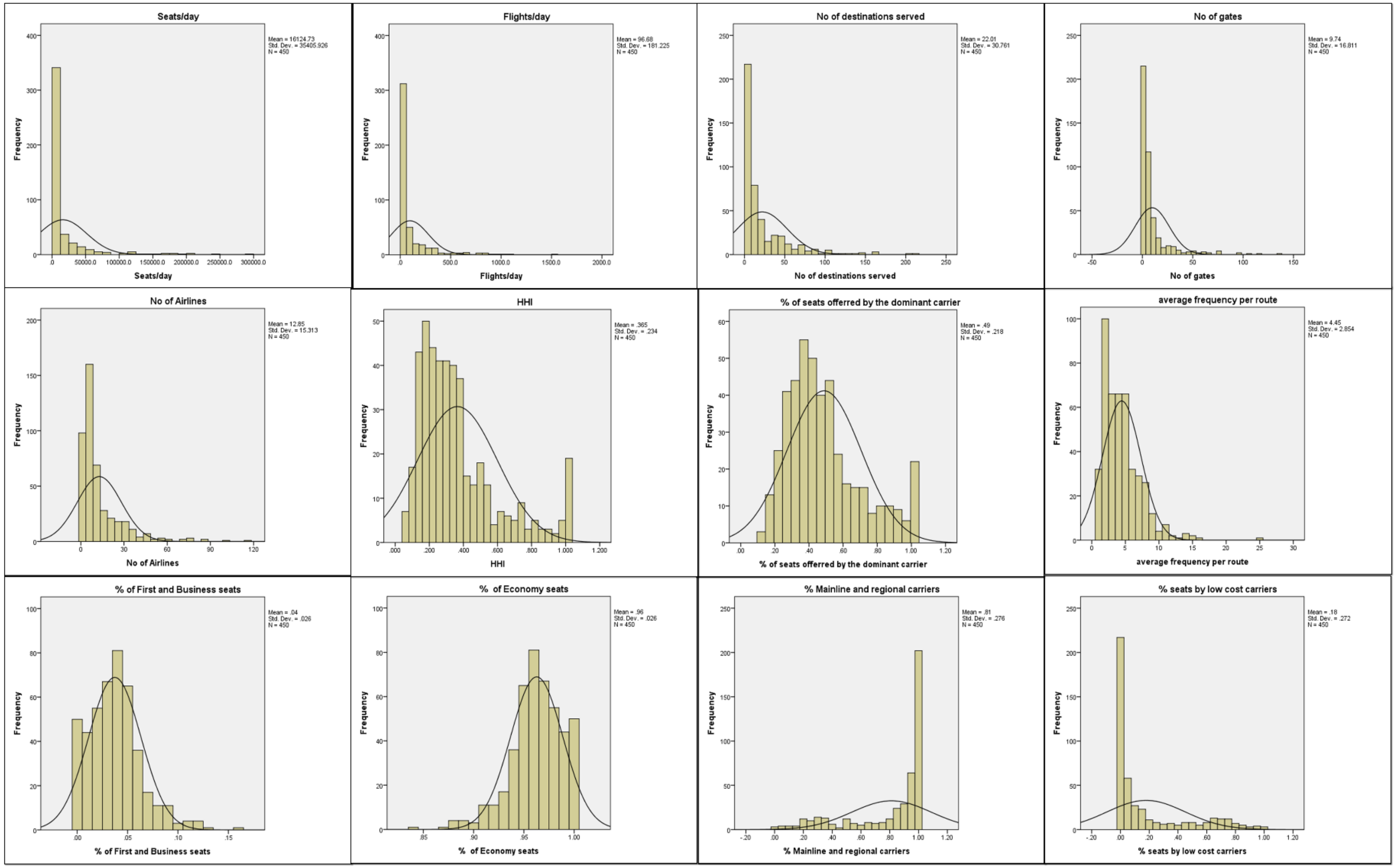

Figure D-1Histograms of airport classification variables

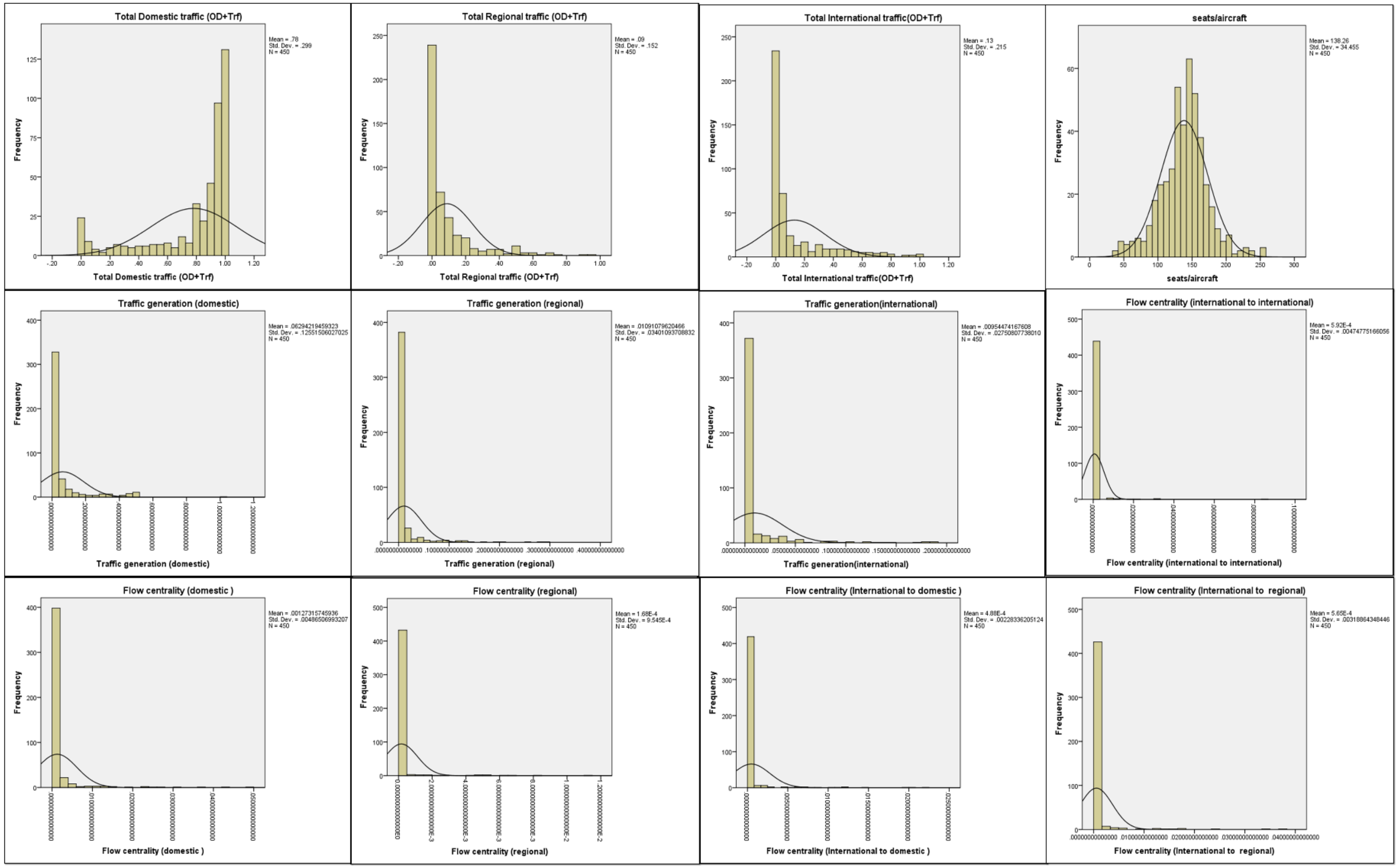

Figure D-2 Histograms of airport classification variables

Table D-1 Correlation matrix of airport classification variables

		Seats/day	Flights/day	No of gates	No of destinations served	No of Airlines	% of seats offered by the dominant carrier	HHI	seats/aircraft	average frequency per route	% of First and Business seats	% of Economy seats	% seats by low cost carriers	% Mainline and regional carriers	Total Domestic traffic (OD+Trf)	Total Regional traffic (OD+Trf)	Total International traffic(OD+Trf)	Traffic generation(international)	Traffic generation (domestic)	Traffic generation (regional)	Flow centrality (international to international)	Flow centrality (domestic)	Flow centrality (regional)	Flow centrality (International to domestic)	Flow centrality (International to regional)
Seats/day	Correlation	1	.982**	.801**	.882**	.834**	-.216**	-.268**	.507**	.324**	.362**	-.362**	-.036	.041	-.285**	.213**	.247**	.652**	.176**	.515**	.469**	.398**	.449**	.569**	.561**
	Sig. (2-tailed)		0.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.448	.381	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Flights/day	Correlation	.982**	1	.907**	.888**	.824**	-.250**	-.301**	.462**	.352**	.327**	-.327**	-.038	.043	-.250**	.189**	.215**	.597**	.191**	.474**	.377**	.404**	.389**	.578**	.473**
	Sig. (2-tailed)	0.000		.000	.000	.000	.000	.000	.000	.000	.000	.000	.418	.367	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
No of gates	Correlation	.801**	.907**	1	.888**	.828**	-.231**	-.282**	.464**	.232**	.379**	-.379**	-.055	.062	-.313**	.233**	.272**	.610**	.163**	.482**	.461**	.295**	.441**	.513**	.537**
	Sig. (2-tailed)	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000	.244	.190	.000	.000	.000	.000	.001	.000	.000	.000	.000	.000	.000
No of destinations served	Correlation	.882**	.888**	.888**	1	.833**	-.272**	-.344**	.499**	.096*	.434**	-.434**	-.095*	.100*	-.456**	.328**	.405**	.699**	.254**	.584**	.495**	.278**	.464**	.536**	.577**
	Sig. (2-tailed)	.000	.000	.000		.000	.000	.000	.000	.042	.000	.000	.044	.035	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
No of Airlines	Correlation	.834**	.824**	.828**	.833**	1	-.373**	-.443**	.549**	.130**	.472**	-.472**	-.049	.050	-.521**	.350**	.479**	.759**	.295**	.631**	.509**	.268**	.496**	.542**	.603**
	Sig. (2-tailed)	.000	.000	.000	.000		.000	.000	.000	.006	.000	.000	.297	.287	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
% of seats offerred by the dominant carrier	Correlation	-.216**	-.250**	-.231**	-.272**	-.373**	1	.972**	-.243**	-.114*	-.079	.079	-.156**	.168**	.144**	-.127**	-.111*	-.134**	-.066	-.107*	.015	-.128**	-.020	-.089	-.011
	Sig. (2-tailed)	.000	.000	.000	.000	.000		.000	.000	.015	.096	.096	.001	.000	.002	.007	.019	.004	.160	.023	.752	.007	.675	.059	.822
HHI	Correlation	-.268**	-.301**	-.282**	-.344**	-.443**	.972**	1	-.318**	-.114*	-.117*	.117*	-.130**	.138**	.208**	-.173**	-.167**	-.188**	-.115*	-.162**	-.026	-.141**	-.069	-.122**	-.065
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000		.000	.015	.013	.013	.006	.003	.000	.000	.000	.000	.014	.001	.583	.003	.141	.010	.171
seats/aircraft	Correlation	.507**	.462**	.464**	.499**	.549**	-.243**	-.318**	1	.136**	.482**	-.482**	.143**	-.115*	-.340**	.205**	.329**	.422**	.069	.345**	.309**	.146**	.319**	.251**	.374**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000		.004	.000	.000	.002	.015	.000	.000	.000	.000	.142	.000	.000	.002	.000	.000	.000
average frequency per route	Correlation	.324**	.352**	.232**	.096*	.130**	-.114*	-.114*	.136**	1	-.081	.081	.138**	-.162**	.218**	-.129**	-.212**	.033	.047	.033	.023	.243**	.030	.118*	.037
	Sig. (2-tailed)	.000	.000	.000	.042	.006	.015	.015	.004		.086	.086	.003	.001	.000	.006	.000	.488	.315	.488	.631	.000	.532	.012	.429
% of First and Business seats	Correlation	.362**	.327**	.379**	.434**	.472**	-.079	-.117*	.482**	-.081	1	-1.000**	-.187**	.193**	-.474**	.320**	.434**	.431**	.206**	.386**	.323**	.065	.316**	.244**	.382**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.096	.013	.000	.086		0.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.169	.000	.000	.000
% of Economy seats	Correlation	-.362**	-.327**	-.379**	-.434**	-.472**	.079	.117*	-.482**	.081	-1.000**	1	.187**	-.193**	.474**	-.320**	-.434**	-.431**	-.206**	-.386**	-.323**	-.065	-.316**	-.244**	-.382**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.096	.013	.000	.086	0.000		.000	.000	.000	.000	.000	.000	.000	.000	.000	.169	.000	.000	.000
% seats by low cost carriers	Correlation	-.036	-.038	-.055	-.095*	-.049	-.156**	-.130**	.143**	.138**	-.187**	.187**	1	-.990**	.093*	-.116*	-.048	-.021	-.090	-.037	-.024	-.032	-.011	-.004	-.023
	Sig. (2-tailed)	.448	.418	.244	.044	.297	.001	.006	.002	.003	.000	.000		0.000	.050	.014	.311	.660	.057	.433	.616	.493	.818	.934	.627
% Mainline and regional carriers	Correlation	.041	.043	.062	.100*	.050	.168**	.138**	-.115*	-.162**	.193**	-.193**	-.990**	1	-.085	.117*	.037	.017	.063	.031	.027	.033	.013	.005	.026
	Sig. (2-tailed)	.381	.367	.190	.035	.287	.000	.003	.015	.001	.000	.000	0.000		.071	.013	.435	.721	.181	.513	.572	.484	.783	.916	.578
Total Domestic traffic (OD+Trf)	Correlation	-.285**	-.250**	-.313**	-.456**	-.521**	.144**	.208**	-.340**	.218**	-.474**	.474**	.093*	-.085	1	-.730**	-.875**	-.529**	-.498**	-.515**	-.301**	-.168**	-.377**	-.192**	-.401**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.002	.000	.000	.000	.000	.000	.050	.071		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Total Regional traffic (OD+Trf)	Correlation	.213**	.189**	.233**	.328**	.350**	-.127**	-.173**	.205**	-.129**	.320**	-.320**	-.116*	.117*	-.730**	1	.308**	.192**	.375**	.299**	.172**	.129**	.253**	.025	.256**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.007	.000	.000	.006	.000	.000	.014	.013	.000		.000	.000	.000	.000	.000	.006	.000	.601	.000
Total International traffic(OD+Trf)	Correlation	.247**	.215**	.272**	.405**	.479**	-.111*	-.167**	.329**	-.212**	.434**	-.434**	-.048	.037	-.875**	.308**	1	.600**	.427**	.505**	.297**	.142**	.344**	.249**	.377**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.019	.000	.000	.000	.000	.000	.311	.435	.000	.000		.000	.000	.000	.000	.003	.000	.000	.000
Traffic generation(international)	Correlation	.652**	.597**	.610**	.699**	.759**	-.134**	-.188**	.422**	.033	.431**	-.431**	-.021	.017	-.529**	.192**	.600**	1	.327**	.854**	.549**	.254**	.603**	.707**	.649**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.004	.000	.000	.488	.000	.000	.660	.721	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000
Traffic generation (domestic)	Correlation	.176**	.191**	.163**	.254**	.295**	-.066	-.115*	.069	.047	.206**	-.206**	-.090	.063	-.498**	.375**	.427**	.327**	1	.378**	.043	.424**	.180**	.267**	.131**
	Sig. (2-tailed)	.000	.000	.001	.000	.000	.160	.014	.142	.315	.000	.000	.057	.181	.000	.000	.000	.000		.000	.359	.000	.000	.000	.005
Traffic generation (regional)	Correlation	.515**	.474**	.482**	.584**	.631**	-.107*	-.162**	.345**	.033	.386**	-.386**	-.037	.031	-.515**	.299**	.505**	.854**	.378**	1	.519**	.266**	.746**	.506**	.654**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.023	.001	.000	.488	.000	.000	.433	.513	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000
Flow centrality (international to international)	Correlation	.469**	.377**	.461**	.495**	.509**	.015	-.026	.309**	.023	.323**	-.323**	-.024	.027	-.301**	.172**	.297**	.549**	.043	.519**	1	.021	.575**	.119*	.875**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.752	.583	.000	.631	.000	.000	.616	.572	.000	.000	.000	.000	.359	.000		.661	.000	.011	.000
Flow centrality (domestic)	Correlation	.398**	.404**	.295**	.278**	.268**	-.128**	-.141**	.146**	.243**	.065	-.065	-.032	.033	-.168**	.129**	.142**	.254**	.424**	.266**	.021	1	.111*	.336**	.062
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.007	.003	.002	.000	.169	.169	.493	.484	.000	.006	.003	.000	.000	.000	.661		.018	.000	.189
Flow centrality (regional)	Correlation	.449**	.389**	.441**	.464**	.496**	-.020	-.069	.319**	.030	.316**	-.316**	-.011	.013	-.377**	.253**	.344**	.603**	.180**	.746**	.575**	.111*	1	.265**	.813**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.675	.141	.000	.532	.000	.000	.818	.783	.000	.000	.000	.000	.000	.000	.000	.018		.000	.000
Flow centrality (International to domestic)	Correlation	.569**	.578**	.513**	.536**	.542**	-.089	-.122**	.251**	.118*	.244**	-.244**	-.004	.005	-.192**	.025	.249**	.707**	.267**	.506**	.119*	.336**	.265**	1	.219**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.059	.010	.000	.012	.000	.000	.934	.916	.000	.601	.000	.000	.000	.000	.011	.000	.000		.000
Flow centrality (International to regional)	Correlation	.561**	.473**	.537**	.577**	.603**	-.011	-.065	.374**	.037	.382**	-.382**	-.023	.026	-.401**	.256**	.377**	.649**	.131**	.654**	.875**	.062	.813**	.219**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.822	.171	.000	.429	.000	.000	.627	.578	.000	.000	.000	.000	.005	.000	.000	.189	.000	.000	

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

D.1 Statistics of the principal component analysis

Table D-2 KMO and Bartlett's test for the five PC solution

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.667
Bartlett's Test of Sphericity	Approx. Chi-Square	7620.655
	df	105
	Sig.	0.000

Table D-3 Anti-image matrix of the five PC solution

Anti-image Matrix	seats/aircraft	% of First and Business seats	% seats by low cost carriers	Traffic generation(international)	Flow centrality (international to international)	Traffic generation (domestic)	Traffic generation (regional)	Flow centrality (domestic)	Flow centrality (regional)	Flow centrality (International to domestic)	Flow centrality (International to regional)	Total Domestic traffic (OD+Trf)	Total Regional traffic (OD+Trf)	Total International traffic(OD+Trf)	average frequency per route
seats/aircraft	.807[a]	-.382	-.244	-.109	.018	.164	.076	-.110	-.034	.023	-.026	-.044	-.048	-.047	-.175
% of First and Business seats	-.382	.871[a]	.252	.022	-.015	-.027	-.036	.091	.042	-.081	-.052	.014	.010	.009	.055
% seats by low cost carriers	-.244	.252	.423[a]	.008	.005	.024	-.003	.062	-.005	-.009	.002	.069	.071	.068	-.092
Traffic generation(international)	-.109	.022	.008	.752[a]	-.078	.102	-.678	.073	.265	-.729	-.246	-.054	-.048	-.070	-.021
Flow centrality (international to international)	.018	-.015	.005	-.078	.690[a]	.091	-.120	-.042	.470	.178	-.802	.060	.062	.063	.033
Traffic generation (domestic)	.164	-.027	.024	.102	.091	.839[a]	-.181	-.309	.100	-.096	-.060	.073	.064	.063	-.119
Traffic generation (regional)	.076	-.036	-.003	-.678	-.120	-.181	.772[a]	-.091	-.549	.280	.278	.037	.031	.043	-.006
Flow centrality (domestic)	-.110	.091	.062	.073	-.042	-.309	-.091	.739[a]	.006	-.181	.042	-.025	-.026	-.025	-.196
Flow centrality (regional)	-.034	.042	-.005	.265	.470	.100	-.549	.006	.682[a]	-.081	-.736	.106	.108	.105	.032
Flow centrality (International to domestic)	.023	-.081	-.009	-.729	.178	-.096	.280	-.181	-.081	.646[a]	.100	.052	.053	.065	-.001
Flow centrality (International to regional)	-.026	-.052	.002	-.246	-.802	-.060	.278	.042	-.736	.100	.687[a]	-.078	-.082	-.077	-.064
Total Domestic traffic (OD+Trf)	-.044	.014	.069	-.054	.060	.073	.037	-.025	.106	.052	-.078	.591[a]	.999	.999	-.025
Total Regional traffic (OD+Trf)	-.048	.010	.071	-.048	.062	.064	.031	-.026	.108	.053	-.082	.999	.379[a]	.999	-.020
Total International traffic(OD+Trf)	-.047	.009	.068	-.070	.063	.063	.043	-.025	.105	.065	-.077	.999	.999	.544[a]	-.016
average frequency per route	-.175	.055	-.092	-.021	.033	-.119	-.006	-.196	.032	-.001	-.064	-.025	-.020	-.016	.694[a]

Table D-4 Eigenvalues and total variance for the five PC solution

Total Variance Explained									
	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.633	37.555	37.555	5.633	37.555	37.555	3.392	22.610	22.610
2	1.867	12.445	50.000	1.867	12.445	50.000	3.094	20.624	43.234
3	1.651	11.008	61.008	1.651	11.008	61.008	2.024	13.492	56.726
4	1.103	7.353	68.361	1.103	7.353	68.361	1.549	10.329	67.055
5	1.023	6.819	75.181	1.023	6.819	75.181	1.219	8.126	75.181
6	.956	6.374	81.555						
7	.604	4.028	85.583						
8	.575	3.830	89.414						
9	.465	3.103	92.516						
10	.430	2.870	95.386						
11	.363	2.419	97.805						
12	.223	1.485	99.290						
13	.065	.436	99.726						
14	.041	.273	99.999						
15	.000	.001	100.000						

Extraction Method: Principal Component Analysis.

Table D-5 The component score coefficient matrix for the five PC solution

Component Score Coefficient Matrix

	Component				
	1	2	3	4	5
seats/aircraft	-.053	.123	.092	-.111	.541
% of First and Business seats	-.049	.170	.152	-.209	.124
% seats by low cost carriers	-.066	.023	-.071	.021	.651
Traffic generation(international)	.060	-.044	.346	-.039	-.029
Flow centrality (international to international)	.360	-.079	-.161	-.042	-.021
Traffic generation (domestic)	-.075	.177	-.055	.386	-.149
Traffic generation (regional)	.152	-.032	.150	.073	-.095
Flow centrality (domestic)	-.049	-.012	.029	.500	-.037
Flow centrality (regional)	.311	-.070	-.085	.049	-.069
Flow centrality (International to domestic)	-.125	-.125	.566	.025	-.043
Flow centrality (International to regional)	.363	-.065	-.142	-.007	-.025
Total Domestic traffic (OD+Trf)	.057	-.355	.083	.005	-.030
Total Regional traffic (OD+Trf)	.032	.334	-.368	.171	.009
Total International traffic(OD+Trf)	-.102	.259	.145	-.129	.036
average frequency per route	.099	-.163	-.156	.452	.285

Extraction Method: Principal Component Analysis. Rotation Method: Varimax witl

Table D-6 Case summaries for the cluster solution based on the five PC Solution

Airport	Airport Name	Country	Region	PC 1	PC2	PC 3	PC 4	PC 5
ASB	Ashgabat	Turkmenistan	AS2	-0.70	2.52	1.76	-2.29	0.61
ATQ	Amritsar	India	AS1	-0.72	1.56	0.67	-1.48	0.99
BHK	Bukhara	Uzbekistan	AS2	-0.63	1.25	0.87	-1.26	-0.63
CCJ	Kozhikode	India	AS1	-0.84	1.88	0.95	-1.48	1.70
DYU	Dushanbe	Tajikistan	AS2	0.13	1.57	2.17	-1.15	-0.84
FRU	Bishkek	Kyrgyzstan	AS2	0.19	1.43	2.44	0.63	-1.87
IKA	Tehran Imam Khomeini	Islamic Republic of Iran	ME1	-0.69	2.54	0.75	-1.60	0.83
ISB	Islamabad	Pakistan	AS1	-0.66	1.41	1.13	-0.64	-0.14
LBD	Khudzhand	Tajikistan	AS2	-0.57	1.79	1.20	-1.41	-0.52
LHE	Lahore	Pakistan	AS1	-0.68	1.50	1.23	-0.68	0.26
NMA	Namangan	Uzbekistan	AS2	-0.81	1.88	1.03	-1.68	-0.04
PEW	Peshawar	Pakistan	AS1	-0.67	1.47	0.74	-1.21	-0.03
SKD	Samarkand	Uzbekistan	AS2	-0.86	1.92	1.45	-1.79	0.24
SKT	Sialkot	Pakistan	AS1	-0.71	1.54	0.65	-1.49	0.01
TJU	Kulyab	Tajikistan	AS2	-0.75	1.88	0.78	-1.40	-0.12
TSE	Astana	Kazakstan	AS2	-0.43	0.17	3.36	0.13	-1.17
UGC	Urgench	Uzbekistan	AS2	-0.52	1.02	0.68	-0.75	-0.43
JED	Jeddah	Saudi Arabia	ME1	-0.18	1.38	2.56	1.05	0.06
KHI	Karachi	Pakistan	AS1	-0.63	1.16	2.00	0.75	-0.07
KIX	Osaka Kansai	Japan	AS4	-0.16	2.25	0.07	-0.45	1.32
RUH	Riyadh	Saudi Arabia	ME1	-0.55	0.92	2.24	1.48	0.16
SHJ	Sharjah	United Arab Emirates	ME1	-0.46	2.10	-0.15	-0.56	1.71
TLV	Tel Aviv	Israel	ME1	-0.95	2.68	2.11	-0.95	0.40
CAN	Guangzhou	China	AS4	-0.43	-0.62	3.21	0.19	0.21
MNL	Manila Ninoy Aquino	Philippines	AS3	-0.46	0.48	2.79	1.92	0.98
NRT	Tokyo Narita	Japan	AS4	0.55	1.79	3.89	-1.30	1.43
PEK	Beijing Capital	China	AS4	-0.01	-0.36	4.11	0.57	0.38
PVG	Shanghai Pudong	China	AS4	0.19	0.53	3.01	-0.04	0.48

Table D-7 Eigenvalues and total variance explained by the Four-PC solution

Total Variance Explained									
	Initial Eigenvalues			Loadings			Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.633	37.555	37.555	5.633	37.555	37.555	3.839	25.596	25.596
2	1.867	12.445	50.000	1.867	12.445	50.000	3.064	20.425	46.020
3	1.651	11.008	61.008	1.651	11.008	61.008	2.116	14.105	60.125
4	1.103	7.353	68.361	1.103	7.353	68.361	1.235	8.236	68.361
5	1.023	6.819	75.181						
6	.956	6.374	81.555						
7	.604	4.028	85.583						
8	.575	3.830	89.414						
9	.465	3.103	92.516						
10	.430	2.870	95.386						
11	.363	2.419	97.805						
12	.223	1.485	99.290						
13	.065	.436	99.726						
14	.041	.273	99.999						
15	.000	.001	100.000						

Table D-9 Communalities of the Four-PC solution

Communalities		
	Initial	Extraction
seats/aircraft	1.000	.659
% of First and Business seats	1.000	.442
% seats by low cost carriers	1.000	.598
Traffic generation(international)	1.000	.843
Flow centrality (international to international)	1.000	.749
Traffic generation (domestic)	1.000	.639
Traffic generation (regional)	1.000	.808
Flow centrality (domestic)	1.000	.600
Flow centrality (regional)	1.000	.725
Flow centrality (International to domestic)	1.000	.605
Flow centrality (International to regional)	1.000	.890
Total Domestic traffic (OD+Trf)	1.000	.933
Total Regional traffic (OD+Trf)	1.000	.567
Total International traffic(OD+Trf)	1.000	.691
average frequency per route	1.000	.505

Table D-8 Unrotated component matrix of the Four-PC solution

Component Matrix[a]				
	Component			
	1	2	3	4
Traffic generation(international)	.873			
Traffic generation (regional)	.859			
Flow centrality (International to	.782	.427		
Total Domestic traffic (OD+Trf)	-.763	.551		
Flow centrality (regional)	.744	.355		
Total International traffic(OD+Trf)	.719	-.392		
Flow centrality (international to	.650	.446	-.347	
% of First and Business seats	.602			
Total Regional traffic (OD+Trf)	.484	-.529		
Traffic generation (domestic)	.468	-.486	.414	
Flow centrality (domestic)			.701	
Flow centrality (International to	.504		.555	
average frequency per route		.407	.540	
% seats by low cost carriers				.700
seats/aircraft	.533			.593
Extraction Method: Principal Component Analysis.				
a. 4 components extracted.				

D.2 Statistics of the cluster analysis

D.2.1 AHC procedures

Table D-10 Agglomeration schedule* and stopping rules for the clusters by degree of airport activity

Agglomeration Schedule									
Stage	Cluster Combined		Coefficients	Stage Cluster First Appears		Next Stage	Number of Clusters		% increase in the coefficient to the next stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2		Before Joining	After Joining	
380	65	216	18968606.9	355	335	413	71	70	5%
381	42	61	19851593.4	0	0	406	70	69	4%
382	1	5	20743711.4	324	357	414	69	68	5%
383	163	262	21723165.6	346	331	399	68	67	5%
384	76	344	22800919.2	0	0	416	67	66	5%
385	41	206	23924958.2	313	342	420	66	65	5%
386	6	30	25113867.8	339	326	413	65	64	5%
387	46	270	26334059.3	0	0	412	64	63	5%
388	64	138	27742952.3	325	317	410	63	62	5%
389	96	183	29187927.8	328	0	408	62	61	6%
390	21	75	30803184.9	366	0	423	61	60	6%
391	20	88	32513535.3	334	364	411	60	59	6%
392	62	90	34324669.0	356	0	418	59	58	5%
393	69	254	36159544.7	358	327	407	58	57	5%
394	130	325	38028637.4	371	0	427	57	56	5%
395	29	49	39974279.7	344	369	422	56	55	5%
396	43	169	41977954.1	350	0	418	55	54	5%
397	55	326	43986405.1	0	0	438	54	53	5%
398	4	37	46066635.5	365	348	425	53	52	6%
399	10	163	48810018.7	359	383	417	52	51	6%
400	3	84	51642500.6	368	343	414	51	50	7%
401	116	209	55086649.9	337	0	416	50	49	7%
402	8	23	58802387.2	345	373	426	49	48	7%
403	112	152	62786972.2	367	360	428	48	47	6%
404	57	120	66857329.3	354	372	422	47	46	8%
405	25	157	71877850.1	362	377	427	46	45	8%
406	42	348	77647385.6	381	0	436	45	44	8%
407	69	358	83726829.2	393	349	423	44	43	8%
408	96	212	90121114.5	389	0	439	43	42	8%
409	13	33	97327315.8	370	379	420	42	41	9%
410	64	73	105942064.1	388	374	429	41	40	9%
411	14	20	115082424.7	378	391	425	40	39	9%
412	46	292	125252519.2	387	376	421	39	38	9%
413	6	65	136559502.9	386	380	426	38	37	9%
414	1	3	148719067.5	382	400	433	37	36	9%
415	102	144	161686941.0	0	0	436	36	35	10%
416	76	116	178473911.3	384	401	431	35	34	10%
417	10	12	195445698.6	399	361	429	34	33	10%
418	43	62	215848922.2	396	392	432	33	32	10%
419	70	139	237833207.4	0	363	431	32	31	10%
420	13	41	262459997.0	409	385	428	31	30	10%
421	46	385	287984694.1	412	0	435	30	29	11%
422	29	57	319680379.7	395	404	434	29	28	11%
423	21	69	355225323.2	390	407	432	28	27	11%
424	160	229	395754100.2	0	0	430	27	26	11%
425	4	14	438850557.6	398	411	433	26	25	13%
426	6	8	494908754.1	413	402	434	25	24	12%
427	25	130	554113995.1	405	394	437	24	23	20%
428	13	112	666463860.3	420	403	437	23	22	19%
429	10	64	791546314.6	417	410	441	22	21	17%
430	83	160	926912686.3	0	424	438	21	20	16%
431	70	76	1071217312.6	419	416	439	20	19	16%
432	21	43	1245879316.4	423	418	442	19	18	18%
433	1	4	1474334416.3	414	425	444	18	17	23%
434	6	29	1813141046.9	426	422	441	17	16	21%
435	46	77	2185712691.1	421	375	443	16	15	17%
436	42	102	2559332310.1	406	415	445	15	14	24%
437	13	25	3177064487.9	428	427	446	14	13	22%
438	55	83	3870475134.7	397	430	443	13	12	21%
439	70	96	4701573247.4	431	408	442	12	11	18%
440	150	308	5565537686.4	0	0	445	11	10	33%
441	6	10	7384485352.6	434	429	444	10	9	46%
442	21	70	10813443575.3	432	439	446	9	8	37%
443	46	55	14832591976.1	435	438	447	8	7	33%
444	1	6	19671993241.0	433	441	448	7	6	38%
445	42	150	27187760553.6	436	440	447	6	5	44%
446	13	21	39221382582.5	437	442	448	5	4	83%
447	42	46	71930749254.0	445	443	449	4	3	**107%**
448	1	13	**148724910871.1**	444	446	449	3	2	278%
449	1	42	562857903146.6	448	447	0	2	1	-

*Stages 380-449

Source: Own elaboration based on SPSS 22 Output

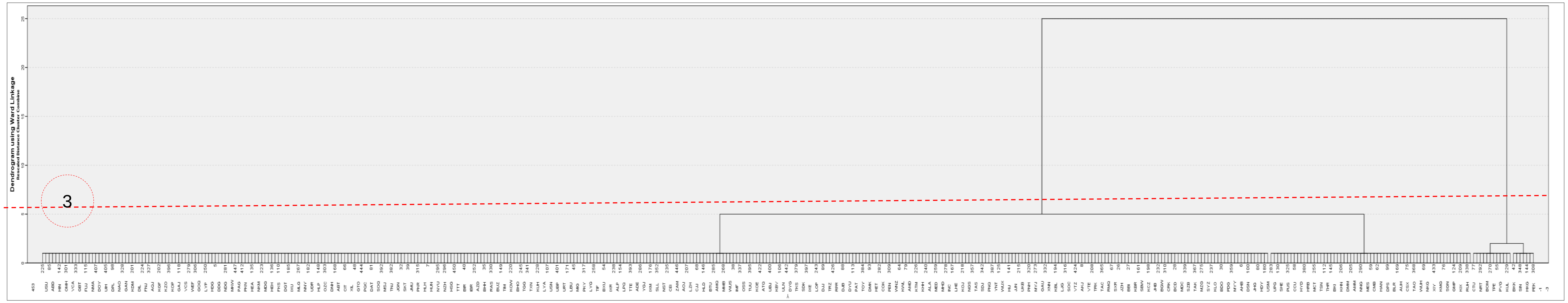

Figure D-3 Dendrogram* for the cluster solution by degree of airport activity

*Distance rescaled to 25

Source: SPSS 22 Output

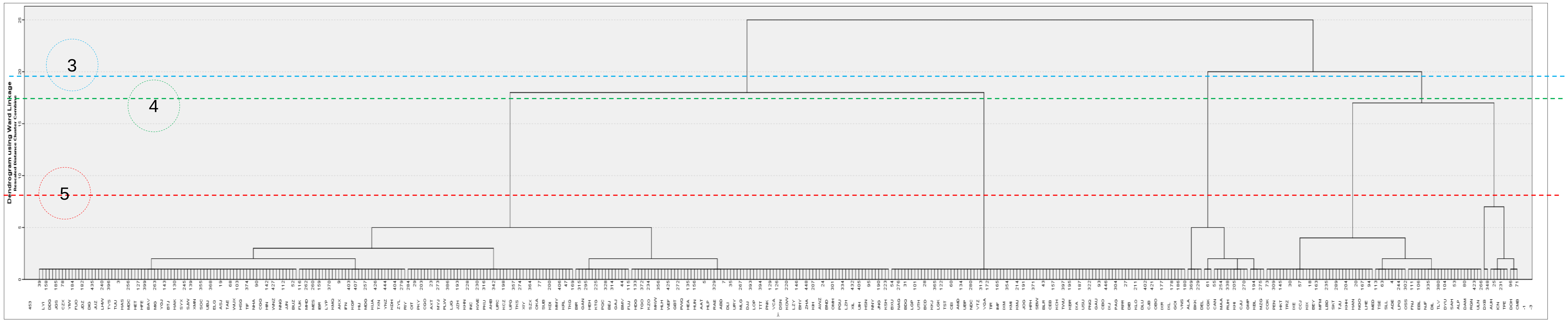

Figure D-4 Dendrogram* for the cluster solution by the four PCs of network and segmentation strategy

*Distance rescaled to 25

Source: SPSS 22 Output

Table D-11 Games-Howell post hoc tests for the AHC solution based on degree of airport activity

Multiple Comparisons							
Dependent Variable	Groups		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Passengers /day	1	2	-22846.33017*	1299.56713	.000	-25967.2730	-19725.3874
		3	-94068.47340*	6550.75219	.000	-110785.4456	-77351.5012
	2	1	22846.33017*	1299.56713	.000	19725.3874	25967.2730
		3	-71222.14323*	6674.86348	.000	-88149.2979	-54294.9886
	3	1	94068.47340*	6550.75219	.000	77351.5012	110785.4456
		2	71222.14323*	6674.86348	.000	54294.9886	88149.2979
Flights/day	1	2	-235.4116*	13.3421	.000	-267.451	-203.372
		3	-766.3814*	55.3544	.000	-907.633	-625.130
	2	1	235.4116*	13.3421	.000	203.372	267.451
		3	-530.9698*	56.8911	.000	-674.847	-387.092
	3	1	766.3814*	55.3544	.000	625.130	907.633
		2	530.9698*	56.8911	.000	387.092	674.847
HHI	1	2	.178132*	.019531	.000	.13193	.22434
		3	.209757*	.020060	.000	.16122	.25830
	2	1	-.178132*	.019531	.000	-.22434	-.13193
		3	.031626	.021696	.319	-.02070	.08395
	3	1	-.209757*	.020060	.000	-.25830	-.16122
		2	-.031626	.021696	.319	-.08395	.02070
Seats/day	1	2	-38294.5099*	2203.8136	.000	-43587.714	-33001.306
		3	-156275.1708*	11698.3081	.000	-186129.045	-126421.297
	2	1	38294.5099*	2203.8136	.000	33001.306	43587.714
		3	-117980.6609*	11899.4227	.000	-148174.463	-87786.859
	3	1	156275.1708*	11698.3081	.000	126421.297	186129.045
		2	117980.6609*	11899.4227	.000	87786.859	148174.463
No of Airlines	1	2	-22.493*	1.645	.000	-26.44	-18.55
		3	-52.306*	5.668	.000	-66.76	-37.85
	2	1	22.493*	1.645	.000	18.55	26.44
		3	-29.813*	5.884	.000	-44.64	-14.98
	3	1	52.306*	5.668	.000	37.85	66.76
		2	29.813*	5.884	.000	14.98	44.64
No of destinations served	1	2	-45.638*	3.079	.000	-53.02	-38.25
		3	-112.337*	9.963	.000	-137.75	-86.93
	2	1	45.638*	3.079	.000	38.25	53.02
		3	-66.700*	10.396	.000	-92.87	-40.53
	3	1	112.337*	9.963	.000	86.93	137.75
		2	66.700*	10.396	.000	40.53	92.87
No of gates	1	2	-19.781*	1.819	.000	-24.15	-15.41
		3	-66.591*	6.540	.000	-83.28	-49.90
	2	1	19.781*	1.819	.000	15.41	24.15
		3	-46.809*	6.782	.000	-63.92	-29.70
	3	1	66.591*	6.540	.000	49.90	83.28
		2	46.809*	6.782	.000	29.70	63.92
% of seats offerred by the dominant carrier	1	2	.12506*	.02217	.000	.0724	.1777
		3	.16421*	.02500	.000	.1025	.2259
	2	1	-.12506*	.02217	.000	-.1777	-.0724
		3	.03915	.02904	.376	-.0312	.1095
	3	1	-.16421*	.02500	.000	-.2259	-.1025
		2	-.03915	.02904	.376	-.1095	.0312

Source: SPSS 22 ANOVA output

Table D-12 Agglomeration schedule* and the percentage change in heterogeneity for the cluster solutions based on original variables and five PCs

Hierarchical Process			Five PCs		Original variables	
Stage	Before Joining	After Joining	Coefficient	% increase to the next stage	Coefficient	% increase to the next stage
430	21	20	305.9	4.9%	1441.2	3.9%
431	20	19	320.7	5.9%	1496.9	3.9%
432	19	18	339.5	5.8%	1555.2	4.2%
433	18	17	359.2	5.8%	1620.1	4.1%
434	17	16	380.0	5.5%	1686.7	4.4%
435	16	15	400.8	5.2%	1760.4	4.2%
436	15	14	421.8	5.0%	1835.1	4.2%
437	14	13	442.9	5.8%	1913.1	4.4%
438	13	12	468.4	6.6%	1997.1	5.3%
439	12	11	499.5	10.5%	2102.7	5.7%
440	11	10	552.2	9.9%	2221.8	7.6%
441	10	9	606.9	12.5%	2389.9	8.2%
442	9	8	682.4	14.7%	2584.8	8.0%
443	8	7	782.5	**19.4%**	2792.5	7.8%
444	7	6	**934.2**	17.6%	3010.8	**10.8%**
445	6	5	1098.2	**22.2%**	**3334.5**	9.9%
446	5	4	**1341.8**	**20.2%**	3665.5	**10.6%**
447	4	3	**1613.3**	17.6%	**4054.3**	**26.4%**
448	3	2	1897.6	18.3%	**5123.0**	31.5%
449	2	1	2245.0	-	6735.0	-

* Stages 430 -449

Source: Own elaboration based on SPSS 22 Output

Table D-13 Agglomeration schedule and the percentage change in heterogeneity of the Four-PC based cluster solution

Agglomeration Schedule									
Stage	Cluster Combined		Coefficients	Stage Cluster First Appears		Next Stage			
	Cluster 1	Cluster 2		Cluster 1	Cluster 2		Before Joining	After Joining	% change in coefficient to the next stage
395	19	50	59.873	388	349	421	56	55	2.6%
396	4	226	61.438	316	340	408	55	54	2.6%
397	20	99	63.011	384	313	414	54	53	2.5%
398	47	76	64.588	377	372	416	53	52	2.7%
399	34	53	66.311	334	0	412	52	51	2.6%
400	69	183	68.047	393	348	419	51	50	2.7%
401	216	373	69.879	351	0	430	50	49	2.7%
402	11	266	71.788	356	368	412	49	48	2.9%
403	13	104	73.856	353	0	424	48	47	2.8%
404	48	87	75.943	357	358	433	47	46	2.9%
405	12	28	78.138	376	360	434	46	45	2.9%
406	18	57	80.414	332	319	431	45	44	2.9%
407	1	22	82.72	362	382	422	44	43	3.0%
408	4	63	85.229	396	339	427	43	42	3.2%
409	231	292	87.934	359	0	415	42	41	3.3%
410	8	27	90.799	387	371	413	41	40	3.2%
411	46	150	93.68	381	0	439	40	39	3.2%
412	11	34	96.653	402	399	424	39	38	3.7%
413	8	43	100.181	410	306	425	38	37	3.5%
414	20	36	103.711	397	370	431	37	36	3.6%
415	21	231	107.454	379	409	440	36	35	3.7%
416	6	47	111.404	373	398	441	35	34	3.6%
417	32	40	115.412	366	127	437	34	33	3.5%
418	42	83	119.437	375	0	429	33	32	3.4%
419	55	69	123.465	391	400	428	32	31	3.6%
420	71	96	127.962	0	386	440	31	30	3.6%
421	3	19	132.56	369	395	435	30	29	3.6%
422	1	114	137.37	407	389	437	29	28	3.8%
423	9	199	142.586	390	392	435	28	27	3.7%
424	11	13	147.876	412	403	433	27	26	3.6%
425	8	16	153.243	413	385	434	26	25	4.0%
426	102	348	159.35	0	0	445	25	24	4.0%
427	4	113	165.74	408	383	438	24	23	4.0%
428	55	124	172.368	419	0	436	23	22	4.4%
429	10	42	180.021	394	418	444	22	21	4.6%
430	79	216	188.286	378	401	436	21	20	4.5%
431	18	20	196.792	406	414	432	20	19	5.6%
432	18	30	207.818	431	380	442	19	18	5.5%
433	11	48	219.289	424	404	438	18	17	5.8%
434	8	12	232.073	425	405	447	17	16	6.3%
435	3	9	246.76	421	423	441	16	15	6.0%
436	55	79	261.617	428	430	439	15	14	6.6%
437	1	32	278.966	422	417	443	14	13	7.9%
438	4	11	301.099	427	433	442	13	12	9.1%
439	46	55	328.584	411	436	444	12	11	8.6%
440	21	71	356.712	415	420	445	11	10	8.2%
441	3	6	385.953	435	416	443	10	9	13.1%
442	4	18	436.65	438	432	446	9	8	13.9%
443	1	3	497.292	437	441	447	8	7	13.0%
444	10	46	562.131	429	439	448	7	6	17.5%
445	21	102	660.284	440	426	446	6	5	**36.7%**
446	4	21	902.481	442	445	448	5	4	**27.8%**
447	1	8	1153.628	443	434	449	4	3	**24.8%**
448	4	10	1439.511	446	444	449	3	2	24.9%
449	1	4	1797.501	447	448	0	2	1	-

* Stages 395 -449

Source: Own Computations and SPSS 22 Output

Table D-14 Welch's F- Test (ANOVA) for the Four-PC based AHC solutions

Welch's F-Test for Robust Tests of Equality of Means												
PC	Five-Cluster				Four-Cluster				Three-Cluster			
	Statistic[a]	df1	df2	Sig.	Statistic[a]	df1	df2	Sig.	Statistic[a]	df1	df2	Sig.
PC 1- International Hub	66.257	4	48.663	.000	74.046	3	80.188	.000	3.262	2	47.122	.047
PC 2 - International Airport	145.018	4	50.033	.000	196.413	3	85.084	.000	285.704	2	49.344	.000
PC 3 - Domestic Hub	40.756	4	49.005	.000	53.075	3	81.141	.000	79.812	2	47.916	.000
PC 4- Low Cost/ Service Frequency	226.916	4	50.685	.000	307.560	3	84.409	.000	1.041	2	55.591	.360

[a]Asymptotically F distributed

Table D-15 Test of homogeneity of variance of criterion variables for the five-Cluster, Four-PC based AHC solution

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
Average distance of a route	29.838	4	445	.000
% of Economy seats	4.811	4	445	.001
% seats by FSC	40.262	4	445	.000
Flow centrality (Global)	186.184	4	445	.000
Traffic generation (Global)	88.969	4	445	.000

Table D-16 Welch's F-Test of criterion variables for the five-cluster, Four-PC based AHC solution

Robust Tests of Equality of Means				
	Statistic[a]	df1	df2	Sig.
Average distance of a route	43.242	4	49.5	.000
% of Economy seats	56.236	4	52.9	.000
% seats by FSC	176.819	4	49.5	.000
Flow centrality (Global)	10.707	4	50.2	.000
Traffic generation (Global)	14.335	4	50.5	.000
a. Asymptotically F distributed.				

Table D-17 *Post Hoc* tests of criterion variables for the five-cluster, Four-PC based AHC solution

Multiple Comparisons

Dependent Variable				Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Average distance of a route	Games-Howell	1	2	-689.37766*	77.76	.000	-906.82	-471.93
			3	152.66267*	32.92	.000	61.99	243.33
			4	-693.61729*	146.47	.001	-1125.37	-261.87
			5	-1629.52180*	256.62	.001	-2472.22	-786.82
		2	1	689.37766*	77.76	.000	471.93	906.82
			3	842.04033*	79.83	.000	619.31	1064.77
			4	-4.23964	163.54	1.000	-473.65	465.17
			5	-940.14415*	266.73	.029	-1792.71	-87.58
		3	1	-152.66267*	32.92	.000	-243.33	-61.99
			2	-842.04033*	79.83	.000	-1064.77	-619.31
			4	-846.27996*	147.58	.000	-1280.30	-412.26
			5	-1782.18447*	257.26	.000	-2625.39	-938.98
		4	1	693.61729*	146.47	.001	261.87	1125.37
			2	4.23964	163.54	1.000	-465.17	473.65
			3	846.27996*	147.58	.000	412.26	1280.30
			5	-935.90451*	294.20	.039	-1832.65	-39.16
		5	1	1629.52180*	256.62	.001	786.82	2472.22
			2	940.14415*	266.73	.029	87.58	1792.71
			3	1782.18447*	257.26	.000	938.98	2625.39
			4	935.90451*	294.20	.039	39.16	1832.65
% of Economy seats	Games-Howell	1	2	.02006*	.00395	.000	.0090	.0311
			3	-.00533	.00228	.137	-.0116	.0009
			4	.01984*	.00487	.003	.0056	.0340
			5	.06824*	.00513	.000	.0518	.0847
		2	1	-.02006*	.00395	.000	-.0311	-.0090
			3	-.02539*	.00414	.000	-.0369	-.0139
			4	-.00023	.00597	1.000	-.0171	.0166
			5	.04818*	.00618	.000	.0299	.0664
		3	1	.00533	.00228	.137	-.0009	.0116
			2	.02539*	.00414	.000	.0139	.0369
			4	.02517*	.00502	.000	.0106	.0397
			5	.07358*	.00527	.000	.0570	.0902
		4	1	-.01984*	.00487	.003	-.0340	-.0056
			2	.00023	.00597	1.000	-.0166	.0171
			3	-.02517*	.00502	.000	-.0397	-.0106
			5	.04841*	.00680	.000	.0285	.0683
		5	1	-.06824*	.00513	.000	-.0847	-.0518
			2	-.04818*	.00618	.000	-.0664	-.0299
			3	-.07358*	.00527	.000	-.0902	-.0570
			4	-.04841*	.00680	.000	-.0683	-.0285
% seats by FSCs	Games-Howell	1	2	.14653*	.02693	.000	.0711	.2220
			3	.61104*	.02305	.000	.5470	.6751
			4	.13263*	.03633	.010	.0255	.2397
			5	.07562	.02495	.071	-.0055	.1568
		2	1	-.14653*	.02693	.000	-.2220	-.0711
			3	.46452*	.03488	.000	.3681	.5609
			4	-.01390	.04478	.998	-.1407	.1129
			5	-.07091	.03617	.304	-.1743	.0325
		3	1	-.61104*	.02305	.000	-.6751	-.5470
			2	-.46452*	.03488	.000	-.5609	-.3681
			4	-.47842*	.04256	.000	-.5996	-.3573
			5	-.53542*	.03338	.000	-.6319	-.4389
		4	1	-.13263*	.03633	.010	-.2397	-.0255
			2	.01390	.04478	.998	-.1129	.1407
			3	.47842*	.04256	.000	.3573	.5996
			5	-.05701	.04362	.689	-.1828	.0688
		5	1	-.07562	.02495	.071	-.1568	.0055
			2	.07091	.03617	.304	-.0325	.1743
			3	.53542*	.03338	.000	.4389	.6319
			4	.05701	.04362	.689	-.0688	.1828
Flow centrality (Global)	Games-Howell	1	2	.00000	.00001	.99995	-.00003	.00003
			3	.00002	.00001	.13378	.00000	.00004
			4	-.000831444244343*	.00018	.00131	-.00137	-.00029
			5	-.002025217441582*	.00049	.01411	-.00365	-.00040
		2	1	.00000	.00001	.99995	-.00003	.00003
			3	.00002	.00001	.54455	-.00001	.00005
			4	-.000832835734978*	.00018	.00129	-.00138	-.00029
			5	-.002026608932216*	.00049	.01405	-.00365	-.00041
		3	1	-.00002	.00001	.13378	-.00004	.00000
			2	-.00002	.00001	.54455	-.00005	.00001
			4	-.000849373817998*	.00018	.00103	-.00139	-.00031
			5	-.002043147015236*	.00049	.01335	-.00366	-.00042
		4	1	.000831444244343*	.00018	.00131	.00029	.00137
			2	.000832835734978*	.00018	.00129	.00029	.00138
			3	.000849373817998*	.00018	.00103	.00031	.00139
			5	-.00119	.00053	.21580	-.00285	.00046
		5	1	.002025217441582*	.00049	.01411	.00040	.00365
			2	.002026608932216*	.00049	.01405	.00041	.00365
			3	.002043147015236*	.00049	.01335	.00042	.00366
			4	.00119	.00053	.21580	-.00046	.00285
Traffic generation (Global)	Games-Howell	1	2	-.00019	.00025	.94111	-.00087	.00049
			3	.00044	.00018	.09273	-.00004	.00092
			4	-.009918223716402*	.00189	.00022	-.01550	-.00434
			5	-.009394969117097*	.00218	.01030	-.01656	-.00223
		2	1	.00019	.00025	.94111	-.00049	.00087
			3	.000628362332108*	.00022	.04712	.00001	.00125
			4	-.009730280308356*	.00190	.00028	-.01532	-.00414
			5	-.009207025709051*	.00219	.01171	-.01638	-.00204
		3	1	-.00044	.00018	.09273	-.00092	.00004
			2	-.000628362332108*	.00022	.04712	-.00125	-.00001
			4	-.010358642640463*	.00189	.00012	-.01594	-.00478
			5	-.009835388041158*	.00218	.00762	-.01700	-.00267
		4	1	.009918223716402*	.00189	.00022	.00434	.01550
			2	.009730280308356*	.00190	.00028	.00414	.01532
			3	.010358642640463*	.00189	.00012	.00478	.01594
			5	.00052	.00288	.99974	-.00794	.00899
		5	1	.009394969117097*	.00218	.01030	.00223	.01656
			2	.009207025709051*	.00219	.01171	.00204	.01638
			3	.009835388041158*	.00218	.00762	.00267	.01700
			4	-.00052	.00288	.99974	-.00899	.00794

*. The mean difference is significant at the 0.05 level.

Table D-18 Test of homogeneity of variance of criterion variables for the three-cluster, Four-PC, AHC Solution

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
Average distance of a route	65.510	2	447	.000
% of Economy seats	14.606	2	447	.000
% seats by FSCs	13.699	2	447	.000
Flow centrality (Global)	97.307	2	447	.000
Traffic generation (Global)	94.126	2	447	.000

Table D-19 Welch's F-Test of criterion variables for the three-cluster Four-PC, AHC solution

Robust Tests of Equality of Means				
	Statistic[a]	df1	df2	Sig.
Average distance of a route	63.251	2	48.809	.000
% of Economy seats	33.152	2	52.822	.000
% seats by FSCs	.394	2	64.680	.676
Flow centrality (Global)	13.932	2	47.177	.000
Traffic generation (Global)	18.546	2	48.322	.000
a. Asymptotically F distributed.				

Table D-20 The p*ost hoc* tests of criterion variables for the three-cluster, four 4 PC based AHC solution

Multiple Comparisons								
Dependent Variable				Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Average distance of a route	Games-Howell	1	2	-863.05256*	84.129	.000	-1063.8667	-662.2384
			3	-732.98589*	146.094	.000	-1098.2378	-367.7340
		2	1	863.05256*	84.129	.000	662.2384	1063.8667
			3	130.06667	166.990	.718	-276.7598	536.8931
		3	1	732.98589*	146.094	.000	367.7340	1098.2378
			2	-130.06667	166.990	.718	-536.8931	276.7598
% of Economy seats	Games-Howell	1	2	.02832*	.00394	.000	0.0189	0.0377
			3	.02121*	.00480	.000	0.0093	0.0332
		2	1	-.02832*	.00394	.000	-0.0377	-0.0189
			3	-.00711	.00601	.468	-0.0216	0.0074
		3	1	-.02121*	.00480	.000	-0.0332	-0.0093
			2	.00711	.00601	.468	-0.0074	0.0216
% seats by FSCs	Games-Howell	1	2	-.02118	.02805	.731	-0.0875	0.0452
			3	-.02495	.03937	.803	-0.1216	0.0717
		2	1	.02118	.02805	.731	-0.0452	0.0875
			3	-.00377	.04285	.996	-0.1077	0.1002
		3	1	.02495	.03937	.803	-0.0717	0.1216
			2	.00377	.04285	.996	-0.1002	0.1077
Flow centrality (Global)	Games-Howell	1	2	-.000292747743400*	.00011	.01973	-0.0005	0.0000
			3	-.000836067916632*	.00018	.00041	-0.0013	-0.0004
		2	1	.000292747743400*	.00011	.01973	0.0000	0.0005
			3	-.000543320173233*	.00021	.03743	-0.0011	0.0000
		3	1	.000836067916632*	.00018	.00041	0.0004	0.0013
			2	.000543320173233*	.00021	.03743	0.0000	0.0011
Traffic generation (Global)	Games-Howell	1	2	-.001616807875757*	.00052	.00679	-0.0029	-0.0004
			3	-.010031798797105*	.00189	.00006	-0.0148	-0.0053
		2	1	.001616807875757*	.00052	.00679	0.0004	0.0029
			3	-.008414990921348*	.00195	.00057	-0.0133	-0.0036
		3	1	.010031798797105*	.00189	.00006	0.0053	0.0148
			2	.008414990921348*	.00195	.00057	0.0036	0.0133
*. The mean difference is significant at the 0.05 level.								

D.2.2 K-means procedures

Table D-21 Initial and Final Cluster Centres for Degree of airport activity

	Initial Cluster Centers			Final Cluster Centers			
	Cluster				Cluster		
	1	2	3		1	2	3
Seats/day	4335.4	42629.9	160610.6	Seats/day	5011.9	49776.4	167515.5
No of Airlines	8	30	60	No of Airlines	8	31	63
No of gates	4	24	71	No of gates	5	27	73
% of seats offerred by the dominant carrier	.51	.39	.35	% of seats offerred by the dominant carrier	.51	.37	.35
No of destinatio ns served	11	57	123	No of destinatio ns served	12	61	127

Input from FILE Subcommand

Table D-22 ANOVA for K-means Clusters for Degree of airport activity

ANOVA

	Cluster		Error		F	Sig.
	Mean Square	df	Mean Square	df		
Seats/day	246773306651	2	155057344	447	1591.497	.000
No of Airlines	34150	2	83	447	412.661	.000
No of gates	46789	2	75	447	627.926	.000
% of seats offerred by the dominant carrier	62%	2	4%	447	13.876	.000
No of destinations served	149613	2	281	447	532.271	.000

The F tests should be used only for descriptive purposes because the clusters have been chosen to maximize the differences among cases in different clusters. The observed significance levels are not corrected for this and thus cannot be interpreted as tests of the hypothesis that the cluster means are equal.

s

Table D-23 Iteration History for K-means Clusters for Degree of airport activity

Iteration History[a]

Iteration	Change in Cluster Centers		
	1	2	3
1	191.068	2420.134	3296.201
2	208.390	2560.567	3608.752
3	163.424	1276.209	0.000
4	113.573	889.574	0.000
5	0.000	0.000	0.000

a. Convergence achieved due to no or small change in cluster centers. The maximum absolute coordinate change for any center is .000. The current iteration is 5. The minimum distance between initial centers is 38294.549.

Table D-24 Initial and final cluster centres for the five-cluster, Four-PC solution

Initial Cluster Centers						Final Cluster Centers					
	Cluster						Cluster				
	1	2	3	4	5		1	2	3	4	5
PC 1- International Hub	-.06154	-.42977	-.21959	.59957	4.51611	PC 1- International Hub	-.06167	-.23059	-.21688	.70354	7.51414
PC 2 -International Airport	-.39662	1.86876	-.47136	.15322	1.64818	PC 2 -International Airport	-.40336	2.05359	-.36098	.17358	.87231
PC 3 - Domestic Hub	-.21851	.02630	-.21550	3.44710	-.86161	PC 3 - Domestic Hub	-.22341	-.05605	-.15035	3.56235	-1.46572
PC 4- Low Cost/ Service Frequency	-.53975	-.12180	1.39148	.28131	.50179	PC 4- Low Cost/ Service Frequency	-.58765	-.14271	1.30501	.08896	.16760
Input from FILE Subcommand											

Table D-26 Iteration history for five-cluster, Four-PC based solution

Iteration History[a]

Iteration	Change in Cluster Centers				
	1	2	3	4	5
1	.040	.135	.109	.177	1.250
2	.008	.108	.040	.100	1.112
3	.011	.071	.009	0.000	.844
4	0.000	0.000	0.000	0.000	0.000

a. Convergence achieved due to no or small change in cluster centers. The maximum absolute coordinate change for any center is .000. The current iteration is 4. The minimum distance between initial centers is 1.939.

Table D-25 ANOVA for the five-cluster, Four-PC based solution

ANOVA

	Cluster		Error		F	Sig.
	Mean Square	df	Mean Square	df		
PC 1- International Hub	75.793	4	.328	445	231.287	.000
PC 2 - International Airport	82.279	4	.269	445	305.414	.000
PC 3 - Domestic Hub	79.428	4	.289	445	274.702	.000
PC 4- Low Cost/ Service Frequency	68.253	4	.405	445	168.630	.000

The F tests should be used only for descriptive purposes because the clusters have been chosen to maximize the differences among cases in different clusters. The observed significance levels are not corrected for this and thus cannot be interpreted as tests of the hypothesis that the cluster means are equal.

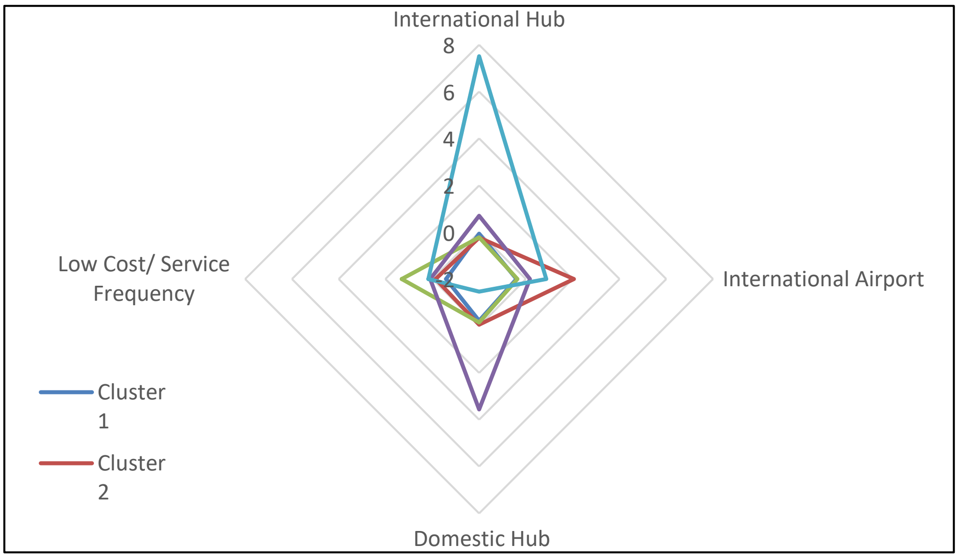

Figure D-5 Profile analysis of Four-PC based K-means five-cluster solution

Table D-27 Initial and final cluster centres for three-cluster, Four-PC based solution

Initial Cluster Centers				Final Cluster Centers			
	Cluster				Cluster		
	1	2	3		1	2	3
PC 1- International Hub	-.10230	.27678	.59957	PC 1- International Hub	-.09935	.24110	.61306
PC 2 -International Airport	-.41589	1.83725	.15322	PC 2 -International Airport	-.43357	1.83150	.21300
PC 3 - Domestic Hub	-.21773	-.10054	3.44710	PC 3 - Domestic Hub	-.21027	-.17470	3.42224
PC 4- Low Cost/ Service Frequency	-.04172	-.03271	.28131	PC 4- Low Cost/ Service Frequency	-.01765	-.08859	.11111
Input from FILE Subcommand							

Table D-28 Iteration history for the three-cluster, Four-PC based solution

Iteration History[a]			
	Change in Cluster Centers		
Iteration	1	2	3
1	.022	.083	.183
2	.010	.042	0.000
3	0.000	0.000	0.000

a. Convergence achieved due to no or small change in cluster centers. The maximum absolute coordinate change for any center is .000. The current iteration is 3. The minimum distance between initial centers is 2.288.

Table D-29 ANOVA for the three-cluster, Four-PC based solution

ANOVA						
	Cluster		Error			
	Mean Square	df	Mean Square	df	F	Sig.
PC 1- International Hub	8.702	2	.966	447	9.012	.000
PC 2 -International Airport	165.586	2	.264	447	628.179	.000
PC 3 - Domestic Hub	155.250	2	.304	447	510.729	.000
PC 4- Low Cost/ Service Frequency	.400	2	1.012	447	.395	.674

The F tests should be used only for descriptive purposes because the clusters have been chosen to maximize the differences among cases in different clusters. The observed significance levels are not corrected for this and thus cannot be interpreted as tests of the hypothesis that the cluster means are equal.

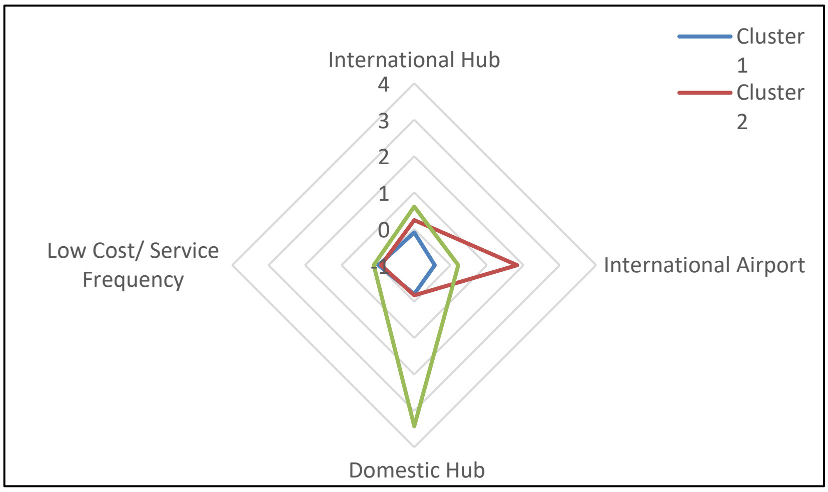

Figure D-6 Profile analysis of Four-PC based K-means three-cluster solution

D.3 Data for the Proposed Taxonomy of Airport Typologies

Table D-30 Welch's F-test for equality of means, 3x3 taxonomy of airports

Variable	Statistic[a]	df1	df2	Sig.
Seats/aircraft	63.113	8	22.690	.000
Average frequency per route	20.089	8	22.541	.000
% of First/ Business seats	23.379	8	23.068	.000
% seats by LCCs	5.264	8	26.443	.001
Traffic generation(international)	19.544	8	21.222	.000
Traffic generation (domestic)	31.114	8	29.546	.000
Traffic generation (regional)	13.173	8	21.109	.000
Flow centrality (domestic)	336.296	8	26.804	.000
Flow centrality (regional)	4.395	8	21.105	.003
Flow centrality (international to international)	2.598	8	21.101	.038
Flow centrality (International to domestic)	7.059	8	21.120	.000
Flow centrality (International to regional)	5.313	8	21.103	.001
% Domestic seats	1407.183	8	26.085	.000
% Regional seats	17.122	8	22.549	.000
% International seats	34.663	8	24.226	.000
Seats/day	78.871	8	21.253	.000
No of destinations	57.106	8	21.251	.000
No of Airlines	51.958	8	21.238	.000
No of gates	26.515	8	21.295	.000
% of seats by the dominant carrier	17.320	8	27.383	.000

Table D-31 Welch's F-test for equality of means, 3x5 taxonomy of airports

Variable	Statistic[a]	df1	df2	Sig.
Seats/aircraft	45.931	11	28.463	.000
Average frequency per route	17.110	11	28.657	.000
% of First/ Business seats	20.584	11	28.548	.000
% seats by LCCs	75.318	11	27.141	.000
Traffic generation(international)	17.299	11	26.609	.000
Traffic generation (domestic)	23.685	11	31.780	.000
Traffic generation (regional)	12.437	11	26.416	.000
Flow centrality (regional)	3.836	11	26.467	.002
Flow centrality (international to international)	2.299	11	26.531	.039
Flow centrality (International to domestic)	8.024	11	26.524	.000
Flow centrality (International to regional)	5.118	11	26.473	.000
% Domestic seats	3454.802	11	31.517	.000
% Regional seats	16.560	11	27.336	.000
% International seats	34.302	11	28.258	.000
Seats/day	59.996	11	26.583	.000
No of Airlines	41.576	11	26.655	.000
No of destinations served	58.216	11	26.953	.000
No of gates	19.117	11	26.614	.000
% of seats by the dominant carrier	12.693	11	31.314	.000

Table D-32 Data for the Criterion Variables and Key Totals for the proposed taxonomy of airports

Criterion Variables/ Key Totals	***Indicators***	**Primary International Hubs**	**Secondary International hubs**	**Medium International Airports**	**Small International Airports**	**Primary Hybrid Airports**	**Medium Hybrid Airports**	**Small Hybrid Airports**	**Large Domestic Airports**	**Medium Domestic OD Airports**	**Small Domestic OD Airports**	**Medium Domestic LCC Airports**	**Small Domestic LCC Airports**
Criterion Variables	*HHI*	0.19	0.36	0.24	0.28	0.19	0.25	0.30	0.18	0.18	0.45	0.21	0.34
	Flights/day	673	256	195	46	920	307	83	646	294	28	230	33
	Passengers/day	92758	23655	21720	4276	107101	34312	8356	71515	26254	2337	20454	3062
	Traffic generation (Global)	1.661%	0.351%	0.405%	0.087%	2.042%	0.678%	0.163%	1.424%	0.525%	0.054%	0.405%	0.063%
	Flow centrality (Global)	0.262%	0.139%	0.012%	0.001%	0.176%	0.031%	0.010%	0.055%	0.018%	0.001%	0.018%	0.001%
	% seats by FSC	89.7%	88.0%	78.9%	82.5%	77.6%	80.5%	96.2%	96.0%	93.7%	96.9%	37.4%	35.2%
	% of Economy seats	89.5%	90.4%	93.1%	95.1%	93.8%	95.6%	95.2%	94.7%	96.3%	96.8%	96.8%	97.3%
	Average distance of a route	2718	2120	1761	1450	1876	1067	1492	1244	1059	778	1164	635
Key Totals	*Domestic OD Traffic (Monthly)*	18424	2145	181564	38469	1920213	604381	103198	1982575	704459	65598	472745	87284
	Regional OD Traffic (Monthly)	1198835	235924	184724	39772	406385	161732	26449	107984	55835	3954	20391	2399
	International OD Traffic (Monthly)	1272452	288251	287629	52752	734840	250868	114819	44437	27146	2288	114620	4481
	Domestic Transfer Traffic (Monthly)	297	0	2386	291	118985	18760	6080	77070	23954	558	23113	685
	Regional Transfer Traffic (Monthly)	27399	10178	961	189	5131	1007	124	54	61	2	53	1
	International to International Transfer Traffic (Monthly)	199276	90828	2836	186	20162	1324	1430	70	121	1	7	1
	International to Domestic Transfer Traffic (Monthly)	19816	364	4371	479	82543	19203	4396	4632	2206	52	3062	72
	International to Regional Transfer Traffic (Monthly)	138989	105603	8836	403	31867	6404	2541	153	105	2	99	0
	Total Traffic (Monthly)	2875488	733294	673306	132540	3320125	1063678	259036	2216976	813887	72454	634089	94922
	Total Seats (Annual)	59228485	17582198	12267266	2295223	63973719	19372480	4095581	39574235	16052996	1293922	12280713	1715093
	Total Frequency(Annual)	245427	93174	70998	16635	335673	111879	30234	235648	107106	9861	83841	11855
	% of seats by Leisure/charter carriers	0.7%	0.2%	0.7%	2.1%	0.4%	2.5%	0.2%	0.0%	0.1%	0.6%	1.0%	1.2%

Table D-33 The list of airports and their typologies

Airport Code	Airport Name	Country	Region	Airport Typology
HEA	Herat	Afghanistan	AS1	Small Domestic OD Airports
KBL	Kabul	Afghanistan	AS1	Small Hybrid Airports
KDH	Kandahar	Afghanistan	AS1	Small Domestic OD Airports
CGP	Chittagong	Bangladesh	AS1	Small International Airports
DAC	Dhaka	Bangladesh	AS1	Small Hybrid Airports
ZYL	Sylhet	Bangladesh	AS1	Small Domestic OD Airports
PBH	Paro	Bhutan	AS1	Small International Airports
IXA	Agartala	India	AS1	Small Domestic LCC Airports
AMD	Ahmedabad	India	AS1	Small Domestic LCC Airports
ATQ	Amritsar	India	AS1	Small International Airports
IXU	Aurangabad	India	AS1	Small Domestic LCC Airports
IXB	Bagdogra	India	AS1	Small Domestic LCC Airports
BLR	Bengaluru	India	AS1	Medium Domestic LCC Airports
BHO	Bhopal	India	AS1	Small Domestic LCC Airports
BBI	Bhubaneswar	India	AS1	Small Domestic LCC Airports
IXC	Chandigarh	India	AS1	Small Domestic LCC Airports
MAA	Chennai	India	AS1	Medium Hybrid Airports
CJB	Coimbatore	India	AS1	Small Domestic LCC Airports
DEL	Delhi	India	AS1	Primary Hybrid Airports
DIB	Dibrugarh	India	AS1	Small Domestic LCC Airports
GOI	Goa	India	AS1	Small Domestic LCC Airports
GAU	Guwahati	India	AS1	Small Domestic LCC Airports
HYD	Hyderabad Rajiv Gandhi	India	AS1	Medium Domestic LCC Airports
IMF	Imphal	India	AS1	Small Domestic LCC Airports
IDR	Indore	India	AS1	Small Domestic LCC Airports
JAI	Jaipur	India	AS1	Small Domestic LCC Airports
IXJ	Jammu	India	AS1	Small Domestic LCC Airports
JDH	Jodhpur	India	AS1	Small Domestic OD Airports
COK	Kochi (IN)	India	AS1	Small International Airports
CCU	Kolkata	India	AS1	Medium Domestic LCC Airports
CCJ	Kozhikode	India	AS1	Small International Airports
IXL	Leh	India	AS1	Small Domestic LCC Airports
LKO	Lucknow	India	AS1	Small Domestic LCC Airports
IXM	Madurai	India	AS1	Small Domestic LCC Airports
IXE	Mangalore	India	AS1	Small International Airports
BOM	Mumbai	India	AS1	Primary Hybrid Airports
NAG	Nagpur	India	AS1	Small Domestic LCC Airports
NDC	Nanded	India	AS1	Small Domestic LCC Airports
PAT	Patna	India	AS1	Small Domestic LCC Airports
IXZ	Port Blair	India	AS1	Small Domestic LCC Airports
PNQ	Pune	India	AS1	Small Domestic LCC Airports
RPR	Raipur	India	AS1	Small Domestic LCC Airports
IXR	Ranchi	India	AS1	Small Domestic LCC Airports
SXR	Srinagar	India	AS1	Small Domestic LCC Airports
TRV	Thiruvananthapuram	India	AS1	Small International Airports
TRZ	Tiruchirapally	India	AS1	Small International Airports
TIR	Tirupati	India	AS1	Small Domestic LCC Airports
UDR	Udaipur	India	AS1	Small Domestic LCC Airports
BDQ	Vadodara	India	AS1	Small Domestic LCC Airports
VNS	Varanasi	India	AS1	Small Domestic LCC Airports
VGA	Vijayawada	India	AS1	Small Domestic LCC Airports
VTZ	Vishakhapatnam	India	AS1	Small Domestic LCC Airports
GAN	Gan Island	Maldives	AS1	Small Domestic OD Airports
KDM	Kaadedhdhoo	Maldives	AS1	Small Domestic OD Airports
MLE	Male	Maldives	AS1	Small International Airports
BIR	Biratnagar	Nepal	AS1	Small Domestic OD Airports
KTM	Kathmandu	Nepal	AS1	Small International Airports
PKR	Pokhara	Nepal	AS1	Small Domestic OD Airports
LYP	Faisalabad	Pakistan	AS1	Small Domestic OD Airports
ISB	Islamabad	Pakistan	AS1	Small International Airports
KHI	Karachi	Pakistan	AS1	Medium Hybrid Airports
LHE	Lahore	Pakistan	AS1	Small International Airports
MUX	Multan	Pakistan	AS1	Small Domestic OD Airports

PEW	Peshawar	Pakistan	AS1	Small International Airports
UET	Quetta	Pakistan	AS1	Small Domestic OD Airports
SKT	Sialkot	Pakistan	AS1	Small International Airports
CMB	Colombo	Sri Lanka	AS1	Secondary International hubs
SCO	Aktau	Kazakstan	AS2	Small Domestic OD Airports
AKX	Aktyubinsk	Kazakstan	AS2	Small Domestic OD Airports
ALA	Almaty	Kazakstan	AS2	Small Hybrid Airports
TSE	Astana	Kazakstan	AS2	Small International Airports
GUW	Atyrau	Kazakstan	AS2	Small Domestic OD Airports
KGF	Karaganda	Kazakstan	AS2	Small Domestic OD Airports
KSN	Kostanay	Kazakstan	AS2	Small Domestic OD Airports
KZO	Kzyl-Orda	Kazakstan	AS2	Small Domestic OD Airports
PWQ	Pavlodar	Kazakstan	AS2	Small Domestic OD Airports
CIT	Shimkent	Kazakstan	AS2	Small Domestic OD Airports
UKK	Ust-Kamenogorsk	Kazakstan	AS2	Small Domestic OD Airports
FRU	Bishkek	Kyrgyzstan	AS2	Small International Airports
OSS	Osh	Kyrgyzstan	AS2	Small International Airports
DYU	Dushanbe	Tajikistan	AS2	Small International Airports
LBD	Khudzhand	Tajikistan	AS2	Small International Airports
TJU	Kulyab	Tajikistan	AS2	Small International Airports
ASB	Ashgabat	Turkmenistan	AS2	Small International Airports
BHK	Bukhara	Uzbekistan	AS2	Small International Airports
NMA	Namangan	Uzbekistan	AS2	Small International Airports
NCU	Nukus	Uzbekistan	AS2	Small Domestic OD Airports
SKD	Samarkand	Uzbekistan	AS2	Small International Airports
TAS	Tashkent	Uzbekistan	AS2	Small Hybrid Airports
UGC	Urgench	Uzbekistan	AS2	Small Domestic OD Airports
BWN	Bandar Seri Begawan	Brunei	AS3	Small International Airports
PNH	Phnom Penh	Cambodia	AS3	Small International Airports
REP	Siem Reap	Cambodia	AS3	Small International Airports
AMQ	Ambon	Indonesia	AS3	Small Domestic OD Airports
BPN	Balikpapan	Indonesia	AS3	Medium Domestic OD Airports
BTJ	Banda Aceh	Indonesia	AS3	Small Domestic OD Airports
TKG	Bandar Lampung	Indonesia	AS3	Small Domestic OD Airports
BDO	Bandung	Indonesia	AS3	Small International Airports
BDJ	Banjarmasin	Indonesia	AS3	Small Domestic OD Airports
BTH	Batam	Indonesia	AS3	Small Domestic OD Airports
BEJ	Berau	Indonesia	AS3	Small Domestic OD Airports
BIK	Biak	Indonesia	AS3	Small Domestic OD Airports
DPS	Denpasar Bali	Indonesia	AS3	Medium International Airports
GTO	Gorontalo	Indonesia	AS3	Small Domestic OD Airports
HLP	Jakarta Halim	Indonesia	AS3	Small Domestic OD Airports
CGK	Jakarta Soekarno-Hatta	Indonesia	AS3	Primary Hybrid Airports
DJB	Jambi	Indonesia	AS3	Small Domestic OD Airports
DJJ	Jayapura	Indonesia	AS3	Small Domestic OD Airports
KDI	Kendari	Indonesia	AS3	Small Domestic OD Airports
KTG	Ketapang	Indonesia	AS3	Small Domestic OD Airports
KOE	Kupang	Indonesia	AS3	Small Domestic OD Airports
MLG	Malang	Indonesia	AS3	Small Domestic OD Airports
MDC	Manado	Indonesia	AS3	Small Domestic OD Airports
MKW	Manokwari	Indonesia	AS3	Small Domestic OD Airports
MES	Medan	Indonesia	AS3	Medium Domestic OD Airports
MKQ	Merauke	Indonesia	AS3	Small Domestic OD Airports
PDG	Padang	Indonesia	AS3	Small Domestic LCC Airports
PKY	Palangkaraya	Indonesia	AS3	Small Domestic OD Airports
PLM	Palembang	Indonesia	AS3	Small Domestic LCC Airports
PLW	Palu	Indonesia	AS3	Small Domestic OD Airports
PKN	Pangkalanbun	Indonesia	AS3	Small Domestic OD Airports
PGK	Pangkalpinang	Indonesia	AS3	Small Domestic OD Airports
PKU	Pekanbaru	Indonesia	AS3	Small Domestic OD Airports
PNK	Pontianak	Indonesia	AS3	Small Domestic OD Airports
LOP	Praya	Indonesia	AS3	Small Domestic OD Airports
SMQ	Sampit	Indonesia	AS3	Small Domestic OD Airports
SRG	Semarang	Indonesia	AS3	Small Domestic OD Airports
SOC	Solo City	Indonesia	AS3	Small Domestic OD Airports
SOQ	Sorong	Indonesia	AS3	Small Domestic OD Airports
SUB	Surabaya	Indonesia	AS3	Medium Domestic OD Airports
TNJ	Tanjung Pinang	Indonesia	AS3	Small Domestic OD Airports
TRK	Tarakan	Indonesia	AS3	Small Domestic OD Airports

TIM	Tembagapura	Indonesia	AS3	Small Domestic OD Airports
TTE	Ternate	Indonesia	AS3	Small Domestic OD Airports
UPG	Ujung Pandang	Indonesia	AS3	Medium Domestic OD Airports
JOG	Yogyakarta	Indonesia	AS3	Small Domestic LCC Airports
LPQ	Luang Prabang	Laos	AS3	Small International Airports
VTE	Vientiane	Laos	AS3	Small International Airports
AOR	Alor Setar	Malaysia	AS3	Small Domestic LCC Airports
BTU	Bintulu	Malaysia	AS3	Small Domestic LCC Airports
JHB	Johor Bahru	Malaysia	AS3	Small Domestic LCC Airports
KBR	Kota Bharu	Malaysia	AS3	Small Domestic LCC Airports
BKI	Kota Kinabalu	Malaysia	AS3	Medium Domestic LCC Airports
KUL	Kuala Lumpur	Malaysia	AS3	Primary Hybrid Airports
SZB	Kuala Lumpur Sultan Abdul	Malaysia	AS3	Small Domestic OD Airports
TGG	Kuala Terengganu	Malaysia	AS3	Small Domestic LCC Airports
KUA	Kuantan	Malaysia	AS3	Small Domestic OD Airports
KCH	Kuching	Malaysia	AS3	Small Domestic LCC Airports
LBU	Labuan	Malaysia	AS3	Small Domestic OD Airports
LGK	Langkawi	Malaysia	AS3	Small Domestic LCC Airports
MYY	Miri	Malaysia	AS3	Small Domestic OD Airports
PEN	Penang	Malaysia	AS3	Small International Airports
SDK	Sandakan	Malaysia	AS3	Small Domestic LCC Airports
SBW	Sibu	Malaysia	AS3	Small Domestic LCC Airports
TWU	Tawau	Malaysia	AS3	Small Domestic LCC Airports
HEH	Heho	Myanmar	AS3	Small Domestic OD Airports
MDL	Mandalay	Myanmar	AS3	Small Domestic OD Airports
NYU	Nyaung-u	Myanmar	AS3	Small Domestic OD Airports
RGN	Yangon	Myanmar	AS3	Small International Airports
BCD	Bacolod	Philippines	AS3	Small Domestic LCC Airports
USU	Busuanga	Philippines	AS3	Small Domestic LCC Airports
BXU	Butuan	Philippines	AS3	Small Domestic LCC Airports
CGY	Cagayan de Oro	Philippines	AS3	Small Domestic LCC Airports
CEB	Cebu	Philippines	AS3	Medium Domestic LCC Airports
CBO	Cotabato	Philippines	AS3	Small Domestic LCC Airports
DVO	Davao	Philippines	AS3	Small Domestic LCC Airports
DPL	Dipolog	Philippines	AS3	Small Domestic LCC Airports
DGT	Dumaguete	Philippines	AS3	Small Domestic LCC Airports
GES	General Santos	Philippines	AS3	Small Domestic LCC Airports
ILO	Ilo-Ilo	Philippines	AS3	Small Domestic LCC Airports
KLO	Kalibo	Philippines	AS3	Small Domestic LCC Airports
LGP	Legaspi	Philippines	AS3	Small Domestic LCC Airports
CRK	Luzon Island	Philippines	AS3	Small International Airports
MNL	Manila Ninoy Aquino	Philippines	AS3	Primary Hybrid Airports
OZC	Ozamis	Philippines	AS3	Small Domestic LCC Airports
PAG	Pagadian	Philippines	AS3	Small Domestic LCC Airports
PPS	Puerto Princesa	Philippines	AS3	Small Domestic LCC Airports
TAC	Tacloban	Philippines	AS3	Small Domestic LCC Airports
ZAM	Zamboanga	Philippines	AS3	Small Domestic LCC Airports
SIN	Singapore Changi	Singapore	AS3	Primary International Hub
DMK	Bangkok Don Mueang	Thailand	AS3	Small Domestic LCC Airports
BKK	Bangkok Suvarnabhumi	Thailand	AS3	Primary Hybrid Airports
CNX	Chiang Mai	Thailand	AS3	Small Domestic LCC Airports
CEI	Chiang Rai	Thailand	AS3	Small Domestic LCC Airports
HDY	Hat Yai	Thailand	AS3	Small Domestic LCC Airports
USM	Koh Samui	Thailand	AS3	Small Domestic OD Airports
KBV	Krabi	Thailand	AS3	Small International Airports
KOP	Nakhon Phanom	Thailand	AS3	Small Domestic LCC Airports
NST	Nakhon Si Thammarat	Thailand	AS3	Small Domestic LCC Airports
PHS	Phitsanulok	Thailand	AS3	Small Domestic LCC Airports
HKT	Phuket	Thailand	AS3	Medium International Airports
SNO	Sakon Nakhon	Thailand	AS3	Small Domestic LCC Airports
URT	Surat Thani	Thailand	AS3	Small Domestic LCC Airports
TST	Trang	Thailand	AS3	Small Domestic LCC Airports
UBP	Ubon Ratchathani	Thailand	AS3	Small Domestic LCC Airports
UTH	Udon Thani	Thailand	AS3	Small Domestic LCC Airports
DIL	Dili (TL)	Timor-leste	AS3	Small International Airports
BMV	Ban Me Thuot	Viet Nam	AS3	Small Domestic OD Airports
VCA	Cantho	Viet Nam	AS3	Small Domestic OD Airports
VCS	Con Dao	Viet Nam	AS3	Small Domestic OD Airports
DLI	Dalat	Viet Nam	AS3	Small Domestic OD Airports

HPH	Haiphong	Viet Nam	AS3	Small Domestic LCC Airports
HAN	Hanoi	Viet Nam	AS3	Medium International Airports
SGN	Ho Chi Minh City	Viet Nam	AS3	Medium Hybrid Airports
HUI	Hue	Viet Nam	AS3	Small Domestic OD Airports
NHA	Nha Trang	Viet Nam	AS3	Small Domestic OD Airports
PQC	Phuquoc	Viet Nam	AS3	Small Domestic OD Airports
PXU	Pleiku	Viet Nam	AS3	Small Domestic OD Airports
UIH	Quinhon	Viet Nam	AS3	Small Domestic OD Airports
VII	Vinh City	Viet Nam	AS3	Small Domestic LCC Airports
AAT	Altay	China	AS4	Small Domestic OD Airports
BAV	Baotou	China	AS4	Small Domestic OD Airports
RLK	Bayannur	China	AS4	Small Domestic OD Airports
BHY	Beihai	China	AS4	Small Domestic OD Airports
PEK	Beijing Capital	China	AS4	Primary Hybrid Airports
NAY	Beijing Nanyuan	China	AS4	Small Domestic OD Airports
CGQ	Changchun	China	AS4	Small Domestic OD Airports
CSX	Changsha	China	AS4	Medium Domestic OD Airports
CZX	Changzhou	China	AS4	Small Domestic OD Airports
CTU	Chengdu	China	AS4	Large Domestic Airports
CKG	Chongqing	China	AS4	Medium Domestic OD Airports
DLU	Dali	China	AS4	Small Domestic LCC Airports
DLC	Dalian	China	AS4	Medium Domestic OD Airports
DDG	Dandong	China	AS4	Small Domestic OD Airports
DAT	Datong	China	AS4	Small Domestic OD Airports
DIG	Deqen	China	AS4	Small Domestic OD Airports
DOY	Dongying	China	AS4	Small Domestic OD Airports
DNH	Dunhuang	China	AS4	Small Domestic OD Airports
FUO	Foshan	China	AS4	Small Domestic OD Airports
FUG	Fuyang	China	AS4	Small Domestic OD Airports
FOC	Fuzhou	China	AS4	Medium Domestic OD Airports
KOW	Ganzhou	China	AS4	Small Domestic OD Airports
GOQ	Golmud	China	AS4	Small Domestic OD Airports
GYS	Guangyuan	China	AS4	Small Domestic OD Airports
CAN	Guangzhou	China	AS4	Primary Hybrid Airports
KWL	Guilin	China	AS4	Small Domestic OD Airports
KWE	Guiyang	China	AS4	Medium Domestic OD Airports
HAK	Haikou	China	AS4	Medium Domestic OD Airports
HLD	Hailar	China	AS4	Small Domestic OD Airports
HDG	Handan	China	AS4	Small Domestic OD Airports
HGH	Hangzhou	China	AS4	Medium Domestic OD Airports
HRB	Harbin	China	AS4	Medium Domestic OD Airports
HFE	Hefei	China	AS4	Small Domestic OD Airports
HET	Hohhot	China	AS4	Small Domestic OD Airports
HIA	Huai'an	China	AS4	Small Domestic OD Airports
JMU	Jiamusi	China	AS4	Small Domestic OD Airports
JGS	Ji'an	China	AS4	Small Domestic OD Airports
JGN	Jiayuguan	China	AS4	Small Domestic OD Airports
TNA	Jinan	China	AS4	Medium Domestic OD Airports
JDZ	Jingdezhen	China	AS4	Small Domestic OD Airports
JHG	Jinghong	China	AS4	Small Domestic LCC Airports
JNG	Jining	China	AS4	Small Domestic OD Airports
KHG	Kashi	China	AS4	Small Domestic OD Airports
KRL	Korla	China	AS4	Small Domestic OD Airports
KMG	Kunming	China	AS4	Medium Domestic OD Airports
LHW	Lanzhou Zhongchuan	China	AS4	Small Domestic OD Airports
LXA	Lhasa/Lasa	China	AS4	Small Domestic OD Airports
LYG	Lianyungang	China	AS4	Small Domestic OD Airports
LJG	Lijiang	China	AS4	Small Domestic OD Airports
LYI	Linyi	China	AS4	Small Domestic OD Airports
LZH	Liuzhou	China	AS4	Small Domestic OD Airports
LYA	Luoyang	China	AS4	Small Domestic OD Airports
LZO	Luzhou	China	AS4	Small Domestic OD Airports
LUM	Mangshi	China	AS4	Small Domestic OD Airports
NZH	Manzhouli	China	AS4	Small Domestic OD Airports
MIG	Mianyang	China	AS4	Small Domestic OD Airports
MDG	Mudanjiang	China	AS4	Small Domestic OD Airports
KHN	Nanchang	China	AS4	Medium Domestic OD Airports
NAO	Nanchong	China	AS4	Small Domestic OD Airports
NKG	Nanjing	China	AS4	Medium Domestic OD Airports

NNG	Nanning	China	AS4	Medium Domestic OD Airports
NTG	Nantong	China	AS4	Small Domestic OD Airports
NNY	Nanyang	China	AS4	Small Domestic OD Airports
NGB	Ningbo	China	AS4	Small Domestic OD Airports
LZY	Nyingchi/Linzhi	China	AS4	Small Domestic OD Airports
DSN	Ordos	China	AS4	Small Domestic OD Airports
TAO	Qingdao	China	AS4	Medium Domestic OD Airports
NDG	Qiqihar	China	AS4	Small Domestic OD Airports
JJN	Quanzhou	China	AS4	Small Domestic OD Airports
JUZ	Quzhou	China	AS4	Small Domestic OD Airports
SYX	Sanya	China	AS4	Medium Domestic OD Airports
SHA	Shanghai Hongqiao	China	AS4	Large Domestic Airports
PVG	Shanghai Pudong	China	AS4	Primary Hybrid Airports
SWA	Shantou	China	AS4	Small Domestic OD Airports
SHE	Shenyang	China	AS4	Medium Domestic OD Airports
SZX	Shenzhen	China	AS4	Large Domestic Airports
SJW	Shijiazhuang	China	AS4	Small Domestic OD Airports
JZH	Song Pan	China	AS4	Small Domestic OD Airports
TYN	Taiyuan	China	AS4	Medium Domestic OD Airports
HYN	Taizhou	China	AS4	Small Domestic OD Airports
TVS	Tangshan	China	AS4	Small Domestic OD Airports
TSN	Tianjin	China	AS4	Medium Domestic OD Airports
TGO	Tongliao	China	AS4	Small Domestic OD Airports
TXN	Tunxi	China	AS4	Small Domestic OD Airports
HLH	Ulanhot	China	AS4	Small Domestic OD Airports
URC	Urumqi	China	AS4	Medium Domestic OD Airports
WXN	Wanxian	China	AS4	Small Domestic OD Airports
WEF	Weifang	China	AS4	Small Domestic OD Airports
WEH	Weihai	China	AS4	Small Domestic OD Airports
WNZ	Wenzhou	China	AS4	Small Domestic OD Airports
WUH	Wuhan	China	AS4	Medium Domestic OD Airports
WUX	Wuxi	China	AS4	Small Domestic OD Airports
WUS	Wuyishan	China	AS4	Small Domestic OD Airports
XMN	Xiamen	China	AS4	Medium Domestic OD Airports
XIY	Xi'an Xianyang	China	AS4	Medium Domestic OD Airports
XIL	Xilinhot	China	AS4	Small Domestic OD Airports
XNN	Xining	China	AS4	Small Domestic OD Airports
XUZ	Xuzhou	China	AS4	Small Domestic OD Airports
ENY	Yan'an	China	AS4	Small Domestic OD Airports
YNZ	Yancheng	China	AS4	Small Domestic OD Airports
YNJ	Yanji	China	AS4	Small Domestic OD Airports
YNT	Yantai	China	AS4	Small Domestic OD Airports
YBP	Yibin	China	AS4	Small Domestic OD Airports
YIH	Yichang	China	AS4	Small Domestic OD Airports
INC	Yinchuan	China	AS4	Small Domestic OD Airports
YIW	Yiwu	China	AS4	Small Domestic OD Airports
UYN	Yulin	China	AS4	Small Domestic OD Airports
DYG	Zhangjiajie	China	AS4	Small Domestic OD Airports
ZHA	Zhanjiang	China	AS4	Small Domestic OD Airports
CGO	Zhengzhou	China	AS4	Medium Domestic OD Airports
HSN	Zhoushan	China	AS4	Small Domestic OD Airports
ZUH	Zhuhai	China	AS4	Small Domestic OD Airports
HUN	Hualien	Chinese Taipei	AS4	Small Domestic OD Airports
KHH	Kaohsiung	Chinese Taipei	AS4	Small International Airports
KNH	Kinmen	Chinese Taipei	AS4	Small Hybrid Airports
MZG	Makung	Chinese Taipei	AS4	Small Hybrid Airports
RMQ	Taichung	Chinese Taipei	AS4	Small International Airports
TNN	Tainan	Chinese Taipei	AS4	Small Domestic OD Airports
TSA	Taipei Sung Shan	Chinese Taipei	AS4	Small International Airports
TPE	Taipei Taiwan Taoyuan	Chinese Taipei	AS4	Primary International Hub
TTT	Taitung	Chinese Taipei	AS4	Small Domestic OD Airports
HKG	Hong Kong	Hong Kong	AS4	Primary International Hub
AXT	Akita	Japan	AS4	Small Domestic OD Airports
ASJ	Amami O Shima	Japan	AS4	Small Domestic OD Airports
AOJ	Aomori	Japan	AS4	Small Domestic OD Airports
AKJ	Asahikawa	Japan	AS4	Small Domestic LCC Airports
FUJ	Fukue	Japan	AS4	Small Domestic OD Airports
FUK	Fukuoka	Japan	AS4	Medium Domestic OD Airports
FKS	Fukushima	Japan	AS4	Small Domestic LCC Airports

HKD	Hakodate	Japan	AS4	Small Domestic OD Airports
HNA	Hanamaki	Japan	AS4	Small Domestic OD Airports
HIJ	Hiroshima	Japan	AS4	Small Domestic OD Airports
IBR	Ibaraki	Japan	AS4	Small Domestic OD Airports
KOJ	Kagoshima	Japan	AS4	Small Domestic OD Airports
KKJ	Kita Kyushu	Japan	AS4	Small Domestic LCC Airports
KCZ	Kochi (JP)	Japan	AS4	Small Domestic OD Airports
KMQ	Komatsu	Japan	AS4	Small Domestic OD Airports
KMJ	Kumamoto	Japan	AS4	Small Domestic LCC Airports
KUH	Kushiro	Japan	AS4	Small Domestic OD Airports
MYJ	Matsuyama	Japan	AS4	Small Domestic OD Airports
MMB	Memambetsu	Japan	AS4	Small Domestic LCC Airports
MSJ	Misawa	Japan	AS4	Small Domestic OD Airports
MMY	Miyako Jima	Japan	AS4	Small Domestic OD Airports
KMI	Miyazaki	Japan	AS4	Small Domestic LCC Airports
NGS	Nagasaki	Japan	AS4	Small Domestic OD Airports
NGO	Nagoya Chubu	Japan	AS4	Medium International Airports
NKM	Nagoya Komaki	Japan	AS4	Small Domestic OD Airports
KIJ	Niigata	Japan	AS4	Small Domestic OD Airports
OBO	Obihiro	Japan	AS4	Small Domestic LCC Airports
OIT	Oita	Japan	AS4	Small Domestic OD Airports
OKJ	Okayama	Japan	AS4	Small Domestic OD Airports
OKA	Okinawa Naha	Japan	AS4	Medium Domestic OD Airports
ITM	Osaka Itami	Japan	AS4	Medium Domestic OD Airports
KIX	Osaka Kansai	Japan	AS4	Medium International Airports
UKB	Osaka Kobe	Japan	AS4	Small Domestic OD Airports
HSG	Saga	Japan	AS4	Small Domestic OD Airports
CTS	Sapporo Chitose	Japan	AS4	Medium Domestic OD Airports
SDJ	Sendai	Japan	AS4	Small Domestic OD Airports
TAK	Takamatsu	Japan	AS4	Small Domestic OD Airports
TKS	Tokushima	Japan	AS4	Small Domestic OD Airports
HND	Tokyo Haneda	Japan	AS4	Primary Hybrid Airports
NRT	Tokyo Narita	Japan	AS4	Primary International Hub
TOY	Toyama	Japan	AS4	Small Domestic OD Airports
UBJ	Ube	Japan	AS4	Small Domestic OD Airports
GAJ	Yamagata	Japan	AS4	Small Domestic OD Airports
YGJ	Yonago	Japan	AS4	Small Domestic OD Airports
MFM	Macau	Macau	AS4	Small International Airports
ULN	Ulaanbaatar	Mongolia	AS4	Small International Airports
FNJ	Pyongyang	North Korea	AS4	Small International Airports
PUS	Busan	South Korea	AS4	Medium International Airports
CJJ	Cheongju	South Korea	AS4	Small Domestic OD Airports
TAE	Daegu	South Korea	AS4	Small Domestic OD Airports
KWJ	Gwangju	South Korea	AS4	Small Domestic OD Airports
CJU	Jeju	South Korea	AS4	Medium Hybrid Airports
HIN	Jinju	South Korea	AS4	Small Domestic OD Airports
KPO	Pohang	South Korea	AS4	Small Domestic OD Airports
GMP	Seoul Gimpo	South Korea	AS4	Medium Hybrid Airports
ICN	Seoul Incheon	South Korea	AS4	Primary International Hub
USN	Ulsan	South Korea	AS4	Small Domestic OD Airports
RSU	Yeosu	South Korea	AS4	Small Domestic OD Airports
BAH	Bahrain	Bahrain	ME1	Secondary International hubs
ABD	Abadan	Iran	ME1	Small Domestic OD Airports
AWZ	Ahwaz	Iran	ME1	Small Domestic OD Airports
ADU	Ardabil	Iran	ME1	Small Domestic OD Airports
PGU	Asaloyeh	Iran	ME1	Small Domestic OD Airports
BND	Bandar Abbas	Iran	ME1	Small Domestic OD Airports
BUZ	Bushehr	Iran	ME1	Small Domestic OD Airports
ZBR	Chah Bahar	Iran	ME1	Small Domestic OD Airports
IFN	Esfahan	Iran	ME1	Small Domestic OD Airports
GBT	Gorgan	Iran	ME1	Small Domestic OD Airports
KSH	Kermanshah	Iran	ME1	Small Domestic OD Airports
KIH	Kish Island	Iran	ME1	Small Domestic OD Airports
MHD	Mashhad	Iran	ME1	Small Domestic OD Airports
RAS	Rasht	Iran	ME1	Small Domestic OD Airports
SYZ	Shiraz	Iran	ME1	Small Domestic OD Airports
TBZ	Tabriz	Iran	ME1	Small Domestic OD Airports
IKA	Tehran Imam Khomeini	Iran	ME1	Small International Airports
THR	Tehran Mehrabad	Iran	ME1	Medium Hybrid Airports

OMH	Urumiyeh	Iran	ME1	Small Domestic OD Airports
AZD	Yazd	Iran	ME1	Small Domestic OD Airports
ZAH	Zahedan	Iran	ME1	Small Domestic OD Airports
NJF	Al Najaf	Iraq	ME1	Small International Airports
BGW	Baghdad	Iraq	ME1	Small International Airports
BSR	Basrah	Iraq	ME1	Small International Airports
EBL	Erbil	Iraq	ME1	Small International Airports
ISU	Sulaymaniyah	Iraq	ME1	Small International Airports
ETH	Eilat	Israel	ME1	Small Domestic OD Airports
TLV	Tel Aviv	Israel	ME1	Medium International Airports
AMM	Amman Queen Alia	Jordan	ME1	Medium International Airports
AQJ	Aqaba	Jordan	ME1	Small International Airports
KWI	Kuwait	Kuwait	ME1	Secondary International hubs
BEY	Beirut	Lebanon	ME1	Medium International Airports
MCT	Muscat	Oman	ME1	Medium International Airports
SLL	Salalah	Oman	ME1	Small International Airports
DOH	Doha	Qatar	ME1	Secondary International hubs
AHB	Abha	Saudi Arabia	ME1	Small Domestic OD Airports
ABT	Al Baha	Saudi Arabia	ME1	Small Domestic OD Airports
RAE	Arar	Saudi Arabia	ME1	Small Domestic OD Airports
BHH	Bisha	Saudi Arabia	ME1	Small Domestic OD Airports
DMM	Dammam	Saudi Arabia	ME1	Medium International Airports
ELQ	Gassim	Saudi Arabia	ME1	Small Domestic OD Airports
URY	Gurayat	Saudi Arabia	ME1	Small Domestic OD Airports
HAS	Hail	Saudi Arabia	ME1	Small Domestic OD Airports
GIZ	Jazan	Saudi Arabia	ME1	Small Domestic OD Airports
JED	Jeddah	Saudi Arabia	ME1	Medium Hybrid Airports
AJF	Jouf	Saudi Arabia	ME1	Small Domestic OD Airports
MED	Madinah	Saudi Arabia	ME1	Small International Airports
EAM	Nejran	Saudi Arabia	ME1	Small Domestic OD Airports
RUH	Riyadh	Saudi Arabia	ME1	Medium Hybrid Airports
TUU	Tabuk	Saudi Arabia	ME1	Small Domestic OD Airports
TIF	Taif	Saudi Arabia	ME1	Small Domestic OD Airports
YNB	Yanbu al Bahr	Saudi Arabia	ME1	Small Domestic OD Airports
ALP	Aleppo	Syria	ME1	Small International Airports
DAM	Damascus	Syria	ME1	Small International Airports
AUH	Abu Dhabi	UAE	ME1	Secondary International hubs
DXB	Dubai	UAE	ME1	Primary International Hub
SHJ	Sharjah	UAE	ME1	Medium International Airports
ADE	Aden	Yemen	ME1	Small International Airports
RIY	Mukalla	Yemen	ME1	Small Domestic OD Airports
SAH	Sanaa	Yemen	ME1	Small International Airports

Appendix E Chapter 5 Appendices

Table E-1 Region-Pair Markets Connected by Asian and Middle East Airports

Region Pair	Seats Available
Southwest Pacific - Western Europe	24325364
Southwest Pacific - North America	7080556
Western Europe - Eastern Africa	6439741
Western Europe - South Africa	3612006
Southwest Pacific - Eastern Europe and Russia	2054083
Southwest Pacific - Eastern Africa	1344628
North America - Western Europe	1297146
Southwest Pacific - North Africa	1208964
North America - Eastern Africa	1165337
Eastern Europe and Russia - Eastern Africa	1062484
North America - Eastern Europe and Russia	954419
Western Europe - North Africa	879839
Southwest Pacific - Central/Western Africa	713885
Eastern Africa - North Africa	673785
North America - South Africa	658255
Eastern Europe and Russia - Western Europe	652944
North America - North Africa	638652
Eastern Europe and Russia - South Africa	602108
Southwest Pacific - South Africa	410834
Western Europe - Western Europe	346821
North Africa - North Africa	274568
South Africa - North Africa	265879
Lower South America - Western Europe	211527
Eastern Europe and Russia - North Africa	172041
Lower South America - Eastern Europe and Russia	142312
Eastern Europe and Russia - Central/Western Africa	114634
Lower South America - North Africa	109278
Central/Western Africa - North Africa	104800
Lower South America - Eastern Africa	102627
Eastern Europe and Russia - Eastern Europe and Russia	94868
Western Europe - Central/Western Africa	83836
Southwest Pacific - Lower South America	34365
Southwest Pacific - Central America	30635
Eastern Africa - Central/Western Africa	29066
North America - Central/Western Africa	7998
Southwest Pacific - Southwest Pacific	4256
Eastern Africa - South Africa	2619
Upper South America - Western Europe	310
Upper South America - North Africa	288
Central America - Eastern Europe and Russia	200

Source: OAG (May 2012)

Table E-2 Average Routing Factors of the Major Airport of Each Country for the Selected Intercontinental Routes

Airport	SYD-LHR	SYD-JFK	SYD-DME	SYD-NBO	LHR-NBO	CDG-HNL	SYD-CAI	LHR-JNB	NBO-JFK	NBO-DME	Average detour
KBL	1.01	1.39	1.02	1.15	1.60	1.47	1.04	1.52	1.36	1.36	1.29
BAH	1.03	1.45	1.10	1.10	1.24	1.56	1.00	1.26	1.18	1.08	1.20
DAC	1.00	1.36	1.01	1.07	2.11	1.59	1.03	1.85	1.61	1.90	1.45
PBH	1.00	1.35	1.01	1.10	2.07	1.55	1.04	1.82	1.58	1.84	1.44
BWN	1.00	1.29	1.00	1.00	2.93	1.73	1.03	2.35	1.99	2.77	1.71
PNH	1.00	1.33	1.00	1.01	2.59	1.69	1.03	2.14	1.85	2.41	1.60
REP	1.00	1.33	1.00	1.02	2.54	1.67	1.03	2.11	1.82	2.36	1.59
PEK	1.01	1.25	1.02	1.26	2.55	1.37	1.14	2.20	1.71	2.39	1.59
TPE	1.00	1.24	1.01	1.16	2.83	1.50	1.10	2.35	1.86	2.68	1.67
HKG	1.00	1.27	1.00	1.11	2.69	1.55	1.08	2.25	1.83	2.52	1.63
BOM	1.02	1.42	1.05	1.01	1.72	1.66	1.01	1.57	1.44	1.51	1.34
DEL	1.01	1.39	1.02	1.09	1.78	1.55	1.03	1.63	1.45	1.55	1.35
CGK	1.01	1.35	1.02	0.92	2.85	1.87	1.00	2.24	2.02	2.71	1.70
IKA	1.02	1.42	1.06	1.19	1.28	1.44	1.03	1.29	1.20	1.08	1.20
BGW	1.03	1.44	1.10	1.20	1.17	1.45	1.02	1.21	1.14	1.02	1.18
EBL	1.02	1.43	1.09	1.23	1.19	1.41	1.03	1.21	1.15	1.02	1.18
TLV	1.04	1.46	1.16	1.23	1.07	1.44	1.01	1.11	1.08	1.00	1.16
NRT	1.02	1.16	1.06	1.32	3.06	1.33	1.21	2.56	1.87	3.00	1.76
AMM	1.04	1.45	1.15	1.22	1.08	1.45	1.01	1.12	1.09	1.00	1.16
ALA	1.00	1.35	1.00	1.23	1.76	1.37	1.09	1.64	1.40	1.50	1.33
KWI	1.03	1.44	1.10	1.14	1.21	1.52	1.01	1.23	1.17	1.05	1.19
FRU	1.00	1.36	1.00	1.23	1.71	1.38	1.08	1.60	1.38	1.45	1.32
VTE	1.00	1.33	1.00	1.05	2.46	1.63	1.04	2.07	1.77	2.27	1.56
BEY	1.04	1.45	1.15	1.25	1.08	1.41	1.02	1.12	1.09	1.00	1.16
MFM	1.00	1.27	1.00	1.11	2.69	1.55	1.07	2.24	1.83	2.51	1.63
KUL	1.01	1.36	1.02	0.95	2.61	1.79	1.01	2.11	1.89	2.44	1.62
MLE	1.04	1.45	1.08	0.92	1.85	1.84	1.00	1.60	1.53	1.69	1.40
ULN	1.00	1.27	1.02	1.29	2.29	1.31	1.15	2.03	1.59	2.11	1.51
RGN	1.01	1.35	1.01	1.03	2.31	1.65	1.03	1.96	1.72	2.11	1.52
KTM	1.01	1.37	1.01	1.09	1.97	1.55	1.04	1.76	1.54	1.74	1.41
FNJ	1.01	1.22	1.03	1.28	2.74	1.35	1.17	2.33	1.77	2.61	1.65
MCT	1.03	1.44	1.08	1.06	1.38	1.61	1.00	1.35	1.26	1.19	1.24
KHI	1.02	1.42	1.05	1.06	1.57	1.59	1.01	1.48	1.36	1.35	1.29
MNL	1.00	1.25	1.00	1.08	2.96	1.61	1.07	2.41	1.95	2.81	1.71
DOH	1.04	1.45	1.10	1.09	1.26	1.58	1.00	1.27	1.19	1.09	1.21
JED	1.06	1.47	1.18	1.10	1.07	1.61	1.01	1.12	1.08	1.00	1.17
RUH	1.04	1.45	1.12	1.10	1.18	1.58	1.00	1.21	1.15	1.04	1.19
SIN	1.01	1.35	1.01	0.95	2.69	1.80	1.01	2.16	1.93	2.52	1.64
ICN	1.01	1.21	1.03	1.27	2.77	1.36	1.16	2.35	1.79	2.65	1.66
CMB	1.03	1.43	1.06	0.94	1.99	1.79	1.00	1.70	1.60	1.81	1.43
DAM	1.04	1.45	1.14	1.24	1.09	1.42	1.02	1.13	1.10	1.00	1.16
DYU	1.01	1.38	1.01	1.19	1.60	1.43	1.06	1.52	1.35	1.34	1.29
BKK	1.00	1.34	1.01	1.02	2.46	1.68	1.03	2.05	1.79	2.27	1.57
DIL	1.00	1.24	1.00	0.95	3.37	1.84	1.02	2.60	2.18	3.26	1.85
ASB	1.01	1.40	1.03	1.20	1.41	1.42	1.05	1.38	1.26	1.17	1.23
AUH	1.03	1.44	1.09	1.07	1.31	1.59	1.00	1.30	1.22	1.13	1.22
DXB	1.03	1.44	1.08	1.08	1.33	1.58	1.00	1.31	1.23	1.14	1.22
TAS	1.00	1.37	1.01	1.21	1.61	1.39	1.07	1.53	1.35	1.35	1.29
SGN	1.00	1.32	1.00	1.01	2.65	1.69	1.03	2.17	1.87	2.47	1.62
SAH	1.07	1.47	1.17	1.00	1.12	1.72	1.01	1.16	1.11	1.03	1.19

Source: Own elaboration

Table E-3 Countries/Economies at Each Stage of Economic Development

Stage 1 Factor Driven	**Transition from 1 to 2**	**Stage 2 Efficiency Driven**	**Transition from 2 to 3**	**Stage 3 Innovation Driven**
Bangladesh	Algeria	Albania	Argentina	Australia
Benin	Azerbaijan	Armenia	**Bahrain**	Austria
Burkina Faso	Bolivia	Bosnia and Herzegovina	Barbados	Belgium
Burundi	Botswana	Bulgaria	Brazil	Canada
Cambodia	**Brunei Darussalam**	Cape Verde	Chile	Cyprus
Cameroon	Egypt	**China**	Croatia	Czech Republic
Chad	Gabon	Colombia	Estonia	Denmark
Côte d'Ivoire	Honduras	Costa Rica	Hungary	Finland
Ethiopia	**Iran, Islamic Rep.**	Dominican Republic	**Kazakhstan**	France
Gambia, The	**Kuwait**	Ecuador	Latvia	Germany
Ghana	**Libya**	El Salvador	**Lebanon**	Greece
Guinea	**Mongolia**	Georgia	Lithuania	**Hong Kong SAR**
Haiti	**Philippines**	Guatemala	**Malaysia**	Iceland
India	**Qatar**	Guyana	Mexico	Ireland
Kenya	**Saudi Arabia**	**Indonesia**	**Oman**	**Israel**
Kyrgyz Republic	**Sri Lanka**	Jamaica	Poland	Italy
Lesotho	Venezuela	**Jordan**	Russian Federation	**Japan**
Liberia		Macedonia, FYR	Seychelles	**Korea, Rep.**
Madagascar		Mauritius	Trinidad and Tobago	Luxembourg
Malawi		Montenegro	Turkey	Malta
Mali		Morocco	Uruguay	Netherlands
Mauritania		Namibia		New Zealand
Moldova		Panama		Norway
Mozambique		Paraguay		Portugal
Nepal		Peru		Puerto Rico
Nicaragua		Romania		**Singapore**
Nigeria		Serbia		Slovak Republic
Pakistan		South Africa		Slovenia
Rwanda		Suriname		Spain
Senegal		Swaziland		Sweden
Sierra Leone		**Thailand**		Switzerland
Tajikistan		**Timor-Leste**		**Taiwan, China**
Tanzania		Ukraine		**United Arab Emirates**
Uganda				United Kingdom
Vietnam				United States
Yemen				
Zambia				
Zimbabwe				

Source: WEF (2012)

Appendix F Chapter 6 Appendices

Table F-1 Data for South Asian airports

Country	Airport Code	Airport Name	Airport Typology	Flights/day	Seats/day	Pax/day	Load factor	No of Airlines	No of destinations served	No of gates	% of seats offerred by the dominant carrier	HHI	Traffic generation (Global)	Flow centrality (Global)	Flow centrality (international all)	Traffic generation (International)	Flow centrality (international to international)	Flow centrality (International to regional)	Traffic generation (regional)	Flow centrality (regional)	% of First and Business seats	% Domestic	% Regional	% international	Traffic generation (domestic)	Flow centrality (domestic)	Flow centrality (International to domestic)	seats/aircraft	average frequency per route	% seats by low cost carriers
Afghanistan	KBL	Kabul	Small Hybrid Airports	65	9391	5415	58%	14	30	6	20%	0.12	0.109%	0.003%	0.041%	2.116%	0.005%	0.034%	4.120%	0.013%	3%	21%	15%	64%	42.832%	3.749%	0.002%	146	3	13%
Afghanistan	KDH	Kandahar	Small Domestic OD Airports	11	1449	762	53%	10	9	2	19%	0.14	0.016%	0.000%	0.006%	0.210%	0.001%	0.000%	0.151%	0.000%	2%	51%	4%	45%	15.104%	0.000%	0.005%	135	2	0%
Afghanistan	HEA	Herat	Small Domestic OD Airports	15	1481	427	29%	6	8	4	35%	0.22	0.009%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	3%	100%	0%	0%	16.681%	0.000%	0.000%	104	2	0%
Bangladesh	DAC	Dhaka	Small Hybrid Airports	120	20536	14535	71%	34	35	15	28%	0.11	0.286%	0.015%	0.437%	6.387%	0.005%	0.218%	9.286%	0.071%	6%	12%	13%	75%	46.325%	2.392%	0.214%	172	4	7%
Bangladesh	CGP	Chittagong	Small International Airports	37	4546	2475	54%	8	10	3	47%	0.27	0.050%	0.001%	0.027%	0.892%	0.000%	0.002%	0.162%	0.000%	4%	39%	1%	60%	25.457%	0.000%	0.025%	125	4	19%
Bangladesh	ZYL	Sylhet	Small Domestic OD Airports	9	1044	705	68%	4	2	12	80%	0.66	0.015%	0.000%	0.000%	0.185%	0.000%	0.000%	0.032%	0.000%	6%	57%	1%	42%	10.532%	0.000%	0.000%	124	5	0%
Bhutan	PBH	Paro	Small International Airports	6	529	372	70%	1	8	1	100%	1.00	0.008%	0.000%	0.000%	0.026%	0.000%	0.000%	1.665%	0.026%	16%	0%	89%	11%	0.000%	0.000%	0.000%	97	1	0%
India	BOM	Mumbai	Primary Hybrid Airports	666	116822	68201	58%	54	90	35	20%	0.11	1.296%	0.115%	2.485%	13.604%	0.134%	0.168%	3.981%	0.031%	6%	62%	1%	37%	15.620%	0.95%	2.184%	176	8	40%
India	DEL	Delhi	Primary Hybrid Airports	771	131460	74255	56%	69	108	78	22%	0.11	1.396%	0.142%	2.616%	12.580%	0.188%	0.351%	12.690%	0.465%	5%	64%	3%	32%	17.465%	1.42%	2.078%	171	8	44%
India	MAA	Chennai	Medium Hybrid Airports	339	49303	31066	63%	34	44	14	15%	0.10	0.617%	0.026%	0.309%	5.647%	0.007%	0.011%	8.820%	0.000%	4%	64%	6%	31%	7.422%	0.322%	0.292%	146	8	49%
India	COK	Kochi (IN)	Small International Airports	117	18304	11424	62%	26	24	5	16%	0.08	0.234%	0.002%	0.038%	4.036%	0.000%	0.000%	0.684%	0.000%	4%	42%	1%	57%	1.838%	0.016%	0.037%	157	5	49%
India	BLR	Bengaluru	Medium Domestic LCC Airports	295	45390	26436	58%	29	41	38	22%	0.12	0.531%	0.016%	0.047%	3.695%	0.000%	0.000%	1.903%	0.000%	4%	76%	1%	23%	7.551%	0.286%	0.046%	154	8	59%
India	HYD	Hyderabad	Medium Domestic LCC Airports	264	36002	20705	58%	21	38	12	27%	0.16	0.406%	0.023%	0.076%	2.828%	0.000%	0.000%	0.277%	0.000%	4%	77%	0%	22%	5.853%	0.400%	0.076%	137	7	62%
India	TRV	Thiruvananthapuram	Small International Airports	80	11900	7419	62%	21	19	5	19%	0.10	0.153%	0.001%	0.011%	2.634%	0.000%	0.000%	1.780%	0.003%	4%	38%	5%	57%	1.095%	0.007%	0.011%	151	5	45%
India	CCJ	Kozhikode	Small International Airports	46	8563	4797	56%	16	20	4	28%	0.17	0.099%	0.000%	0.008%	2.625%	0.000%	0.000%	0.007%	0.000%	6%	12%	0%	88%	0.223%	0.001%	0.008%	188	3	45%
India	CCU	Kolkata	Medium Domestic LCC Airports	261	38825	21889	56%	25	42	18	31%	0.17	0.427%	0.026%	0.032%	1.996%	0.000%	0.001%	4.460%	0.031%	2%	81%	4%	15%	6.458%	0.490%	0.031%	150	7	68%
India	AMD	Ahmedabad	Small Domestic LCC Airports	102	16031	10119	63%	15	18	5	33%	0.18	0.207%	0.002%	0.001%	1.296%	0.000%	0.000%	0.131%	0.000%	4%	79%	0%	21%	3.082%	0.041%	0.001%	158	6	75%
India	TRZ	Tiruchirapally	Small International Airports	28	3927	2672	68%	9	7	2	34%	0.18	0.055%	0.001%	0.020%	1.050%	0.008%	0.000%	1.385%	0.000%	1%	26%	10%	64%	0.267%	0.000%	0.012%	145	4	77%
India	ATQ	Amritsar	Small International Airports	24	3740	2202	59%	14	12	4	34%	0.18	0.045%	0.001%	0.020%	0.947%	0.016%	0.000%	0.186%	0.000%	7%	28%	2%	70%	0.240%	0.000%	0.003%	160	2	37%
India	LKO	Lucknow	Small Domestic LCC Airports	51	8395	4761	57%	14	13	8	34%	0.19	0.097%	0.001%	0.005%	0.837%	0.000%	0.000%	0.033%	0.000%	2%	72%	0%	28%	1.301%	0.025%	0.005%	165	4	72%
India	IXE	Mangalore	Small International Airports	29	3622	2425	67%	8	11	6	30%	0.19	0.050%	0.000%	0.002%	0.609%	0.000%	0.000%	0.026%	0.000%	3%	59%	0%	40%	0.559%	0.002%	0.002%	129	3	71%
India	GOI	Goa	Small Domestic LCC Airports	75	11356	6125	54%	20	22	5	19%	0.12	0.126%	0.000%	0.001%	0.518%	0.000%	0.000%	0.115%	0.000%	4%	86%	0%	14%	2.044%	0.009%	0.001%	154	4	56%
India	JAI	Jaipur	Small Domestic LCC Airports	54	7455	4823	65%	13	17	2	33%	0.19	0.096%	0.003%	0.006%	0.438%	0.000%	0.000%	0.047%	0.000%	2%	85%	0%	15%	1.536%	0.062%	0.006%	140	4	84%
India	PNQ	Pune	Small Domestic LCC Airports	79	11790	6877	58%	11	13	6	24%	0.14	0.141%	0.001%	0.000%	0.211%	0.000%	0.000%	0.102%	0.000%	2%	95%	0%	5%	2.521%	0.017%	0.000%	150	7	67%
India	CJB	Coimbatore	Small Domestic LCC Airports	42	5508	3018	55%	11	9	2	23%	0.17	0.061%	0.001%	0.022%	0.201%	0.000%	0.000%	0.051%	0.000%	1%	88%	0%	12%	1.026%	0.006%	0.022%	134	5	76%
India	PAT	Patna	Small Domestic LCC Airports	29	4348	2693	62%	8	4	4	35%	0.22	0.055%	0.001%	0.000%	0.144%	0.000%	0.000%	0.010%	0.000%	2%	91%	0%	9%	0.948%	0.009%	0.000%	152	8	77%
India	NAG	Nagpur	Small Domestic LCC Airports	39	6063	3413	56%	9	11	2	52%	0.32	0.070%	0.000%	0.002%	0.110%	0.000%	0.000%	0.005%	0.000%	1%	95%	0%	5%	1.252%	0.007%	0.002%	159	4	87%
India	VNS	Varanasi	Small Domestic LCC Airports	21	2881	1281	44%	8	8	2	34%	0.21	0.026%	0.001%	0.000%	0.092%	0.000%	0.000%	0.796%	0.000%	3%	76%	12%	11%	0.370%	0.011%	0.000%	139	3	37%
India	VTZ	Vishakhapatnam	Small Domestic LCC Airports	39	4486	2977	66%	8	9	3	25%	0.22	0.061%	0.001%	0.000%	0.089%	0.000%	0.000%	0.047%	0.000%	3%	95%	0%	5%	1.087%	0.013%	0.000%	117	5	68%
India	BDQ	Vadodara	Small Domestic LCC Airports	19	2999	1948	65%	5	3	1	35%	0.29	0.040%	0.000%	0.000%	0.075%	0.000%	0.000%	0.037%	0.000%	1%	93%	0%	6%	0.708%	0.001%	0.000%	167	7	66%
India	BBI	Bhubaneswar	Small Domestic LCC Airports	38	5443	2985	55%	5	8	2	50%	0.36	0.061%	0.001%	0.002%	0.060%	0.000%	0.000%	0.012%	0.000%	2%	97%	0%	3%	1.109%	0.015%	0.002%	145	5	70%
India	IXM	Madurai	Small Domestic LCC Airports	21	1965	1312	67%	6	5	3	37%	0.30	0.027%	0.000%	0.000%	0.059%	0.000%	0.000%	0.008%	0.000%	1%	93%	0%	7%	0.474%	0.000%	0.000%	95	5	72%
India	IXB	Bagdogra	Small Domestic LCC Airports	18	2505	1518	61%	7	6	2	29%	0.20	0.031%	0.000%	0.000%	0.042%	0.000%	0.000%	0.104%	0.00017%	4%	94%	1%	5%	0.556%	0.001%	0.000%	145	3	67%

Table F-1 continued…

Country	Airport Code	Airport Name	Airport Typology	Flights/day	Seats/day	Pax/day	Load factor	No of Airlines	No of destinations served	No of gates	% of seats offered by the dominant carrier	HHI	Traffic generation (Global)	Flow centrality (Global)	Flow centrality (international all)	Traffic generation (International)	Flow centrality (international to international)	Flow centrality (International to regional)	Traffic generation (regional)	Flow centrality (regional)	% of First and Business seats	% Domestic	% Regional	% international	Traffic generation (domestic)	Flow centrality (domestic)	Flow centrality (International to domestic)	seats/aircraft	average frequency per route	% seats by low cost carriers
India	IXC	Chandigarh	Small Domestic LCC Airports	26	3220	2022	63%	9	7	2	23%	0.15	0.042%	0.000%	0.000%	0.037%	0.000%	0.000%	0.014%	0.000%	3%	97%	0%	3%	0.760%	0.003%	0.000%	129	4	59%
India	IDR	Indore	Small Domestic LCC Airports	38	5198	2456	47%	7	12	6	41%	0.27	0.049%	0.002%	0.004%	0.035%	0.000%	0.000%	0.051%	0.000%	1%	97%	0%	3%	0.892%	0.037%	0.004%	139	4	82%
India	GAU	Guwahati	Small Domestic LCC Airports	76	9851	5113	52%	10	13	2	26%	0.18	0.101%	0.005%	0.003%	0.034%	0.000%	0.000%	0.092%	0.00017%	3%	98%	0%	1%	1.867%	0.095%	0.003%	131	6	76%
India	BHO	Bhopal	Small Domestic LCC Airports	21	2281	1178	52%	5	8	2	57%	0.40	0.024%	0.001%	0.004%	0.027%	0.000%	0.000%	0.010%	0.000%	3%	96%	0%	4%	0.430%	0.009%	0.004%	110	3	71%
India	SXR	Srinagar	Small Domestic LCC Airports	35	5522	4146	75%	9	6	8	28%	0.19	0.085%	0.000%	0.000%	0.027%	0.000%	0.000%	0.013%	0.000%	3%	99%	0%	1%	1.592%	0.005%	0.000%	161	6	73%
India	UDR	Udaipur	Small Domestic LCC Airports	15	1564	741	47%	7	5	2	44%	0.32	0.015%	0.000%	0.000%	0.024%	0.000%	0.000%	0.011%	0.000%	3%	94%	0%	5%	0.267%	0.006%	0.000%	109	3	45%
India	IXR	Ranchi	Small Domestic LCC Airports	15	2109	1098	52%	7	4	2	36%	0.23	0.023%	0.000%	0.000%	0.021%	0.000%	0.000%	0.003%	0.000%	7%	97%	0%	3%	0.414%	0.000%	0.000%	146	4	61%
India	IXU	Aurangabad	Small Domestic LCC Airports	13	1631	1070	66%	5	5	4	48%	0.38	0.022%	0.000%	0.004%	0.021%	0.000%	0.000%	0.023%	0.000%	7%	96%	0%	4%	0.397%	0.003%	0.004%	131	3	65%
India	JDH	Jodhpur	Small Domestic OD Airports	9	1084	500	46%	4	6	3	45%	0.39	0.010%	0.000%	0.004%	0.019%	0.000%	0.000%	0.000%	0.000%	7%	93%	0%	7%	0.179%	0.001%	0.004%	124	2	13%
India	RPR	Raipur	Small Domestic LCC Airports	30	3962	2135	54%	6	9	2	41%	0.31	0.043%	0.001%	0.001%	0.018%	0.000%	0.000%	0.027%	0.000%	1%	98%	0%	1%	0.796%	0.022%	0.001%	136	4	82%
India	IXZ	Port Blair	Small Domestic LCC Airports	17	2499	1679	67%	8	4	4	29%	0.18	0.035%	0.000%	0.000%	0.007%	0.000%	0.000%	0.011%	0.000%	3%	99%	0%	1%	0.649%	0.000%	0.000%	156	5	41%
India	IXJ	Jammu	Small Domestic LCC Airports	28	4174	2469	59%	9	6	2	23%	0.17	0.051%	0.001%	0.000%	0.005%	0.000%	0.000%	0.004%	0.000%	2%	100%	0%	0%	0.948%	0.009%	0.000%	150	5	76%
India	VGA	Vijayawada	Small Domestic LCC Airports	11	927	446	48%	5	4	2	35%	0.26	0.009%	0.000%	0.000%	0.004%	0.000%	0.000%	0.000%	0.000%	2%	99%	0%	1%	0.171%	0.000%	0.000%	86	3	58%
India	IXL	Leh	Small Domestic LCC Airports	8	1112	969	87%	5	4	2	39%	0.26	0.020%	0.000%	0.000%	0.003%	0.000%	0.000%	0.008%	0.000%	4%	99%	0%	0%	0.372%	0.003%	0.000%	154	2	63%
India	IMF	Imphal	Small Domestic LCC Airports	20	2709	1413	52%	7	7	2	40%	0.30	0.029%	0.000%	0.000%	0.002%	0.000%	0.000%	0.000%	0.000%	2%	100%	0%	0%	0.545%	0.004%	0.000%	137	3	56%
India	TIR	Tirupati	Small Domestic LCC Airports	11	1087	759	70%	5	3	2	33%	0.30	0.016%	0.000%	0.000%	0.002%	0.000%	0.000%	0.000%	0.000%	5%	100%	0%	0%	0.294%	0.000%	0.000%	107	4	68%
India	IXA	Agartala	Small Domestic LCC Airports	24	3020	1720	57%	6	5	4	36%	0.25	0.035%	0.000%	0.000%	0.001%	0.000%	0.000%	0.001%	0.000%	0%	100%	0%	0%	0.668%	0.001%	0.000%	127	5	84%
India	DIB	Dibrugarh	Small Domestic LCC Airports	6	853	475	56%	4	3	2	42%	0.30	0.010%	0.000%	0.000%	0.001%	0.000%	0.000%	0.001%	0.000%	1%	100%	0%	0%	0.183%	0.001%	0.000%	157	2	78%
India	NDC	Nanded	Small Domestic LCC Airports	3	400	352	88%	2	3	2	76%	0.64	0.007%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	3%	100%	0%	0%	0.137%	0.000%	0.000%	160	1	100%
Maldives	MLE	Male	Small International Airports	85	11044	6706	61%	31	41	3	20%	0.11	0.137%	0.001%	0.034%	2.328%	0.000%	0.034%	8.972%	0.003%	8%	17%	26%	56%	44.516%	0.378%	0.000%	131	3	0%
Maldives	GAN	Gan Island	Small Domestic OD Airports	10	456	345	76%	1	2	1	100%	1.00	0.007%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0%	100%	0%	0%	13.224%	0.000%	0.000%	48	5	0%
Maldives	KDM	Kaadedhdhoo	Small Domestic OD Airports	11	450	332	74%	1	3	1	100%	1.00	0.007%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0%	100%	0%	0%	12.698%	0.000%	0.000%	44	4	0%
Nepal	KTM	Kathmandu	Small International Airports	224	16141	10670	66%	33	40	3	15%	0.07	0.220%	0.001%	0.028%	3.308%	0.001%	0.026%	12.076%	0.032%	4%	28%	22%	50%	49.220%	0.000%	0.001%	73	6	16%
Nepal	PKR	Pokhara	Small Domestic OD Airports	29	945	632	67%	2	2	1	51%	0.50	0.013%	0.000%	0.000%	0.001%	0.000%	0.000%	0.001%	0.000%	0%	100%	0%	0%	10.475%	0.011%	0.000%	34	15	0%
Nepal	BIR	Biratnagar	Small Domestic OD Airports	31	1059	717	68%	2	2	2	51%	0.50	0.015%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0%	100%	0%	0%	11.910%	0.002%	0.000%	35	16	0%
Pakistan	KHI	Karachi	Medium Hybrid Airports	132	23996	15809	66%	22	43	16	42%	0.21	0.303%	0.024%	0.708%	4.225%	0.020%	0.205%	1.956%	0.000%	6%	48%	2%	50%	42.129%	0.470%	0.483%	183	4	4%
Pakistan	LHE	Lahore	Small International Airports	78	14005	9734	70%	15	37	7	48%	0.26	0.198%	0.004%	0.106%	3.892%	0.011%	0.008%	0.323%	0.000%	6%	34%	1%	66%	18.220%	0.118%	0.086%	182	3	2%
Pakistan	ISB	Islamabad	Small International Airports	84	13878	9898	71%	17	43	8	53%	0.30	0.202%	0.003%	0.079%	3.776%	0.001%	0.003%	0.665%	0.000%	5%	36%	1%	62%	20.054%	0.104%	0.075%	168	2	2%
Pakistan	PEW	Peshawar	Small International Airports	32	4930	3202	65%	12	20	4	42%	0.23	0.065%	0.001%	0.022%	1.517%	0.000%	0.002%	0.020%	0.000%	4%	23%	0%	77%	4.099%	0.004%	0.020%	157	2	4%
Pakistan	SKT	Sialkot	Small International Airports	6	981	568	58%	2	8	2	84%	0.73	0.012%	0.000%	0.001%	0.271%	0.000%	0.000%	0.001%	0.000%	4%	23%	0%	77%	0.741%	0.001%	0.001%	168	1	0%
Pakistan	MUX	Multan	Small Domestic OD Airports	11	967	844	87%	3	6	2	62%	0.46	0.017%	0.000%	0.000%	0.165%	0.000%	0.000%	0.006%	0.000%	0%	69%	0%	31%	3.237%	0.003%	0.000%	91	2	0%
Pakistan	LYP	Faisalabad	Small Domestic OD Airports	6	670	467	70%	2	5	4	72%	0.60	0.010%	0.000%	0.000%	0.081%	0.000%	0.000%	0.004%	0.000%	2%	72%	0%	28%	1.881%	0.001%	0.000%	131	2	0%
Pakistan	UET	Quetta	Small Domestic OD Airports	11	1231	820	67%	2	9	4	85%	0.75	0.016%	0.001%	0.023%	0.069%	0.000%	0.000%	0.001%	0.000%	3%	82%	0%	18%	3.763%	0.010%	0.023%	114	2	0%
Sri Lanka	CMB	Colombo	Secondary International hubs	132	26828	15136	56%	34	51	12	52%	0.29	0.256%	0.057%	1.704%	5.122%	0.203%	1.501%	21.029%	1.144%	7%	0%	28%	71%	44.528%	0.000%	0.000%	204	3	7%

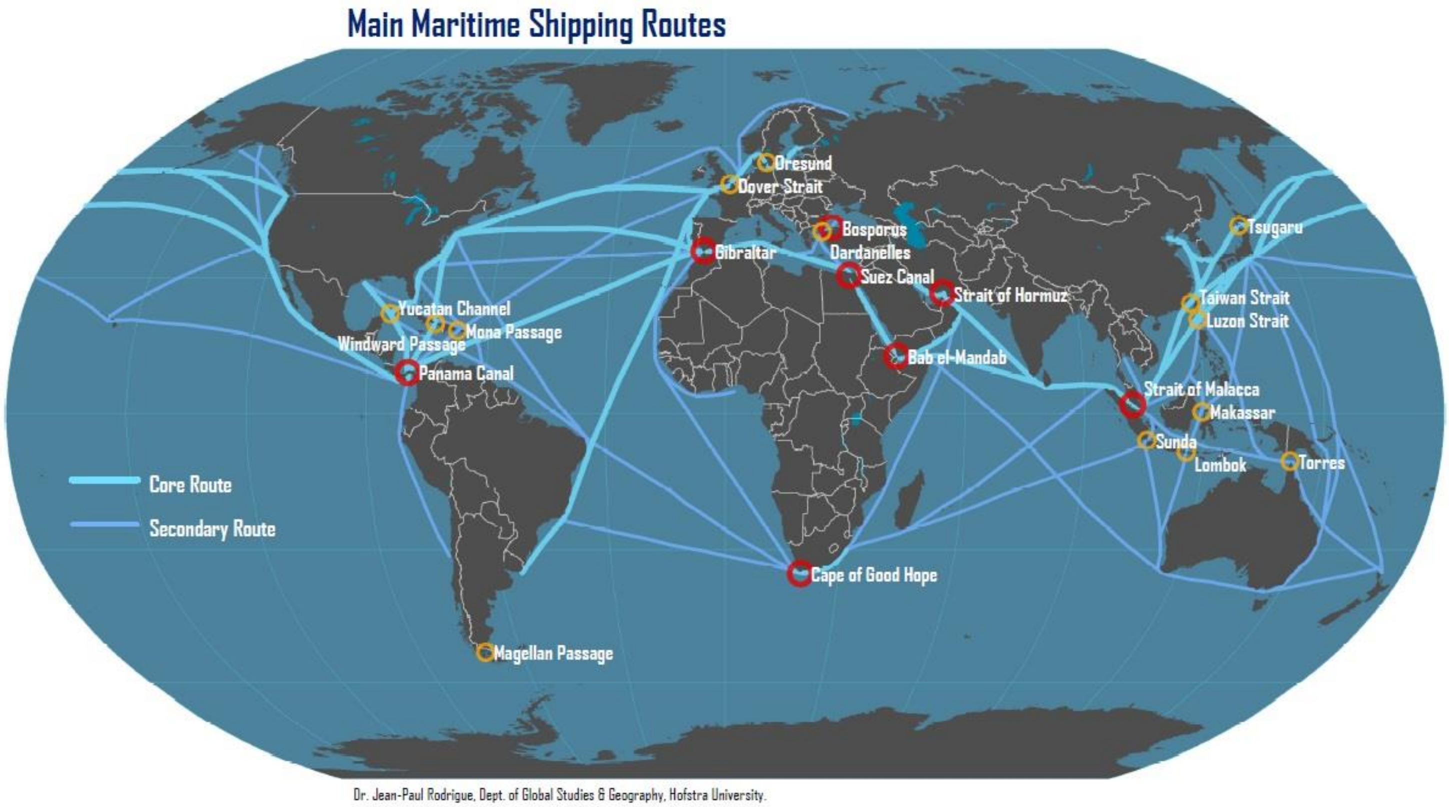

Figure F-1 Main Maritime Shipping Routes

(Rodrigue, 2016)