EFFECTIVENESS OF THE AIRPORT CITY

(AEROTROPOLITAN) CONCEPT

A Thesis

Submitted to the Department of Civil Engineering, University of Moratuwa

In Fulfillment of Requirements for the award of

Doctor of Philosophy in Civil Engineering

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November, 2019

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ABSTRACT

Airport city becomes a trend to many airports in 21st century. Airport city concept is a novel concept to the world. This research is focused on to identify how airport cities emerge in the world and its usefulness to any given airport. Further, it investigates the effectiveness of current practices of airport functions and their potential to be an airport city (aerotropolitans). This study focused on identifying the key factors contribute towards an airport become an airport city and developed "airport city effectiveness criteria (ACEC)" to evaluate the city status of for any given airport. Possible influencing factors were identified through a comprehensive literature survey and opinion survey. Inductive approach was used to collect data through studies and industry experts. After interviewing industry experts, seven factors, namely geographic location, demand, technology, nature of the airport, non-aeronautical activity centers, business management and access modes were identified as the key factors influencing airport city status.

The AHP technique was use to rank the seven criteria selected based on importance towards achieving airport city status. A stratified sampling technique was used to select industry experts for ranking. It is identified that non-aeronautical activities, geographic location, demand, nature of the airport are more important, to achieve airport city status. Access modes, business management and technology are the other factors that must be considered to be an airport city. By utilizing the seven identified factors, Airport City Effective Criteria (ACEC) was developed. Key performance indicators and its measures were identified for each factor. Weight was assigned for each key performance indicators by interviewing industry experts. Bandaranaike International Airport is considered as a case study based airport. Decision makers of the industry including board of directors and senior managers assigned score against weights to each key performance indicator. Hong Kong International Airport (HKG) measures were calculated and it utilized as a benchmarking airport. Finally, it is identified that how effective BIA for achieving airport city status.

Keywords: Airport City, Evaluation Criteria, Key Performance Indicators, Airport City Drivers

ACKNOWLEDGEMENT

This research would not be possible without the guidance and dedication of numerous respectable individuals and organizations. Therefore, I take this opportunity to convey my gratefulness to every one of them for their invaluable contribution.

First and foremost, I pay my sincere gratitude to supervisor, Senior Professor J. M. S. J. Bandara for all the guidance, assistance and continuous encouragement provided to me throughout the research work. Thank you very much Sir.

I acknowledged the valuable suggestions made by Dr. Namali Sirisoma as chairman of progress review panel. Her enormous guidance given towards this study was well noted. Thank You Madam.

I wish to express my greatest appreciation to all the practitioners in the aviation industry who contributed to this study by supporting to the data collection process, especially Civil Aviation Authority, Airport and Aviation Services Sri Lanka Limited and Sri Lankan Airline. Thank You All.

I would like to thank to the Department of Civil Engineering for giving this opportunity. It is also my obligation to acknowledge the assistance offered in numerous ways by all the lecturers and non-academic staff members in the Department of Civil Engineering. Thank You for the help.

I would like to thank Department of Transport and Logistics Management, University of Moratuwa for granting me study leave for reading doctor of philosophy. Without their permission and encouragement, I would not be able to complete this task. Thank you all the members of TLM Family.

Last, but not least, I give my immeasurable thanks to my parents, my sisters, my friends for their assistance and guidance in various ways. Thank You for being on my side always.

DECLARATION

I hereby declare that this submission is my own work and that to the best of my knowledge and belief, it contains neither materials published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma or university or other institute of higher studies, except where an acknowledgement made in the text.

…… ……

W.W. A. S. Fernando Date

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…… ……

Supervisor Date

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DEDICATION

I dedicate this effort

to

My Loving Amma & Thaththa

My Dear Teachers: Kindergarten to University

My Sisters & Brothers

(Kumudu, Thushari , Kushani, Nishantha, Thushara ,Malitha)

Methupa Kulan Surendra

&

Matheesha Surendra

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Abbreviation

AASL: Airport and Aviation Services Sri Lanka Limited

ACEC: Airport City Effectiveness Criteria

ACI: Airport Council International

AMS: IATA Three Letter Code for Amsterdam Schiphol International Airport

BIA: Bandaranaike International Airport

CAA: Civil Aviation Authority

CMB: IATA Three Letter Code for Bandaranaike International Airport

CMR: Colombo Metropolitan Region

HKG: IATA Three Letter Code for Hong Kong International Airport

HKIA: Hong Kong International Airport

IATA: International Air Transport Association

ICN: IATA Three Letter Code for Incheon International Airport

KPIs: Key Performance Indicators

MRIA: Mattala Rajapaksa International Airport

O-D: Origin Destination

SIN: IATA Three Letter Code for Changi International Airport

SLA: Sri Lankan Airlines Limited

TSA: IATA Three Letter Code for Taipei Songshan International Airport

WLU: Work Load Unit

CHAPTER 01

1.0 INTRODUCTION

1.1 Background of the Research

The world has become smaller due to the globalization and time has become more valuable to reconcile. Globalization integrates people internationally by interchanging their products, ideas and their culture. Airport provides gateway to the people and goods which are moving internationally and domestically by air. Modern gateways are managing their functions through airport city concept. Airport city concept can be described as while performing core aeronautical activities, airports provides significant non-aeronautical activities to the passengers. Airport city (aerotropolis) optimization is based on airport planning, urban planning and business site planning (Kasarda, 2006). Lami et al (2015) found out that commercial orientation was one of the important drivers for changing in airports industries.

There is hardly any research has been done to develop evaluation criteria to measure the potential of airport city. This study is focused on to identify how airport cities emerge in the world and its usefulness to any given airport. Further, it investigates the effectiveness of current practices of the airport functions and its' potential to be Airport city (aerotropolitans). Bandaranaike International Airport is considered as a case study based airport. Accordingly, the study presents a detailed analysis of the factors to be an airport city in terms of aeronautical and non-aeronautical facilities, benchmarking lessons learnt from well-established aerotropolis like Hong Kong International Airport.

1.2 Airport City Models

Historically, Airport is considered as a place which directly served aircraft, passengers and cargo. It meant that, earlier airports are more focused on core aeronautical activities, aircraft landing, and take-off and passenger movements. Now the focus is given to non-aeronautical activities such as logistics parks, shopping malls, theaters, conference halls,

etc. while facilitating the core activities (Kasarda, 2006). Airport city models consist of an airport core functions and aviation oriented businesses. There are many well established airport cities in world wide. Following are some of the successful airport city models and it is indicated their main business category as well.

- Hong Kong International Airport, Hong Kong: 30 High-End Designer Clothing Shops/ HKairportShop.com website is coupling demand and supply
- Changi International Airport, Singapore: Cinemas, Saunas and Swimming Pool
- Las Vagas Mccarran International Airport, United States of America: Museum
- Amsterdam Schiphol International Airport, Netherlands: Dutch Masters Gallery
- Frankfurt International Airport, Germany: World Largest Terminal Clinic which treats more than 30,000 patients annually
- Stockholm Arlanda International Airport, Sweden: Chapel which celebrates over 450 weddings annually
- Dubai International Airport, United Arab of Emirates: airport connects commercial and residential zones by light rail system

1.3 Research Gap and Problem Statement

World passenger traffic is increasing and the growth is 6.6% in the year 2017. By considering Asia pacific region the growth is 10.6%. Hong Kong International Airport in Hong Kong (HKG), Incheon International Airport in South Korea (ICN) and Changi International Airport in Singapore (SIN) are performing well in this region. All mentioned airports are airport cities. A consequences of the growth of airport cities is in the rise. For a particular airport for achieving an airport city status is a strategic decision. Therefore, there should be a decision making tool to support top managers to make the final decision.

Before making a strategic decision, it is important to understand current scenario of the airport cities and how they performed. It will help top managers to gather information to evaluate and make their decision. Therefore, the main research problem of this study is

"What are the factors that influence to become an airport city and how to calculate the effectiveness of airports to become airport city?".

This research will assist the Airport Management to identify the current status of the airport for achieving an airport city status by evaluating airport city effectiveness criteria (ACEC).

1.4 Research Objectives

1. Identify the factors that can contribute for an airport to be an Airport City by benchmarking case studies of newly industrialized economies (Hong Kong, South Korea, Singapore and Taiwan)
2. Develop criteria to evaluate the potential to become an Airport City
3. Evaluate the potential to be an airport city – Bandaranaike International Airport Case Study

1.5 Research Method

Inductive research approach was utilized for the research since there is hardly any research done to evaluate airport city effectiveness. Comprehensive literature survey was done on airport cities and related areas as a secondary data collection. Well established airport cities around the world, airport city master plans, annual reports of the airports and airlines, and research articles were referred. For the factor analysis, framework was developed for evaluate each factor. Key Performance Indicators (KPIs) and sub measures were found by referring literature.

Methodological approaches including both quantitative and qualitative studies were adopted as shown in Table 1. 1. It clearly described the actions towards three research objectives. Interviews were conducted in different stages of the research with industry experts to identify their views regarding airport city concept and to identify their current practice as primary data collection. First round of interviews was done to define the

factors for the research by evaluating literature survey data. After carefully analyzing data gathered from interviews, seven factors (07) were defined for the research. Second round of interviews were done to rank the factors to be accomplished for achieving airport city status. Third set of interviews were conducted to weight each factor for being an airport city.

Questionnaire A and B (Appendix 2) were utilized for the research and questionnaire was developed by using primary data and secondary data. AHP was utilized for the data analysis. A survey at BIA was done to model airport functions and maps its facilities. SWOT analysis was done to identify BIA's strengths, weaknesses, opportunities and threats to develop as airport city. Since BIA is the case study based airport for the research, market survey and spatial analysis were done at BIA. Final output of the research is an evaluation criterion for measuring the effectiveness of being an airport city. As a case study, Bandaranaike International Airport was evaluated by utilizing developed airport city effectiveness criteria.

1.6 Chapter Breakdown

Background of the research, airport city models, objectives of the research and research method are discussed in chapter 01. Airport city concept, benchmark newly industrialized economies, airport city drivers, present situation of the aviation industry, key socio-economic indicators of Sri Lanka, key performance indicators in aviation industry and description about Bandaranaike International Airport are reviewed in chapter 02.

Research boundary, types of data, data collection process, data collection techniques, questionnaire, sample selection and data analysis techniques are discussed in chapter 03. Seven factors for the research, results of analytical hierarchy process, development of airport city effectiveness criteria (ACEC), KPIs and weighted ACEC are illustrated in chapter 04. Research output against research objective and recommendation for further research were addressed on chapter 05.

Table1.1: Research Method

	Action	Method	Output
1.	Comprehensive Literature Survey (Objective 01)	**Secondary Data Sources** -Airport City related international conference papers - Airport City related Journal articles - Media Reports of Airport Cities (HKG, SIN, TSI & ICN) - Airport City project reports	Identify eighteen **(18) factors** to be an airport city
2.	Factor Analysis and Brainstorming Session (Objective 01)	**Semi Structured Interviews** with experienced personnel in Aviation Industry Sample Size: 10 Sampling Method: Convenient Sampling	Define seven **(07) factors** for the research
		Questionnaire based interviews with industry experts including airport operators, regulators, service providers Sample Size: 50 Sampling Method: Random Sampling Method of Ranking : AHP	Ranking the **importance** of each factor for achieving airport city status
3.	Developing Airport City Effectiveness Criteria (ACEC) (Objective 02)	**Literature Survey** based on seven factors to identify KPIs and measurements of KPIs in the industry	Identify **KPIS & Measures** to evaluate airport city effectiveness
		Questionnaire Based Interview to weight each factor Method of Weighting : AHP	**Develop ACEC** with **weighted factors**
4.	Evaluating BIA by utilizing ACEC (Objective 03)	**Secondary Data Collection** of BIA related to KPIs and Measures.	**Framework** was developed to find information & prepared information sheet (**Fact Sheet**) before interviews.
		Fact based Interviews with Decision Making personnel in Aviation Industry Population based on CAA/ SLA/ AASL Sample Size: Stratified Sampling	**Weighting each factor** on developed ACEC

CHAPTER 02

2.0 LITERATURE REVIEW

2.1 Airport City Concept

Airport is an infrastructure facility which provides air transport service to the passengers and cargo. It can be considered as international and domestic traffic. Modern airports are facilitating the trend through the airport city concept. Airport city concept is grounded in the fact that in addition to their core aeronautical infrastructure and services, airports have developed significant non aeronautical facilities, services and revenue streams (Kasarda, 2006).

Lami et al (2015) have found out that commercial orientation was one of the important drivers for changing in airports industries. Major airports are more concerned about commercial activities which link urban form to airport (Stevens, 2006). IATA, 2012 highlighted that airport city is not only the shopping malls within the terminal but also has more connectivity to business conglomerates.

Today, many airports receive greater percentages of their revenues from non-aeronautical sources like hotels, retail complexes, conference and exhibition centers, than from aeronautical sources like landing fees, gate leases, passenger service charges. (Kasarda,2008). The current trend in an airport management is to complement traditional technical airport functions with terminal and land side commercial activities. Linda et al, 2012 found out that in developing countries, the airport city concept is being used as an urban planning tool to accommodate strong economic and population growth. Being a new mode of airport economy development, an airport city has the six major characteristics; airport -oriented, industrial cluster, space gradient, market efficiency, global accessibility and technological preeminence (Xia and Li, 2006).

In the past decade, the focus of international airport development has shifted from a transportation hub towards a multi-functional aero metropolis (Wang and Hong, 2010). Multi-functional aero metropolis (airport cities) increases time which travelers spend in terminals. It offers more new services and amenities such as shops and entertainments. Airport Cities have international businesses in close proximity.

2.2 Airport City Examples

Airport city consists of an airport core and extensive outlying corridors and clusters of aviation oriented businesses and their associated residential development. Amsterdam Schiphol Airport in Netherlands, Seoul International airport in South Korea, Changi Airport in Singapore, Las Vagas Mccarran Airport in United States, Dubai International Airport in United Arab of Emirates and Delhi International Airport in India are the few examples of developed airport cities in recent years. Session 1.2 listed their main business segments. Some aspects of the airport city concept clearly hold benefits like integrate multi modal transport, connectivity of passengers and businesses. Section 2.2.1 to section 2.2.4 will discuss few airport cities and how they penetrate to commercial activities at airports.

2.2.1. Amsterdam Schiphol Airport

Schiphol International Airport (AMS) is well established, well developed and it has state art of technology to be an airport city. AMS had integrated all three functions, airport planning, urban planning and business site planning together to achieve its airport city status. AMS utilized its function as inside fence and outside fence. All core functions related to passenger movements are facilitated under inside fence. Their non-aeronautical activities are facilitated in outside fence. Figure 2.1 illustrate the conceptual framework of AMS airport city.

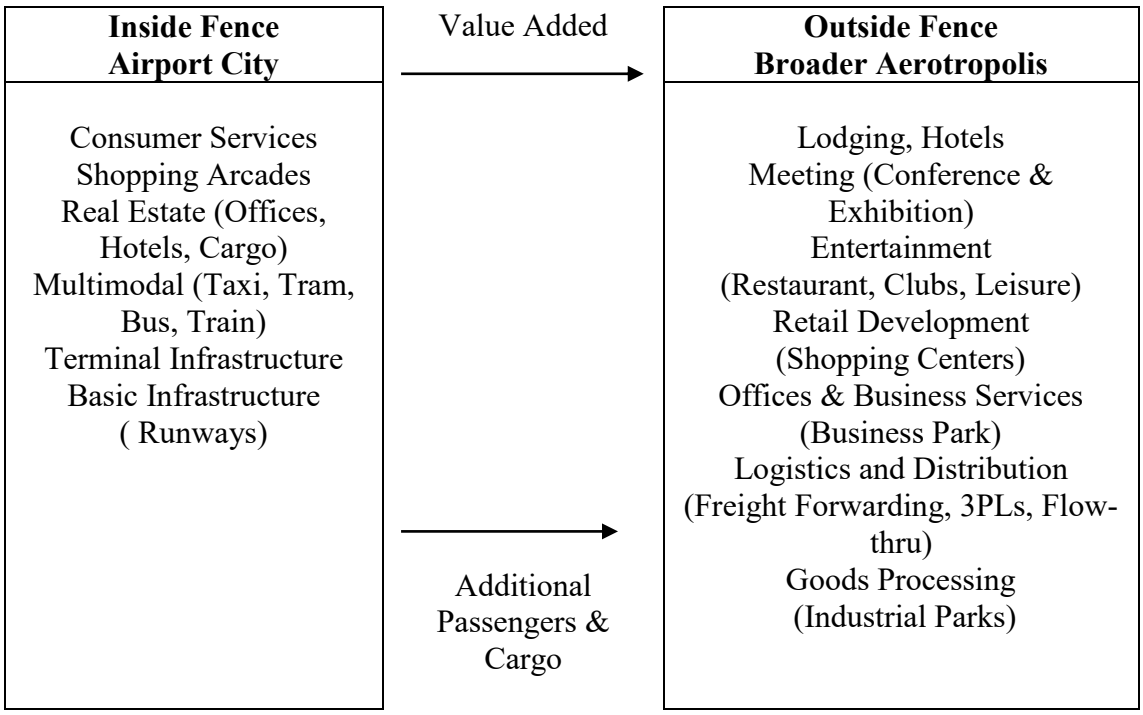


Figure 2.1: Amsterdam Schiphol Airport City Conceptual Framework

2.2.2. Hong Kong International Airport

Hong Kong International airport (HKIA) is a best example for airport city in Asia Pacific region. HKIA is the world's busiest cargo gateway (2010 to now) and 8th busiest airport worldwide by passenger traffic (Annual Report, 2017/2018). HKIA started commercial operations in the year 1998 and The International Air Transport Association names HKIA as the world's best airport in the year 2014 (Annual Report, 2017/2018). HKIA has one of the world's largest passenger terminal buildings. SKYCITY is the main plan they implemented for being airport city by a 25-hectare integrated commercial development at HKIA in the year 2016. One of the main business segment in HKIA airport terminal is high end designer clothing shops (nearly 30 shops).

2.2.3. Frankfurt International Airport

Frankfurt Airport is the busiest airport by passenger traffic in Germany (Annual Report, 2017). It is a very famous airport city with having world largest terminal clinic. Airport clinic is open to passengers for 24 hours. It is treating over 30,000 patients yearly.

2.2.4. Stockholm Arlanda International Airport

Stockholm Arlanda International Airport is operating the airport chapel. This is untouched marketing concept at airports. They believed that passengers spend quiet free time at airport and they can join to celebrate weddings at airport. The chapel is open to visitors, regardless of their religion. They celebrate over 450 weddings annually.

2.3 Airport City Drivers

Airport functions are dependent on passenger traffic and air cargo traffic. Without passenger trips, it is very difficult to sell their product “Seat for Passenger” and “Space for Cargo”. Worldwide international traffic jumped by 7.7% and worldwide aircraft movements increased 1.1% (ACI, 2012). It is positive sign for the aviation industry itself. China and India play huge role for Asian market to grow.

This study is focused on to identify how airport cities emerge in the world and its usefulness to any given airport. The identification of all relevant factors to be performed as an airport city was done through a comprehensive literature survey. More than twenty-five (25) research articles were referred to identify airport city drivers to be an airport city. The eighteen (18) airport city drivers which required being an airport city were extracted from the literature and summary table is given in Table 2.1. It provided extracted information, title of the paper, authors and year of publication and details are given at Appendix 1.

Table 2.1- Airport City Drivers

No	Airport City Drivers / Description	Author (Year)
01	**Geographic Location**	
	Land Use – Competition between airport and surrounding airport areas	Steve, Nicholas J. (2006)
	Air Routes Regional Planning	Ben Derudder, Lomme Devriendt, Frank Witlox (2010)
	Accessibility - The global network of air transportation overcome geographic barriers	Kung Jeng Wang, Wang Chung Hong (2011)
02	**Attractiveness**	
	Spatial economic position	Michael Drob, Bart de Jong (2007)
	Business model of the airport (Aeronautical and non-aeronautical revenue sources)	Stephen J. Appold, John D. Kasarda (2011)
	Trend for developing multi-functional airport (Tourist Destinations, Commercial Destinations, Industrial activities) & Market efficiency	Kung Jeng Wang, Wang Chung Hong (2011)
03	**Aviation Policy of the country**	
	Decision making and Jurisdictions	Steve, Nicholas J. (2006)
	Create new non-aeronautical revenue sources	Kasarda (2008)
04	**Nature of the Airport**	
	Spatial economic position as transfer passengers	Michael Drob, Bart de Jong (2007)
	New management and Investment opportunities	John D. Kasarda (2008)
	Airport Services and Its Ownership	Airport Business Rigas Doganis (1992)
05	**Traffic**	
	OD Passengers/ Airport Users/ Airlines (International, Flag Carrier, Full Service/ LCC/ Efficient and Regular Services/ Competitive Prices/ More Frequencies)	Ben Derudder, Lomme Devriendt, Frank Witlox (2010)

	Identify the niche market by considering Income, frequency of service, travel time ratio, employment, economy fare	Tobias Grosche, Franz Rothlauf, Armin Heinzl (2007)
06	**Infrastructure (Air side & Land Side)**	
	Land Use and Cost & Facilities available at airport	Steve, Nicholas J. (2006)
	Planned physical and commercial infrastructure	Kung Jeng Wang, Wang Chung Hong (2011)
	Complete local infrastructure and Transport network	
07	**Level of Service**	
	Efficiency of Services	Rigas Doganis (1992)
08	**Logistics and Just in Time Manufacturing**	
	clusters of airport linked shopping centers, business parks, industrial parks, logistics parks	John D. Kasarda (2008)
09	**Free Trade Zones (FTZ)**	
	Commercial Investments/ Reduce Taxes, cut red tape, boost exports/ Country Economy	Steve, Nicholas J. (2006)
	Patterns of ownership of operations	Rigas Doganis (1992)
	To attract companies, to have tax free incentives when importing the components, FTZ is the mechanism	
10	**Flexible & Advanced Technology**	
	air transportation relies much on high technology support	Kung Jeng Wang, Wang Chung Hong (2011)
11	**Intermodal Freight Hub**	
	Brings together air, rail, highways, ports	Rigas Doganis (1992)
12	**Related and supporting industries**	

	Office Parks, Office Corridors, Exhibition and Conference Centers, Hotels, retail clusters, Medical and wellness clusters, Academic and Research Clusters	Kung Jeng Wang, Wang ChungnHong (2011)
	Industries within the airport city	Z. Y. Xia and P. Li (2006)
	Connect to markets Medical Tourism Research centers	Rigas Doganis (1992)
	The formation of urban centers around the airports, increasing the creation of jobs in the airport region. These centers can be expanded up to 20km around the airport	Tadeu Hygo Ferreira Braga, Silva Jersone Tasso Moreira (2010)
13	**Mixed Used Residential Areas**	
	Airport employee needs incidental service like housing, recreation, food services, retail, health, child day care and so on.	John D. Kasarda (2008)
14	**Local and Global Interests**	
	Regional Planning	Ben Derudder, Lomme Devriendt, Frank Witlox (2010)
	airport centric commercial development	John D. Kasarda (2008)
15	**Airport Access Modes**	
	Clustering of developments at the airport territory	Michael Drob, Bart de Jong (2007)
	Transport network (Trains, expressways, busses, taxis)	Kung Jeng Wang, Wang Chung Hong (2011)
	Airport expressways link to business development	John D. Kasarda (2008)
	Aerolanes and Aerotrains	John D. Kasarda (2006)
	Expectation and perception of the passenger matters for the choice of access mode	Mei Ling TAM, Mei Lam TAM, William H.K. LAM (2005)
16	**Land Supply**	

	Land owner and municipalities play a controlling rule when it comes to land policy. Space for Future development	Michael Drob, Bart de Jong (2007)
17	**Land Availability**	
	Commercial sector pursuit of affordable, accessible land	John D. Kasarda (2008)
18	**Performance of the airport**	
	Evaluation is based on supply, Airline demand, passenger demand, management side	Daniel L. Stuffle Beam (2000)

2.4 Benchmarking Airport City Performances

Although extracted literature was pooled to eighteen (18) airport city drivers, some of them are inter related each other. It is essential to identify how these drivers fit to the airport for being an airport city. Airport City (Aerotropolitan) is airport oriented business. Therefore, it is necessary to identify the airport performances to manage the airport city related functions for effectively maintaining airport city status. Benchmarking is a process of measuring the performance of product and services against the best in the industry. Graham et al 2002 argued that airport benchmarking is a performance improvement technique to survive the challenges which airport faces.

Benchmarking can be done internally and externally or locally and internationally. It is based on the purpose of the benchmarking process. In this study, ultimate objective is to evaluate the effectiveness of the airport to become an airport city. To evaluate the particular airport there should be evaluation criteria. Section 2.3 identified the airport city drivers and by utilizing benchmarking method, it is going to identify the potential of airport to become an airport city.

2.4.1 Benchmarking Airports under Four Indicators

One of the method to benchmark performance of the airport is evaluating operational, efficiency, service quality and financial indicators.

1. Operational Indicators

   Airport Facilities (Baggage Belt Handling, Aerobridges, Frequencies, Catering…)

2. Efficiency Indicators

   Check-in Time, Baggage Presentation Time, Immigration Clearance Time, Security Screening Time, Taxi Queue Time

3. Service Quality Indicators

   Satisfaction with Speed of Clearance, Cleanliness of Airport, Real Time Information

4. Financial Indicators

   Total Revenue, Return on Investment, Revenue per Passengers, and Revenue from Retail Space

2.4.2 Benchmarking Airport Performances

Hong Kong, South Korea, Singapore and Taiwan are the newly industrialized economies which change the world economy recently. International airports based on those countries are benchmarked against BIA. BIA is the case study based airport for this study. Table 2.2 shows the benchmarked information about five international Airports, namely Hong Kong International Airport in Hong Kong (HKG), Incheon International Airport in South Korea (ICN), Changi International Airport in Singapore (SIN), Taipei Songshan International Airport in Taiwan (TSA) and Bandaranaike International Airport in Sri Lanka (CMB).

Table 2.2: Benchmarking Airport Performances - 2016

	Category	**Performance**				
		(CMB)	**(HKG)**	**(ICN)**	**(SIN)**	**(TSA)**
i	Passenger Movements (Annual)	7 million	60.7 million passengers	50 million passengers	55 million passengers	6 million
ii	Aircraft Movements (Annual)	52,194	377,476	271,224	346,334	61,929
iii	Cargo Throughput (Annual Tones)	191,224	4,938,000	2,464,385	1,853,087	43,528.4
iv	Functions	Passenger hub	Transshipment Center, Passenger Hub	Transit Hub, Transshipment Center, Passenger Hub	Transport Hub	Commercial Airport
v	Number of Terminals and Space	Terminal1 850,000m^2	Terminal 1 570,000 m^2 Terminal 2 140,000 m^2	Terminal 1 594,000m^2	Terminal 1 308,000m^2 Terminal 2 Terminal 3 Budget Terminal	Terminal 1 59,518m^2 Terminal 2 18,115m^2
vi	Number of Runways and Length of the	3,350m	Runway 01: 3800m	Runway 01: 3750m Runway 02: 3750m	Runway 01 4000m	Runway 01 2605m

	Category	Performance				
		(CMB)	**(HKG)**	**(ICN)**	**(SIN)**	**(TSA)**
	runway		Runway 02: 3800m	Runway 03: 4000m	Runway 02 4000m Runway 03 2750m	
vii	Number of Gates	12	66	76	134	8
viii	Airlines	26	95	62	76	15
ix	Destinations	64	160	240	124	24
x	Employees	Over 5000	Over 60,000 People	Over 60,000 People	Over 60,000 People	Over 3000
xi	Market	Asia	Asia Pacific and Chinese	Seoul Capital Area Worldwide	South Asia and Worldwide	China and Worldwide
xii	Baggage Delivery	First Bag: within 2 minutes	First Bag: within 2 minutes Last Bag: within	First Bag: within 2 minutes Last Bag: within 40	First Bag: within 2 minutes Last Bag: within 40	First Bag: within 2 minutes Last Bag: within

	Category	Performance				
		(CMB)	**(HKG)**	**(ICN)**	**(SIN)**	**(TSA)**
		Last Bag: within 40 minutes	40 minutes	minutes	minutes	40 minutes
xiii	Awards		Seventh Place Skytrax World Airport Awards	Best Airport Worldwide (Airport Council International) World's Cleanest Airport & World's Best International Transit Airport (Skytrax) World Best Duty Free Shopping Mall in 2013	World best Airport in 2016 (Skytrax)	Government Service quality award -2014

2.5 Multi Criterion Analysis

This study is focused on developing criteria to evaluate the potential for being an airport city and there should be a method to analyze it. Since there are several factors to evaluate multi criterion analysis is the method to analyze. There are many Multi Criterion Analysis Techniques such as Analytical Network Process (ANP), Analytical Hierarchy Process (AHP), Data Envelopment Analysis, ELECTRE (outranking), Relative Merit Method (RMM) and the Evidential Reasoning Approach to identify the importance of factors affecting to decision making (Sekaran, 2003).

ANP is a technique where structures decision in to network and AHP is a technique where structures decision in to hierarchy. Both occupy pairwise comparison to assign a value and to rank the alternatives in the decision. AHP has particular application in group decision making. DEA utilized decision making units to measure the productivity. ERA analyzes quantitative and qualitative criteria under various uncertainties. When compared with other techniques, Analytical Hierarchy Process (AHP) enables decision makers to have a practical decision making with the knowledge about criteria and also judgment on one criterion can be made effectively relative to another criterion. AHP can be considered as an effective tool since it can handle numbers of alternatives at once even some other method like Relative Merit Method can handle only two alternatives at once (Bahurmoz, 2006). In this research, decision making is crucial with experts' perceptions in number of alternatives. Therefore, AHP model is used for this study. It is selected for ranking the importance of each factor to be an airport city and for assigning weight for KPIs at Airport City Effectiveness Criteria (ACEC).

The input can be obtained from subjective opinion such as satisfaction, feelings and preference. Therefore, AHP model is used for this study and it is selected for ranking the importance of seven factors at first.

AHP involve the following phases;

- Structuring of a hierarchy
- Pair-wise comparison
- Priority vector computation
- Check for the consistency of the judgments

To evaluate the importance of the factor, AHP uses a pair wise comparison technique. For the pair wise comparison, 1-9-point scale is commonly used (Saaty, 1980). This scale is very important for AHP analysis since it can derive well defined results due to meaningful explanations associated with each numerical value in scale (Table 2.3). Pair wise comparison of seven factors was done by industry experts. Integrated value for entire sample had been taken as the input for the matrix.

Table 2.3: AHP Pair Wise Comparison Scale

Importance for Comparison	Numeric Value	Reciprocal Value
Extremely Important	9	1/9 (0.111)
Very Strongly Important	7	1/7 (0.143)
Strongly Important	5	1/5 (0.200)
Moderately Important	3	1/3 (0.333)
Equally Important	1	1(1.000)
Preference between the above range	2,4,6,8	

After constructing the matrix, relative weights for each factor can be obtained. First matrix must be converted to a normalized matrix and then standardized Eigen vector must be extracted from the normalized matrix. The calculated Eigen vector can be interpreted as the weight, or importance of specific criteria relative to all other criteria. If cell value is C_{ij} (i-row, j- column) and derived weight is denoted by W_{ij}, Equation 1 can be applied for calculating weights.

$$W_{ij} = \frac{\sum_{j=1}^{n} \frac{C_{ij}}{\sum_{i=1}^{n} C_{ij}}}{n}$$

The consistency check is an important part of the study in order to verify the consistency of data. To do that principle Eigen value (λ max) is needed. First consistency vector (CV) for each individual row is calculated by multiplying pair-wise matrix with the weight matrix. λ max is obtained as the average of CV values. Consistency index (CI) must be computed by using Equation 2.

$$\text{Consistency Index } (CI) = \frac{\lambda \max - n}{(n-1)}$$

The consistency Ratio (CR) is calculated in a systematic approach by using Equation 3.

$$\text{Consistency Ratio (CR)} = \frac{\text{Consistency Index (CI)}}{\text{Random Consistency Index (RI)}}$$

If the value of CR is smaller than 10% or equal 10%, the consistency is acceptable. If value is greater than 10%, it is needed to revise the subjective judgment.

2.6 Opinion Survey Techniques

This study is mainly based on opinions of experts in the aviation industry. Most used techniques for conducting opinion surveys are brainstorming, Delphi method, and interviews (Sekaran, 2003).

Brainstorming is a method for generating ideas to solve a problem. It is done by group of people under the direction of a facilitator. The advantage of having brainstorming is that participant has free environment to provide their ideas and come up with broader solution with other members of the group. The Delphi method is a question and answer session between panel of experts. The experts answer questions two or more times. After each session, facilitator provides a summary of the experts' opinion. Then they can change their previous answer/judgement/ opinion. After few rounds of questions, they come up with the best solution. This is mostly used on forecasting. An interview is a conversation where questions are asked and answers are given.

All can be done by using structured and unstructured way. For this research brainstorming was done in the beginning to identify the factors to develop Airport City Effectiveness Criteria. Four interviews were conducted in different stages. First interview was done for factor analysis. Second Interview was done for ranking the importance of seven factors. Third interview was carried out to weight ACEC KPIs. Final interview was done to evaluate effectiveness of BIA for becoming an airport city. Questionnaires were used for the second third and fourth interviews and structured questions were utilized for first interview.

Third objective of this research is to evaluate the potential of becoming airport city by utilizing developed airport city effectiveness criteria. BIA is considered as case study based airport for evaluating against criteria and it is necessary to identify BIA current status before evaluating. Not only BIA, but also a country's status to welcome the new concept of airport city. Section 2.7 describes about BIA's current status and the Sri Lankan context.

2. 7 Case Study based Airport - Bandaranaike International Airport

Bandaranaike International Airport (BIA) is the main international airport in Sri Lanka. BIA experienced nearly 10 million passenger traffic in 2017. There is a positive sign for international traffic for BIA and it is medium size airport with compared to passenger movements. BIA is located in Katunayake, 35 km away from Colombo. Figure 2.2 shows the location map of BIA. Airport and Aviation Services (Sri Lanka) Ltd is the operator of BIA and BIA is the hub of Srilankan Airlines, the national carrier of Sri Lanka.

BIA has a single runway (04/22) with 3350m length and 60m width. In year 2016, 41 scheduled airlines have used BIA, flying to and from and it covers 45 cities around the world (AASL, 2016). International Flight movements of BIA for the year 2016 recorded a total of 61,637. BIA is a home for Sri Lankan Airlines, British Airways, AirAsia, Indian Airlines, Condor, Qatar Airways, Cathay Pacific Airways, Emirates and Jet Airways and etc.

BIA is a house for nearly 150 tenants and following are the tenants which are categorized in to their main business.

- Aviation Fuel Suppliers
- Food and Beverage Concessions
- Various Shops
- Banks and Foreign exchange
- Airline Catering Services
- Taxi Services
- Car Rentals/ Car Parking
- Airport Advertising
- Airport/ City Transport Services

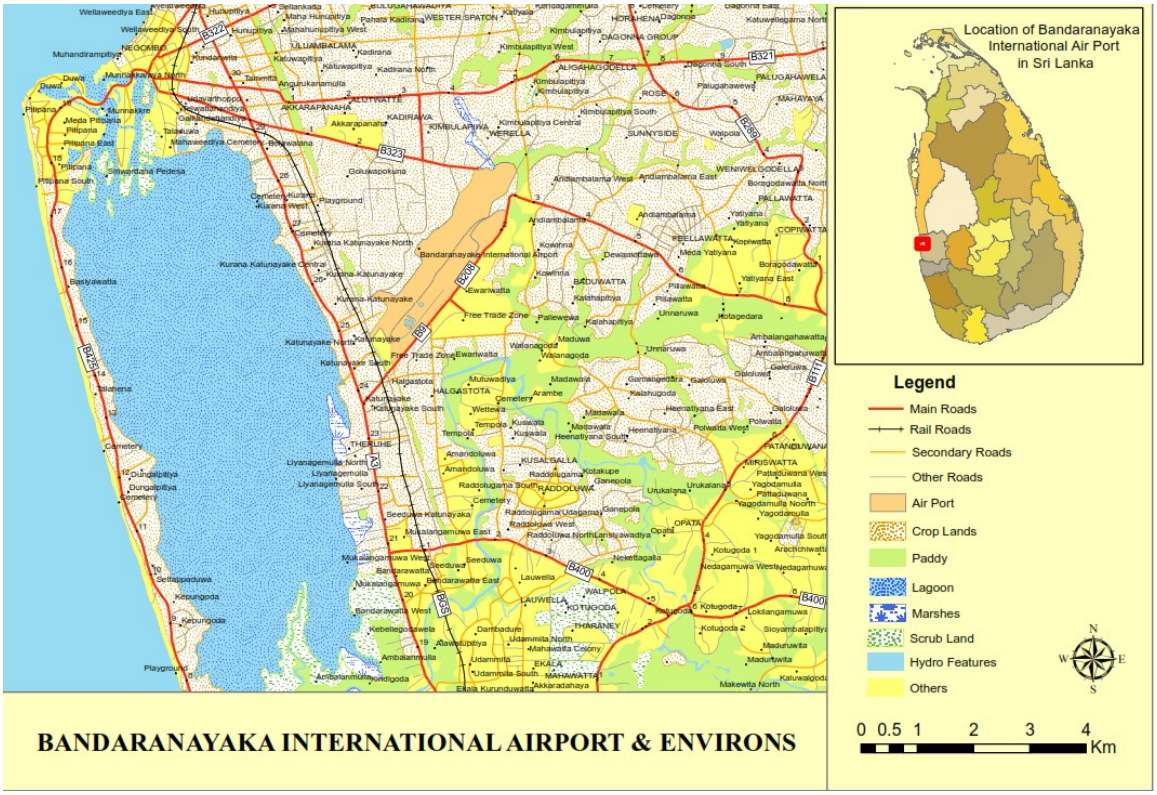


Figure 2.2: Location Map of Bandaranaike International Airport

- Duty Free Shops (Liquor and Tobacco, Perfume and Toiletries, Watches, Optical and Electronic Equipment)
- Petrol/Automobile Service Stations
- Hairdressing/Barber Shop
- Hotels/Motels
- Freight Consolidators/Forwarders or Agents
- Souvenir Shops

2.7.1 Key Performance Indicators for BIA

All international passenger and cargo movements were handled by Bandaranaike International Airport since year 2013. Government established Mattala Rajapaksa International Airport (MRIA) as second international airport and due to the political issue its operations were shut downed on January 2015. Again BIA is the sole operator in international travel. Table 2.4 illustrates the key performance indicators of BIA as an international gateway. Completion of civil war was a blessing for international traffic. Sri Lanka is a famous for tourist destination. From BIA's traffic, 80% of the traffic encountered by local people. 20% of the traffic was generated through foreigners. From 1995 to 2009, due to the civil war tourism industry failed totally.

Table 2.4: Key Performance Indicators of BIA

(Source: Annual Report AASL- 2016)

Item	Performance (2016)
Total Air Traffic Movements	9,466,248
Cargo (Metric Tons)	248,347
Aircraft Movement	61,637
Overflying Movements	35,118
Total No. of Employees (As at Dec 31st)	3,810

Demand is a main factor for being an airport city. BIA is approaching its passenger handling capacity which is 10 million passengers per annum. In the year 2017 it handled 9.5 million passengers. It is a positive trend towards passenger demand. BIA has single runway and it can handle 25 aircraft movements per hour (landing and takeoff both). BIA is a home for forty (40) airlines.

2.7.2 Connectivity with other modes of transport

Airport is a multi-modal hub and airport access modes plays vital role in airport city. Therefore, it is crucial to have a good connectivity with other transport modes as an airport. To have better connectivity with BIA, a passenger train service was launched between the Airport and Colombo Secretariat Station as a part of airport development program. Colombo-Katunayake Expressway (E03) is one of the new high-speed roads linking the airport to Colombo, which was launched in year 2013.

2.7.3 Expansion and Developments of BIA

As discussed in section 2.7.1, BIA is reaching its maximum terminal handling capacity. Always there should be a room for expansion when we are dealing with growing aviation business. Currently, BIA is on-going with development projects and new constructions. It is expected to double the passengers to 20 million passengers per year. Thus it moves steadily towards becoming an aviation and commercial hub. BIA is expecting to have its second runway to support the Airbus A380, a further eight passenger gates, a domestic terminal, a five storied car-park, and a five-star hotel neighboring the airport. The new proposed passenger terminal building has separate arrivals and departures vertically, with 08 boarding gates and 14 passenger boarding bridges with a dedicated gate comprising two passenger boarding bridges for the operations of the new Airbus A380.

There would also be a remote apron and an additional nine parking stands to ease air traffic movements. There would be a tax free apparel shopping mall at the Katunayake Board of investment (BOI) Zone to attract more business visitors to Sri Lanka. The tax free shopping mall is to be located adjacent to the arrival terminal and connected by a sky bridge. Further, AASL is expected to add a transit hotel of 24 luxury rooms and equipped with a spa, massage and aromatherapy facilities commitment to enhance the commercial

facilities housed in the terminal buildings in order to infuse greater comfort and promote a more rewarding shopping experience to passengers.

Additionally, to have an express speed train, construction will commence from BIA Terminal 2 to Fort railway station at Colombo railway station. It will run 30 km. Trains will leave every 15 minutes for the 15-minute journey. Trains depart from BIA Terminal 2 station. Further a sea plane in Seeduwa Daadugam Oya near the airport is using for travelling inside the country in Sri Lanka (Aero City Master Plan- 2014).

BIA is main international gateway for international travelers. Country's status matters for tourist attraction and also all the foreign investments. Therefore, section 2.7.4.1 will describes country's status for welcoming international travelers and tourist sector performances.

2.7.4 Key Socio-Economic Indicators of Sri Lanka

After civil war completion on May 2009, socio-economic indicators of the country were gradually increased. Since transport is a subsidiary industry in Sri Lanka, government influence on decision making is immense. Aviation industry is monopolistic market in Sri Lanka. Aviation product is much more expensive than land transportation and it need more financial power to obtain the service to the passengers. Therefore, socio economic indicators are directly influence to the aviation business. Table 2.5 represented the key economic indicators of the country in the year 2016.

Population is an important parameter for trip generation. Population of the country is 21 million and it is increasing at a rate of 15.2 per 1000 persons. GDP growth rate is decreasing after year 2015 and deflation is 8.2. Aviation is dealt with international traffic and it is highly dependent of foreign currency. Deflation can be effected value of

currency over time. Therefore 2016 data of socio economic indicators are negatively influenced to aviation industry growth.

Table 2.5: Key Socio Economic Indicators of Sri Lanka
(Source: Central Bank Annual Report-2016)

Indicator	Value
Population (# of Persons)	21,444,000
GDP (Rs. Billion)	13,289
GDP Growth Rate (%)	3.1
Deflation (%)	8.2
Unemployment Rate (%)	4.2
Mean household income (Rs.)	62,237 per month
Literacy Rate -Average	93.1%

Aviation product is expensive; therefore, consumer has to have a high buying power. Mean household income had increased in the year of 2016 and it is a positive trend for the industry itself. Increasing living standard of the people of a country will tend to generate more personal trip than earlier. Literacy rate of the country also increased and it is 93.1%. Literacy of people of a country is valuable and influential parameter for international traffic.

Aviation industry of Sri Lanka is administrated by Ministry of Transport and there are three bodies to facilitate the service. Airport and Aviation Services Sri Lanka Limited (AASL) is doing its business as an operator. Civil Aviation Authority of Sri Lanka

(CAASL) is acting as a regulator and Sri Lankan Airlines Limited is operating as a service provider.

Sri Lanka attracted around one million tourists in 2012 by accessing the target of 950,000 with an increase of 17.5 per cent since the year 2011 records 855, 975 tourist arrivals. BIA placed in 16th in Top 25 fastest growing Airports in 2010 while being 226th of world rank. Sri Lankan Airline (pvt) Limited plays huge role as a national carrier at BIA. Following Table 2.6 represented the performance of Sri Lankan Airlines.

Table 2.6: Key Performance Indicators of Sri Lankan Airline
(Source: Sri Lankan Airlines Annual Report 2016/17)

Item	Performance (2017)
Revenue Per Kilometers (Mn)	12,455.05
Available Seat Kilometers (Mn)	15,608.10
Available Ton Kilometers(Mn)	2,167.92
Passenger Load Factor	79.80%
Overall Load Factor	68.05%
Aircraft Fleet	24

Passenger load factor is 79.80% and it clearly indicates the fine operational efficiency of the SLA. Overall load factor is reduced due to the cargo efficiency and it is the area that management should alarm on. In the year 2016 there was only twenty-one (21) aircraft fleet and it increased to twenty-four (24). Aircraft fleet is Airbus and it contains A320, A321, A330 and A320neo to facilitate better and uninterrupted service to the passengers. According to the Tourism Development Authority and Tourism Board Sri Lanka**,** tourism industry contribution to GDP (Gross Domestic Products) is closed to 2.5% in

2013. It can be compared with Malaysia, Vietnam and Singapore by 12.5%, 7.5% and 5% respectively. Sri Lanka is targeting to increase contribution by 5% in coming years. Sri Lankan tourism industry holds the position as the third largest foreign exchange earner to the country (Tourism Development Authority, 2013). It remains USD 1.7 billion after overseas remittances, (USD 6.4 billion textiles) and apparel exports (USD 4.5 billion).

CHAPTER 03

3.0 RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the methodology adopted to achieve outcome which was expected on three research objectives. It described the research area, types of data, data sources, and data collection process and data analysis techniques.

3.2 Research Boundary

Airport city is aimed to develop aviation and non-aviation activities at airport and its surrounding. Therefore, it is essential to consider land side (access interface) to air side (flight) for developing criteria for being Airport City. Section 2.2.1, it is discussed Amsterdam Schiphol Airport City (AMS) Conceptual Framework, like that for this research airport inside fence and outside fence also concerned. Figure 3.1 shows the research boundary which considered producing better outcomes of the research.

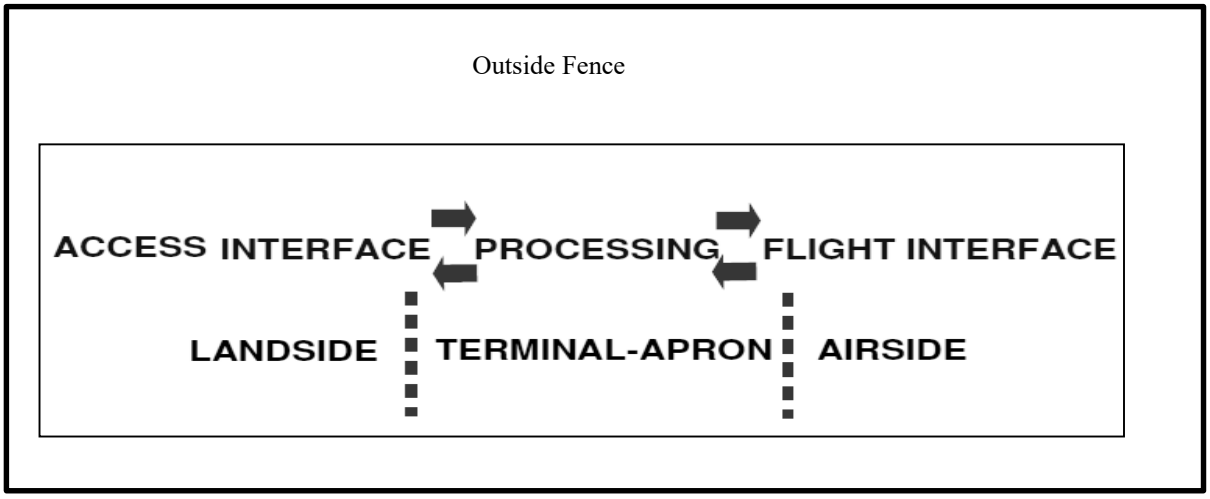


Figure 3.1: Research Boundary

In this research, some of the air side activities are not considered. It meant apron and air side activities were ignored for the research. They are not directly influence to airport city concept. Although Aircraft movements are considered as airside activity, it is considered for the research under demand factor (one main factor in Airport City Effectiveness Criteria).

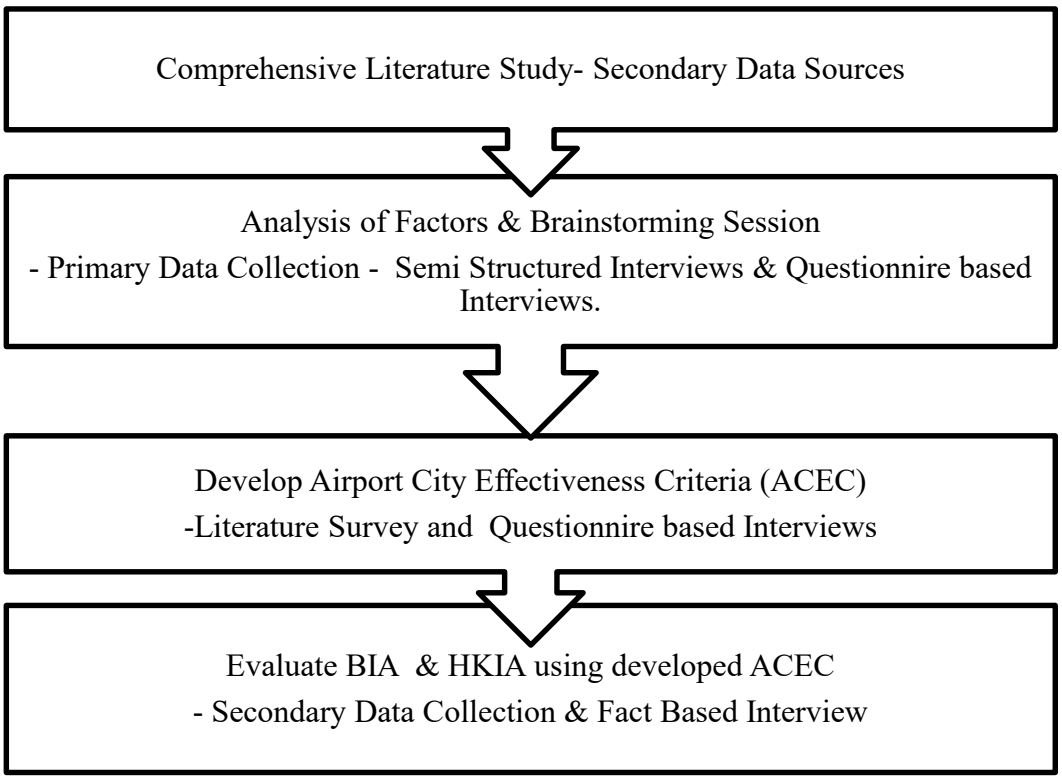


Figure 3.2: Research Process

3.3 Research Process and Data Collection

Figure 3.2 describes the research process adopted to achieve the research outcome. Inductive approach is used to start with the data collection through literature (secondary data). The secondary data is defined as an available data which was collected for documentary purposes. The data which are available at Department of Census, research papers, newspaper articles, statistics, etc. are come under secondary data category. Literature, which related to airport city concept, worldwide examples and statistics related to socio economic factors and key performance indicators were searched (Figure 3.3). The identification of all relevant key factors was done through a comprehensive literature survey. And also airport city related research papers, newspaper articles, annual reports of airports, airport master plans and airport web site information were referred as comprehensive literature survey. While reading, information which are relevant to measure effectiveness of airport and also relevant to this research was extracted. Referred literature was processed in chapter 2: Literature Review and in Appendix 1.

3.3.1 Comprehensive Literature Study and Factor Analysis

Over twenty-five (25) research articles were referred to identify the airport city drivers to be an airport city as discussed in section 2.3. The detailed summary of these airport city drivers are in Appendix 1 it is provided extracted information, title of the paper, authors and year of publication. As mentioned above, literature summary table was developed by referring published research articles.

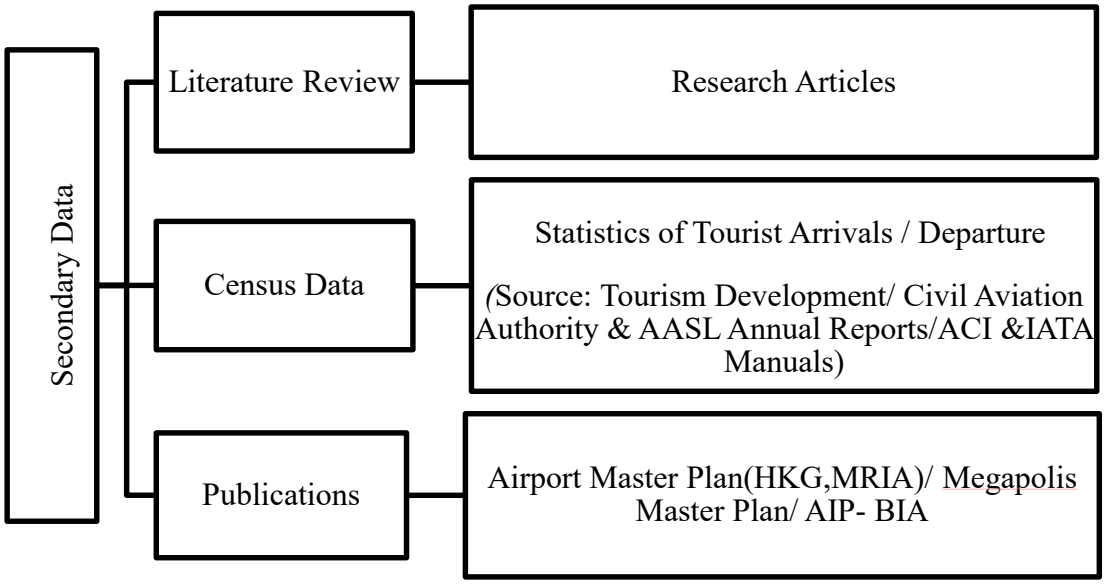


Figure 3.3: Secondary Data Collection

For the factor analysis, industry experts were involved. Factor analysis was conducted to identify and finalize the factors which considered as backbone of airport city effectiveness criteria. Develop airport city effectiveness criteria is second objective of this research.

The airport city drivers which are listed in Table 2.1 (Appendix 1) are general and there are repetitions of the information as well. To align those to airport city effectiveness criteria, aviation industry experts' views were solicited. A convenient sampling technique was used to select industry experts. Airport managers, aviation policy makers, regulators, executives in aviation industry are included in the sample (Figure 3.4). Face to face interview was carried out with experts.

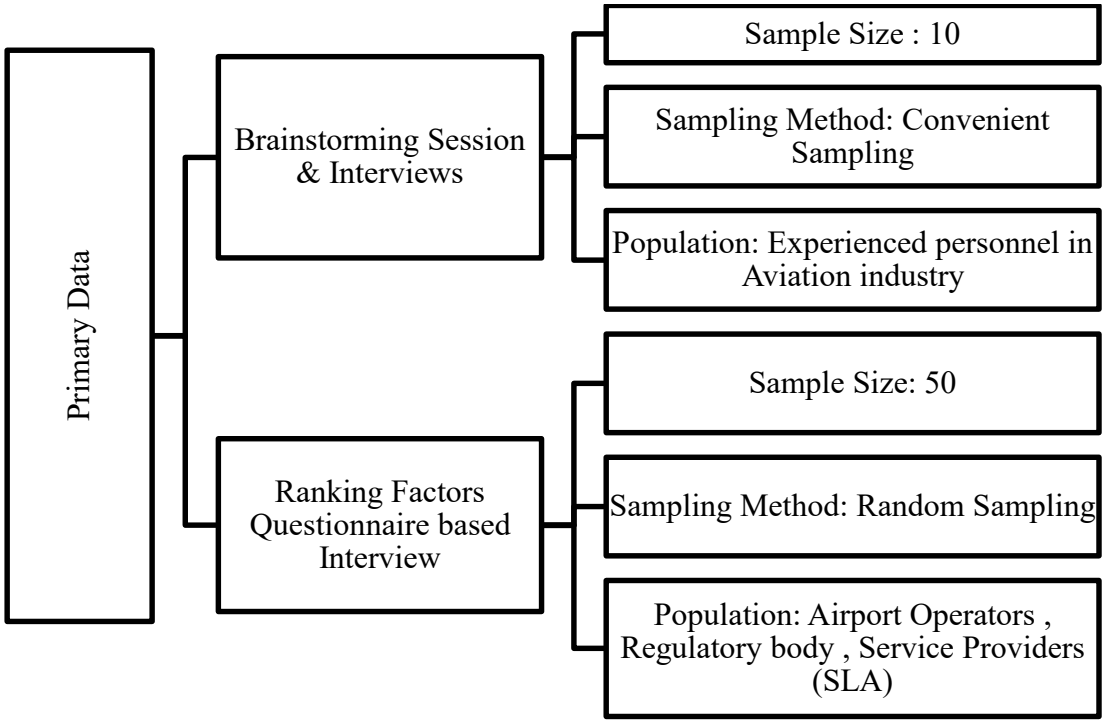


Figure 3.4: Primary Data Collection

The sample of expert resource persons selected is having more than 15 years of experience in the aviation industry. They were asked to screen the airport city drivers identified from the literature and come up with important factors to be considered when airport is planning to become an airport city. Therefore, with having clear background, resource persons were asked to align the identified airport city drivers for developing the criteria. Initially they were asked to carefully analyze the identified airport city drivers from literature. Then they were asked to pool airport city drivers in to different groups according to their similarity and their relationship. Majority of the resource persons identified that some airport city drivers were highly depended on each other about their judgments.

By considering relationship and interconnection all airport city drivers were pooled in to sub sets and then started the brainstorming session with same set of resource persons.

Researcher acted as a facilitator for brainstorming session. Resource persons provided their inputs, ideas and suggestions towards the sub sets. At the end of brainstorming session, it is finalized seven (07) factors for developing airport city effectiveness criteria.

After finalizing seven factors, next step is to rank the importance of those factors. For the ranking, questionnaire based interview was conducted and as discussed in section 3.4. By using AHP, ranking was done and final output of the ranking is to calculate the weight of the factor. Weight of the factor will be used to calculate the effectiveness of particular airport. It will discuss in detailed in section 4.3.

3.3.2 Developing an Airport City Effectiveness Criteria (ACEC)

Finalized seven factors were used to develop Airport City Effectiveness Criteria (ACEC) namely non- aeronautical activity centers, geographic location, demand, nature of the airport, access modes, business management and technology. This Criterion is mainly focused to evaluate an airport, the degree to which is successful to become an airport city.

The methodology followed for developing Airport City Effectiveness Criteria (ACEC) is,

i. Identify the key performance indicators (KPIs) to measure each factor

To measure each factors, there should be a method. Key performance indicators were used as parameter to evaluate factors individually. Key performance indicators were identified by using framework. Figure 3.5 illustrates the framework used to identify KPIs. Framework was developed according to the comments made by industry experts and referring literature on airport cities. Airport Council International had introduced guide to airport performance measures and it was highly concentrated when identifying KPIs. Identified KPIs for seven factors separately discussed in section 4.4.1.

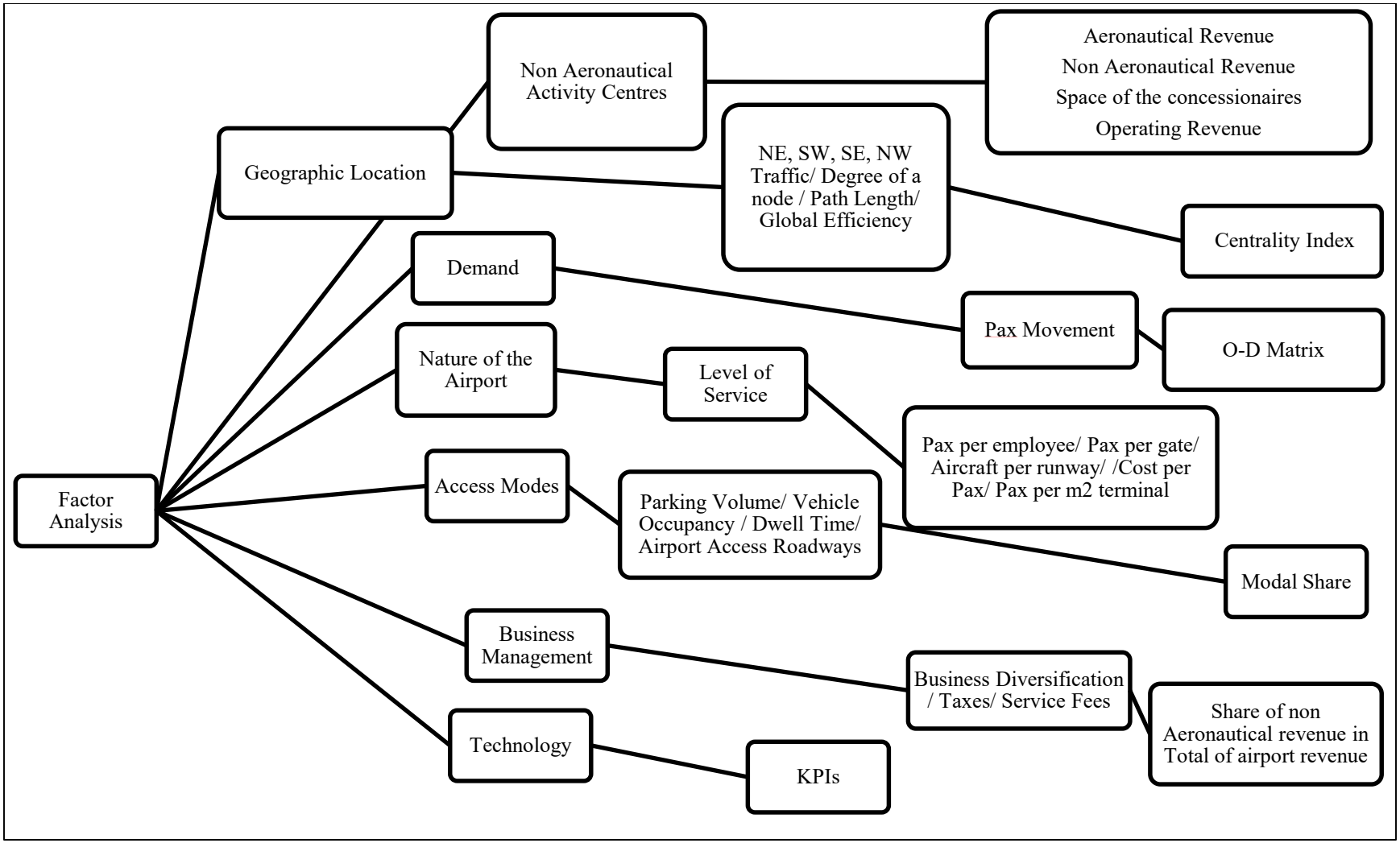


Figure 3.5: Evaluation Framework

ii. Identify Sub Measures to evaluate each KPI

KPIs are the measures to evaluate ACEC seven factors. Key performance indicators are useless without having evaluation. Therefore, sub measures were identified for each KPIs to evaluate their performances. Sub measures are used to evaluate KPIs. All Sub measures were discussed in section 4.4.1.

iii. Assign weights for each KPI

Industry experts were asked to go through each KPI under each factor. And also it is asked them to carefully analyze sub measures as well. Pairwise comparison table was given to them to compare the KPIs. Final value was considered as weight for each KPI. Process which was utilized to weight KPI will be discussed in section 4.4.2.

iv. Evaluate particular airport by assigning a score out of weighted value

Decision makers from the Industry which consisted of board of directors and senior managers were asked to assigned final score for the KPIs under ACEC. They have given fact sheets with having information related to each factor, KPIs and Sub measures for BIA and HKIA. HKIA is used as a control for them to have an understanding about current airport city. Fact sheet was developed by carefully analyzing data of case study based airport (BIA) by utilizing same framework used under KPI selection. HKIA is performing well as established airport city and BIA has many lesson to learn from HKIA. Process which was utilized to weight KPI will be discussed in section 4.8. Detail discussion of the ACEC will be discussed in Chapter 4: Research Findings.

3.3.3 Evaluating Case Study Based Airport: Bandaranaike International Airport, Sri Lanka

Case study based airport for the research is Bandaranaike International Airport (BIA) in Sri Lanka. Therefore, BIA is evaluated by using developed Airport City Effectiveness Criteria (ACEC). As mentioned in section 3.3.2, HKIA is used as a control. Field visits were done to get familiar for the activities followed by the airport. BIA fact sheet was developed by using the data gathered from literature and interviews which are discussed in earlier sections. For HKIA, all the data gathered from HKIA annual report 2017 and

their published master plan. All the data gathered to evaluate BIA for being airport city is carefully analyzed by using framework with different techniques (Figure 3.5) and evaluation of BIA against developed ACEC will discuss in section 4.5.2.

3.4 Data Collection Technique- Questionnaire

Questionnaire A (Appendix 2), is used as a second part of the primary data collection to rank the seven factors. Questionnaire consists of two sections, section A and Section B. Section A is aimed to rank main factors and Section B is aimed to rank KPIs. Section A and B of the questionnaire was given to airport operators, regulators and service providers in two stages at the research process.

Respondent (Section A) was asked to compare two factors at the same time since the data analysis will be done by using AHP technique. There are 21 pairs to compare and rank by using 1-9 scale which shows in Table 2.3 in section 2.5. Additionally, they were asked to specify the perspective towards Airport city concept and the seven factors. The method followed for the analysis is discussed in section 2.5. Section B of questionnaire was used after airport city effectiveness criteria (ACEC) was developed and respondent was asked to compare KPIs. Details of the interviews and analysis will discuss in section 2.6.

3.5 Data Analysis Technique-Analytical Hierarchy Process (AHP)

In this research, decision making is crucial with experts' perceptions in number of alternatives. Therefore, AHP model is used for this study. Details of the AHP was discussed in section 2.5. Calculated Eigen vectors are used as weights of the factors and weights of the KPIs in Airport City Effectiveness Criteria.

3.6 Sample Selection

For this research four interviews were conducted in different stages. First interview was done for factor analysis and brainstorming session. Resource persons were selected by

using convenient sampling techniques and random sampling techniques (Figure 3.3). Convenient sampling was used for the interviews and sample size is ten (10) experienced personnel in aviation industry. Second Interview was done for ranking the importance of seven factors. Random sampling was used for the questionnaire survey and sample size is fifty industry persons. That sample was consisted airport operators, regulatory bodies and aviation service providers. Third interview was carried out to weight ACEC KPIs. Random sampling technique and the sample size is 50. Final interview sample was selected by utilizing stratified sampling technique because it is based on decision making personnel in Aviation Industry. Table 3.1 represented the summary of interviews carried out with population, sample size, sampling technique and output.

Table 3.1: Interviews with Sample

Interview	Output
1. Brainstorming Session with experienced personnel in Aviation Industry Sample Size: 10/ Sampling Method: Convenient Sampling	**Define seven (07) factors** for the research
2. Questionnaire based interviews with industry experts including airport operators, regulators, service providers - Sample Size: 50/ Sampling Method: Random Sampling Method of Ranking : AH*P*	**Weight Factors in ACEC**
3. Questionnaire Based Interview weight each factor with industry experts including airport operators, regulators, service providers - Sample Size: 50/ Sampling Method: Random Sampling / Method of Ranking : AHP **4. Fact Based Interview** Stratified Sampling- Top Managers and Board of Directors -34 Sample Size	**Weighted KPIs in ACEC** **Score BIA Performances**

CHAPTER 04

4.0 RESEARCH FINDINGS

4.1 Introduction

The earlier chapter was focused on the methodology of this research in detailed manner. This chapter is mainly focused on the findings that were gathered throughout the research by utilizing discussed methodology.

4.2 Seven Factors

As discussed in research methodology (chapter 3), secondary data and primary data were obtained to develop seven factors for the research. Secondary data was gathered to collect information regarding airport cities, to check how they are functioning and to identify the airport city drivers. Chapter 2 and Appendix 1 show all the data gathered from comprehensive literature study. Brainstorming session was carried out to finalize the seven factors with industry experts. Resource persons for the session have considered all the data gathered from the literature and their experience related to aviation industry. Seven factors were the backbone of the criteria which is the main output of this research. Seven factors were defined at the end of the brainstorming session and definition of each factor is given below.

A. Non- Aeronautical Activity Centers

Commercial orientation is main driver for an airport city. Therefore, this is the key element to fulfill to be an airport city. To encourage customers, it should be given priorities to logistic parks, conference centers, free trade zones, office parks and office corridors, exhibition and conference centers, hotels, entertainment, retail clusters, academic and research clusters. From this factor, it is considered how airport is facilitating non aeronautical activities aligning with airport customers' main functions.

B. Geographic Location

This refers the location where particular airport is located. Approachability to the airport, air routes around the area, neighbor countries, airway distance, overflying are the most important aspects in geographic location. Different land uses of the nearby areas are also identified as geographic location.

C. Demand

This refers all airport users like passengers including arrival, departure and transfers, employees, visitors, government agency representatives and concessionaires. Space and infrastructure which is facilitating all the needs of the users are also included. Forecasted demand also concerned in this factor.

D. Nature of the Airport

This refers current status of the airport. Its current capacity and the maximum capacity, infrastructure availability, future development and performance of the airport also considered here, because when converting to an airport city, airport performances are very much important.

E. Access Modes

This explains the multimodal connectivity from and to airport. Dedicated expressway links (Aerolanes) and high speed rail (Aerotrains) should be there to provide accessibility with mobility. Modal share also considered in this factor.

F. Business Management

This refers the relevant laws and regulation about airport city development. Aviation policy of the country should be directing airport city concept. Management concept of the airport should be innovative, profitable and flexible to being airport city. Air traffic right, investment opportunities and international image will generate more traffic towards airport city.

G. Technology

This explains integrity, flexibility and advancement of the technology that airport is currently using and identify its potential to manage airport city status. Air Transportation relies much on high technology support. Therefore, technology plays a key role for passenger handling, cargo flow, functions of airport facilities and the environment. Real time information sharing is also depended on technology.

4.3 Ranking Importance of Seven Factors

It is essential to know how much each factor is weighted comparing with each other. And also this weight is considered as weight of the factor for calculating effectiveness of each factor in ACEC. As discussed in section 3.6, Analytical Hierarchy Process (AHP) was consumed to rank the order of importance of each factor. New sample was used for the ranking survey because this is highly focused on this study.

Pair wise comparison of seven factors was done by industry experts and 21 pairs were compared. Integrated value for entire sample had been taken as the input for the matrix. Questionnaire (Appendix 2) is used for the pair wise comparison. Respondent were informed in advanced about the intention of this study and all seven factors were discussed before responding to questionnaire. Fifty (50) respondents were evaluated and sample of the respondents consists of airport operators, regulatory body, and service providers.

Normalized matrix which was developed by using average value of responses is given in Appendix 3. Following results were obtained when calculating consistency check.

Principal Eigen Value = 7.64 Consistency Index (CI) = 1.08

Random Consistency Index (RI) = 1.32 The Consistency Ratio (CR) =0.08

If the value of CR is smaller than 10% or equal 10%, the consistency is acceptable. If value is greater than 10%, it is needed to revise the subjective judgment. Calculated CR value is 0.082, which is smaller than 10% or equal 10%. That meant data is consistent and results can be accepted from this study. Table 4.1 represents the summary of the results which is used for ranking the factors.

Table 4.1: Summary of the AHP results

Rank	Factor	Percentage of Importance
1	Non- Aeronautical Activity Centers	28.4
2	Geographic Location	22.9
3	Demand	18.1
4	Nature of the Airport	13.7
5	Access Modes	8.1
6	Business Management	7.1
7	Technology	1.6

According to the Table 4.1, "Non Aeronautical Activity Centers" has highest priority vector with obtaining 28.4%. Airport city concept is highly concentrated on non-aeronautical activities. Especially duty free shops, logistic arks, shopping complexes, restaurants, hotels and conference room for their passengers are the main target of having aerotropolis. Therefore, airport must give priority for its non-aeronautical activities and it will be a good advantage for being a competitive airport city. The result of the analysis shows that "Non Aeronautical Activity Centers" is the most important factor for being

airport city. Decision makers must give most priority for this factor when developing their action plan.

"Geographic Location" is the second important factor for being airport city and it accounts 22.9% importance from other factors. Geographic location is very much important to attract passengers. Approachability to the airport, air routes around the area, neighbor countries, airway distance, overflying are added value to the airport city. Third highest factor for being aerotropolis is "Demand" and it has 18.1% importance. As explained by interviewer, demand is dependent on geographic location and non-aeronautical activities. Destination choice which airport should be selected to land is based on passenger perception. For the business travelers they do not have options but for leisure travelers they have option to select airport. Not only arrival and departure passengers, transfer passengers also consider facilities and geographic location before their choice. Facilities must be adequate for fulfilling all passenger expectation.

"Nature of the Airport" is the fourth factor to be considered. Investigation of current capacity of the airport and its performances is highly depended to be an airport city. Not only current capacity, evaluating potential or productivity of the airport must be concerned. Then it is easy to build up achievable targets. "Access modes" is fifth factor to be considered and it will affect for the passenger perception of the airport and the country. If passenger had negative impression towards airport accessibility, they will think twice before placing tickets. Passenger values his or her time because time is very expensive in modern world. By improving mobility, customer demand can be improved.

"Business Management" is a sixth factor and it refers the laws and regulation about airport city. After identify the feasibility for being an airport city, management concept should be developed. Investment opportunities are highly affected for the non-aeronautical activities and there should be free trade zones to encourage suppliers. Reducing taxes will be a positive strategy to attract customers. The least important criterion is "Technology". Although respondent of the pair wise comparison selected it as a least factor with compared to others, technology must be blended with all the

operations. Since technology is influencing to all the operations. It must be advanced and flexible to any user to operate.

4.4 Airport City Effectiveness Criteria (ACEC)

In aviation industry, there is no criterion to evaluate the effectiveness of airport for being an airport city. Second objective of this research is to introduce Airport City Effectiveness Criteria. Seven factors were used as backbone for the ACEC. It investigates the effectiveness of current practices of the airport functions and its' potential to be airport city (aerotropolitans). According to the order of importance, it will discuss all the factors one by one. Key Performance Indicators were identified by using

- Guide to Airport Performance measures – Airports Council International (2012)
- Resource Guide to Airport Performance Indicators – Federal Aviation Administration (ACRP Report 19A)

4.4.1 Identify the Key Performance Indicators (KPIs) and Measures

4.4.1.1 Identify the KPIs and Measures for Non Aeronautical Activity Centers

Key Performance Indicators were defined for main seven factors and also sub measures were defined to evaluate each KPI. Three main key performance indicators were identified as evaluators for non-aeronautical activity centers namely; industry revenue, number of terminal users and revenue sources. There are measures to evaluate KPI like aeronautical revenue per passenger, non-aeronautical revenue per passenger and so on. Table 4.2 represented the non-aeronautical activity centers KPIs. As discussed in section 3.3 framework (Figure 3.5) was utilized when selecting KPIS.

Table 4.2: Non Aeronautical Activity Centers KPIs

A	**Non Aeronautical Activity Centers**	
	KPI	**Measures**
A.1	**Industry Revenue**: This includes the airport financial strength. Aeronautical Charges: Charges for services or facilities directly related to the processing of aircraft and their passengers and cargo in connection with facilitating travel. ICAO approved user charges by airports are; Aircraft landing/ take-off charges, Passenger service charges, Lighting charges, Security charges, Aircraft parking charges, Infrastructure charges, Aero bridge charges, Cargo Charges, Fuel Charges, Hanger Charges, Environmental Charges, Air Navigational Charges. **A.1.1 Aeronautical Revenue per Passenger** It measures for a year and it is sensitive to changes in the level of passengers. It used to have overall picture of the revenue. **A.1.2 Aeronautical Revenue per Movement** Average of aeronautical revenues collected per movement for use of airfield, gate charges, terminal space, passenger related chargers, ground handling revenue. This excludes air traffic control fees and facility renting for ancillary buildings (maintenance hangers and cargo buildings) **Non Aeronautical Charges:** Charges related to the ancillary commercial services, facilities and amenities available at an airport. Concession fees for aviation fuel and oil, Concession fees from commercial activities, Revenue from car parking and car rentals, Rentals for airport land, space	

A	**Non Aeronautical Activity Centers**	
	KPI	**Measures**
	in buildings and equipment, fees charged for tours and admissions, fees derived from provision of engineering services, utilities, advertising, consulting services, education and training services, management contract of other airports, equity investments in travel related or other ventures, equity investments in other airports. **A.1.3Non Aeronautical Revenue per Passenger** This measures for a year and it drives with the degree of competition between vendors, commercial opportunities and natural resources of site. **A.1.4Non Aeronautical Operating Revenue as percent of Total Operating Revenue** It measured over the course of a year.	
A.2	**Number of Passenger per Terminal** This includes the passengers who enter to the duty free area after the check-in has done. They are the one who really entertains the non-aeronautical activity till board to the aircraft. **A.2.1 Arrival (Local/ Foreigners)** **A.2.2 Departure (Local/ Foreigners)** **A.2.3 Transit**	

A	**Non Aeronautical Activity Centers**	
	KPI	**Measures**
A.3	**Revenue Sources:** This includes the performance of commercial functions of the particular airport. **A.3.1 Capital Stock** Total amount of a firm's capital. **A.3.2 Sales** This is applicable for all commercial services at airports. This sale generally limited to terminal concessions. High gross sales may not translate into high revenue to the airport depending on the airport's contractual arrangement with the concessionaires. It can be measures annual and monthly. **A.3.3 Gross Turnover** This refers the amount of assets or liabilities that a business cycles through in comparison to the sales level that it generates. **A.3.4 Choice of shopping** Variety of the concessioners is considered in here as their main business purpose.	

4.4.1.2 Identify the KPIs and Measures for Geographic Location

Two main key performance indicators were identified as evaluators for geographic location namely; air network and land use. There are measures to evaluate KPI like choice of destination, route stability, and total area and so on. Table 4.3 represented the geographic location KPIs.

Table 4.3: Geographic Location KPIs

B	**Geographic Location**	
	KPI	**Measures**
B.1	**Air Network:** This is a competitive advantage for aviation business. This measures the strength of an air network to facilitate the business. **B.1.1 Choice of Destination**: Number of Destination **B.1.2 Route Stability (Impediment Value)** Measure of spatial resistance was calculated to identify the ease of movement within the network **B.1.3 Airline Concentration: Number of Airlines** **B.1.4Availability of Direct Flights (Degree Centrality)** It can be defined as the proportion of nodes directly connected to the node in question out of the totality of nodes within the network. It measures the average minimum number of transfers. **B.1.5 Ease of Transit through Airport (Closeness Centrality)** It measures the ease of movement between a node and the rest of the network.	

B.2	**Land Use:** All the information related to land use of airport is evaluated in here. **B.2.1 Total Area** Total land area of the airport and its surrounding are considered. **B.2.2 Terminal Landside Area per Passenger** This measures average space for a passenger. Number of departure lounge, vehicle parking & capacity (vehicle count) is also considered. **B.2.3 Distance to District** This refers the average distance to the district center from airport entrance. **B.2.4Economic profile** This considers vendors of the airport and tenants who are doing their business at airport premises. **B.2.5Locations of the surroundings** Different land uses of airport surrounding are considered here. **B.2.6 Size of the Market** Local and international markets are referred.

4.4.1.3 Identify the KPIs and Measures for Demand

Four main key performance indicators were identified as evaluators for demand namely; passengers, employees, aircraft movements and cargo. There are measures to evaluate KPI like O-D passengers, passenger per employee, staff cost, aircraft movement per employee and tons of cargo handled and so on. Table 4.4 represented the demand KPIs.

Table 4.4: Demand KPIs

C	**Demand**	
	KPI	**Measures**
C.1	**Passengers:** This is the core indicator for all the airports to track the fundamental measures. Passengers including enplaning and deplaning are measured over the year. This drives airline route planning and pricing decisions. **C.1.1 Origin Destination of Passengers** Passengers whose air travel begins or ends at the airport measures over the period of time. **C.1.2 Passenger per Employee** This is a useful primarily benchmarking of all commercial airports. It measures employee productivity and level of service. **C.1.3 Operating cost per passenger** It measures the total cost divided by passengers. It is a useful measure for management decisions and level of service offered by the airport versus being left to individual airlines or vendors. **C.1.4 Passenger per m^2** It measures the total passengers divided by square meters. This is a useful measure for increase demand.	
C.2	**Employees:** All the workers in the airport are considered here.	

C	**Demand**	
	KPI	**Measures**
	C.2.1 Staff Costs It refers the all costs for maintaining staff.	
C.3	**Aircraft Movements:** Aircraft takeoff or landings at an airport measures over a year. **C.3.1 Aircraft Movements per Employee** Range of services provided by the airport, extent of outsourcing of airport functions, average aircraft size, airport flight volume and flight peaking profile and mix of carrier types can be measured by using this method. **C.3.2 Aircraft Movements per Runway** This refers the runway capacity and runway utilization can be measured of the airport. **C.3.3 Aircraft Movements per Gate** This is the airport gate capacity. This can be useful for airline schedule development and mix of traffic. **C.3.4 Operating Cost per Movement** It measures operating cost divided by movement over a year. This measure is useful for the management decisions. **C.3.5 Number of Aircraft Standing Positions** Capacity of the pier is considered from this factor.	
C.4	**Cargo:** Freight loaded and unloaded at the airport measures in n tones over a year.	

C	**Demand**	
	KPI	**Measures**
	C.4.1Tons of Cargo handled per Year Total amount (Tons) of cargo carried throughout the year. **C.4.2 Operating Cost per WLU (Work Load Units)** This measure of airport costs is influenced by multiple factors such as labor, contract services, maintenance and so on. **C.4.3 Airport Warehouse Space / Cargo Handling Facility Area** It measures the percentage of airport warehouse space over total space. It meant the occupancy of space for the storage.	

4.4.1.4 Identify the KPIs and Measures for Nature of the Airport

Three main key performance indicators were identified as evaluators for Nature of the Airport namely; capacity utilization, on time performances and level of service. There are measures to evaluate KPI like terminal handling capacity, gate departure delays, process capabilities, baggage delivery time and so on. Table 4.5 represented the Nature of the Airport KPIs.

Table 4.5: Nature of the Airport KPIs

D	**Nature of the Airport**	
	KPI	**Measures**
D.1	**Capacity &Utilization:** This is an important area since it reflects the airport performance to the user. **D.1.1 Terminal Handling Capacity** It measures number of passengers (Arrival, Departure, Transfer) that terminal can accommodate in the given period of time. There is a design capacity and the operational capacity for the terminals. **D.1.2 Practical Hourly Capacity** It measured by using maximum aircraft movements per hour. It is a largely a function of runway capacity which is determined by the number of runways, their configurations, and separation, taxiway access and capacity, air traffic system restrictions, weather and terrain, type and mix of aircraft, arrival / departure mix. **D.1.3 Airport Size** Maximum passengers that can be handled are categorized as small, medium and large airports.	
D.2	**On time Performances:** This refers the on time performance of the processes of the airport and by knowing that it can be facilitate high stand of services to the passengers. It measured from scheduled departure time at average and peak times. It is useful measure for all commercial airports since it influences airport capacity constraints, limited air traffic system capacity, airline scheduling practice, airline operational issues.	

D	**Nature of the Airport**	
	KPI	**Measures**
	D.2.1 Gate Departure Delay This refers average gate departure delay per flight in minutes. **D.2.2 Taxi Departure Delay** This refers average taxi delay for departing aircraft per flight in minutes. It measured by comparing actual taxi time versus unimpeded taxi time at average and peak times. **D.2.3 Process Capabilities** All the processes related to passenger movement and cargo movement can be measured in here like check in process, security checking process, baggage handling process etc.	
D.3	**Level of Service:** This refers how passengers perceive the level of service provided by the airport and also administrative efforts to provide the best service. **D.3.1 Baggage Delivery Time** This refers the average time for delivery of first bag and last bag. It is a measurement of ground handling operational performance, airline schedule practices, security screening issues and airport layout facilities and equipment. **D.3.2 Security Clearing Time** It measures the average security clearing time from entering queue to completion of processing. This is a useful measure for determine level of security staffing, types of screening technology used, screening procedures and number of units in operation.	

D	Nature of the Airport	
	KPI	**Measures**
	D.3.3 Check -in to Gate Time Average time from entering the check –in queue to arrival at the boarding gate. This is useful for all commercial airports especially larger airports since it has longer walking distances. **D.3.4 Customer Satisfaction** This can be measured by survey responses from the passengers. Customer satisfaction is driven by multiple factors; cleanliness, ease of way findings, variety of shops, comfort of terminal, reliability of escalators and moving walkways etc. Airport must understand what drives their customer satisfaction rating in order to take appropriate action. **D.3.5 Service Category** IATA level of Service category is considered here.	

4.4.1.5 Identify the KPIs and Measures for Access Modes

Three main key performance indicators were identified as evaluators for Access Modes namely; modal split, access cost and transport options. There are measures to evaluate KPI like means of transport, average monetary cost, and availability of public transport and so on. Table 4.6 represented the Access Modes KPIs.

Table 4.6: Access Modes KPIs

E	**Access Modes**	
	KPI	**Measures**
E.1	**Modal Split:** This measures the percentage of travelers using a particular type of transportation method to/ from airport. **E.1.1 Car** Number of cars (2 passengers) used for the travelling to Airport **E.1.2 Van** Number of vans (3to 6 passengers) used for the travelling to Airport **E.1.3 Bus** Number of bus (more than 7 passengers) used for the travelling to Airport **E.1.4 Roadway Vehicles** This measure the percentage of vehicles which occupied the road for reach to airport and the percentage of vehicles which enter to the roads from Airport.	
E.2	**Access Costs:** Generalized cost incurred for traveling to/from airport. **E.2.1 Average Monetary Cost** Monetary value for travelling to/ from airport. This can be illustrated as utility	

E	**Access Modes**	
	KPI	**Measures**
	monetary cost function. **E.2.2 Average Time Cost** Time value for travelling to/ from airport. This can be illustrated as utility time cost function.	
E.3	**Transport Options:** All transportation methods are available to facilitate the service is considered here. The possibilities traveler may evaluate before select the transportation method are considered here. **E.3.1 Availability of public Transport** This refers the public transport options available at the airport and distance they have to travel to catch the bus/ rail, facilities available to move baggage and so on. **E.3.2 Car Park Area** Reliability of car parking areas to keep their vehicles and the space provided are considered before using private vehicles to the airport. This method is called "Park and Ride". Curb Frontage in meters The area which is provided by the airport authority to drop and pick the travelers to the vehicle. This method called "Kiss and Ride". **E.3.3Taxi Availability** Availability of taxis at the airport premises, security and the reliability are considered when selecting the mode of transport.	

4.4.1.6 Identify the KPIs and Measures for Business Management

Four main key performance indicators were identified as evaluators for Business Management namely; capital invested, price of capital, policy decisions and tourist industry. There are measures to evaluate KPI like capital expenditure per WLU, retail concession revenue per passenger, partnerships and so on. Table 4.7 represented the Business Management KPIs.

Table 4.7: Business Management KPIs

F	**Business Management**	
	KPI	**Measures**
F.1	**Capital invested:** Total amount of money invested to facilitate the service. Productivity refers to the relationship of output to input. In here it is measured the productivity by using following measures. It is useful for understanding the investment opportunities and how to spend over results **F.1.1 Capital Expenditure per WLU (Work Load Unit)** This measure the utilization of capital expenditure over cargo handles. **F.1.2 Capital Expenditure per Passenger** This measure the utilization of capital expenditure over passenger handles. **F.1.3 Return on Invested Capital** This refers the percentage amount that a company is making for every percentage of cost of capital. It is a profitability ratio that measures how efficiently a company can generate profits. **F.1.4 Return on Assets** It is a financial ratio that shows the percentage of profit a company earns in relation to its overall resources. It is commonly defined as net income divided by total assets.	
F.2	**Price of Capital:** The revenue generated from the capital that invested. ***F.2.1 Retail Concession Revenue per Square Meter of Retail Space*** This refers concession revenue received by the airport as a percentage of total airport	

F	**Business Management**	
	KPI	**Measures**
	retail space. **F.2.2Retail Concession Revenue per Passenger** This refers concession revenue received by the airport as a percentage of total passenger handled. **F.2.3Car Parking Revenue per Car Parking Space** This is usually one of the most important sources of non-aeronautical revenue. Major cities may produce lower revenue due to the availability of public transportation. **F.2.4 Price of Labor** This is sum of all wages paid to employees, as well as the cost of employee benefits and payroll taxes paid by an employer. **F2.5 Cargo Handling Facility Area** Total space for the storage s considered here.	
F.3	**Policy Decisions:** This refers the regulations, agreements, partnerships, loans and laws which can influence to the airport business cluster. ***F.3.1 Partnerships*** A partnership is an arrangement where parties, agree to cooperate to advance their mutual interests.	

F	**Business Management**	
	KPI	**Measures**
	F.3.2 Bi-Lateral Agreements An exchange agreement between two nations or trading groups that gives each party favored trade status pertaining to certain goods obtained from the signatories. The agreement sets purchase guarantees, removes tariffs and other trade barriers. **F.3.3 International Regulations** The regulation forced by IATA, ICAO and FAA for doing aviation business. **F.3.4 Air Freedom Rights** Aviation is always dealt with seven freedom of air and while commencing the business it is essential to obey the freedom of rights. **F.3.5 Long Term Debt per Passengers** Amount of long term debt is likely to be a function of the airport development spending for major projects like terminal, airfield, and roadway improvements. This is useful for internal and external benchmarking in all commercial airports which has long term debt.	
F.4	**Tourist Industry:** This focus on the international passengers who visit the country. **F.4.1Tourist Arrivals** Number of tourist arrival for the year. **F.4.2 Origin Country**	

F	**Business Management**	
	KPI	**Measures**
	Travelers 'behavior is very much important to set the business. Therefore, in here it is considering the origin country of the international passenger to provide the better service. **F.4.3 Purpose of the Visit** Business packages are varying according to the purpose of visit. For an example business traveler behavior is vary with the leisure traveler. **F.4.4 Seasonality Variations** Every airport has its peak period with respect to month of the year, day of the week and hour of the day. To survive with the flow, seasonality variations of the airport according to the history of data must be calculated. **F.4.5Duration of the Stay** Duration of the stay in the country is different for an individual tourist. There should be accommodation facilities for them to stay in the country and transportation facilities too.	

4.4.1.7 Identify the KPIs and Measures for Technology

Three main key performance indicators were identified as evaluators for Technology namely; real time information for passengers, applications and smart indicators. There are measures to evaluate KPI flight details, quality of information, airline information, mobile applications, on time information and so on. Table 4.8 represented the Technology KPIs.

Table 4.8: Technology KPIs

G	**Technology**	
	KPI	**Measures**
G.1	**Real Time Information for Passengers:** Aviation is 24 x 7 business. Therefore, information must be displayed all the times. **G.1.1 Flight Details Screens &Airline Information** All the details of particular flight including Standard time of arrival (STA), Standard time of departure (STD), Status of the flight (final call, gate open, check-in open) should be displayed. **G.1.2Airport Display Screens** Hotel information, banking facilities, taxi availability, train schedules, bus schedules which provides the decision support information are considered in here. **G.1.3 Clarity/ Quality of Information** This measures the quality of being clear to understand. **G.1.4 Way Findings and Terminal Signage** According to the size of the airport and its functions, it can be a complex scenario for some passengers. Therefore, way finding and terminal signage should be accompanied where necessary and it should be simple. International standards should be followed.	
G.2	**Applications** **G.2.1 Mobile Application**	

	This refers the mobile application which introduce for the air passengers. For an example he/she can check the flight status form their mobile. **G.2.2 Online Self Check-ins** Air travelers prefer online check in since they value time and privacy. If airport can provide online check-in facility it can be an airport marketing tool. **G.2.3 Integrated Modular Solutions** This measures how effectively air traveler can connect to the airport functions. After booking tickets, it can be given the details about that flight to the mobile like, average delay percentage, passenger loading factor and so on without burdening traveler's curiosity.
G.3	**Smart Indicators** **G.3.1 On time information** A computer system that responds to transactions by immediately updating the appropriate master files and/or generating a response in a time frame fast enough to keep an operation moving at its required speed. **G.3.2 Information Accuracy** This refers the freedom of error. Information accuracy is highly depended on how data is collected and the source of data. **G.3.3 Customer Complaints** This measure the percentage of survey responses received from customer. **G.3.4 Data Recovery** It is a process of salvaging (retrieving) inaccessible, lost, corrupted, damaged or

	formatted data from secondary storage, removable media or files, when the data stored in them cannot be accessed in a normal way. **G.3.5 Delay Statistics** It can be obtained from airport data records. **G.3.6 Data Processing Time** This refers the time consuming for collection and manipulation of items of data to produce meaningful information. **G.3.7 Security** Percentage of attacks resolved within one hour of detection, percentage of intrusions detected within 15 minutes of attack and the amount of time needed to identify and contain high security vulnerability.

4.4.2 Assign weights for KPI: AHP Analysis for Questionnaire Section B

Industry experts were asked to go through each KPI under each factor. And also it is asked them to carefully analyze sub measures as well. Fifty (50) experts (sample) evaluated and sample of the respondents consists of airport operators, regulatory body, and service providers. Questionnaire (Appendix 2): section B is utilized for the pair wise comparison for KPIs. Pairwise comparison table was given to them to compare the KPIs. Integrated value for entire sample had been taken as the input for the matrix. Final Eigen value was considered as weight for each KPI.

This was the third interview carried out with industry experts and all factors and briefing to research were discussed before commencing an interview and before responding to questionnaire. Sub measures under KPIs were not weighted, since it can be varying with the particular airport. Therefore, user can add or delete measures according to their requirement. After analyzing questionnaire responses, weight was calculated and summary of the weights for each KPI is given on Table 4.9. Analysis of the AHP including normalized matrix are listed in Appendix 4.

Table 4.9: Weights for each KPI

	Factor	Weight		KPIs	Weight
A	Non Aeronautical Activity Centers	28	A.1	Number of Terminal Users	6
			A.2	Industry Revenue	26
			A.3	Revenue Sources	68
B	Geographic Location	23	B.1	Air Network	67
			B.2	Land Use	33
C	Demand	18	C.1	Passengers	30
			C.2	Employees	7
			C.3	Aircraft Movements	39
			C.4	Cargo	24
D	Nature of the Airport	14	D.1	Capacity &Utilization	45
			D.2	On-Time Performance	9
			D.3	Level of Service	46
E	Access Modes	8	E.1	Modal Split	8
			E.2	Access Cost	49
			E.3	Transport Options	43
F	Business Management	7	F.1	Capital Invested	21
			F.2	Price of Capital	8
			F.3	Policy Decisions	41
			F.4	Tourist Industry	30
G	Technology	2	G.1	Real Time Information	20
			G.2	ICT Application	40

			G.3	Smart Indicators	40

4.5 Effectiveness of BIA

Third objective of the research is to evaluate the potential to be an airport city. First two objectives are already achieved by developing evaluation criteria for an airport city which is Airport City Effectiveness Criteria (ACEC). As discussed in chapter 3.3.3, evaluation framework (Figure 3.5) was used to evaluate the effectiveness of BIA. Quantitative and qualitative data were gathered to confirm and to improve ACEC and to evaluate BIA's airport city status. And also these data were utilized to develop fact sheet of BIA. HKIA used as control airport to compare their status as airport city example. Although HKIA is far head with BIA, it is better to benchmark with well-established airport city. This section will discuss the findings of BIA with relevant to ACEC.

4.5.1 SWOT Analysis

SWOT analysis for BIA was done to identify strength and weaknesses of BIA as internal factors and opportunities and threats as external factors. The objective of conducting a SWOT analysis to BIA is to identify its current status towards welcoming airport city status. Figure 4.1 represented the SWOT Analysis of BIA.

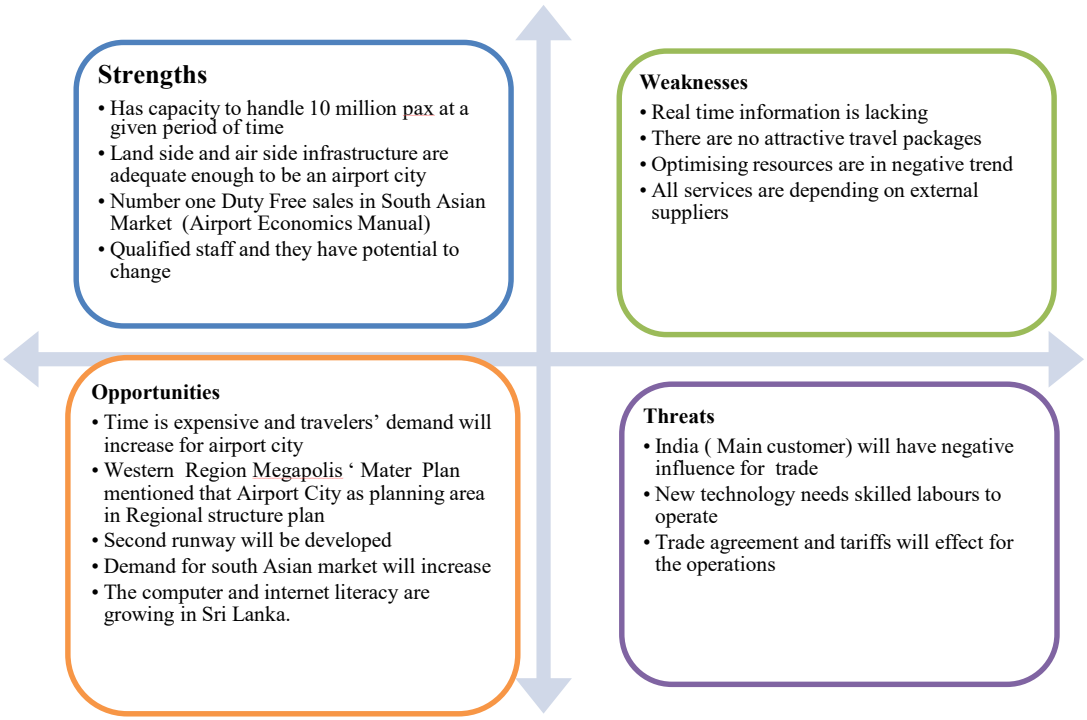


Figure 4.1: SWOT Analysis

Strength

- Has capacity to handle 10 million passengers at a given period of time (AASL Annual Report ,2016)
- Land side and air side infrastructure are adequate enough to be an airport city (AASL Annual Report ,2016)
- Number one Duty Free sales in South Asian Market (Airport Economics Manual,2017)
- Qualified staff and they have potential to change (AASL Annual Report ,2016)

Weaknesses

- Real time information is lacking (www.airport.lk and Flight Stats Analysis, 2017)
- There are no attractive travel packages (Sri Lanka Tourist Board Annual Report , 2016)
- Optimising resources are in negative trend (AASL Annual Report ,2016)
- All services are depending on external suppliers (AASL Annual Report ,2016)

Opportunities

- Time is expensive and travelers' demand will increase for airport city (Airport Cities, 2015)
- Western Region Megapolis Mater Plan ,2016 mentioned that Airport City as planning area in Regional structure plan
- Second runway will be developed ((AASL Annual Report ,2016)
- Demand for south Asian market will increase (ACI, 2012 and IATA, 2012)
- The computer and internet literacy are growing in Sri Lanka (Central Bank Report,2014)

Threats

- India (Main customer) will have negative influence for trade
- New technology needs skilled labours to operate
- Trade agreement and tariffs will effect for the operations

4.5.2 Evaluation of Case Study Based Airport- BIA by utilizing ACEC

Bandaranaike International Airport was evaluated as case study based airport and detail description of seven factors which was included in Airport City Effectiveness Criteria are discussed in below.

4.5.2.1 Evaluate Effectiveness of Non- Aeronautical Activity Centers

Figure 4.2, used as a framework to evaluate non-aeronautical activity centers.

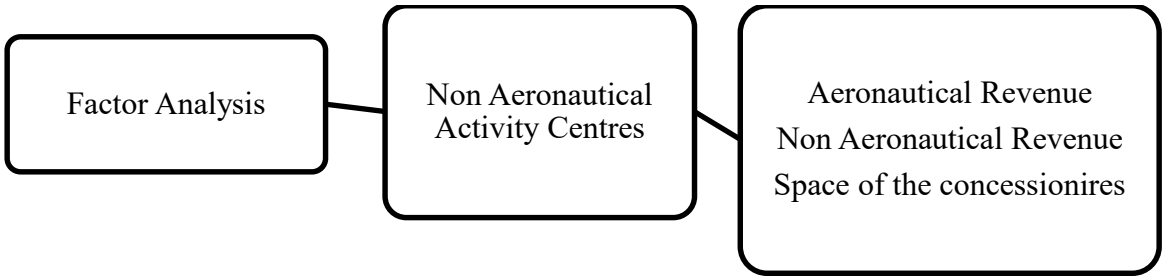


Figure 4.2: Framework to evaluate NAAC

According to the Air Transport Research Society (ATRS, 2013), Colombo became first in Asia Pacific region for percentage of non-aeronautical revenue. It accounts 75% and average percentage of non-aeronautical revenue is 48%. Colombo is well performing and in Figure 4.3 represented it as CMB (IATA 3 letter code for BIA). Airport and Aviation Services Sri Lanka Limited which was the owner of the airport highlighted that non-aeronautical revenue (Figure 4.4) was estimated as 73% from the company revenue structure (AASL Annual Report, 2016).

While carefully analyzing where it generated non-aeronautical revenue, it showed that Middle East countries like Kuwait, Saudhi Arabia are in front line with having 118% and 63% growth rate. Australia also generates non-aeronautical revenue for the company.

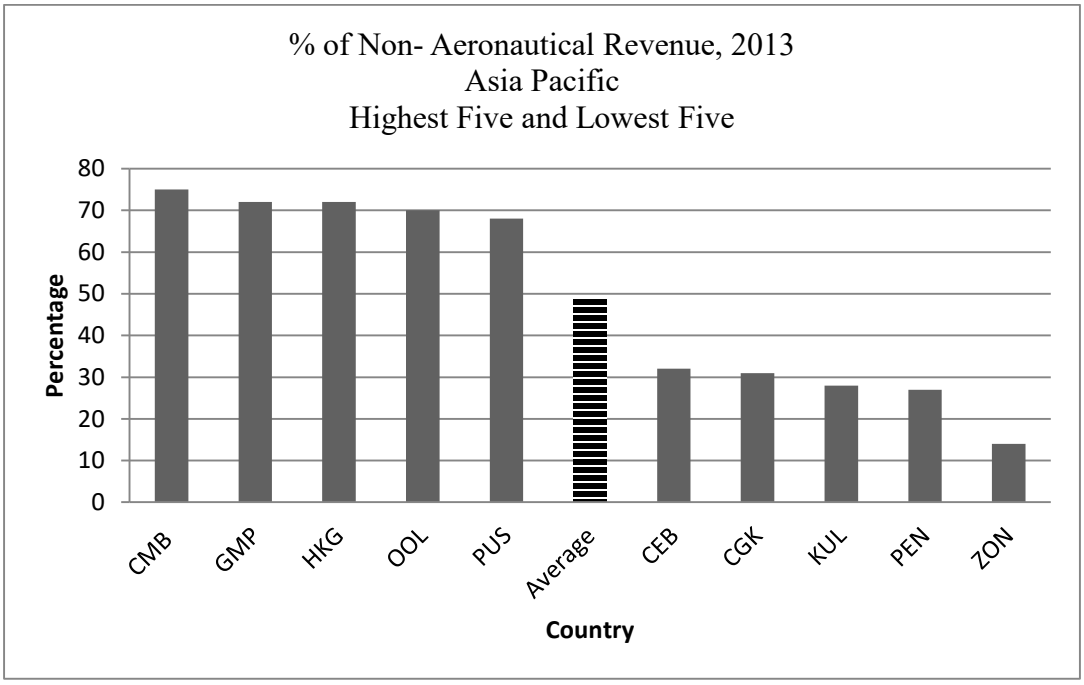


Figure 4.3: Percentage of Non- Aeronautical Revenue
(Source: ATRS Findings, 2014)

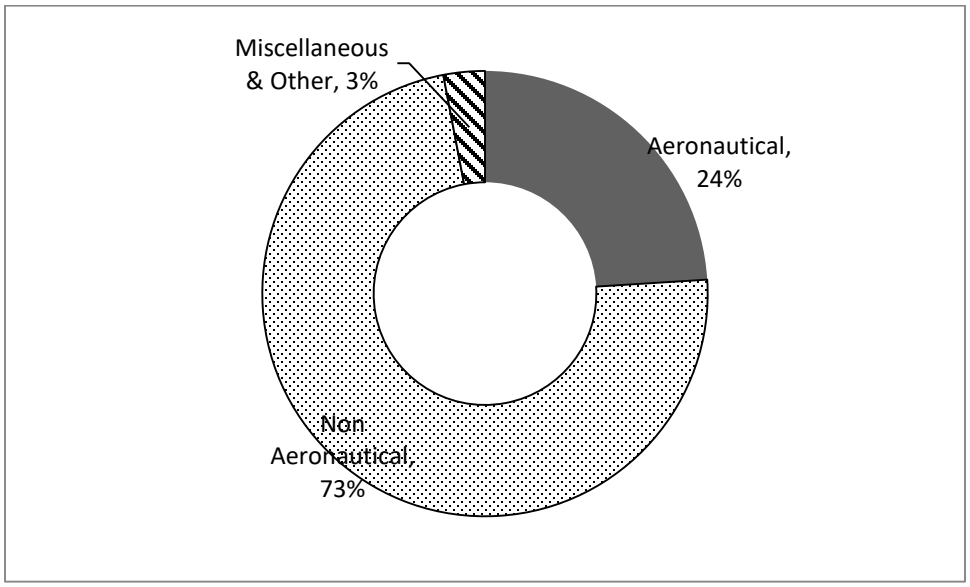


Figure 4.4: Company Revenue Structure
(Source: Sri Lankan Airline Ltd Annual Report 2015/2016)

Table 4.10 represented the revenue and growth rates for top three countries to BIA non-aeronautical revenue.

Table 4.10: Revenue Growth Rates

Country	Revenue - US$ (2014)	Revenue - US$ (2013)	Growth %
Kuwait	850,895	391,146	118%
Saudhi Arabia	1,714,978	1,049,414	63%
Australia	347,710	220,973	57%

Table 4.11 represented the top three revenue generators for duty free sales at BIA. Liquor, tobacco, confectioneries and perfumes' gross turnover is 87 million. When calculating trend of growth, food and beverage is gradually increasing their sales over years. This is considered revenue source KPI (A.3) under non aeronautical activity centers.

Table 4.11: Duty Free Segments of BIA

	Duty Free Segment	Gross Turnover (USD)	Annual Increase
1	Liquor, Tobacco, Confectioneries & Perfume	87Million	24%
2	Electrical and Electronics & Home appliances	33 Million	7%
3	Food and Beverage	5 Million	75%

4.5.2.2 Evaluate Effectiveness of Geographic Location

Geographic Location is a competitive advantage for any business in the world. Air Network and Land Use planning play critical role in Geographic Location. Figure 4.5 represented the framework which used to evaluate geographic location.

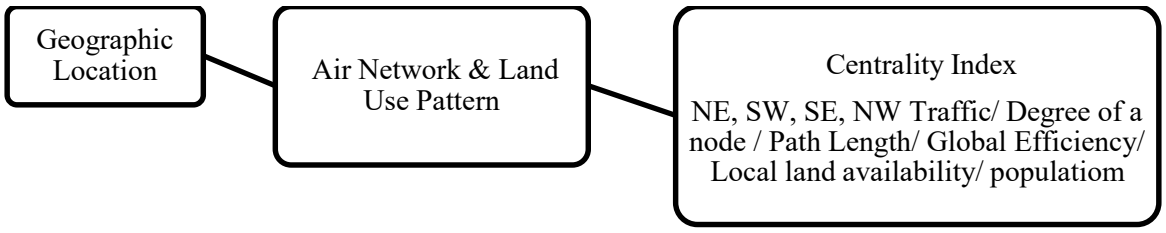


Figure 4.5: Framework to Evaluate GL

4.5.2.2.1Air Network Connectivity

Air network can be consisted with airports (nodes) and air routes (links). Air routes are more important aspects for air network. Connectivity is the main measurement of the air network and to measure air network connectivity, centrality index was used. 41 destinations were identified in the Sri Lankan Airlines network; these destinations were used to analyze the impact of the centrality indexes. Table 4.12 represented destinations which were used for analysis and their IATA three letter codes.

First, Impediment Value (d_{ij}), measure of spatial resistance was calculated to identify the ease of movement within the network. Data is collected from Flight Stats. Equation 4 is used for the calculation of impediment value.

$$d_{ij} = 8 \times t_{ij} / f_{ij} \quad (4)$$

Where,

t_{ij}= average inter peak travel time (mints)

f_{ij}= average frequency of service per hour

Table 4.12: IATA Codes of Destinations

IATA Code	Airport	Code	IATA Code	Airport	Code
CMB	Colombo	1	NRT	Tokyo	22
MLE	Male	2	BKK	Bangkok	23
GAN	Gan Island	3	KUL	Kuala Lumpur	24
MAA	Chennai	4	SIN	Singapore	25
TRV	Trivandrum	5	CGK	Jakarta	26
TRZ	Trichy	6	HKG	Hong Kong	27
BOM	Mumbai	7	PEK	Beijing	28
BLR	Bangalore	8	PVG	Shanghai	29
DEL	Delhi	9	CAN	Canton	30
COK	Kochi	10	KMG	Kunming	31
VNS	Varanasi	11	BAH	Bahrain	32
IXM	Madurai	12	KWI	Kuwait	33
CCU	Kolkata	13	DOH	Doha	34
HYD	Hyderabad	14	MCT	Muscat	35
VTZ	Visakhapatnam	15	DXB	Dubai	36
CJB	Coimbatore	16	AUH	Abu Dhabi	37
KHI	Karachi	17	DMM	Dammam	38
LHE	Lahore	18	JED	Jeddah	39
DAC	Dhaka	19	RUH	Riyadh	40
SEZ	Seychelles	20	MEL	Melbourne	41
LHR	London	21			

Lower the score is ease of movement. After 820 city pair analysis it is found out that node 24 Kuala Lumpur International Airport (KUL) – 25 and Changi International Airport (SIN) route is having the lowest impediment score, which is 0.22. Thus a higher frequency service reduces the disutility of the trip while being subject to a principle of diminishing returns.

Degree Centrality was calculated and it can be defined as the proportion of nodes directly connected to the node in question out of the totality of nodes within the network. It measures the average minimum number of transfers (Scheurer & Curtis, 2008). It meant lower the score is the fewer transfers. Degree Centrality was calculated by using Equation 5.

$$\text{Degree Centrality } (DC_i) = \sum Pmin_{ij} / (N-1) \quad (5)$$

Where,

$Pmin_{ij}$= minimum number of transfers required between nodes i & j

N= total number of activity nodes in the network

Since the network of Sri Lankan Airlines is considered for the analysis, 1 Colombo International Airport (CMB) is connected to all the nodes in the network. Therefore, apart from 1 Colombo International Airport (CMB), 36 Dubai International Airport (DXB) is having the lowest DC score which shows that DXB is well connected to other nodes in the network. On the other hand, node 3 Gan International Airport in Maldives (GAN) is having the highest DC score indicating poor connectivity with other nodes in the network considered. Table 4.13 summaries the scores of degrees of centrality. These numbers will contribute to measure air network KPI (B.1).

Code	Airport	DCi	Code	Airport	DCi
1	Colombo	0.00	21	London	0.35
2	Male	0.60	22	Tokyo	0.60
3	Gan Island	0.95	23	Bangkok	0.28
4	Chennai	0.33	24	**Kuala Lumpur**	0.20
5	Trivandrum	0.53	25	**Singapore**	0.25
6	Trichy	0.65	26	Jakarta	0.58
7	**Mumbai**	0.25	27	Hong Kong	0.43
8	Bangalore	0.38	28	Beijing	0.53
9	**Delhi**	0.15	29	Shanghai	0.58
10	Kochi	0.53	30	Canton	0.50
11	Varanasi	0.83	31	Kunming	0.70
12	Madurai	0.80	32	Bahrain	0.50
13	Kolkata	0.58	33	Kuwait	0.48
14	Hyderabad	0.33	34	Doha	0.30
15	Visakhapatnam	0.78	35	Muscat	0.38
16	Coimbatore	0.83	36	**Dubai**	0.13
17	Karachi	0.63	37	**Abu Dhabi**	0.20
18	Lahore	0.60	38	Dammam	0.58
19	Dhaka	0.45	39	Jeddah	0.40
20	Seychelles	0.88	40	Riyadh	0.40
			41	Melbourne	0.65

Table 4.13: Scores of Degrees of Centrality

Closeness centrality was calculated for each node using the impediment scores calculated for each route. Closeness centrality measures the ease of movement between the center node and the rest of the nodes in the network. Hence, lower the Closeness centrality scores indicate ease of movement between the center node and the network. Scores of the closeness centrality is listed in Table 4.14.

$$CCi = \Sigma Lij/(N-1) \quad (6)$$

where:

CCi = Closeness centrality of node i

Lij = cumulative impediment between nodes i and j, with j Ɛ N and i≠j

N = all activity nodes in the network

Table 4.14: Scores of Closeness Centrality

Code	Airport	CCi	Code	Airport	CCi
1	Colombo	34.16	21	London	43.61
2	Male	20.25	22	Tokyo	19.91
3	Gan Island	25.83	23	Bangkok	13.14
4	Chennai	18.92	24	Kuala Lumpur	86.03
5	Trivandrum	15.63	25	Singapore	83.96
6	Trichy	16.84	26	Jakarta	39.84
7	Mumbai	52.18	27	Hong Kong	16.57

Code	Airport	CCi	Code	Airport	CCi
8	Bangalore	21.81	28	Beijing	28.21
9	Delhi	35.99	29	Shanghai	17.71
10	**Kochi**	7.70	30	Canton	34.41
11	Varanasi	15.93	31	Kunming	27.16
12	**Madurai**	7.42	32	Bahrain	28.30
13	Kolkata	8.11	33	Kuwait	46.92
14	Hyderabad	20.22	34	Doha	25.41
15	Visakhapatnam	9.25	35	Muscat	20.56
16	**Coimbatore**	7.06	36	Dubai	25.17
17	Karachi	26.70	37	Abu Dhabi	57.40
18	Lahore	25.15	38	Dammam	17.09
19	Dhaka	22.51	39	Jeddah	42.09
20	Seychelles	25.31	40	Riyadh	50.88
			41	Melbourne	37.60

Analysis of centrality indexes are given on Appendix 5.

4.5.2.2.2. Land Use

Following are the current land uses of BIA. Colombo Metropolitan Region (CMR) provides accommodation facilities for 42% tourists who visit the country (Kumarage et al, 2001). Expansion and development of BIA was discussed in section 2.7.3.

Table 4.15: Land Use of BIA

Facility	Description
Transportation - Multimodal	Parking facility (Terminal Car Park -400 vehicles/ Remote Car Park, New Car Park, Coach Park) Ticketing and fares/ shuttle services/ waiting areas Limousine, taxies to city, buses, railway and rent a car services, car hiring agencies / travel agents.
Road systems Airport Access Provision	Separations of Traffic/ Ramps / Special Routes for Pedestrians / Curbside access (for long Stay and short stay)/ Terminal and surrounding areas
Cargo Handling Facilities	Cargo terminals (import / export) floor area 7785m^2, 20Forklifts, and weighing facility up to 25,000 kg. ETV facility/ cold room (50 C) and freezer room (-20o C) of area 77m^2 each, Bonded area, custom strong room and animal room available/ total room capacity 9100m^2
Passenger Facilities/ Hotels /Lounges /Bank/ Post Office	City hotels by prior arrangements

Facility	Description
	Day rooms at the airport Five Stars Hotel Counters available at the Arrival Lobby
Restaurants	Available both in transit and public area. Snack bars, Shops available in the passenger both Arrival and Departure lobby areas.Duty-free shops at both Arrival, Departure and Transit areas. Bond baggage service, Left luggage service, Passenger assistance service, Passenger meeting service, Day room facility, shower facility available at specified rates.
Medical Facilities	First aid and Ambulance available at airport. Negombo General Hospital - 10km Ragama General Hospital - 19km Sri Lanka Air Force Hospital Seeduwa - 5 km
BOI Zone	12 Export Processing Zones and Industrial Parks (Katunayake, Biyagama, Malwatta, Seethawaka, Horana, Mirigama, Wathupitiwala, Koggala, Mirijjawila, Kandy, Mawathagama, Polgahawela)

4.5.2.3 Evaluate Effectiveness of Demand

Passenger arrival, departure and transfers were considered as passenger movements. Additionally, cargo movements and aircraft movements are also concerned. Figure 4.6 represented the framework which used for the evaluation of demand.

Figure 4.6: Framework to Evaluate Demand

When consider about BIA, passenger, cargo and aircraft movements were increased over the past years. Yearly comparison was given in Table 4.16. Arrival, departure, transfer and transit passengers were included in passengers and export, import and transshipment cargo was included for the calculation of total cargo. Employees of the BIA were reduced over the years. Hong Kong International Airport (HKIA), details included to compare BIA status. It clearly showed that cargo and flights change in HKIA (Annual Report, 2016/2017) were high with BIA changes. Passenger change was low in HKIA with compared to BIA changes.

Table 4.16: Demand Changes BIA & HKG

Performance	BIA 2014	BIA 2015	Change % BIA	Change% HKG
Passengers	7,780,724	8,505,740	9.32	6.6
Cargo (MT)	209,607	218,402	4.2	5.5
Flights	54,960	56,156	2.18	4.9
Employee	3,932	3,871	-1.55	-

In modern world aviation is a huge business. Therefore, it is necessary to be aware of current demand and also forecasted demand to sustain in the market. In this research detailed analysis were carried out for current demand and forecasted demand as well.

4.5.2.3.1 Current Demand at BIA

BIA handled nearly 10 million passengers in 2017 (Annual report, 2017) and it was 5% growth with compared to 2016 passenger traffic. 20% from the total passengers are foreigners. Locals who are using BIA, there is no other option to select since Sri Lanka has single international Airport. Foreigners have options when selecting their flying destination and still they select Sri Lanka as their travel destination. Figure 4.7, represented the growth of passenger traffic at BIA over the years.

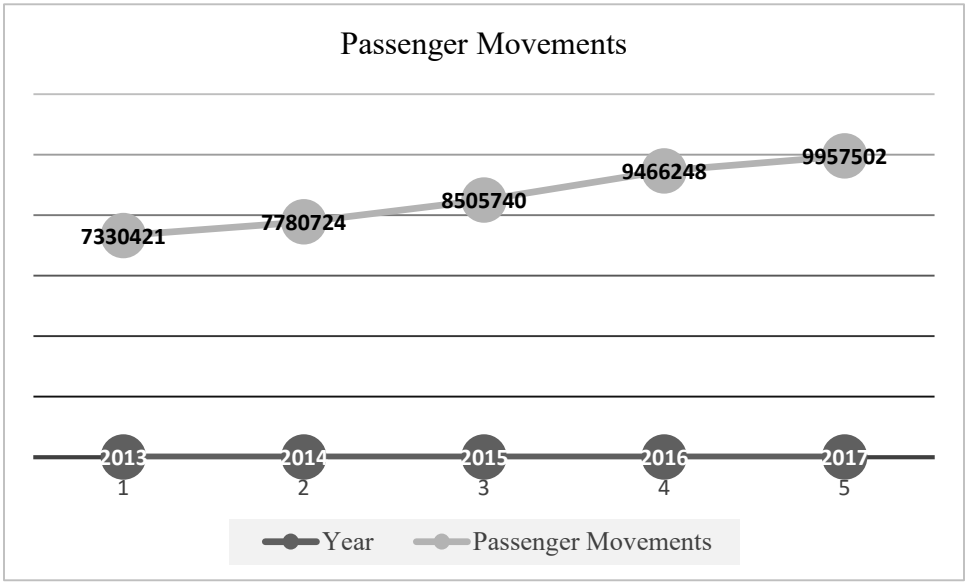
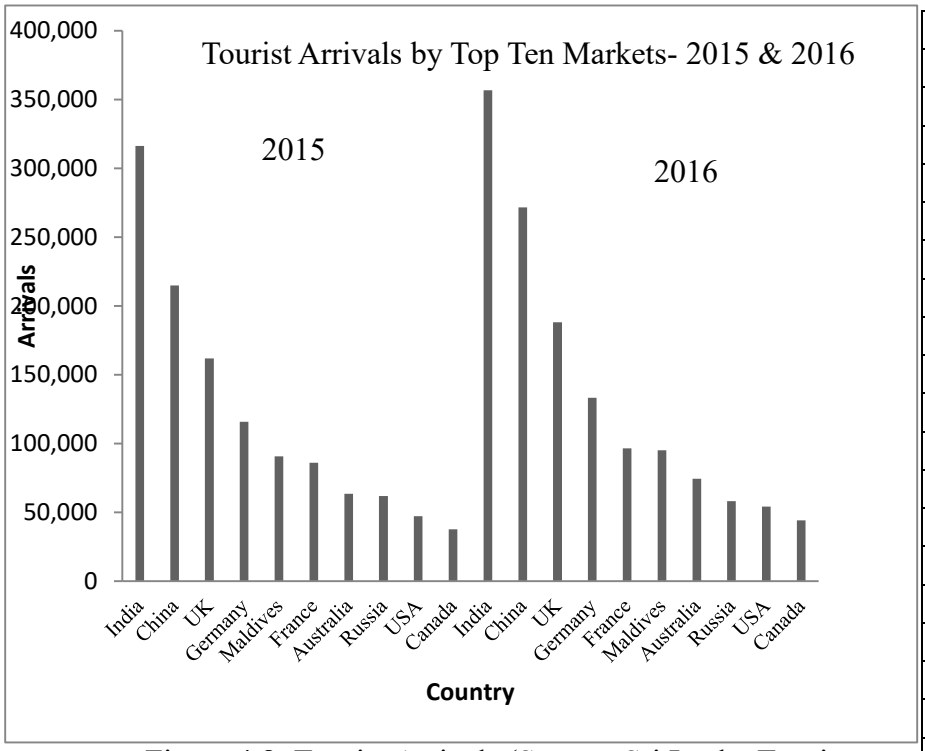


Figure 4.7: Passenger Movements

India and China are the main customers in the year 2015 and year 2016 (Figure 4.8). India has good rapport through the years of visiting Sri Lanka**.**



India	316,247	2015
China	214,783	
UK	161,845	
Germany	115,868	
Maldives	90,617	
France	86,126	
Australia	63,554	
Russia	61,846	
USA	47,211	
Canada	37,732	
India	356,729	2016
China	271,577	
UK	188,159	
Germany	133,275	
France	96,440	
Maldives	95,167	
Australia	74,496	
Russia	58,176	
USA	54,254	
Canada	44,122	

Figure 4.8: Tourist Arrivals (Source: Sri Lanka Tourist Board-2015/16)

July and December are the peak period of tourist arrivals and it showed in Figure 4.9.

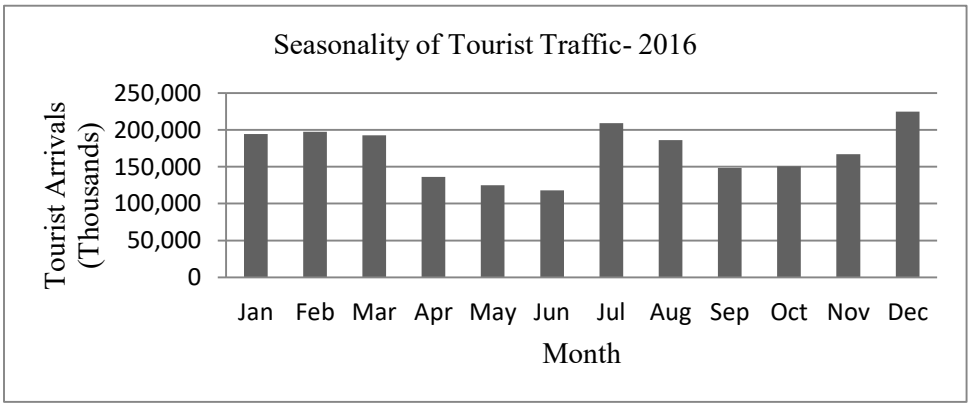


Figure 4.9: Seasonality of Tourist Arrivals (Source: Sri Lanka Tourist Board-2015/16)

Most common purpose of visit Sri Lanka is pleasure and visiting friends and relations is the second best purpose. Purpose of travel by tourists are represented in Figure 4.10.

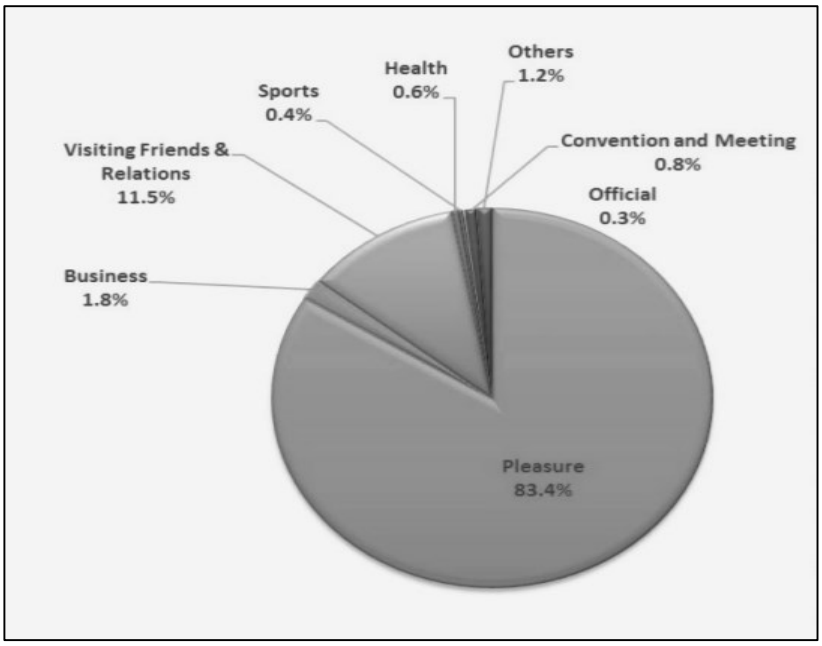
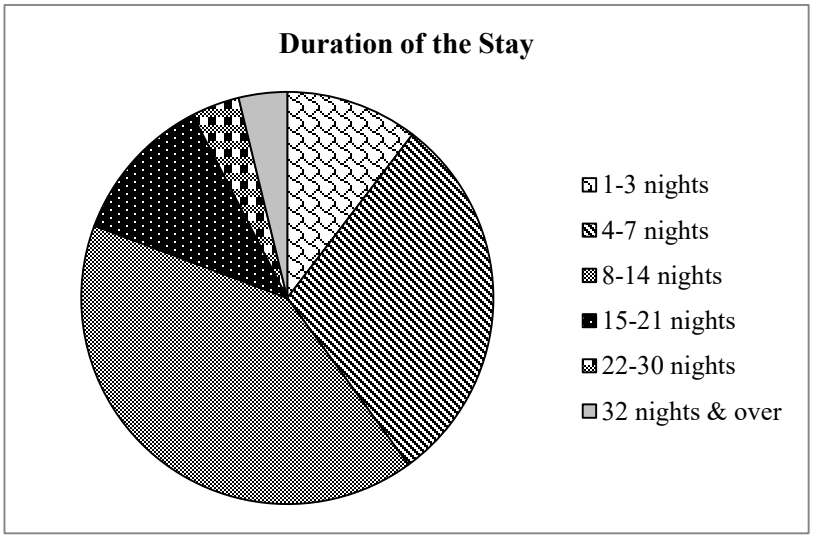


Figure 4.10: Purpose of Visit (Source: Sri Lanka Tourist Board-2015/16)

Average duration of the stay is 4to 7 nights in the year 2015 and in the year 2016 it increased to 8 to 14 days. Figure 4.11 represented all the details of the durations.



Period	2016	2015
1-3 nights	10.40%	11.40%
4-7 nights	29.60%	31.90%
8-14 nights	40.70%	27.10%
15-21 nights	11.70%	14.30%
22-30 nights	3.80%	11.60%
32 nights & over	3.80%	3.80%

Figure 4.11: Duration of the Stay (Source: Sri Lanka Tourist Board-2015/16)

4.5.2.3.2 Forecasted Demand for BIA

In this research it is focused to find out the status of being an airport city. Therefore, forecasting demand is very much useful to handle the business without any interruptions. Bandara and Wirasinghe (2001) introduced regression model to forecast demand for BIA based on 12 years past data. Demand models for BIA which was introduced from that research are as follows.

Probable : All Passengers $= -669146 + 16.527$ x GDP Sri Lanka

Upper Bound: All Passengers $= -1512312 + 391.675\ xPercapitaGDPSriLanka$

Lower Bound : All Passengers

$= -1370787 + 384.758$ x Per capita GDP Sri Lanka

$- 108029$ x years with terrorist activities and other civil unrest

Since earlier models were introduced in war period, Piyathilaka et al (2011) introduced revised model for Bandara &Wirasinghes' models to forecast passenger demand in BIA. The model is estimated for 15 years' period and best fit model which introduced is as follows.

Actual Passenger Numbers

$= -257615.3 + 3.6$ xReal GDP at Factor price in millions $(1996 = 100)$

$- 591236.7$ x Terrorism$(Yes = 1, No = 0)$

Priyadarshana and Fernando (2015) developed demand model to forecast passenger traffic for BIA by using multiple linear regression and logarithmic regression. Total air passenger demand model is developed by analyzing demand factors over past 24 years. The research has explained the strong correlation between the passenger demand which is the dependent variable and country's GDP, oil prices and growth of the tourism industry which are independent variables.

$$\text{Total Demand} = 12.2557 + 0.53611(\ln \text{GDP in USD billion}) + 0.06404(\ln \text{Jet Fule Price per gallon }) + 0.147(\ln \text{Turrist Traffic Growth Index Sri Lanka}) - 0.10757(\text{Terrorist Activity})$$

According to those researches following Table 4.17 shows the estimated traffic for year 2016 (Actual figyre: 9,466,248) by using models. According to the table Piyathilaka et al (2011) is having less deviation from the actual numbers handled on BIA in respective year. Therefore, estimated traffic for BIA in the year 2020 according to Piyathilaka et al (2011), is 10,310,568 (variation 3%).

Table 4.17: Forecasted Demand

Research	Forecasted Passengers	Variation
Bandara and Wirasinghe (2001)	6,795,342	-12.60%
Piyathilaka et al (2011)	7,455,899	-4.1%
Priyadarshana & Fernando (2015)	8,697,272	+11.7%

Time series analysis was also done for the tourist arrival and it showed that in 2020, BIA will handle 2,356,719 international passengers. It is 50% growth with compared to the year 2014 tourist arrivals. Figure 4.12 shows the forecasted traffic of tourist arrivals. It is clearly shown that the trend curve is gradually increasing with years. Trend analysis will discuss on Appendix 6.

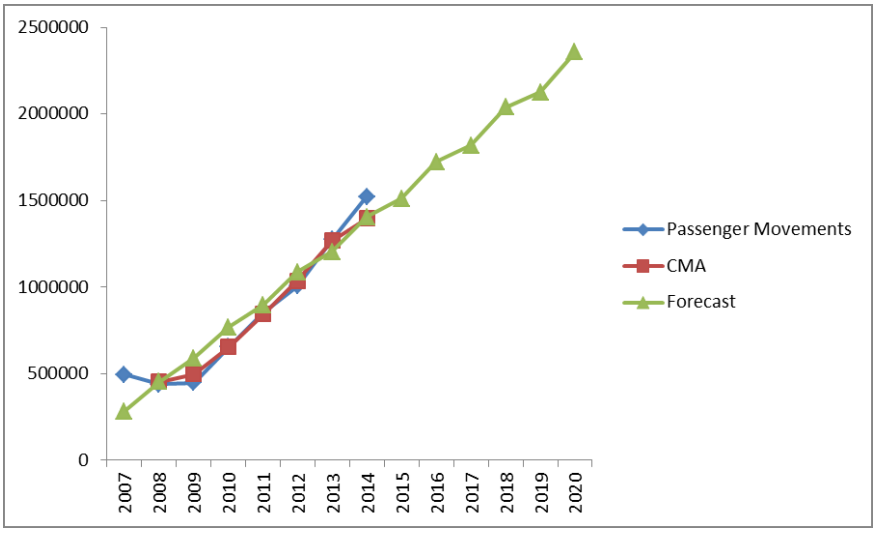


Figure 4.12: Forecasted Tourist Traffic - Time Series Analysis

4.5.2.4 Evaluate Effectiveness of Nature of the Airport

Figure 4.13, was used to evaluate the nature of the airport of BIA and for the analysis, 2015 and 2016data are obtained.

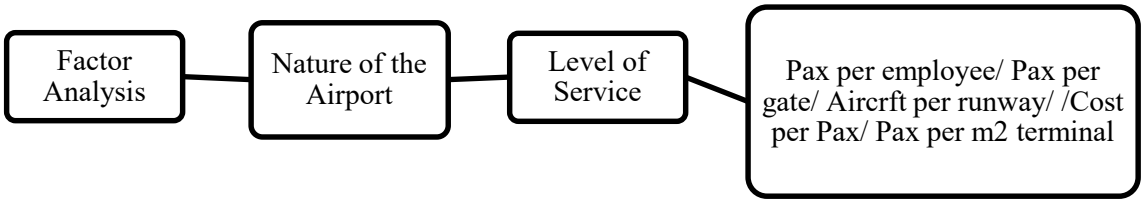


Figure 4.13: Framework to Evaluate NA

BIA is Medium Size Airport which means it can handle up to 10million passengers. Following are the performance of BIA.

- Terminal Capacity – 10, 000,000 Passengers (10Million)
- Terminal Handling Capacity – 5,000,000 Passengers (5Million)
    - 1.5 times of passenger traffic was handled BIA in the Year 2015
- Passenger per Aircraft – 151
- Revenue per Passenger – LKR 1,846
    - Global Airport Revenue per passenger - USD 21.22 (LKR 3000)
- Average Non Aeronautical Revenue per Passengers - LKR 1349
    - Global Non Aeronautical Revenue per Passengers- USD 8.58 (LKR 1200)
- Passenger per employee- 2197
- Passenger per Gate- 432,000 (12/20)
- Aircraft Movements per Runway-56,156 Yearly

4.5.2.5 Evaluate Effectiveness of Access Modes

Galagedara et al, 2014 found out that there are 71,000vehicles per day on airport roadway. In 2014, Road Development Authority Sri Lanka introduced Colombo – Katunayake Express Way (E 03) . It is highly used by the airport passengers and the employees of the airport. Figure 4.14 shows the framework which utilized to evaluate

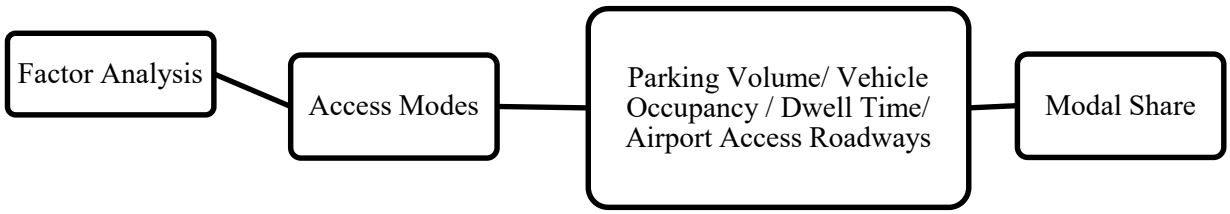


Figure 4.14: Framework to Evaluate AM

access modes.

Modal share calculated by the Galagedara et al, 2014 are given in the following Table 4.18.

Table 4.18: Modal Share

Arrival Curb	Modal Share	Departure Curb	Modal Share
591 Vehicles/ Hour		291 Vehicles/ Hour	
Vans & Jeeps	57%	Cars	41%
Cars	42%	Dual purpose Vehicles	36%
Heavy Vehicles	1%	Three wheels	23%

BIA is situated in Negombo city and the distances for the other district from the airport are also considered. Since Sri Lanka is small country, the maximum distance is 370km to Jaffna. Table 4.19 showed the distance for all districts from BIA. If there is scheduled access modes, passenger can easily reach the airport. There is no information available for cost analysis and time analysis for access (to/from) airport. Expressway network must be linked to airport to reduce travel time. BIA has linked to expressway (E03) to reduce access to/from travel time.

Table 4.19: Distance for all Districts

	District	Distance (km)			District	Distance (km)
1	Ampara	306		14	Kurunegala	74
2	Anuradhapura	274		15	Mannar	216
3	Badulla	230		16	Matale	128
4	Batticaloa	212		17	Matara	184
5	Colombo	36		18	Monaragala	271
6	Galle	154		19	Mullativu	282
7	Gampaha	**20**		20	Nuwara Eliya	161
8	Hambantota	289		21	Pollonnaruwa	204
9	Jaffna	**370**		22	Puttalum	107
10	Kalutara	100		23	Rathnapura	100
11	Kandy	104		24	Trincomalee	277
12	Kegalle	67		25	Vauniya	225
13	Kilinochchi	304				

4.5.2.6 Evaluate Effectiveness of Business Management

Airport and Aviation Services Sri Lanka Limited (AASL) is the owner of BIA. The principal operational activities are run by AASL. Under the mandate granted by Civil Aviation Act No. 14 of 2010, gazette on November 2010, AASL continued to fulfill its role as the sole statutory service provider. Framework in Figure 4.15 is used for evaluate Business Management.

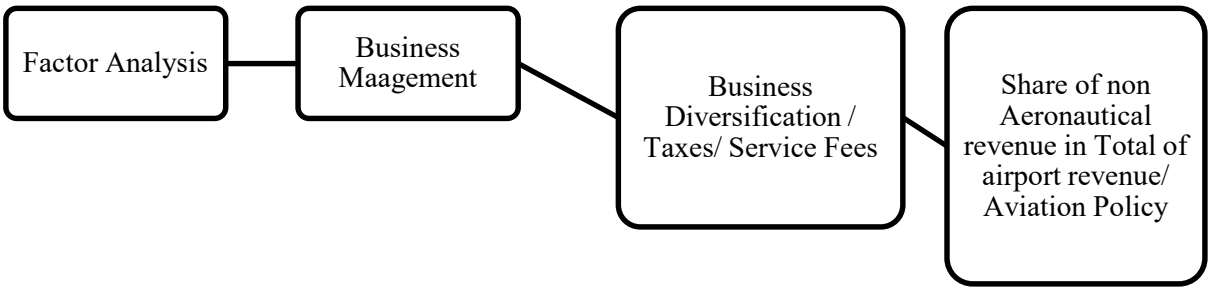


Figure 4.15: Framework to Evaluate BM

BIA has more than 400 tenants at the airport and Appendix 7 represented all business partners in BIA. There is over 4 million square meters' commercial accommodation at BIA. There are service agreements with government agencies (immigration/ customs/ health/ plant and animal quarantine/ police/security authority/tourist board), oil suppliers for refueling and storage, airline operator's committee (freight forwarders association/duty free operator's association/travel agents association/ taxi association) and bi lateral agreements with countries.

Table 4.20 represented the facilities available at BIA (Terminal 1) to facilitate the business and also expansions (Terminal 2) they are planning to manage their business.

Table 4.20: Facilities available at BIA

Facilities	**Existing Terminal (T1)**	**New Terminal (T2)**
Floor Area (m^2)	90,000	180,000
Check-in Counters	53	96
Departure Passport Control Counters	21	32
Airside Security Control positions	8 positions at Pear 1 2 positions at bus gate	20 positions each at Pear 2 and Pear 3
Contact Gates	8	16
Bus Gates	6	10

Facilities	Existing Terminal (T1)	New Terminal (T2)
Airline Lounges	4	6
Airline Passport Control Counters	27	56
Baggage Claim Carousels	6	7
Baggage Make-up Carousels	3	7
Escalators	6	52
Elevators	19	55
Moving Walkways	8	10
Apron	269,000m^2	210,000m^2

4.5.2.7 Evaluate Effectiveness of Technology

Smart indicators were considered for evaluating technology and Figure 4.16 represented the framework used for evaluating technology. Real time flight information, airline information technology aligns with airline business and operations, security requirements, mobile applications, online self-check-in, integrated modular solutions: telephone, public address system, flight management systems, databases, language selection and automatic announcement are the required technology for being airport city.

Figure 4.16: Framework to Evaluate Technology

Following are the Key Performance Indicators for Technology according to Sri Lankan Airline annual report -2016/2017.

- Enhancing passenger and crew connectivity by utilizing mobile and information technology
    - Displaying & sending real time information about departure and arrivals
    - Onboard travel details via on Wi-Fi and In-Flight Entertainment Systems
    - Credit Card and debit card transactions for onboard real time purchases
    - Air to ground connectivity with ground service units (airline operational control center, maintenance control center, catering, crew scheduling and inflight services) through Wi-Fi and data (3G)
- Improving online presence with higher passenger reach
    - Sri Lankan Airline corporative website is modernized
    - Improved with 11 languages
    - Provide mobile friendly site
    - Mobile App is modernized with bidding and fly smiles loyalty program
- Keeping the business aligned with systematic budgetary controls
    - Financial Management via ERP
    - Introduce budget planning system (inclusive reviewing and tracking features
- Implementation of Learning Management System
    - Efficiency manage student enrollment
    - Facilitate administrative processes
- Service Management Excellence
    - Awarded “ISO/IEC” 20000-1:2011 Certification for IT Services
    - Awarded “ISO/IEC” 27001:2013 Certification for Information Security Systems
    - Awarded “ISO” 9001:2008 Certification for Quality Management Systems in Software Engineering

4.6 Fact Sheet

Case study for the research is Bandaranaike International Airport (BIA). In the section 4.5, effectiveness of BIA was discussed under the factors of Airport City Effectiveness Criteria. Hong Kong International Airport (HKIA) is functioning as an airport city and it is well established airport city in the Asian region. Before moving to final interview with board of directors and senior managers, fact sheet was developed for BIA and HKIA for making awareness about airports. Fact sheets were developed by utilizing the findings from section 4.5.2. This is the summary of the findings about BIA and HKIA against ACEC.

It also helped to provide comparison towards being an airport city (HKIA) and to becoming an airport city (BIA). All the qualitative data and quantitative data gathered up to this point was used to develop fact sheet and it is based on the year of 2016 and 2017. Table 4.21 represented the key performance of two airports at a glance.

Table 4.21: Key Performances (Year 2016/2017)

Operational Performances	BIA	Growth Rate	HKIA	Increament
International Flight Movements	62,850	+2%	410,440	0.1%
Passenger Movements	9,957,502	+5.2%	70.5 Million	1.1%
Cargo Movements (Tons)	274,044	+10.3%	4.6Million	6.7%
Overflying Movements	39,413	+12.2%	-	-
Total No of Employees (31st Dec)	3908	+2.5%	over 60,000	+20.1%

Table 4.22 to Table 4.28 represented the developed fact sheets of each criterion.

Table 4.22: Fact Sheet - Non Aeronautical Activity Centers

A	KPI	Sub Measures	BIA	HKIA
A.1	Industry Revenue	*A.1.1* Total Revenue (TR) - (Revenue Per Pax) *Global revenue per passenger USD 21.22 – LKR 3,200)*	LKR 20.5 Billion (LKR 2,085) +13% Increment	HKD 18,627 Million HKD 264 – LKR 6,336 +2.4%
		A.1.2 Aeronautical Revenue	LKR 4.6 Billion 22% of TR	HKD 719 Million 4% of TR
		A.1.3Non Aeronautical Revenue (Non Aeronautical Revenue Per Pax) *Global non aeronautical revenue per passenger USD 5.58 – LKR 1300)*	LKR 15.9 Billion (LKR 1,600) 77% of TR	HKD 17,908 Million (HKD 254 – LKR 6,100) 96% of TR
		A.1.4 Non Aeronautical operating Revenue as percent of Total Operating Revenue	100%	*NA*
A.2	Number Terminal Users	*A.2.1* Arrival (Local & Foreigners) *A.2.2* Departure (Local & Foreigners) *A.2.3* Transit	10 Million	70.5 Million
A.3	Revenue Sources	*A.3.1* Capital Stock	LKR 87 Billion worth	HKD 74,320 Million LKR 1783 Billion
		A.3.2 Sales (List is attached) Concession Income	LKR 5.6 Billion +13% Increment	HKD 2,719 Million +7.4%
		Rental Income	LKR 3.6 Billion +18 Increment	HKD 1,336 Million +8%
		A.3.3 Gross Turnover	*LKR 20,758 Million (13%)*	-
		A.3.4 Choice of shopping(List is attached)	Over 78 Shops	Over 400 shops

Table 4.23: Fact Sheet - Geographic Location

B	KPI	Sub Measures	BIA	HKIA
B. 1	Air Network	*B.1.1* Choice of Destination	41 Cities	198 cities
		B.1.2 Route Stability (Impediment Value) Lowest Score : 0.22 KUL to SIN the frequency between the nodes is higher, the disutility of the trip reduces	1.84	1.49
		B.1.3 Airline Concentration	41	100
		B.1.4 Availability of Direct Flights (Degree Centrality) Lowest Score :) 0.13 DXB connection between the nodes	0.00	0.43
		B.1.5 Ease of Transit through Airport (Closeness Centrality) Best Connectivity : 7.06 CJB	34.16	16.57
B. 2	Land Use	*B.2.1* Total Are - Landside	850,000m^2	12,550,000 m^2
		B.2.2 Terminal Landside area per passenger Number of Departure Lounge	Araliya: LKR 170 Mn Lotus: LKR 125 Mn Silk: LKR 209 Mn Executive: LKR 25 Mn	Terminal 1 570,000 m^2 Terminal 2 140,000 m^2
		Vehicle Parking Capacity	400 Vehicle Space	Over 3,000 Vehicle Space
		B.2.3 Distance to city centers	Max: 370 km Min : 20km	90 cities and towns linked to airport
		*B.2.4*Economic profile	Residential Zone with middle income people	
		*B.2.5*Locations of the surrounding	BOI, FTZ and Garment Factories	NA
		B.2.6 Size of the Market	Asia	Asia Pacific and Chinese

Table 4.24 : Fact Sheet - Demand

C	KPI	Sub Measures	BIA	HKIA
C.1	Passengers	C.1.1 OD of Passengers	Max: India	Max: China
		C.1.2 Passenger per employee	2,548	36,321
		C.1.3 Operating cost per passenger	LKR 10.5 Billion (LKR 1,054)	HKD 8,875 Million HKD 126 – LKR 3,024
		C.1.4 Passenger per m^2	11	5
		C.1.5 Passenger per aircraft	151	172
C.2	Employees	C.2.1 Staff Cost	LKR 5.2 Billion +5%	HKD 2,241 Million +10.2%
		C.2.2 Staff Cost per employee (Per Annum)	LKR 1,664,000	HKD 37,350 LKR 896,400
C.3	Aircraft Movements	C.3.1 Aircraft Movenets per employee	16	7
		C.3.2 Aircraft Movements per Runway	62,850	410,000/2= 205,000
		C.3.3 Aircraft Movements per Gate	3,143	6,218
		C.3.4 Operating Cost per movement	LKR 167,064	HKD 21,646 LKR 519,504
		C.3.5 Number of Aircraft Standing positions	8	106
C.4	Cargo	C.4.1Tons of Cargo handled per year	274,044 Tons	4.6 Million Tons
		C.4.2 Operating Cost per WLU (Work Load Units)	LKR 38,315	HKD 1,900 Million
		C.4.3 Airport warehouse Capacity	250,000 MT	7,000,000 MT

Table 4.25: Fact Sheet - Nature of the Airport

D	KPI	Sub Measures	BIA	HKIA
D.1	Capacity &Utilization	D.1.1 Terminal Handling Capacity	6 Million	53 Million
		D.1.2 Practical Hourly Capacity	NA	NA
		D.1.3 Airport Size	Medium< 15 Mn Pax	Major >15Mn Pax
D.2	On time Performances	D.2.1 Gate departure Delay Number of Gates	12(20)	66
		D.2.2 Taxi Departure Delay	NA	NA
		D.2.3 Process Capabilities Average Delay	NA	NA
D.3	Level of Service	D.3.1 Baggage Delivery Time	First Bag – within 2 minutes Last Bag- within 40 minutes	First Bag – within 2 minutes Last Bag- within 40 minutes
		D.3.2 Security Clearing Time	< 4.5 Minutes	< 4.5 Minutes
		D.3.3 Check in to Gate time Check in Counters	NA 55	<4.5 minutes 400
		D.3.4 Customer Satisfaction	NA	Excellent
		D.3.5 Service Category (IATA)	C	A B- Peak Hour

Table 4.26 : Fact Sheet - Access Modes

E	KPI	Sub Measures	BIA	HKIA	
E.1	Modal Split	E.1.1 Car	42% | (41%)	Taxi	12%
		E.1.2 Van /Jeeps	57% |NA	Franchised Bus	47%
		E.1.3 Dual purpose Vehicles	NA | (36%)	Private Car	8%
		E.1.4 Heavy Vehicles	1% |(NA)	Airport Express Line	24%
		E.1.5 Three Wheeler	NA | (23%)	Other	8%
		Arrival Curb : 591 Vehicles/ Hour |(Departure Curb : 291 Vehicles/ Hour)			
E.2	Access Costs	E.2.1 Monetary Cost	LKR Per km		HKD*
		Car	60 -100	Taxi	330
		Van /Jeeps	45- 80	Franchised Bus	21-45
		Dual purpose Vehicles	NA	Private Car	150-270
		Heavy Vehicles	NA	Airport Express Line	140
		Three Wheelers	NA	Other	100
		E.2.2 Average Time Cost	Minutes per km		Minutes
		Car	NA	Taxi	30
		Van /Jeeps	NA	Franchised Bus	75-95
		Dual purpose Vehicles	NA	Private Car	30
		Heavy Vehicles	NA	Airport Express Line	40
		Three Wheelers	NA	Other	23
E.3	Transport Options	E.3.1 Availability of public	Colombo-	Airport Express Line arrives at Central	

		Transport	Katunayaka Expressway link	downtown in 24 minutes, AsiaWorld-Expo in 2 minutes Franchised bus companies operate about 49 routes
		E.3.2 Car Park Area	400 Vehicle Space	Over 3,000 Vehicle Space
		E.3.3 Taxi Availability	arrival Lobby with a fleet over 600 vehicles	operates a fleet of 295 vehicles

*ANALYSIS OF AIRPORT ACCESS MODE CHOICE: A CASE STUDY IN HONG KONG, Mei Ling TAM, Mei Lam TAM, William H.K. LAM, Journal of the Eastern Asia Society for Transportation Studies, Vol. 6, pp. 708 - 723, 2005

Table 4.27: Fact Sheet - Business Management

F	KPI	Sub Measures	BIA	HKIA
F.1	Capital invested	*F.1.1* Capital Expenditure Capital Expenditure per WLU	LKR 9,473 Million LKR 35	HKD 5,389 Million HKD 1,171 – LKR 28,104
		F.1.2 Capital Expenditure per Passenger	LKR 951	HKD 76 – LKR 1,824
		F.1.3 Return on Invested Capital Invested Capital	 LKR 1.9 Billion	 HKD 52,187 Million
		F.1.4 Return on assets		
F.2	Price of Capital	*F.2.1* Retail Concession revenue Retail Concession revenue per square meter of retail space	LKR 7.8 Billion +27% Retail Space NA	HKD 12,831 Million +4% Retail Space NA
		F.2.2 Retail Concession revenue per passenger	LKR 783	HKD 182 – LKR 4,368
		F.2.3 Car Parking revenue per car parking space	LKR 2,653.5 Million	NA
		F.2.4 Price of Labor	LKR 1,664,000	HKD 37,350 LKR 896,400

		F.2.5 Cargo Handling Facility Area	45,621 m^2(Total) Imports Terminal – 21,500 m^2 Exports Terminal -11887 m^2 TerminalII Ground Floor – 3287 m^2 Terminal II-4691 m^2 Terminal III- 3188 m^2 Floor(1^{st}/2^{nd}/3^{rd}) - 1069 m^2	42 hectares (Total) 420,000 m^2 Asia Airfreight Terminal (8H) Cathay Pacific Terminal (11H) DHL Central Asia Hub(3.5H) HK Air Cargo Terminal (17H) Air Mail Centre (2H)
F.3	Policy Decisions	*F.3.1* Partnerships	Discussed in section 4.5.2.6	SKY City Program Airport's SkyMart consist with 160 shopping outlets and 40 restaurants
		F.3.2 Bi-Lateral Agreements		
		F.3.3 International Regulations		
		F.3.4 Air Freedom Rights	NA	
		F.3.5 Long Term Debt	JICA LKR 29 Billion	
F.4	Tourist Industry	*F.4.1* Tourist Arrivals	2,116,407 +3.2%	
		Tourism Revenue* SriLanka Tourism Development Authority	USD 287.4- LKR 4.3 Billion	
		F.4.2 Origin Country	India & China	
		*F.4.3*Purpose of the visit	Visiting Friends & Relatives	
		*F.4.4*Seasonality variations	July and December	
		F.4.4 Duration of the stay	8- 14 Nights	

Table 4.28: Fact Sheet – Technology

G	**KPI**	**Sub Measures**	**BIA**	**HKIA**
G.1	Real Time Information For Passengers	*G.1.1* Flight Details *G.1.2* Screens *G.1.3* Clarity *G.1.4* Quality of Information *G.1.5* Airline Information *G.1.6* Way findings and Terminal Signage	Establish Information Technology Policy and Guest Experience Program Maintain IATA standards for signage & information Marketing Unit of the company is responsible for all functions Discussed in section 4.5.2.7	Fully Automated the functions
G.2	Applications	*G.2.1* Mobile Application *G.2.2* Online Self Check-ins *G.2.3* Integrated Modular Solutions		
G.3	Smart Indicators	*G.3.1* On time information *G.3.2* Information Accuracy *G.3.3* Customer Complaints *G.3.4* Data Recovery *G.3.5* Delay Statistics *G.3.6* Data Processing Time *G.3.7* Security		

4.7Fact Based Interviews

Fact based interview was done to evaluate BIA against developed ACEC. Interviews were conducted with decision makers of the aviation industry. Developed Airport City Effectiveness Criteria (ACEC) was utilized for the interviews and decision makers were asked to evaluate BIA information and offer a mark out of weight of KPI. Objectives of this research and fact sheets were briefed before commencing an interview to familiarize to the research. As mentioned in section 3.6 stratified sampling was used to select the sample. Aviation decision makers of the country including Airport and Aviation Services Sri Lanka Limited (Operator), Civil Aviation Authority (Regulator) and Sri Lankan Airline (Service Provider) were included to the sample.

To become Airport City Status is a strategic decision and board of directors and senior managers are the responsible parties to get final decision for that strategic move. Airport City Effectiveness Criteria will act as a decision making tool for them to finalize the decision. That is the baseline which decision makers are involved for this interview. Final marks obtained from the interviewees are listed in Table 4.29 under the column "Marks obtained"

After their responses towards the ACEC, Effectiveness of the factor was calculated by using following equation.

$$\text{Effectiveness of the fact}or = \frac{Weight\ of\ Factor\ i}{10{,}000} \sum_{i=1}^{7} (KPI)$$

For an example, weight for the factor for non-aeronautical activity centers is 28%. Scores of KPIs out of weight of KPI were 4 out of 6 for number of terminal uses, 24 out of 26 for industry revenue and 64 out of 68 for revenue sources. Then cumulative value of KPIs is calculated. It multiplied with weight of the factor and divided by 10,000. Finally, effectiveness of the factor was obtained. Effectiveness of the non-aeronautical activity center is 0.25. Calculation of effectiveness of the non-aeronautical activity center

is given below. Accordingly, calculation was done for finding effectiveness of each factor.

Example: Effectiveness of the NAAC = $\frac{28 \quad x\ (4+24+64)}{10000}$

= 0.258

4.8 Scores of ACEC at BIA

Final result of each factor is given on Table 4.29. According to the Table 4.29, "Non Aeronautical Activity Centers" has highest effectiveness with obtaining 0.258. Highest value that can be obtained is 1 and still there is high room for the development for BIA to achieve this factor. Duty free shops, restaurants and banks are functioning well and still logistic parks, shopping complexes, hotels and conference rooms should be developed within the airport to facilitate it as an airport city.

Table 4.29: Scores of ACEC

	Factor	%		KPIs	%	Marks Obtained	Effectiveness
A	Non Aeronautical Activity Centers	28	A.1	No of Terminal Users	6	4	**0.258**
			A.2	Industry Revenue	26	24	
			A.3	Revenue Sources	68	64	
B	Geographic Location	23	B.1	Air Network	67	65	**0.219**
			B.2	Land Use	33	30	
C	Demand	18	C.1	Passengers	30	28	**0.144**
			C.2	Employees	7	5	
			C.3	Aircraft Movements	39	32	
			C.4	Cargo	24	15	
D	Nature of the Airport	14	D.1	Capacity &Utilization	45	35	**0.105**
			D.2	On-Time Performance	9	7	
			D.3	Level of Service	46	33	
E	Access Modes	8	E.1	Modal Split	8	6	**0.048**
			E.2	Access Cost	49	40	
			E.3	Transport Options	43	14	
F	Business Management	7	F.1	Capital Invested	21	16	**0.056**
			F.2	Price of Capital	8	6	
			F.3	Policy Decisions	41	33	
			F.4	Tourist Industry	30	25	
G	Technology	2	G.1	Real Time Information	20	15	**0.014**
			G.2	ICT Application	40	20	
			G.3	Smart Indicators	40	25	

“Geographic Location” is the second effectiveness factor for being airport city and it accounts 0.219. Air network and land use performances are relatively high at BIA with having 65 points out of 67 and 30 points out of 33 respectively. It clearly indicates the strategic position of the country itself. Third highest effective factor for being Aerotropolis is Demand and it has a value of 0.144. Key performance indicators of demand, passenger, employee, aircraft movement and cargo are functioning well at BIA. This is the core functions of an airport and this should be integrated with other functions to provide the service as an airport city.

"Nature of the Airport" is the fourth effective factor to be considered for being an airport city. Capacity utilization and level of service is performing poor with compared to on-time performances. Capacity utilization scored 35 out of 45 and level of service scored 33 out of 46. These KPIs should be concentrated before gaining airport city status. "Business Management" is a fifth effective factor and it refers capital invested, price of capital, policy decisions and tourist industry. Policy decisions are scored low due to the political instability of the country and other scores are satisfactory. Since Sri Lanka is a tourist destination, decision makers on tourism industry must be aligned with policy makers to achieve airport city status. Investment opportunities are highly affected for the non-aeronautical activities and there should be free trade zones to encourage suppliers. Reducing taxes will be a positive strategy to attract customers.

"Access modes" is sixth effective factor and it scored 0.048. Modal split, access cost and transport options are the key performance indicators of this factor and transport options scored low by having 14 out of 43. In Sri Lanka, transport options are less at airport. If passenger had negative impression towards airport accessibility, customer retention is difficult. Passenger values his or her time because time is very expensive in modern world. By improving mobility, we can increase customer demand. Modal split and access cost are in appositive trend by scoring 6 out of 8 and 40 out of 49.

The least effectiveness criterion is "Technology". Although respondent it scored low, technology must be blended with all the operations to achieve airport city status. Real time information, ICT application and Smart indicators must be thoroughly concentrated to provide better service.

Effectiveness of all the factors are less than 0.300 and it clearly indicates low potential of BIA to become airport city status. Still there is 70% of improvement for all factors. Decision makers must carefully analyze the scenario for being an airport city, since it is a

strategic decision to the airport and to the country. Figure 4.17 represented scores of BIA effectiveness as cob web graph.

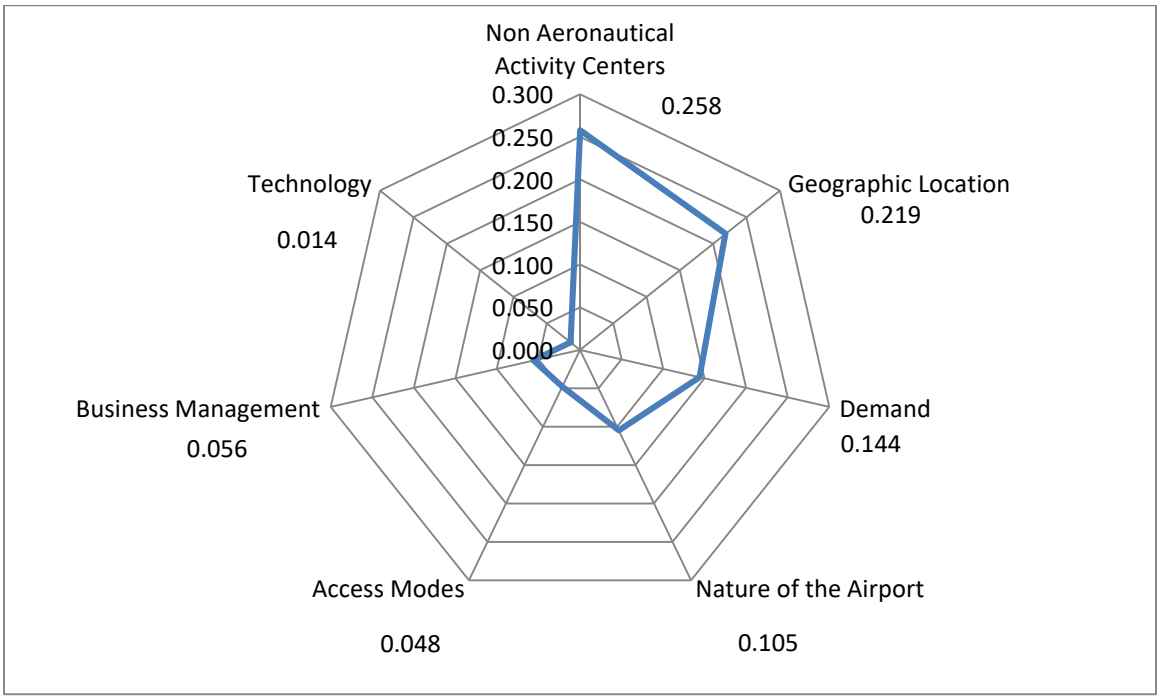


Figure 4.17: Scores of ACEC- BIA

As mentioned earlier, Hong Kong International Airport (HKIA) is functioning as an airport city. In this research HKIA is utilized as a comparison airport. Fact sheets were developed by referring 2016/2017 data from HKIA annual report. By utilizing fact sheets data effectiveness of each factor was calculated and it is assumed maximum scores for all KPIs. Table 4.30 represented comparison score of BIA and HKIA. It is observed that all scores of HKIA are larger than BIA scores due to its aligned processes towards airport city functions and well performances.

There is significant difference in technology with compared to others at BIA and HKIA. It is 100% effective at HKIA. It is due to all the airport functions at HKIA are synchronized with technology. There is significant difference between business

management and access modes as well. Airport Policy contributes well to performing as an airport city and all airport functions are managed by central planning team. It created effective platform to perform as an successful airport city.

Table 4.30 : Effectiveness of BIA and HKIA

	Factor	BIA	HKIA
A	Non Aeronautical Activity Centers	0.258	0.900
B	Geographic Location	0.219	0.900
C	Demand	0.144	0.900
D	Nature of the Airport	0.105	0.900
E	Access Modes	0.048	0.950
F	Business Management	0.056	0.900
G	Technology	0.014	1.000

Figure 4.18 represented graph of the scores of BIA and HKIA effectiveness. It is clear that BIA has to improve their airport functions a lot to becoming an airport city with compared to HKIA.

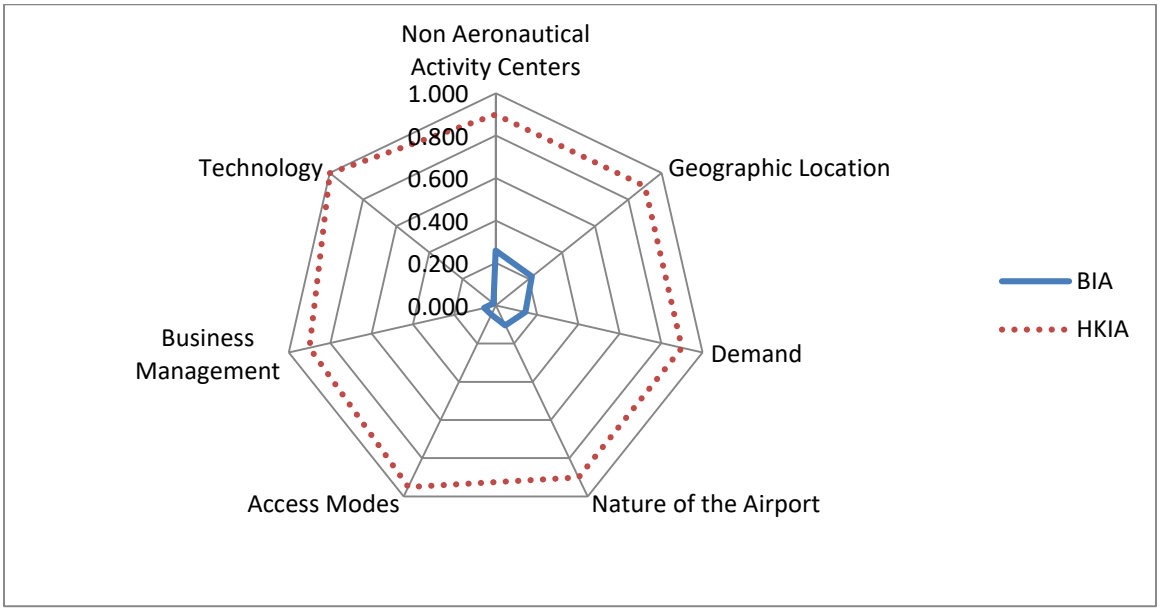


Figure 4.18: Scores of ACEC – BIA and HKIA

CHAPTER 05

5.0 RECOMMENDATIONS AND CONCLUSIONS

5.1 Introduction

In the previous discussion, a finding of the empirical study was analyzed. This chapter was mainly focused on conclusions, recommendation to BIA and the future research works. Conclusions on the overall research problem were presented at the beginning of this chapter. Further recommendations were provided based on the findings of the research. Finally, the new research areas and directions which emerged from this study were stated.

5.2 Observations

This research has developed Airport City Effectiveness Criteria (ACEC) as a decision making tool. Objectives of this research were to identify the factors to be an Airport City, develop evaluation criteria for an airport city and evaluate the potential to be an airport city.

The first objective of this research was to identify the factors to be an Airport City. To achieve this objective, comprehensive literature survey was carried out and it was discussed in detail at chapter 2 and appendix 1. And also interviews were conducted to finalize the factors and it was discussed in section 3.4 and section 3.6. Seven factors were finalized namely geographic location, demand, technology, nature of the airport, non-aeronautical activity centers, business management and access modes (section 4.2).

The second objective of this research was to develop evaluation criteria for an airport city. The baseline for the criteria was seven factors which were finalized from objective one. Factor Analysis was done to identify key performance indicators and measures for the evaluation criteria (Section 4.4.1). Finalized KPIs and measures are indicated in Table 5.1.

Table 5.1: KPIs and Measures of ACEC

	Factor		KPIs	Measures
A	Non Aeronautical Activity Centers	A.1	Industry Revenue	A.1.1 Aeronautical Revenue Per Passenger A.1.2 Aeronautical Revenue Per Movement A.1.3 Non -Aeronautical Revenue Per Passenger A.1.4 Non- Aeronautical Revenue Per Movement
		A.2	No of Terminal Users	A.2.1 Arrivals A.2.2 Departure A.2.3 Transit
		A.3	Revenue Sources	A.3.1 Capital Stock A.3.2 Sales A.3.3 Gross Turnover A.3.4 Choice of Shopping A.3.5 Utilities per m^2 of Terminal
B	Geographic Location	B.1	Air Network	B.1.1 Choice of Destination B.1.2 Route Stability B.1.3 Airline Concentration B.1.4 Degree of Centrality B.1.5 Closeness Centrality
		B.2	Land Use	B.2.1 Total Area B.2.2 Terminal Land Side Area per Passenger B.2.3 Distance to City Centre B.2.4 Economic Profile B.2.5 Locations of the Surroundings

	Factor		KPIs	Measures
				B.2.6 Size of the local Market
C	Demand	C.1	Passengers	C.1.1 OD Passengers C.1.2 Passenger Per Employee C.1.3 Operating cost per Passenger C.1.4 Passenger per m^2
		C.2	Employees	C.2.1 Staff Cost
		C.3	Aircraft Movements	C.3.1 Aircraft Movements per Employee C.3.2 Aircraft Movements per Runway C.3.3 Aircraft Movements per Gate C.3.4 Operating cost per Movement C.3.5 Number of Aircraft Standing Positions
		C.4	Cargo	C.4.1 Tons of Cargo handled by year C.4.2 Operating Cost per WLU C.4.3 Airport Warehousing Space
D	Nature of the Airport	D.1	Capacity & Utilization	D.1.1. Terminal Handling Capacity D.1.2 Practical Hourly Capacity
		D.2	On-Time Performance	D.2.1 Gate Departure Delay D.2.2 Taxi Departure Delay D.2.3 Process Capabilities
		D.3	Level of Service	D.3.1 Baggage Delivery Time D.3.2 Security Clearing Time D.3.3 Check in to Gate Time D.3.4 Customer Satisfaction D.3.5 Service Category
E	Access Modes	E.1	Modal Split	E.1.1 Car E.1.2 Van

	Factor		KPIs	Measures
				E.1.3 Bus E.1.4 Roadway Vehicles
		E.2	Access Cost	E.2.1 Average Monetary Cost E.2.2 Average Time Cost
		E.3	Transport Options	E.3.1 Availability of Public Transport E.3.2 Car Park Area E.3.3 Taxi Availability
F	Business Management	F.1	Capital Invested	F.1.1 Capital Expenditure per WLU F.1.2 Capital Expenditure per Passenger F.1.3 Return on Invested Capital F.1.4 Return on Assets
		F.2	Price of Capital	F.2.1 Retail Concession Revenue per m2 F.2.2 Retail Concession Revenue per Passenger F2.3 Car Parking Revenue F.2.4 Price of Labor F.2.5 Cargo Handling Facility Area
		F.3	Policy Decisions	F.3.1 Partnership F.3.2 Bi- Lateral Agreement F.3.3 International Regulations F.3.4 Air Freedom Right F.3.5 Long Term Debt per Passengers
		F.4	Tourist Industry	F.4.1 Tourist Arrivals F.4.2 Origin Country F.4.3 Purpose of the Visit F.4.4 Seasonality Variations F.5.5 Duration of the Stay

	Factor		KPIs	Measures
G	Technology	G.1	Real Time Information	G.1.1 Flight Details Screen and Airline Information G.1.2 Airport Display Screens G.1.3 Clarity/Quality of Information G.1.4 Way Findings and Terminal Signage
		G.2	ICT Application	G.2.1 Mobile Application G.2.2 Online Self Check-ins G.2.3 Integrated Modular Solutions G.2.4 Network in Service Time
		G.3	Smart Indicators	G.3.1 On Time Information G.3.2 Information Accuracy G.3.3 Customer Complains G.3.4 Data Recovery G.3.5 Delay Statistics G.3.6 Data Processing Time G.3.7 Security

To evaluate the effectiveness weight was calculated through AHP analysis (section 3.5, section 4.3, and section 4.4.2.). Interviews were conducted with aviation industry experts who have more than 15 years of experience in the industry (Section 3.6). Developed Airport City Effectiveness Criteria with assigned values are indicated in Table 5.2.

Table 5.2: ACEC with Assigned Weights

	Factor	%		KPIs	%
A	Non Aeronautical Activity Centers	28	A.1	No of Terminal Users	6
			A.2	Industry Revenue	26
			A.3	Revenue Sources	68
B	Geographic Location	23	B.1	Air Network	67
			B.2	Land Use	33
C	Demand	18	C.1	Passengers	30
			C.2	Employees	7
			C.3	Aircraft Movements	39
			C.4	Cargo	24
D	Nature of the Airport	14	D.1	Capacity &Utilization	45
			D.2	On-Time Performance	9
			D.3	Level of Service	46
E	Access Modes	8	E.1	Modal Split	8
			E.2	Access Cost	49
			E.3	Transport Options	43
F	Business Management	7	F.1	Capital Invested	21
			F.2	Price of Capital	8
			F.3	Policy Decisions	41
			F.4	Tourist Industry	30
G	Technology	2	G.1	Real Time Information	20
			G.2	ICT Application	40
			G.3	Smart Indicators	40

The third objective of this research was to evaluate the potential to be an airport city. Bandaranaike International Airport is considered as a case study based airport (section

2.7). Decision makers of the industry including board of directors and senior managers assigned weights to each key performance indicator and finally it is identified that how effective BIA for achieving airport city status (section 4.5). Effectiveness values of the BIA against developed ACEC are indicated in Table 5.3.

Table 5.3: Effectiveness of BIA

	Factor	Effectiveness
A	Non Aeronautical Activity Centers	**0.258**
B	Geographic Location	**0.219**
C	Demand	**0.144**
D	Nature of the Airport	**0.105**
E	Access Modes	**0.048**
F	Business Management	**0.056**
G	Technology	**0.014**

5.3 Conclusion and Recommendation to BIA

The global business trend is going more towards online businesses caused by many reasons such as it provides ease to all stakeholders, disseminating more information. Aviation Industry is also more information sensitive business. Airport city will be a new concept for Sri Lankan market. Therefore, decision making process, strategy development process and implementation process can be most critical for converting BIA to airport city status. Following explains the recommendation for BIA to achieve airport city status based on the research findings.

Decision makers of the airport management have to aware about bird eye view of the concept and they have to integrate each and every function of the airport to achieve the success. There should be a central planning team including all the department representatives like, operation, sales, marketing, legal, planning, mechanical, civil, supply chain management and etc. Most importantly, the responsibilities of each and every department should be clearly defined and structured to comply with the marketing plan created. All the internal forces must get together and form groups to carry out the core operations of the organization aligning with marketing plan.

For an example, airport policy makers must work with investors, airport users, and airport planners, and marketing team before establishing a policy decision. Airport managers must aware about all the customers of the airport including passengers, employees, airlines, visitors, concessionaires and so on.

As findings of this research, the seven factors, non-aeronautical activity centers, geographic location, demand, nature of the airport, access modes, business management and technology make clear what is involved in building effective airport city. It is highlighted that seven factors are interconnected. They are the seven pillars of effective airport city management. This session will discuss recommendation for BIA to

setting out airport management status to airport city derived from both quantitative and qualitative results.

- **Identify Niche Market**

Business Strategy of BIA would be joint marketing efforts and promotional activities with schedule planners, Sri Lanka tourism and business investors. Results of the geographic location factor suggested that easiest markets for BIA to reach is Madras, India. In air network, Abudhabi (AUH), Dubai (DXB), Delhi (DEL) and Kuala Lumpur (KUL) have minimum transfers from BIA. Possible catchment areas of the passengers are from western Europe and Australia. According to non aeronautical revenue sources, Middle East Markets, India and Italy have a lead. When entering to the market there should be a high ground marketing promotion carried out to educate the pros of using IT system to purchase airport products. Destinations, frequency, convenience of the schedule, distance to city center , travel time, availability of the investors, passenger choice factors must also be considered when developing a marketing strategy.

- **Utilize airport capacity**

1.5 times passenger traffic was handled in the year 2016 and it shows BIA can handle their airport capacity when there is a huge demand. Level of service and service quality standards must be maintained. Service agreements with concessionaires should be developed according to the airport capacity. For an example space can be divided according to their past sales for concessionaires at terminal.

- **Identify Potential Suppliers**

Current trend was analyzed at BIA duty free segments and sales. Service contracts must be renewed according to their business performance only. There should be investment opportunities like restaurants since there is 75% annual increment for food and beverage at BIA. Hotels, conference centers, logistics parks, game zones should be established to

promote airport city commercial activities. Multi modal connectivity is weak at BIA and only E01 (Colombo – Katunayake Express way) is provided the link to Paliyagoda city. Aero rail and Aero bus service should be started and it should be identified potential suppliers for that. It should be developed supplier selection criteria and investment plan as well.

- **Develop Aero City Residential Zone**

Airport is the place where employments and economic activities are generated by air transport. Human resource plays greater role in airport planning since this is a service industry. Residential zone will increase employees' motivation and it increases their productivity. There is 2.5% increment of employees at BIA and it should be concerned future demand as well.

- **Contracts with Airlines**

Airport is a home for many airlines and BIA is home for 41 airlines. Airline should continue to find new routes to enhance network connectivity. Developing a successful airport city needs business model to facilitate the service. Airline management and airport management should work together to introduce business model like full service carrier, low cost carrier or hybrid.

- **Develop Travel Packages for Foreigners and Locals Separately**

BIA is serving for 80% locals and remain is foreigners. Foreign traveler has different priorities, therefore business traveler and leisure traveler packages should be separately developed. There should be conference centers and business centers within the airport to facilitate business travelers need. And also it is necessary to increase the standards of airport hotels, and airport rest rooms. When considering the local passengers, there are more visitors accompanied with them. There should be a public waiting area with various kind of activities to have better insight of the airport. For the transfer

passengers, BIA can have separate waiting area with library, TV room, game room and photo gallery and so on. Sri Lanka has proud history and it can be a marketing tool for BIA to attract passengers by well spending their time at airport.

- **IT Plan**

All technology KPIs should be synchronized with Airport functions and there should be central security control system, data center at airport. peak capacity optimization techniques, no ques concept, self-service check in and self-service baggage drop off should be implemented. IT should be user friendly and accessible to all users of the airport.

5.4 Further Research Directions

- Airport City Effectiveness Criteria developed by this research is only aimed for seven factors. It can be further divided in to sub categories.
- Even though, sub measures are used for the KPI analysis it is not weighted by using AHP. This can be extended by calculating values for the sub measures as well.
- According to the BIA case study done for this research, evaluation of effectiveness was considered towards airport city status. It can be extended to recommending solutions to enhance the effectiveness by developing business plan.
- Cost analysis and time analysis for airport access can be done

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Appendix

A.1 : Literature Summary Table

No	Criteria	Description	Research Title	Author (Year)
01	Geographic Location	Land Use – Competition between airport and surrounding airport areas	City Airports to Airport Cities	Steve, Nicholas J. (2006)
		Air Routes Regional Planning	A spatial analysis of multiple airport cities	Ben Derudder, Lomme Devriendt, Frank Witlox (2010)
		Global Accessibility: The global network of air transportation overcome geographic barriers, and accessibility to such is most preferred by multi-national corporations (MCNs)	Competitive advantages analysis and Strategy formulation of Airport city development – the case of Taiwan	Kung Jeng Wang, Wang Chung Hong (2011)
02	Attractiveness	Spatial economic position	Planning airports in an era of glocalisation: A spatial economic and institutional	Michael Drob, Bart de Jong (2007)

			comparison between Amsterdam Airport Shiphol (AMS) and Munich Airport International (MUC)	
		Business model of the airport (Aeronautical and non-aeronautical revenue sources)	Seeding growth at airports and airport cities: Insights from the two sided market literature	Stephen J. Appold, John D. Kasarda (2011)
		Trend for developing multi-functional airport (Tourist Destinations, Commercial Destinations, Industrial activities) & Market efficiency	Competitive advantages analysis and Strategy formulation of Airport city development – the case of Taiwan	Kung Jeng Wang, Wang Chung Hong (2011)
03	Aviation Policy of the country	Decision making and Jurisdictions	City Airports to Airport Cities	Steve, Nicholas J. (2006)

		Create new non-aeronautical revenue sources	Shopping in the Airport City and Aerotropolis New Retail Destinations in the Aviation Century	John D. Kasarda (2008)
04	Nature of the Airport	Spatial economic position as transfer passengers	Planning airports in an era of glocalisation: A spatial economic and institutional comparison between Amsterdam Airport Shiphol (AMS) and Munich Airport International (MUC)	Michael Drob, Bart de Jong (2007)
		New management and Investment opportunities	Shopping in the Airport City and Aerotropolis New Retail Destinations in the Aviation Century	John D. Kasarda (2008)
		Airport Services and Its Ownership	Airport Business	Rigas Doganis (1992)

05	Traffic	OD Pax/ Airport Users/ Airlines (International, Flag Carrier, Full Service/ LCC/ Efficient and Regular Services/ Competitive Prices/ More Frequencies) Identify the niche market by considering Income, frequency of service, travel time ratio, employment, economy fare	A spatial analysis of multiple airport cities Gravity models for airline passenger volume estimation	Ben Derudder, Lomme Devriendt, Frank Witlox (2010) Tobias Grosche, Franz Rothlauf, Armin Heinzl (2007)
06	Infrastructure (Air side & Land Side)/ Land Use and Cost & Facilities available at airport	The Competitive advantage of any city rests on a well-planned physical and commercial infrastructure Complete local infrastructure and Transport network	City Airports to Airport Cities Competitive advantages analysis and Strategy formulation of Airport city	Steve, Nicholas J. (2006) Kung Jeng Wang, Wang Chung Hong (2011)

			development – the case of Taiwan	
07	Level of Service	Efficiency of Services	Airport Business	Rigas Doganis (1992)
08	Logistics and JIT Manufacturing	With the airport itself serving as a region wide multimodal transportation and commercial nexus, strings, and clusters of airport linked shopping centers, business parks, information and communication technology complexes, industrial parks, logistics parks, wholesale merchandise marts and mixed used developments are forming along airport arteries up to 20 miles outward.	Shopping in the Airport City and Aerotropolis New Retail Destinations in the Aviation Century	John D. Kasarda (2008)
09	Free Trade Zones (FTZ)	Commercial Investments/ Reduce Taxes, cut red tape, boost exports/ Country Economy	City Airports to Airport Cities	Steve, Nicholas J. (2006)

		Patterns of ownership of operations To attract companies, to have tax free incentives when importing the components, FTZ is themechanism	Airport Business A logistics study of the Brazilian Airport Model and Its Employment at the Tancredo Neves International Airport	Rigas Doganis (1992) Tadeu Hygo Ferreira Braga, Silva Jersone Tasso Moreira (2010)
10	Flexible & Advanced Technology	Technological preeminence : air transportation relies much on hi-technology support, which play key role in passenger and cargo flow, airport facilities and the environment	Competitive advantages analysis and Strategy formulation of Airport city development – the case of Taiwan	Kung Jeng Wang, Wang Chung Hong (2011)
11	Intermodal Freight Hub	Brings together air, rail, highways, ports	Airport Business	Rigas Doganis (1992)

12	Related and supporting industries Office Parks and Office Corridors Exhibition and Conference Centers Hotels, entertainment, retail clusters Medical and wellness cluster Academic and Research Cluster	Industrial Cluster: Industries oriented towards, related to or dependent on airport operation and air transportation tend to cluster within the airport city Connect air travel-intensive executives and professionals quickly to distant markets Trade and knowledge exchange magnets Serve long distance travelers and local needs Medical Tourism and healthcare provision Executive's education and research centers	Competitive advantages analysis and Strategy formulation of Airport city development – the case of Taiwan Study on Airport Economy	Kung Jeng Wang, Wang Chung Hong (2011) Z. Y. Xia and P. Li (2006)
		Airport Revenue Sources The formation of urban centers around the airports, offering multivariable services and increasing the creation of jobs in the airport region. These centers can be expanded in a	Airport Business A logistics study of the Brazilian airport Model and Its Employment at the Tancredo Neves International Airport	Rigas Doganis (1992) Tadeu Hygo Ferreira Braga, Silva Jersone Tasso

		ratio of up to 20km around the airport.		Moreira (2010)
13	Mixed Used Residential Areas	Airport employee needs incidental service like housing, recreation, food services, retail, health, child day care and so on.	Shopping in the Airport City and Aerotropolis New Retail Destinations in the Aviation Century	John D. Kasarda (2008)
14	Local and Global Interests	Regional Planning	A spatial analysis of multiple airport cities	Ben Derudder, Lomme Devriendt, Frank Witlox (2010)

		Evolving airport edge cities, together with substantial other airport centric commercial development are giving rise to a new urban form.	Shopping in the Airport City and Aerotropolis New Retail Destinations in the Aviation Century	John D. Kasarda (2008)
15	Airport Access Modes	Clustering of developments at the airport territory Transport network (Trains, expressways, busses, taxis)	Planning airports in an era of glocalisation: A spatial economic and institutional comparison between Amsterdam Airport Shiphol (AMS) and Munich Airport International (MUC) Competitive advantages analysis and Strategy formulation of Airport city development – the case of Taiwan	Michael Drob, Bart de Jong (2007) Kung Jeng Wang, Wang Chung Hong (2011)

		Airport expressways serving as a catalyst and magnet for airport linked business development	Shopping in the Airport City and Aerotropolis New Retail Destinations in the Aviation Century	John D. Kasarda (2008)
			Airport Cities and the Aerotropolis	
		Dedicated expressway links (Aerolanes) and high speed rail (Aerotrains)	An analysis of airport access mode choice – A case study in Hong Kong	John D. Kasarda (2006)
		Expectation and perception of the passenger matters for the choice of access mode		Mei Ling TAM, Mei Lam TAM, William H.K. LAM (2005)

16	Land Supply	Land owner and municipalities play a controlling rule when it comes to land policy. Space for Future development	Planning airports in an era of glocalisation : A spatial economic and institutional comparison between Amsterdam Airport Shiphol (AMS) and Munich Airport International (MUC)	Michael Drob, Bart de Jong (2007)
17	Land Availability	Commercial sector pursuit of affordable, accessible land	Shopping in the Airport City and Aerotropolis New Retail Destinations in the Aviation Century	John D. Kasarda (2008)
18	Performance of the airport	Evaluation is based on supply, Airline demand, passenger demand, management side	Performance evaluation of International Airports in the region of East Asia	Daniel L. Stuffle Beam (2000)

A.2: Questionnaire

Instructions

Please compare the importance of each criterion in the left hand side with the criteria in the right hand side in each row. Your observation should be indicated in one of the cell in a row (1-9 scale).

Pair wise comparison scales

Scale	Meaning	Explanation
1	Equally Important	Both criteria are equally important for the decision
3	Slightly Important	Judgment slightly favor towards one element
5	Important	One element is important than the other
7	Very important	One element is very important than other
9	Extremely important	One element is extremely important than the other
2,4,6,8	Intermediate values	Express judgments in between.

Example: If you consider Geographic Location is less important than demand, then you should mark on 5 in the right hand cell as indicated below.

Section A	**Extremely Important**		**Very Important**		**Important**		**Slightly Important**		**Equally Important**		**Slightly Important**		**Important**		**Very Important**		**Extremely Important**	
Criteria	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**Criteria**
Geographic Location													x					Demand

Questionnaire will consist two stages.

A: Pair-wise comparison of Main Criteria

B: Pair-wise comparison of Sub Criteria

	Section A	Extremely Important		Very Important		Important		Slightly Important		Equally Important		Slightly Important		Important		Very Important		Extremely Important	
	Criteria	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Criteria
1	Geographic Location																		Demand
2	Geographic Location																		Technology
3	Geographic Location																		Nature of the Airport
4	Geographic Location																		Non Aeronautical activity Centers
5	Geographic Location																		Business Management
6	Geographic Location																		Access Modes
7	Demand																		Technology
8	Demand																		Nature of the Airport
9	Demand																		Non Aeronautical activity Centers
10	Demand																		Business Management
11	Demand																		Access Modes
12	Technology																		Nature of the Airport
13	Technology																		Non Aeronautical activity Centers
14	Technology																		Business Management
15	Technology																		Access Modes
16	Nature of the Airport																		Non Aeronautical activity Centers
17	Nature of the Airport																		Business Management
18	Nature of the Airport																		Access Modes
19	Non Aeronautical activity Centers																		Business Management
20	Non Aeronautical activity Centers																		Access Modes
21	Business Management																		Access Modes

Section B.1 *Geographic Location*	**Extremely Important**		**Very Important**		**Important**		**Slightly Important**		**Equally Important**		**Slightly Important**		**Important**		**Very Important**		**Extremely Important**	
Criteria	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**Criteria**
Air Network																		Land Use

Section B.2 *Demand*	**Extremely Important**		**Very Important**		**Important**		**Slightly Important**		**Equally Important**		**Slightly Important**		**Important**		**Very Important**		**Extremely Important**	
Criteria	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**Criteria**
Passengers																		Employees
Passengers																		AC Movements
Passengers																		Cargo
Employees																		AC Movements
Employees																		Cargo
AC Movements																		Cargo

Section B.3 *Technology*	**Extremely Important**		**Very Important**		**Important**		**Slightly Important**		**Equally Important**		**Slightly Important**		**Important**		**Very Important**		**Extremely Important**	
Criteria	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**Criteria**
Real Time Information																		ICT Application
Real Time Information																		Smart Indicators
ICT Application																		Smart Indicators

Section B.4 *Nature of the Airport*	**Extremely Important**		**Very Important**		**Important**		**Slightly Important**		**Equally Important**		**Slightly Important**		**Important**		**Very Important**		**Extremely Important**	
Criteria	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**Criteria**
Capacity & Utilization																		On time performance
Capacity & Utilization																		Level of Service
On time performance																		Level of Service

Section B.5 *Access Modes*	**Extremely Important**		**Very Important**		**Important**		**Slightly Important**		**Equally Important**		**Slightly Important**		**Important**		**Very Important**		**Extremely Important**	
Criteria	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**Criteria**
Modal Splits																		Access Costs
Modal Splits																		Public Transport Options
Access Costs																		Public Transport Options

Section B.6 *Non Aeronautical Activity Centers*	**Extremely Important**		**Very Important**		**Important**		**Slightly Important**		**Equally Important**		**Slightly Important**		**Important**		**Very Important**		**Extremely Important**	
Criteria	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**Criteria**
Industry Revenue																		Number of Terminal Users
Industry Revenue																		Revenue Sources
Number of Terminal Users																		Revenue Sources

Section B.7 *Business Management*	**Extremely Important**		**Very Important**		**Important**		**Slightly Important**		**Equally Important**		**Slightly Important**		**Important**		**Very Important**		**Extremely Important**	
Criteria	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**Criteria**
Capital Invested																		Price of Capital
Capital Invested																		Policy Decisions
Capital Invested																		Tourist Industry
Price of Capital																		Policy Decisions
Price of Capital																		Tourist Industry
Policy Decisions																		Tourist Industry

A.3: AHP Analysis Section A- Normalized Matrix

Criteria	Geographic Location	Demand	Technology	Nature of the Airport	Non Aeronautical activity Centers	Business Management	Access Modes	Total	Average	%
Geographic Location	0.11	0.56	0.22	0.41	0.04	0.12	0.15	1.61	0.23	**22.94**
Demand	0.01	0.07	0.19	0.46	0.29	0.24	0.01	1.27	0.18	**18.12**
Technology	0.01	0.01	0.02	0.01	0.04	0.01	0.004	0.11	0.02	1.61
Nature of the Airport	0.01	0.01	0.09	0.05	0.29	0.24	0.27	0.96	0.14	13.74
Non Aeronautical activity Centers	0.79	0.07	0.17	0.05	0.29	0.36	0.27	1.98	0.28	**28.40**
Business Management	0.04	0.01	0.10	0.01	0.03	0.04	0.27	0.50	0.07	7.08
Access Modes	0.02	0.28	0.19	0.01	0.03	0.004	0.03	0.57	0.08	8.10
Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	100.00

A.4: AHP Analysis – Section B

	Criteria	Key Performance Indicators					Total	Average	Percentage
A	Non Aeronautical Activity Centres 28%		Terminal Users	Industry Revenue	Revenue Sources	-			
		#of Terminal Users	0.059	0.020	0.094	-	0.174	0.058	**6**
		Industry Revenue	0.471	0.163	0.151	-	0.785	0.262	**26**
		Revenue Sources	0.471	0.816	0.755	-	2.042	0.681	**68**
								λ max= 10.463 | CI= 0.037 | CR= 0.064	
B	Geographic Location 23%		Air Network	Land Use					
		Air Network	0.667	0.667	-	-	1.333	0.667	**67**
		Land Use	0.333	0.333	-	-	0.667	0.333	**33**
								λ max= 4.000 | CI= 0.005 | CR= 0.000	
C	Demand 18%		Passengers	Employees	AC Movements	Cargo			
		Passengers	0.241	0.467	0.395	0.100	1.203	0.301	**30**
		Employees	0.034	0.067	0.079	0.100	0.280	0.070	**7**
		AC Movements	0.241	0.333	0.395	0.600	1.569	0.392	**39**
		Cargo	0.483	0.133	0.132	0.200	0.948	0.237	**24**
								λ max= 17.899 | CI= 0.046 | CR= 0.051	
D	Nature of the Airport 14%		Capacity Utilization	On time Perfor:	Level of Service				
		Capacity Utilization	0.455	0.455	0.455	-	1.364	0.455	**45**

		On time Performance	0.091	0.091	0.091	-	0.273	0.091	**9**
		Level of Service	0.455	0.455	0.455	-	1.364	0.455	**45**
								λ max= 9.000 | CI= 0.030 | CR= 0.052	
E	Access Modes 8%		Modal Split	Access Cost	Transport Ops:				
		Modal Split	0.077	0.067	0.091	-	0.234	0.078	**8**
		Access Cost	0.538	0.467	0.455	-	1.460	0.487	**49**
		Transport Options	0.385	0.467	0.455	-	1.306	0.435	**44**
								λ max= 9.049 | CI= 0.030 | CR= 0.052	
F	Business Management 7%		Capital Invested	Price of Capital	Policy Decisions	Tourist Industry			
		Capital Invested	0.138	0.308	0.079	0.313	0.837	0.209	**21**
		Price of Capital	0.034	0.077	0.132	0.063	0.305	0.076	**8**
		Policy Decisions	0.690	0.231	0.395	0.313	1.628	0.407	**41**
		Tourist Industry	0.138	0.385	0.395	0.313	1.230	0.307	**31**
								λ max= 18.099 | CI= 0.047 | CR= 0.052	
G	Technology 2%		Real Time Infor:	ICT Application	Smart Indicators				
		Real Time Information	0.143	0.400	0.063	-	0.605	0.202	**20**
		ICT Application	0.143	0.400	0.625	-	1.168	0.389	**39**
		Smart Indicators	0.714	0.200	0.313	-	1.227	0.409	**41**
								λ max= 11.083 | CI= 0.041 | CR= 0.070	

Section B.1: Non Aeronautical Activity Centers

Comparison Matrix

Criteria		Number of Terminal Users	Industry Revenue	Revenue Sources
		1	2	3
Number of Terminal Users	1	1	0.125	0.125
Industry Revenue	2	8	1	0.2
Revenue Sources	3	8.000	5	1

Normalized Matrix

Criteria		Number of Terminal Users	Industry Revenue	Revenue Sources	sum	NPV	PV
		1	2	3			
Number of Terminal Users	1	0.059	0.020	0.094	0.174	0.058	5.786
Industry Revenue	2	0.471	0.163	0.151	0.785	0.262	26.160
Revenue Sources	3	0.471	0.816	0.755	2.042	0.681	68.054

Normalized matrix which was developed by using average value of responses is given in Table 4.1. Following results were obtained when calculating consistency check.

Principle Eigen Value = 10.463
Consistency Index (CI) = 0.0373
Random Consistency Index (RI) = 0.58
The Consistency Ratio (CR) =0.06

If the value of CR is smaller than 10% or equal 10%, the consistency is acceptable. If value is greater than 10%, it is needed to revise the subjective judgment. Calculated CR value is 0.06, which is smaller than 10% or equal 10%. That meant data is consistent and results can be accepted from this study.

Section B.2 – Geographic Location

Comparison Matrix

Criteria		Air Network	Land Use
		1	2
Air Network	1	1	5
Land Use	2	0.2	1

Normalized Matrix

Criteria		Air Network	Land Use	sum	NPV	PV
		1	2			
Air Network	1	0.667	0.667	1.333	0.667	66.667
Land Use	2	0.333	0.333	0.667	0.333	33.333

Principle Eigen Value = 4.00

Consistency Index (CI) = 0.005

Random Consistency Index (RI) = 0.00

The Consistency Ratio (CR) =-

If the value of CR is smaller than 10% or equal 10%, the consistency is acceptable. If value is greater than 10%, it is needed to revise the subjective judgment. Calculated CR value is 0.06, which is smaller than 10% or equal 10%. That meant data is consistent and results can be accepted from this study.

Section B.3 – Demand

Comparison Matrix

Criteria		Passengers	Employees	AC Movements	Cargo
		1	2	3	4
Passengers	1	1.000	7.000	1.000	0.500
Employees	2	0.143	1.000	0.200	0.500
AC Movements	3	1.000	5.000	1.000	3.000
Cargo	4	2.000	2.000	0.333	1.000

Principle Eigen Value = 17.89

Consistency Index (CI) = 0.046

Random Consistency Index (RI) = 0.9

The Consistency Ratio (CR) =0.051

If the value of CR is smaller than 10% or equal 10%, the consistency is acceptable. If value is greater than 10%, it is needed to revise the subjective judgment. Calculated CR value is 0.05, which is smaller than 10% or equal 10%. That meant data is consistent and results can be accepted from this study.

Normalized Matrix

Criteria		Passengers	Employees	AC Movements	Cargo	sum	NPV	PV
		1	2	3	4			
Passengers	1	0.241	0.467	0.395	0.100	1.203	0.301	30.070
Employees	2	0.034	0.067	0.079	0.100	0.280	0.070	7.002
AC Movements	3	0.241	0.333	0.395	0.600	1.569	0.392	39.236
Cargo	4	0.483	0.133	0.132	0.200	0.948	0.237	23.692

Section B.4 – Nature of the Airport

Comparison Matrix

Criteria		Capacity & Utilization	On time Performance	Level of Service
		1	2	3
Capacity & Utilizations	1	1	5	1
On time Performance	2	0.2	1	0.2
Level of Service	3	1.000	5	1

Normalized Matrix

Criteria		Capacity & Utilization	On time Performance	Level of Service	sum	NPV	PV
		1	2	3			
Capacity & Utilization	1	0.455	0.455	0.455	1.364	0.455	45.455
On time Performance	2	0.091	0.091	0.091	0.273	0.091	9.091
Level of Service	3	0.455	0.455	0.455	1.364	0.455	45.455

Principle Eigen Value = 9.00

Consistency Index (CI) = 0.03

Random Consistency Index (RI) = 0.58

The Consistency Ratio (CR) =0.052

If the value of CR is smaller than 10% or equal 10%, the consistency is acceptable. If value is greater than 10%, it is needed to revise the subjective judgment. Calculated CR value is 0.052, which is smaller than 10% or equal 10%. That meant data is consistent and results can be accepted from this study.

Section B.5 – Access Modes

Comparison Matrix

Criteria		Modal Split	Access Cost	Transport Options
		1	2	3
Modal Split	1	1.000	0.143	0.200
Access Cost	2	7.000	1.000	1.000
Transport Options	3	5.000	1.000	1.000

Normalized Matrix

Criteria		Modal Split	Access Cost	Transport Options	sum	NPV	PV
		1	2	3			
Modal Split	1	0.077	0.067	0.091	0.234	0.078	7.817
Access Cost	2	0.538	0.467	0.455	1.460	0.487	48.656
Transport Options	3	0.385	0.467	0.455	1.306	0.435	43.528

Principle Eigen Value = 9.049

Consistency Index (CI) = 0.030246

Random Consistency Index (RI) = 0.58

The Consistency Ratio (CR) =0.052

If the value of CR is smaller than 10% or equal 10%, the consistency is acceptable. If value is greater than 10%, it is needed to revise the subjective judgment. Calculated CR value is 0.052, which is smaller than 10% or equal 10%. That meant data is consistent and results can be accepted from this study.

Section B.6 – Business Management

Comparison Matrix

Criteria		Capital Invested	Price of Capital	Policy Decisions	Tourist Industry
		1	2	3	4
Capital Invested	1	1.000	4.000	0.200	1.000
Price of Capital	2	0.250	1.000	0.333	0.200
Policy Decisions	3	5.000	3.000	1.000	1.000
Tourist Industry	4	1.000	5.000	1.000	1.000

Normalized Matrix

Criteria		Capital Invested	Price of Capital	Policy Decisions	Tourist Industry	sum	NPV	PV
		1	2	3	4			
Capital Invested	1	0.138	0.308	0.079	0.313	0.837	0.209	20.927
Price of Capital	2	0.034	0.077	0.132	0.063	0.305	0.076	7.637
Policy Decisions	3	0.690	0.231	0.395	0.313	1.628	0.407	40.692
Tourist Industry	4	0.138	0.385	0.395	0.313	1.230	0.307	30.745

Principle Eigen Value = 18.099

Consistency Index (CI) = 0.04699

Random Consistency Index (RI) = 0.9

The Consistency Ratio (CR) =0.052

If the value of CR is smaller than 10% or equal 10%, the consistency is acceptable. If value is greater than 10%, it is needed to revise the subjective judgment. Calculated CR value is 0.052, which is smaller than 10% or equal 10%. That meant data is consistent and results can be accepted from this study.

Section B.7 – Technology

Comparison Matrix

Criteria		Real Time Information	ICT Application	Smart Indicators
		1	2	3
Real Time Information	1	1	1	0.2
ICT Application	2	1	1	2
Smart Indicators	3	5.000	0.5	1

Normalized Matrix

Criteria		Real Time Information	ICT Application	Smart Indicators	sum	NPV	PV
		1	2	3			
Real Time Information	1	0.143	0.400	0.063	0.605	0.202	20.179
ICT Application	2	0.143	0.400	0.625	1.168	0.389	38.929
Smart Indicators	3	0.714	0.200	0.313	1.227	0.409	40.893

Principle Eigen Value = 11.083

Consistency Index (CI) = 0.0404

Random Consistency Index (RI) = 0.58

The Consistency Ratio (CR) =0.07

If the value of CR is smaller than 10% or equal 10%, the consistency is acceptable. If value is greater than 10%, it is needed to revise the subjective judgment. Calculated CR value is 0.07, which is smaller than 10% or equal 10%. That meant data is consistent and results can be accepted from this study.

A.5: Analysis of Centrality Index

Assumptions:

1. Only the direct flights were considered to obtain the frequency between two nodes. However, the indirect flight frequency was calculated for the top 6 nodes according to degree centrality
2. When calculating the frequency of indirect flights, only the flights having the shortest duration (including transit) time was considered.
3. The destinations of SLA mentioned in the website was considered as Nodes to collect data

Formulas

Column1	Column2
Impediment Value (Dij)	(Total Travel Time in Minutes) /(Frequency per direction per week)
Degree Centrality (CDi)	Sum(Minimum number of transfers between nodes 'i' and 'j')/ (Number of Nodes - 1)
Closeness Centrality (CCi)	Sum(impediment value between nodes 'I' and 'j')/ (Number of Nodes -1)

Code	Code2	IATA Code	Column3	Code	Code2	IATA Code	Column3	Code	Code2	IATA Code	Column3
CMA_1	1	CMA	Colombo	KHI_17	17	KHI	Karachi	CGK_26	26	CGK	Jakarta
MLE_2	2	MLE	Male	LHE_18	18	LHE	Lahore	HKG_27	27	HKG	Hong Kong
GAN_3	3	GAN	Gan Island	DAC_19	19	DAC	Dhaka	PEK_28	28	PEK	Beijing
MAA_4	4	MAA	Chennai	SEZ_20	20	SEZ	Seychelles	PVG_29	29	PVG	Shanghai
TRV_5	5	TRV	Trivandrum	LHR_21	21	LHR	London	CAN_30	30	CAN	Canton
TRZ_6	6	TRZ	Trichy	NRT_22	22	NRT	Tokyo	KMG_31	31	KMG	Kunming
BOM_7	7	BOM	Mumbai	BKK_23	23	BKK	Bangkok	BAH_32	32	BAH	Bahrain
BLR_8	8	BLR	Bangalore	KUL_24	24	KUL	Kuala Lumpur	KWI_33	33	KWI	Kuwait
DEL_9	9	DEL	Delhi	SIN_25	25	SIN	Singapore	DOH_34	34	DOH	Doha
COK_10	10	COK	Kochi					MCT_35	35	MCT	Muscat
VNS_11	11	VNS	Varanasi					DXB_36	36	DXB	Dubai
IXM_12	12	IXM	Madurai					AUH_37	37	AUH	Abu Dhabi
CCU_13	13	CCU	Kolkata					DMM_38	38	DMM	Dammam
HYD_14	14	HYD	Hyderabad					JED_39	39	JED	Jeddah
VTZ_15	15	VTZ	Visakhapatnam					RUH_40	40	RUH	Riyadh

CJB_16	16	CJB	Coimbatore						MEL_41	41	MEL	Melbourne

Reference Number	Node (i)	i	Node (j)	j	Frequency per Week per direction	Travel time (hours)	Travel time (mins)	Total Travel Time in Minutes	Flight Schedule Valid Date	Minimum Number of Transfers
1	CMB_1	1	MLE_2	2	43	1	25	85	30/Sep/17	0
2	CMB_1	1	GAN_3	3	5	1	50	110	30/Sep/17	0
3	CMB_1	1	MAA_4	4	49	1	30	90	28/Oct/17	0
4	CMB_1	1	TRV_5	5	7	1	0	60	17/Aug/18	0
5	CMB_1	1	TRZ_6	6	14	1	0	60	28/Oct/17	0
6	CMB_1	1	BOM_7	7	21	2	30	150	28/Oct/17	0
7	CMB_1	1	BLR_8	8	18	1	25	85	28/Oct/17	0
8	CMB_1	1	DEL_9	9	18	3	35	215	30/Nov/17	0
9	CMB_1	1	COK_10	10	14	1	20	80	30/Oct/17	0
10	CMB_1	1	VNS_11	11	3	3	25	205	31/Oct/17	0
11	CMB_1	1	IXM_12	12	14	0	55	55	30/Oct/17	0
12	CMB_1	1	CCU_13	13	3	3	0	180	17/Aug/18	0
13	CMB_1	1	HYD_14	14	4	1	55	115	28/Oct/17	0
14	CMB_1	1	VTZ_15	15	4	2	0	120	10/Oct/17	0
15	CMB_1	1	CJB_16	16	4	1	15	75	10/Oct/17	0
16	CMB_1	1	KHI_17	17	7	3	40	220	28/Oct/17	0
17	CMB_1	1	LHE_18	18	3	3	55	235	2/Dec/17	0
18	CMB_1	1	DAC_19	19	7	3	15	195	31/Oct/17	0
19	CMB_1	1	SEZ_20	20	4	4	0	240	18/Aug/18	0
20	CMB_1	1	LHR_21	21	7	11	25	685	28/Oct/17	0
21	CMB_1	1	NRT_22	22	4	8	50	530	28/Oct/17	0
22	CMB_1	1	BKK_23	23	28	3	30	210	28/Oct/17	0
23	CMB_1	1	KUL_24	24	45	3	45	225	30/Sep/17	0

24	CMB_1	1	SIN_25	25	38	4	5	245	28/Oct/17	0
25	CMB_1	1	CGK_26	26	7	4	40	280	19/Aug/18	0
26	CMB_1	1	HKG_27	27	12	5	30	330	31/Oct/17	0
27	CMB_1	1	PEK_28	28	4	7	25	445	29/Oct/17	0
28	CMB_1	1	PVG_29	29	8	7	10	430	29/Oct/17	0
29	CMB_1	1	CAN_30	30	9	5	45	345	31/Oct/17	0
30	CMB_1	1	KMG_31	31	6	4	45	285	30/Oct/17	0
31	CMB_1	1	BAH_32	32	12	5	10	310	28/Oct/17	0
32	CMB_1	1	KWI_33	33	17	5	25	325	19/Aug/18	0
33	CMB_1	1	DOH_34	34	42	5	5	305	28/Oct/17	0

There are 820 pairs for the calculation.

	CMB	LHR_1	FRA_2	KWI_3	RUH_4	KUL_5	DXB_6	JED_7	TRZ_8	KHI_9	DOH_10	PVG_11	MAA_12	DEL_13	MLE_14	COK_15	KMG_16	PEK_17	BLR_18	CAN_19	SIN_20	BKK_21	BOM_22	NRT_23	AUH_24	CDG_25	TRV_26	DMM_27	HKG_28	SHJ_29	LHE_30	BAH_31	MCT_32	CTU_33	IXM_34	DAC_35	IST_36	CGK_37	HRI_38	SEZ_39	KNO_40	ICN_41	CCU_42	43	Dcij
CMB	0	1	2	1	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	14	0.33
LHR_1	1	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	0	1	1	1	1	1	0	1	1	2	1	1	1	0	1	1	0	1	31	0.72
FRA_2	2	0	0	1	1	1	1	0	1	1	1	1	0	0	0	0	1	1	0	1	0	1	1	1	1	0	1	1	1	1	1	0	1	2	2	1	0	1	0	1	2	0	1	33	0.77
KWI_3	1	0	1	0	0	1	0	0	1	1	0	1	1	0	2	0	2	1	1	1	2	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	2	1	1	36	0.84
RUH_4	1	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	0	1	0	0	1	2	1	1	35	0.81
KUL_5	0	0	1	1	0	0	1	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	0	1	0	1	1	0	1	0	1	0	0	1	0	1	0	17	0.40
DXB_6	0	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0	1	1	0	1	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	1	0	13	0.30
JED_7	0	0	0	0	1	0	0	0	0	0	0	1	1	1	1	1	2	1	2	1	1	1	1	1	1	1	1	0	1	1	1	2	1	1	2	0	0	0	0	1	2	1	1	33	0.77
TRZ_8	0	1	1	1	1	0	1	0	0	1	1	1	0	1	1	1	2	2	1	2	0	1	1	2	1	2	2	1	1	2	1	1	1	2	1	1	2	1	0	2	1	2	1	47	1.09
KHI_9	0	1	1	1	1	1	0	0	1	0	0	1	1	1	1	1	1	0	1	1	1	1	1	2	0	1	1	1	1	0	1	0	1	2	1	1	1	0	1	2	1	2	1	37	0.86
DOH_10	0	1	1	0	1	1	0	0	1	0	0	0	1	0	1	1	1	0	1	1	1	1	1	0	0	1	0	1	0	0	1	0	0	1	1	0	1	0	0	1	2	0	0	23	0.53
PVG_11	0	1	1	1	1	1	1	1	1	1	0	0	1	0	1	1	0	0	1	0	1	0	1	0	0	1	1	1	0	2	1	1	1	0	1	1	1	1	0	1	1	0	1	30	0.70
MAA_12	0	1	0	1	1	0	0	1	0	1	1	1	0	0	1	0	1	1	0	1	0	1	0	1	0	1	0	1	1	1	1	0	1	1	0	1	1	1	0	2	1	1	0	27	0.63
DEL_13	0	1	0	0	1	0	0	1	1	1	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	1	1	0	1	1	1	0	16	0.37
MLE_14	0	1	0	2	1	0	0	1	1	1	1	1	1	1	0	0	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	2	1	1	1	1	0	1	0	1	1	1	1	35	0.81
COK_15	0	1	0	0	1	0	0	1	1	1	1	1	0	0	0	0	1	1	0	1	0	1	0	1	0	1	0	0	1	0	1	1	0	1	0	1	1	1	0	1	1	1	1	24	0.56
KMG_16	1	1	1	2	1	0	1	2	2	1	1	0	1	1	1	1	0	0	1	0	1	0	1	1	1	0	1	1	1	2	1	1	2	1	2	0	1	1	0	1	1	1	0	39	0.91
PEK_17	1	1	1	1	1	0	1	1	2	0	0	0	1	1	1	1	0	0	1	0	1	1	1	1	1	1	1	1	1	2	1	1	1	0	1	1	1	1	0	1	1	0	1	35	0.81
BLR_18	1	1	0	1	1	1	0	2	1	1	1	1	0	0	0	0	1	1	0	1	0	1	0	1	0	1	0	1	1	1	1	1	0	0	0	1	2	1	0	1	1	1	0	29	0.67
CAN_19	1	0	1	1	1	0	1	1	2	1	1	0	1	0	1	1	0	0	1	0	0	0	1	1	1	1	1	1	0	1	1	1	1	0	2	1	1	0	0	1	1	0	1	31	0.72
SIN_20	0	0	0	2	1	0	0	1	0	1	1	1	0	0	1	0	1	1	0	0	0	0	1	1	0	1	0	1	0	1	1	1	1	1	1	1	1	0	0	1	0	1	1	25	0.58
BKK_21	0	1	1	1	1	0	0	1	1	1	1	0	1	0	1	1	0	1	1	0	0	0	0	0	0	1	1	1	0	2	0	1	0	1	1	1	0	0	0	1	0	0	0	23	0.53
BOM_22	0	1	1	0	1	0	0	1	1	1	1	1	0	0	1	0	1	1	0	1	1	0	0	0	0	0	0	0	1	1	1	0	0	1	1	0	0	1	0	0	1	0	0	20	0.47
NRT_23	1	1	1	1	1	0	1	1	2	2	0	0	1	0	1	1	1	1	1	1	1	0	0	0	0	0	1	1	0	2	1	1	1	0	2	1	0	0	0	2	1	0	1	33	0.77
AUH_24	0	1	1	0	0	0	0	1	1	0	0	0	0	0	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	1	0	0	12	0.28
CDG_25	1	0	0	1	1	1	1	1	2	1	1	1	1	0	1	1	0	1	1	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1	2	1	0	1	0	0	1	0	1	33	0.77
TRV_26	0	1	1	1	1	1	0	1	2	1	0	1	0	0	0	0	1	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	1	0	1	0	1	1	0	1	1	1	1	27	0.63
DMM_27	0	1	1	1	1	1	0	0	1	1	1	1	1	0	1	0	1	1	1	1	1	1	0	1	0	1	0	1	0	0	1	1	1	0	0	1	1	1	0	1	2	1	1	31	0.72
HKG_28	0	1	1	1	1	0	1	1	1	1	0	0	1	0	1	1	1	1	1	0	0	0	1	0	0	1	1	1	0	1	1	1	1	0	1	1	0	0	0	1	1	0	0	26	0.60
SHJ_29	0	1	1	1	1	1	0	1	2	1	0	2	1	1	1	0	2	2	1	1	1	2	1	2	1	1	0	1	1	0	1	1	1	0	2	1	1	1	0	0	2	1	1	42	0.98
LHE_30	0	1	1	1	1	0	0	1	1	0	1	1	1	0	1	1	1	1	1	1	1	0	1	1	0	1	1	1	1	1	0	1	0	1	2	1	0	1	0	1	2	1	1	34	0.79
BAH_31	0	0	0	1	1	1	0	2	1	1	0	1	0	0	2	1	1	1	1	1	1	1	0	1	0	1	1	0	1	1	1	0	0	1	1	1	0	1	0	1	2	1	1	32	0.74
MCT_32	0	1	1	1	1	1	0	1	1	0	0	1	1	0	1	0	2	1	0	1	1	0	0	1	0	1	0	0	1	1	0	0	0	1	1	0	1	1	0	1	2	1	1	28	0.65
CTU_33	1	1	2	1	1	0	0	1	2	1	1	0	1	1	1	1	1	0	0	0	1	1	1	0	1	1	1	1	0	0	1	1	1	0	2	1	1	1	0	2	1	0	1	35	0.81
IXM_34	0	2	2	1	1	1	0	2	1	2	1	1	0	1	1	0	2	1	0	2	1	1	1	2	1	2	0	1	1	2	2	1	1	2	0	2	2	2	0	2	2	1	1	51	1.19
DAC_35	0	1	1	1	0	0	0	0	1	1	0	1	1	0	1	1	0	1	1	1	1	1	0	1	0	1	1	1	1	1	1	1	0	1	2	0	1	1	0	1	1	1	0	30	0.70
IST_36	0	1	0	1	1	1	0	0	2	1	1	1	1	1	0	1	1	1	2	1	1	0	0	0	0	0	1	0	0	1	0	0	1	1	2	1	0	0	0	1	1	0	1	28	0.65
CGK_37	0	1	1	1	0	0	0	0	1	1	0	1	1	1	1	1	1	1	1	0	0	0	1	0	0	1	1	1	0	1	1	1	1	1	2	1	0	0	0	1	0	0	1	27	0.63
HRI_38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
SEZ_39	0	1	1	1	1	1	1	1	2	1	1	1	2	1	1	1	1	1	1	1	1	1	0	2	0	0	1	1	1	0	1	1	1	2	2	1	1	1	0	0	2	1	1	42	1.00
KNO_40	1	1	2	2	2	0	1	2	1	2	2	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	2	1	2	2	2	2	1	2	1	1	0	0	2	0	1	1	50	1.16
ICN_41	1	0	0	1	1	1	1	1	2	1	0	0	1	1	1	1	1	0	1	0	1	0	0	0	0	0	1	1	0	1	1	1	1	0	1	1	0	0	0	1	1	0	1	27	0.63
CCU_42	0	1	1	1	1	0	0	1	1	2	0	1	0	0	1	1	0	1	0	1	1	0	0	1	0	1	1	1	0	1	1	1	1	1	1	0	1	1	0	1	1		0	28	0.65

Top 25 Impediment values

Reference Number	Node (i)	i	Node (j)	j	Frequency per Week per direction	Dij	Dij (Final)
668	KUL_24	24	SIN_25	25	294	0.22	0.22
228	BOM_7	7	DEL_9	9	461	0.28	0.28
818	JED_39	39	RUH_40	40	336	0.28	0.28
265	BLR_8	8	HYD_14	14	171	0.41	0.41
685	SIN_25	25	CGK_26	26	259	0.42	0.42
227	BOM_7	7	BLR_8	8	235	0.43	0.43
121	MAA_4	4	BLR_8	8	123	0.49	0.49
800	MCT_35	35	DXB_36	36	117	0.51	0.51
233	BOM_7	7	HYD_14	14	156	0.54	0.54
816	DMM_38	38	RUH_40	40	118	0.55	0.55
669	KUL_24	24	CGK_26	26	216	0.58	0.58
779	BAH_32	32	DXB_36	36	128	0.59	0.59
260	BLR_8	8	DEL_9	9	280	0.59	0.59
296	DEL_9	9	CCU_13	13	205	0.66	0.66
120	MAA_4	4	BOM_7	7	168	0.68	0.68
127	MAA_4	4	HYD_14	14	96	0.73	0.73
717	HKG_27	27	PVG_29	29	212	0.73	0.73
787	KWI_33	33	DXB_36	36	150	0.73	0.73
297	DEL_9	9	HYD_14	14	167	0.78	0.78
129	MAA_4	4	CJB_16	16	84	0.83	0.83
261	BLR_8	8	COK_10	10	74	0.88	0.88

776	BAH_32	32	KWI_33	33	70	0.93	0.93
420	CCU_13	13	DAC_19	19	63	0.95	0.95
125	MAA_4	4	IXM_12	12	77	0.97	0.97
755	CAN_30	30	KMG_31	31	154	0.97	0.97
731	PEK_28	28	CAN_30	30	200	1.00	1.00
651	BKK_23	23	SIN_25	25	144	1.01	1.01
809	DXB_36	36	RUH_40	40	110	1.05	1.05
122	MAA_4	4	DEL_9	9	155	1.10	1.10
785	KWI_33	33	DOH_34	34	82	1.10	1.10
815	DMM_38	38	JED_39	39	120	1.13	1.13
781	BAH_32	32	DMM_38	38	30	1.17	1.17
653	BKK_23	23	HKG_27	27	145	1.17	1.17

	j																																									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	Closeness Centrality
1		1.98	22.00	1.84	8.57	4.29	7.14	4.72	11.94	5.71	68.33	3.93	60.00	28.75	30.00	18.75	31.43	78.33	27.86	60.00	97.86	#####	7.50	5.00	6.45	40.00	27.50	111.25	53.75	38.33	47.50	25.83	19.12	7.26	11.90	5.74	13.33	76.25	30.00	47.14	86.43	34.16
2	1.98		3.28	41.67	4.71		1.71	19.17	1.79	15.00													18.93	39.29	15.83		97.50	153.33	99.00					20.36		11.43	37.14			147.50		18.24
3	22.00	3.28					3.79		3.93															4.72	4.72											5.71	5.71					1.35
4	1.84	41.67			3.48	2.32	0.68	0.49	1.10	2.00		0.97	2.23	0.73	4.44	0.83			50.00		92.86		29.29	4.29	4.90		54.17					28.50	62.00	20.71	8.21	6.58	12.38		#####	145.00		18.92
5	8.57	4.71		3.48			6.19	1.79	8.00	2.50				15.00										83.33	66.25							42.14	53.33	28.50	12.50	9.62	13.42	40.00	#####	61.00		15.63
6	4.29			2.32			15.00		15.00					15.00										83.33	66.25							42.14	53.33	28.50	12.50	9.92	13.42	41.43	#####	61.00		15.71
7	7.14	1.71	3.79	0.68	6.19	15.00		0.43	0.28	1.43	4.64	17.86	1.32	0.54	17.14	3.14	20.00	21.15	25.71	53.00	16.43	71.43	5.52	10.79	8.82	21.36	20.88	96.25	23.82	24.64	25.24	12.50	11.43	8.60	3.93	1.62	3.66	32.14	16.39	14.17	25.71	16.41
8	4.72	19.17		0.49	1.79		0.43		0.59	0.88	20.71	11.43	1.26	0.41	3.39	2.22					91.43		32.86	15.94	8.33		49.29						60.00	39.29	15.36	8.39	11.43		#####	142.50		21.81
9	11.94	1.79	3.93	1.10	8.00	15.00	0.28	0.59		3.03	1.31	48.75	0.66	0.78	5.65	12.50	38.33	85.00	20.71	38.57	13.33	26.67	5.43	13.00	12.50	40.00	11.61	121.67	30.83	22.14	71.25	13.89	18.21	8.57	5.71	2.29	5.36	17.86	41.25	40.00	245.00	26.61
10	5.71	15.00		2.00	2.50		1.43	0.88	3.03					2.27										12.14	21.15							40.00	29.50	11.82	6.72	4.36	6.86	66.25	38.33	38.13		7.70
11	68.33						4.64	20.71	1.31				11.43	8.57									45.00	65.83	66.25											72.00	75.00					10.98
12	3.93			0.97			17.86	11.43	48.75					15.00										87.14	67.50											38.57	96.43					9.69
13	60.00			2.23			1.32	1.26	0.66		11.43			2.32	9.09				0.95				4.21	21.36	20.00		49.00				21.43			47.14		26.82	45.00					8.11
14	28.75			0.73	15.00	15.00	0.54	0.41	0.78	2.27	8.57	15.00	2.32		1.38	6.92					87.86		35.83	17.33	16.47		#####					30.00	147.50	39.29	8.75	5.63	9.23	68.75	47.86	90.00		20.22
15	30.00			4.44			17.14	3.39	5.65				9.09	1.38										78.33	83.33											0.00	0.00					5.82
16	18.75			0.83			3.14	2.22	12.50					6.92										0.00	70.00											0.00	0.00					2.86
17	31.43						20.00		38.33									1.33	48.75		#####		29.50	90.00	0.00			91.25				20.00		12.14	5.79	2.10	7.94	92.50	14.41	40.00		20.01
18	78.33						21.15		85.00								1.33				#####		38.57	72.00	0.00					167.50		55.00	30.00	16.43	12.00	6.72	12.65	50.00	15.48	27.00		21.69
19	27.86			50.00			25.71		20.71				0.95				48.75				#####		4.84	3.79	7.14		58.75			30.71	19.29	71.00	24.00	15.87	157.50	8.61	44.29	56.67	35.00	18.95		22.51
20	60.00						53.00		38.57															0.00	0.00									48.57		19.29	21.15					6.01
21	97.86			92.86			16.43	91.43	13.33					87.86			255.00	178.33	#####			#####	24.64	39.25	18.69	286.67	13.24	28.57	28.33	49.29		18.81	22.06	8.37	23.95	4.72	15.71		30.00	28.93		43.61
22	#####						71.43		26.67												#####		9.29	18.33	10.48	22.38	2.46	10.65	1.96	41.43				105.00		96.43	99.29				48.08	19.91
23	7.50	18.93		29.29			5.52	32.86	5.43		45.00		4.21	35.83			29.50	38.57	4.84		24.64	9.29		1.97	1.01	7.41	1.17	5.63	3.38	2.18	4.24	57.86	63.57	11.71	17.14	6.11	19.75				31.18	13.14
24	5.00	39.29	4.72	4.29	83.33	83.33	10.79	15.94	13.00	12.14	65.83	87.14	21.36	17.33	78.33	0.00	90.00	72.00	3.79	0.00	39.25	18.33	1.97		0.22	0.58	2.83	15.63	8.78	4.38	20.45	0.00	0.00	22.14	23.82	19.76	31.43	0.00	75.00	156.67	16.79	29.14
25	6.45	15.83	4.72	4.90	66.25	66.25	8.82	8.33	12.50	21.15	66.25	67.50	20.00	16.47	83.33	70.00	0.00	0.00	7.14	0.00	18.69	10.48	1.01	0.22		0.42	1.59	10.57	4.57	4.38	27.22	0.00	0.00	22.86	0.00	12.43	62.86	0.00	#####	0.00	7.81	24.84
26	40.00						21.36		40.00												#####	22.38	7.41	0.58	0.42		6.86	60.71	37.00	14.05				25.24	68.57	33.93	36.43		28.57	175.00	96.25	25.04
27	27.50	97.50		54.17			20.88	49.29	11.61				49.00	#####					58.75		13.24	2.46	1.17	2.83	1.59	6.86		1.49	0.73	4.29	7.38			38.57		15.15	75.00				16.82	16.57
28	#####	#####					96.25		121.67								91.25				28.57	10.65	5.63	15.63	10.57	60.71	1.49		2.76	1.00	1.64			77.14		26.58	75.71				236.67	28.21
29	53.75	99.00					23.82		30.83												28.33	1.96	3.38	8.78	4.57	37.00	0.73	2.76		2.68	3.51			87.14		37.86	83.57				46.07	13.89
30	38.33						24.64		22.14									167.50	30.71		49.29	41.43	2.18	4.38	4.38	14.05	4.29	1.00	2.68		0.97			77.14	112.50	34.29	0.00		#####	131.25	41.07	24.90
31	47.50						25.24		71.25				21.43						19.29				4.24	20.45	27.22		7.38	1.64	3.51	0.97						141.67	0.00					9.79
32	25.83			28.50	42.14	42.14	12.50		13.89	40.00				30.00			20.00	55.00	71.00		18.81		57.86	0.00	0.00								0.93		2.64	0.59	3.27	1.17	4.00	1.79		11.80
33	19.12			62.00	53.33	53.33	11.43	60.00	18.21	29.50				#####				30.00	24.00		22.06		63.57	0.00	0.00							0.93		1.10	4.82	0.73	2.56	7.22	2.92	2.58		15.42
34	7.26	20.36		20.71	28.50	28.50	8.60	39.29	8.57	11.82			47.14	39.29			12.14	16.43	15.87	48.57	8.37	#####	11.71	22.14	22.86	25.24	38.57	77.14	87.14	77.14			1.10		1.88	0.00	0.00				118.57	23.75
35	11.90			8.21	12.50	12.50	3.93	15.36	5.71	6.72				8.75			5.79	12.00	#####		23.95		17.14	23.82	0.00	68.57				112.50		2.64	4.82	1.88		0.51	1.71	4.23	6.09	6.09		13.37
36	5.74	11.43	5.71	6.58	9.62	9.92	1.62	8.39	2.29	4.36	72.00	38.57	26.82	5.63	0.00	0.00	2.10	6.72	8.61	19.29	4.72	96.43	6.11	19.76	12.43	33.93	15.15	26.58	37.86	34.29	141.67	0.59	0.73	0.00	0.51		30.00	1.27	1.94	1.05	38.10	18.71
37	13.33	37.14	5.71	12.38	13.42	13.42	3.66	11.43	5.36	6.86	75.00	96.43	45.00	9.23	0.00	0.00	7.94	12.65	44.29	21.15	15.71	99.29	19.75	31.43	62.86	36.43	75.00	75.71	83.57	0.00	0.00	3.27	2.56	0.00	1.71	30.00		3.04	5.86	3.55	57.86	26.05
38	76.25				40.00	41.43	32.14		17.86	66.25				68.75			92.50	50.00	56.67					0.00	0.00							1.17	7.22		4.23	1.27	3.04		1.13	0.55		14.01
39	30.00			#####	#####	#####	16.39	#####	41.25	38.33				47.86			14.41	15.48	35.00		30.00			75.00	262.50	28.57				191.67		4.00	2.92		6.09	1.94	5.86	1.13		0.28		42.09
40	47.14	#####		#####	61.00	61.00	14.17	#####	40.00	38.13				90.00			40.00	27.00	18.95		28.93			156.67	0.00	175.00				131.25		1.79	2.58		6.09	1.05	3.55	0.55	0.28			34.50
41	86.43						25.71		245.00													48.08	31.18	16.79	7.81	96.25	16.82	236.67	46.07	41.07				118.57		38.10	57.86					27.81

A.6: Passenger Forecast at BIA

Year	Passenger Movements	Moving Average	CMA(2)	St, It	St	Deseasonal	Tt	Forecast
2007	494008				0.97355	507428.38	292312	284581
2008	438475	466241.5	454712	0.96429	1.0064	435685.34	449959	452840
2009	447890	443182.5	497183	0.90086	0.97355	460057.53	607606	591536
2010	654476	551183	653204	1.00195	1.0064	650312.1	765253	770153
2011	855975	755225.5	843008	1.01538	0.97355	879228.7	922900	898492
2012	1005605	930790	1035445	0.97118	1.0064	999207.15	1080547	1087466
2013	1274593	1140099	1268986	1.00442	0.97355	1309219	1238195	1205447
2014	1521153	1397873	1397873	1.08819	1.0064	1511475.1	1395842	1404779
2015					0.97355		1553489	1512402
2016					1.0064		1711136	1722092
2017					0.97355		1868783	1819358
2018					1.0064		2026430	2039405
2019					0.97355		2184077	2126313
2020					1.0064		2341725	2356719

Year	St
1	0.97355
2	1.0064

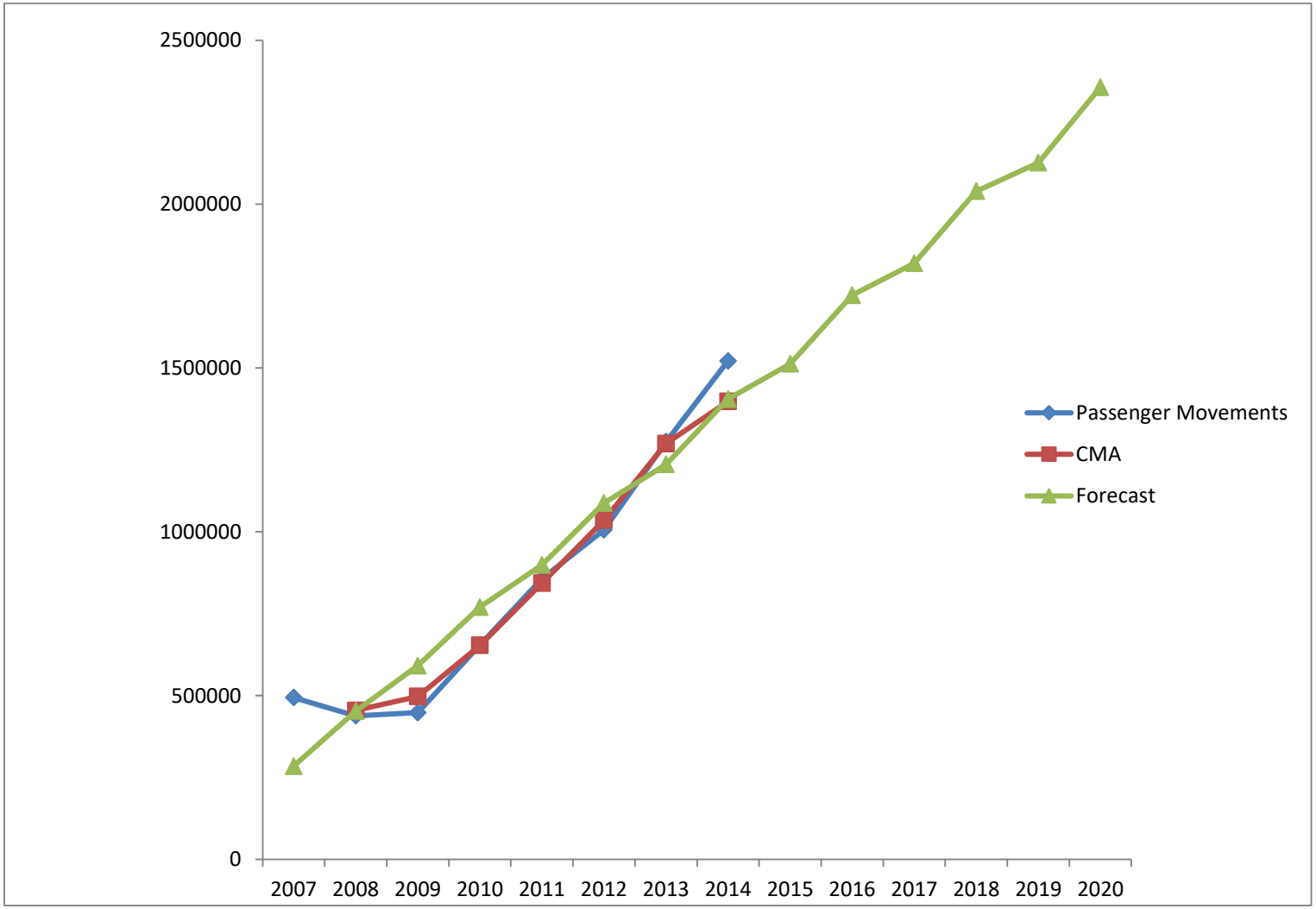
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.95179831
R Square	0.90592002
Adjusted R Square	0.89024002
Standard Error	134412.25
Observations	8

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1.04E+12	1.04E+12	57.77552	0.00026996
Residual	6	1.08E+11	1.81E+10		
Total	7	1.15E+12			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-316105531	41698321	-7.58077	0.000274	-418137646	-2.1E+08	-4.2E+08	-2.1E+08
Year	157647.156	20740.26	7.601021	0.00027	106897.567	208396.7	106897.6	208396.7


2500000
2000000
1500000
1000000
500000
0
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Passenger Movements
CMA
Forecast

A.7: Business Partners at BIA

A.5.1 Duty Free	Consumer Durables & related Items	Gift Items (Bags, Sunglasses etc.)	Sunglasses, writing instruments, wristwatches, cameras, light electrical/ electronic house hold appliances and high quality toys	Liquor of all types , Perfumes, Cosmetics / Toiletries, Confectionary and Tobacco Products	Branded and designer ware sunglasses, wristwatches, writing instruments, leather accessories and cameras
1	Abans Pvt Ltd	30 Chamber of Gifts	32 Dipco Gallery	35 Flemingo International Limited	38 Gomez's
2	AMF Duty Free Company Pvt Ltd	31 Odel (Pvt) Ltd	33 Gomez's	36 World Duty Free	39 W.A.De Silva & Company (Pvt) Ltd
3	Asian's Electricals		34 W.A.De Silva & Company (Pvt) Ltd	37 Autogril	
4	Aventure Holdings (Pvt) Ltd				
5	Classic Electronics				
6	Crown Electronics				
7	D.M.Jeevan (Pvt) Ltd				
8	Edison Electricals				
9	Eswaran Brothers				

10	F.W. Electronic Duty Free (Pvt) Ltd				
11	Fio International				
12	Free Lanka				
13	Hunter & Co. Ltd				
14	Jade Electronics Pvt) Ltd				
15	Joan Arc				
16	Metro International (pvt) Ltd.				
17	Morich Trading Co. Ltd				
18	Pacific Traders				
19	Pesons				
20	Project Prospects				
21	Royale Electronics				
22	S.N. Jayasinghe				
23	Shrmila's Duty Free				
24	Singer (SL) Ltd				
25	Softlogic Retail (Pvt) Ltd				
26	St. Anthony's Ltd.				
27	Telcey (Pvt) Ltd				
28	Victory Silk				
29	We Do Lanka (Pvt) Ltd				

A.5.2 Duty Free	Apparels And Accessories (Leading menswear specialist)	Electrical items, Wrist Watches, Gift Items, Toys, Handicrafts, Leather goods and Paintings	High fashion Jewelers and quality souvenir items	Imported Photographic equipment and Accessories	Electrical, Electronics and IT related appliances	Imported Handicrafts
1	40 Hameedia	42 Aventura	44 Mohksha Limited	47 Photo Technica (Pvt) Ltd	48 Siedles (Private) Ltd	50 Unique Multi Artists
2	41 Odel (Pvt) Ltd	43 Indika International (Pvt)	45 Odel (Pvt) Ltd		49 Singer Lanka Pvt Limited	51 Yoland Collection
3			46 Stone "N" String (Pvt) Ltd			

A.5.3 Restaurant	Non- alcoholic beverages, pre-prepared food items such as sandwiches, lasagna, deserts	Fresh Fruit juice and Ice Cream and Short-eats	Burger King Food and Beverages	Tea Salon/Dessert/ Bar/Boutique	
1	52 Baristar Coffee Lanka (Pvt) Ltd	56 Deli Food & Spicy (Pvt) Limited	57 Burger king	58 H.V. A Foods	59 Nestle Lanka PLC
2	53 International Brands Ceylon				
3	54 Palm Strip Restaurant				
4	55 Relax Inn Fast Food Outlet				

A.5.4 Health , Beauty & Leisure	Health guard Pharmacy
1	60 Natures Beauty creations Ltd
2	61 R.S Leisure
3	62 Spa Ceylon

A.5.5 Banks	Names
1	63 Commercial Bank
2	64 Sampath Bank
3	65 Peoples' Bank
4	66 Thomas Cook
5	67 Bank of Ceylon

A.5.6 Sri Lanka Tourism (Official Tourist Information)	Names
1	68 Tourist Drivers' Association
2	69 Ceylon Hotels Corporation
3	70 Lanka Travel Agent Association
4	71 Airwing Tours
5	72 Abans Tours
6	73 Lanka Heritage & Tours
7	74 Helitours

A.5.5.7 Telecommunication	Names
1	75 Mobitel
2	76 Dialog Telecom
3	77 Hutch
4	78 Etisalat