Capacity forecasting at Kenyan Airports.

BY

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DECLARATION

I the undersigned, declare that this is my original work and has not been presented to any other university for academic credit.

Signed..... Date..... 11.11.2011

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This project has been submitted for examination with my approval as university supervisor.

Signed..... Date.....

Dr. X.N Iraki.

DEDICATION

This project is dedicated to my parents who saw to it that I got the best in support, education and encouraged me to do only the best and to my brothers and sisters who supported me throughout out the course.

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I will like to express my gratitude to the almighty God for the grace and blessings in all my life and for enabling me come this far in life. My humble appreciation to all those who assisted, encouraged and supported me in completing this project, my supervisor Dr. Iraki, who gave me good guidance and advice on how to go about it. I am also very thankful to all my lecturers at the school of business, UON, who gave me good background knowledge that was necessary in compiling this report. Finally, I also appreciate my family, friends and workmates who supported and assisted me in not only my class work but also during the research period because I may not have accomplished this without them.

ABSTRACT

Planning for growth in capacity requires accurate prediction of future volume data. Airports, like other national facilities requires good knowledge of both economic and social trends that is currently undergoing in a nation and data of the past to accurately foretell the future which it aways tries to pursue. Since investment of such facilities are huge, accurate future estimates is paramount for efficient and cost effective expansion or growth strategy. Today it is well known that air transportation is basically an economic activity and is also dependent on socioeconomic factors of the country and the region it operates in as it is also a key contributor to national economy.

This study is focused on estimating future air cargo capacity for airports and in particular JKIA. It demonstrated a better tool that provide accurate forecast to predict future capacity where historical data is not accurate enough for prediction and bearing in mind that this is an industry that is highly dynamic in nature. Multi-linear regression model was developed to predict future export cargo volume as the dependent variable dependent on other eight socioeconomic parameters which were deemed significant and useful in this forecast model. The available data for the selected indicators were also statistically analyzed and were observed that most are highly volatile by themselves.

Some of the Limitations of the study were due to limited and inaccurate data. Many organizations do not keep data that can be useful for good forecast and those that have do not avail it. This is a challenge for especially those that are responsible for planning to collect and store proper data for good forecast.

Other quantitative analysis like simulation can also be applied as support for this model whenever possible and the same result obtained herein can be used with a good probability to determine GDP forecast.

ACRONYMS AND ABBREVIATIONS

ACI	Airports Council International
AMACS	Atlanta Metropolitan Aviation Capacity Study
ATM	Air Traffic Management Systems
FAA	Federal Aviation Authority
FACT	Future Airport Capacity Task
FPEAK	Fresh Produce Exporters Association of Kenya
FTK	Freight Ton Kilometre
GDP	Gross Domestic Product
IATA	International Air Transport Association
ICAO	International Civil Aviation Authority
JKIA	Jomo Kenyatta International Airport
LCC	Low Cost Carriers

IATA Airport Codes

AMS	Schiphol Airport - Amsterdam
CAI	Cairo International Airport - Cairo
CDG	Charles de Gaulle - Paris
FRA	Frankfurt International - Frankfurt
JNB	O.R Tambo International - Johannesburg
LHR	London Heathrow - London
NBO	JKIA - Nairobi
STN	Stansted Airport - London

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Chapter One: Introduction

This chapter introduces the concept of capacity management and capacity forecasting at airports locally with comparison to established world-class counterparts. It also elaborates on research problem and knowledge gaps in this field of infrastructure and finally states questions and objectives of the study. The chapter in the end tries to pin point possible contributions done earlier on the subject and value added from this project.

1.1 Background of the study.

Capacity management is a process that is designed to identify and maintain the ideal balance between efficiency of a business operation and the satisfaction that customers receive from the goods and services offered by that business. The goal is to operate the business at the optimum level of capacity while also taking steps to earn and maintain loyal and satisfied customers over the long term. A business that does not constantly evaluate whether or not it is operating at optimal capacity will eventually loose customers to competitors.

A root problem in management of any business entity is the unavoidable uncertainty in predicting future demand. Efficiency of any entity on the other hand is linked with a better understanding of exactly what is being demanded of the system. All processes are affected by what is needed, when and where.

Over the years, management have spent considerable time and effort working with their historical data to project future demand, often using approximations of what they believe to be current demand to planning. For those who demand even more accuracy,

mathematical models and algorithms are applied to match the educated guesses with actual data trends to keep the forecasts synchronized with what is actually taking place on the ground. Combining history with the present, adjustments are made that should bring a closer congruence between what the firm thinks should occur and what really takes place.

Capacity has four key dimensions; quantity, quality, time and location. Forecasting capacity is a basic management tool that will help determine how much and when capacity is needed. Management of capacity includes management of equipment, space, employee skill e.t.c.

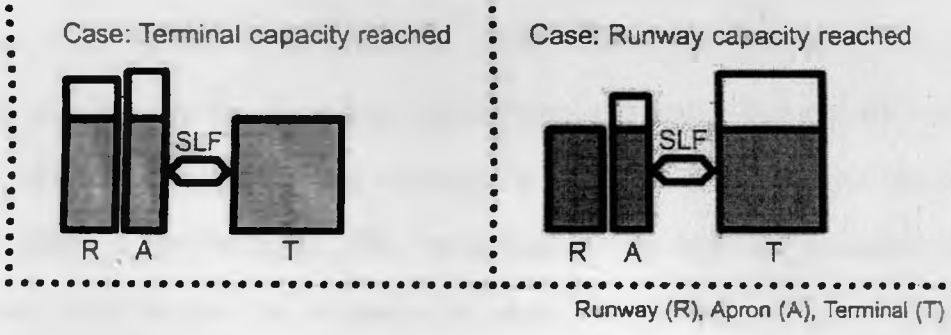
Airport capacity cannot be fabricated overnight but through long term planning that goes beyond any current existing crisis. Using capacity constraints at most major European and American airports as examples, there is greater need to optimize existing infrastructure and also allow development of new infrastructure where needed.

By definition, airports are simply locations where aircrafts take off and land. Aircrafts may also be stored and/or maintained at an airport. An airport consists of at least one or more flat surfaces called runway for a plane to take off and land and buildings such as control towers, hangars and terminals. Larger airports may have fixed base operator services and ramps, air traffic control tower, passenger facilities such as restaurants, lounges and emergency services. (See Fig. 1 in the appendix).

Capacity measurement and efficiency studies of airports have traditionally relied on econometrical approaches and mathematical modeling (Gilbo, 1997). This is due to complexities and multi dimensional nature of variables that constitutes an airport as shown on the Fig.2 below. A sub component can attain maximum capacity limiting any further airport capacity while the other parts remain under utilized. Stochastic

programming and simulations are usually employed to find a more perfect match within partitions. In order to obtain best results of the whole unit, there is need first, to sub divide it into different sectors followed by how to combine these activities so as to come up with a workable solution of the overall system. Methodologies used to determine efficient utilization of airports differ in literatures due to combinatorial nature and multidimensional complexities of airport set-ups and there is no consensus existing this far regarding the best approach (Muller and Ulku, 2010).

Fig. 2 Example of limiting factors for capacity and interdependencies at airports



SLF - Seat Load Factor

Source: Bubalo B. (2009)

Despite global economic pressure, high oil prices and aviation deregulation towards 'open skies' as challenges to air transportation, air traffic is expected to grow continuously around the globe and in Africa. European Air Traffic is projected to grow at 4% average per year over the next decade (2010-2020) and is about to double by 2025. "Un-accommodated demand by 2025 could cost the European economy €90bn/year." (ACI-Europe conference. October, 2008).

Due to the fact that both goods and passengers are moved at airports, a sub division is done so as to improve on the study of these dissimilar operations. Airport Operations are divided into airside (runways, aprons and ramps) and landside (terminal) activities. Cargo terminal and aprons are separated from passenger terminals so that

cargo crafts are directed to a separate location. Most cargo in developing countries also come under belly of passenger aircrafts and are then trucked on trolleys to the cargo shed and vice versa. Only specialized equipment for the specific division handle that specific nature of goods. Airbridges, luggage belts etc are on passenger terminals while powered high mast crane and folk-lift trucks are located at cargo terminal.

This study will make a case study on Jomo Kenyatta International Airport (JKIA). It is Kenya's largest aviation facility, and busiest airport in East & Central Africa. It ranks as the 6th busiest airport in Africa. The airport is situated 15 kilometers (9.3 miles) from Nairobi's Central Business District. The airport is served by a single Runway 06/24. Runway 06 is ILS-equipped (instrument landing system), and is used for both take-offs and landings. Currently it is served by one terminal building constructed in the 1970s. In 2008, the terminal served 4,922,542 passengers and current cargo facilities has a capacity to handle 200,000 tones of cargo annually. (http://www.kenyaairports.co.ke). Cargo facilities include Kenya Airfreight Handling Limited (KAHL), Transglobal Cargo Centre, Nairobi Cargo Centre, Siginon Freight and the animal Holding Station. With the addition of the newly completed Swissport complex, cargo handling space has increased by 10,500 square meters and an additional total capacity of 150,000 tons per year. Our domestic cargo currently stands at 1.4 million kilograms while our international segment is 304 million kilograms annually.

Kenya's strategic location in Central/East Africa makes it an important hub of international trade. It is therefore of great value and importance that air cargo sector be viewed as an economically beneficial and profitable industry in the region.

Looking at how fast the new terminals at JKIA has been overwhelmed by increase of customers and capacity within a short span of time, it is evident that unless supply

side capacity availability and facilities utilization tally with the pace of growth, demand will soon outstrip supply. This has also been manifested by the continuous complaints received from customers either not able to find parking slots at departure/arrival terminals or the long dwell time for exporters at cargo shed and by high navigation and landing charges that is reflected on the overall cost of air transport. From a critique observation as shown in Fig F3 & Table T1 in appendix 3, it is evident that design of the runway system installed, unless employed optimally, is least productive, lacks contingencies and limits expansion for maximum utilization rate. The project will compare similar design airport capacity utilization for comparative study and determine future capacity requirement through data analysis and forecasting.

Having a better insight into airport activities will bring better solutions and will deliver better indicators for productivity benchmarks. The idea of having productivity benchmark indicator based on operations/flights and taking capacity utilization into account by using throughput measures like total flights per

hour per runway or, airports figures which are generated from real world daily flight schedules, should be used. As shown in Table T1, appendix 3 Aircraft mix and runway configuration need to be considered and hardly are airports identical (Bubalo, 2009). In the table, JKIA runway utilization does not compare to similar configured Stansted airport – UK. but, note this airport as a whole was designed to accomodate 2.5 million passenger and its handling over 5.5 million passengers currently (KAA data, 2011).

Heathrow (LHR) has double the no of runways, 2, configuration 4 as per fig 3. Heathrow handles 65,881,669 pax(2010). Stansted, similar configuration like JKIA

handled 18.573,803 pax (2010). more than 3 times that of JKIA. Utilization rate as given by the Annual demand/annual service volume (Tabel T1) indicates underutilization of runway, leading to underutilization of the airport as a unit entitiy. Clearly this is not reflected at JKIA with plane parking problems, flight delays and terminal congestion which arises time and time and will in future discourage landing of major airlines. A scenario arises due to imbalance, bottlenecks and poor planning. Hence therefore, a need for proper research on utilization and forecasting.

1.2 Research Problem:

The gateway to global commerce and international supply chain solution that moves economy fast and efficient is through airfreight. Their is need to take a critical examination of current facility capacity and expansion regimes that are more accurate and in line with economic growth. Failure to do this will lead to losses in global commerce, Gross domestic product (GDP) and foreign direct investments (Kasarda and Green, 2002). Bazargan and Vasigh (2003) compared U.S. Airports to determine if there is a relationship between size and efficiency of an airport. They implemented data envelopment analysis(DEA) by using; operating expenses, the non-operating expenses, number of runways and the number of gates as inputs while the number of passengers, number of air carrier operations, number of other operations, aeronautical revenue, the non-aeronautical revenue and the percentage of on-time operations as outputs. They realized a direct relationship between the two. The larger the airport size, the higher the efficiency. This study will atest to this in the outcome.

This project will address capacity measurement and forecast air cargo volume to determine future capacity levels. It will examine past and present capacity, constraints

thereof, survey elements that are perceived as critical factors in volume forecasting and that are key to growth of the industry.

Forecasting can be defined as a kind of art that practices predicting future events with studying past conditions. Neufville and Odoni (2001) defined forecasting as an art because there can be more than one correct method and that is subjective to choice of the decision-maker. A proper air freight volume forecast is useful for a planned airport expansion and key in airport management planning. It is important to management to know actual capacity so as to justify any increase in investment and meet air cargo customer satisfaction. "It is evident that forecasting process can be the most critical factor in the development of the airport" (Howard, 1974). "Mistakes made in this phase of the process may be very costly and damaging for local economies. Underestimating demand may lead to increased congestion, delays and lack of storage facilities as is currently experience at JKIA terminals. Hence, a need to improve on better analysis and forecasting for such critical facilities that require massive capital expenditure for any government.

Having noticed lack of good data both on total actual volume of air-cargo at our airports and the lack of proper planned expansion/investment propositions, this study will improve on forecast data that will eventually make improvements on efficiency and utilization of resources for such critical projects. It will also check if the GDP forecasts are comparatively similar to air freight as suggested by (Kasarda and Green, 2002) in our local environment.

1.3 Research Objectives:

The basic questions in capacity management always looks at how much capacity is needed, when and how efficiently utilized it is. This project will try to;

1. Establish current and future capacity of goods and services at JKIA.
2. Develop and test a forecasting model for capacity.

1.4 Value of the study

Commercial viability of airports has assumed utmost importance and the trend to privatize them and make them economically self-sustaining has gained worldwide opinion. JKIA and most major airports in this continent are viewed as prestigious facilities. Governments expect lots of revenue from them. Hence, the many taxes and revenue authority organs attached at the facility. This makes cost of doing business questionable and bureaucracy brings down efficiency in service productivity.

Economically, facility expansion and timing is also critical. The better the equipment, the faster the ground handing operations, the higher the operational efficiency and better customer satisfaction. The key factor is to keep cost reasonable and provide efficient service. Stake holder's of this facility i.e carriers, government and regulatory agencies, exporters, handling agents, clearing/forwarding agents, employees and facilities owners will benefit directly if they know factors that affects efficiency and how to grow in order to meet future demands. For the academics, the study will try to add value on capacity determination and forecasting that is useful in the design and expansion phases of such critical facilities to an economy of a nation.

Chapter Two: Literature review

2.1 Introduction

This chapter presents literature on capacity management in airports. It'll look at constraints, cost of capacity and how to forecast correct capacity levels.

2.1.1 Capacity management

Capacity of a production unit is defined as its ability to produce or do that which the customer requires. Lovelock (1992), states that a system has capacity if it has at least some of each resource needed to perform its intended function. Adenso and Diaz (2002), noted that the aim of capacity management is to minimize customer waiting time and avoid idle capacity, with the aim of meeting customer demand in time in the most efficient way possible. Stevenson (2007) pointed out that design capacity is defined as maximum output rate or service capacity an operation, process, or facility is designed for. This however is larger than effective capacity and actual capacity is always slightly less than designed capacity. This is due to allowances of human factors, scrap and other down times. 80% efficiency is always the rule of the thumb.

In operations management, capacity is often categorized into three. Potential Capacity is capacity that can be made available to influence the planning of senior management (e.g. in helping them to make decisions about overall business growth, investment etc). This is essentially a long-term decision that does not influence day-to-day production management.

Immediate Capacity is the amount of production capacity that can be made available in the short-term. This is the maximum potential capacity - assuming that it is used

productively and since not all productive capacity is actually used or usable in practice, effective capacity, is most important for production managers as this is capacity that is actually achievable.

Capacity in general, must be measured in the unit of work done. The actual volume of production that the entity can produce will depend on the amount of work involved in production (e.g. does a product require 1, 5, 10 standard hours? Any additional time required in production (e.g. set-up times, maintenance) must be added and most importantly, one has to look at productivity or effectiveness of the entity. In aviation, both the airfield capacity and airspace capacity have to be considered hand in hand. Airfield capacity is determined by several factors including airport layout, runway use, aircraft fleet mix, total annual operations and the dominating aircraft type.

FAA Order 5090.3C, Field formulation of the national plan of integrated airport systems states that capacity improvements should be considered when an airfield demand reaches 60% of the annual service volume(ASV) and average delays exceed three (3) minutes per aircraft.

2.1.2 Constraints on capacity:

In capacity management there are usually two potential constraints time and capacity. Time may be a constraint where a customer has a particular required delivery date. In this situation, capacity managers often "plan backwards". In other words, they allocate the final stage (operation) of the production tasks to the period where delivery is required; the penultimate task one period earlier and so on. This process helps identify whether there is sufficient time to meet the production demands and whether capacity needs to be increased, albeit temporarily. Van Looy *et al,* (1998) observed that

capacity management problems resulted from the manner in which forecasting was done, prioritizing, scheduling and how other controls are employed.

Sumner and Cannon (2006) summarized constraints in a master plan study of Millington regional jetport via a capacity analysis that assessed the capability of the existing airport facility to accommodate current and future levels of aircraft operational activity. Airfield capacity is determined by a list of factors as addressed in the previous section that included delays in arrivals and take offs. In addition there is constrains on airspace capacity. In the local case set-up, JKIA airspace has and must consider its traffic operations to that of Wilson airport as is expected when increased traffic and aircraft class expands at both airfields. Currently airspace overlap is minimal due to dissimilar aircraft mix, operational hours and distance between approach and departure of dominating aircrafts.

2.1.3 Bottlenecks and controls

Air freight is a key part of the airline industry and of the wider global economy. It accounts for around 35% of global merchandise trade by value, equivalent to $4.2 trillion of the $12 trillion value of trade in 2006. The air freight sector provides estimated total annual revenues of almost US$ 55 billion, equivalent to 12% of the airline industry's total revenue according to IATA, Air Cargo Market Outlook (2006). Air freight demand still moves in a similar pattern to global trade, but is forecasted to grow at a lower rate, of around 5% per annum.

From World Bank statistics (2009), International air freight within Asia and exported from Asia to other regions already accounts for around 45% of total international freight, and will account for over 55% of new traffic to 2011. Growth is also set to be

above average in the Middle East and Africa. However, the strong growth in Asia Pacific is set to increase the imbalance in trade volumes from and to the region. Revenues are concentrated on the outbound leg from Asia but costs are faced across both legs of the journey.

Fuel prices declined in the second half of 2009 but have since seen a return towards record high levels of around $120 a barrel currently, World Bank statistics (2011). Looking ahead, most analysts expect that slower, yet still strong, global economic growth combined with increased supply should see a gradual easing in fuel prices over the next two years, though they will remain at relatively high levels. Cost pressures may also emerge on the labor side. Airlines have made significant progress in improving labor productivity in recent years, but the risk of skill shortages in some key areas (e.g. pilots) could place upward pressure on wage demands.

Air freight face increased competition from other modes, especially container shipping, even for high-value, time-sensitive goods. Container shipping has become more competitive as route networks and frequencies have increased (Except for this region with the pirate menace which is some weird sort of blessing in the short term). However, container shipping potentially faces its own capacity bottlenecks (especially at ports) that could constrain its growth and ability to compete against air freight.

The expected slower rate of growth in air freight revenues in 2007, combined with high fuel prices, will place downward pressure on profitability in the air freight sector. A return to declining yields, especially while fuel prices remain high, will increase the break-even load factor for air freight. An increase in new deliveries over the next three to four years could place further downward pressure on yields. World Bank statistics (2011).

Nevertheless, with positive economic conditions and further demand growth, opportunities for profitable growth still exist. New routes and new aircraft can open up new geographical and product markets for air freight, lower cost due to increased aircraft efficiency.

2.2 Economic Environment

Globalization, Digitalization, Aviation and Time-based Competition are Converging. This is primarily due to nature of air cargo. Higher value to weight product ratios are increasing in the market. Firms are simultaneously more geographically dispersed and functionally integrated (through supply chains) and the way of doing business has increased in speed and agility, become more competitive with Just-In-Time (JIT) manufacturing and delivery, global sourcing and global sales. Customization (built to order) is the future of production. Today's customers can't or won't wait as time is more important.

World merchandise trade growth has been very strong since 2003, boosted by the increased globalization of production and by fast growth in developing economies. World trade growth is forecast to slow slightly from 10% in 2006 to 7% in 2007, but is forecast to remain around 7-8% per annum until 2011. However, the magnitude of its impact upon air freight demand appears to have weakened since 2004. Air freight demand still moves in a similar pattern to global trade, but is forecast to grow at a lower rate, of around 5% per annum, to 2011. The nature of world trade growth has changed, especially with the strong growth in China. Higher growth in world trade than in air freight is largely due to commodities (e.g. oil) that are unsuitable for air freight.

Conditions in the global manufacturing sector, a key customer for air freight, remain relatively strong. The JP Morgan global manufacturing purchasing managers index (PMI) is a good gauge of business confidence and the outlook is still positive.

2.3 Revenues and Traffic

Air freight has provided a relatively strong boost to airline revenues over the last two years even though traffic growth has been relatively low. Airlines have seen a degree of pricing power, allowing them to pass a proportion of the higher fuel costs on to customers through fuel surcharges. However, strong competition – within the industry and with other modes – and increased capacity is placing downward pressure on yields, with revenues expected to grow at a lower rate than traffic over the next two years.

The low rate of growth is a.reflection of several factors; strong competition from other modes, structural changes such as lighter manufacturing components in electronics and growth among new entrant airlines. Asia Pacific is set to see the highest annual growth rate in freight volumes to date. International freight within Asia and exports from Asia to other regions already accounts for around 45% of international freight, and will account for over 55% of new traffic to forecast of 2011. Growth is also set to be above average in the Middle East and Africa, though slower in the more mature markets of Europe and North America (Kasarda and Green, 2002).

The strong growth in Asia Pacific is set to increase the imbalance in trade volumes from and to the region. The nature of the imbalances mean that a large proportion of the revenues on a cargo flight from this region and is earned on the outbound leg (in terms of both higher volumes and higher rates). However, while revenues are

concentrated on the outbound leg, costs are faced across both legs of the journey. Increasing capacity to meet higher demand on the outbound leg also raises the risk of excess capacity on the return leg. Airlines have to seek new cargo types or to have multiple stops on the return leg in order to improve return load factors.

Fuel accounts for a larger proportion of operating costs on the freight than on the passenger side. As such, the air freight side has faced even greater pressure on profitability due to high oil prices. It is difficult to find figures for just cargo operations, but taking account of all airline operations fuel now accounts for the largest operating cost item. Fuel's share of costs has risen in recent years while improvements in labour productivity have helped to reduce the share of labour costs. However, these trends could change over the next two years, with most economic forecasts expecting oil prices to ease, while the risk of skill shortages in some important parts of the airline sector (e.g. engineers, pilots) could lead to upward pressure on labour costs.

Air freight is a highly competitive industry between individual airlines. But it is also increasingly facing strong competition from other modes, even for high-value, time-sensitive goods. Land-based modes and short-shipping have traditionally offered competition on short-haul routes, especially in the US and within Europe. However, air freight is also increasingly facing competition for shipments on longer-haul routes from container shipping. Air freight grew at less than half the rate of container shipping between 2001 and 2005 (Lufthansa consulting research, 2007).

2.3 Capacity benchmark.

An International airport capacity benchmark compares the current capacity of 3 main continental airport hubs as well as examining developments as a result of expansion plans. By comparing capacities of various international airports, a clearer picture will emerge of the possibilities for developing an airport. Airports that still have a lot of room to expand will find it easier to remain competitive than airports with little or no room for growth. We will compare JKIA with two direct rivals in this region, Cairo international airport (CIA) and O.R Tambo international (JNB) in our benchmark report. These we chosen due to the fact that they rank higher than JKIA both in supply side capacity and demand and are in direct competition geographically and in global commerce.

Recent developments in the aviation sector have thrown a new light on a growing debate about capacity and capacity expansion. Until recently, it appeared that JKIA, which currently has 80,000 aircraft movements per year (KAA, 2011), find it very difficult to handle the increased traffic demands. Therefore, there are options for expanding capacity. However, it is now clear that a period of decline in the amount of traffic will temporarily interrupt the airport's growth. As a consequence, the feeling that capacity expansion was urgent has decreased. Nevertheless, it is realistic to assume that the demand for air travel will increase once again – together with the associated need for this form of transportation.

Airports serve as hubs where airside and landside traffic converge and exchanges occur between the various transport systems. This project will focus on the capacity issues in relation to airside traffic. Airside capacity is determined not only by the number of runways, but also by the capacity of the terminals, number of packing

aprons, ground handling facilities and personnel and the Air Traffic Management (ATM) system. It can, hence, be defined in terms of the maximum number of aircraft movements that the airport can handle within a given amount of time (hour/year). The runway system as a whole, the ATM system and the terminals are the factors that combine to determine airside capacity. It is often difficult to consider the airport's physical capacity separately from the constraints of environmental measures taken to regulate noise levels at the airport and in the surrounding area. The benchmark is therefore based on two key pieces of data provided by the airports themselves (declared capacity): the annual capacity and the peak hour capacity. Both indicators take into account the policy on capacity and, in particular, the restrictions imposed by noise regulations.

2.4 Capacity Forecasting

In literature, various studies of forecasting capacity have been done to determine demand. Most documented are usually for passenger service. Some of examples listed below:

International Civil Aviation Organization (ICAO), which works under United Nations and has mandate to regulate and promote civil aviation around the world, published a handbook in 1985 titled "Manual on Air Traffic Forecasting". In this manual trend projection techniques which are based on time series analysis was discussed and applications of multi-linear regression was used. Mentioned also in the manual were econometric methods and survey analysis. Riyadh Airport in Saudi Arabia, Logan International Airport in United States, Western European Airports, Newark Airport in

United States, and Abidjan International Airport in Ivory Coast were used as case studies of this manual.

Taneja *et al.*(1975) published a paper about statistical evaluation of econometric air travel demand models. In his work he studied regression models. He points out that judging high R^2 values may not be enough for deciding multimillion-dollar investments.

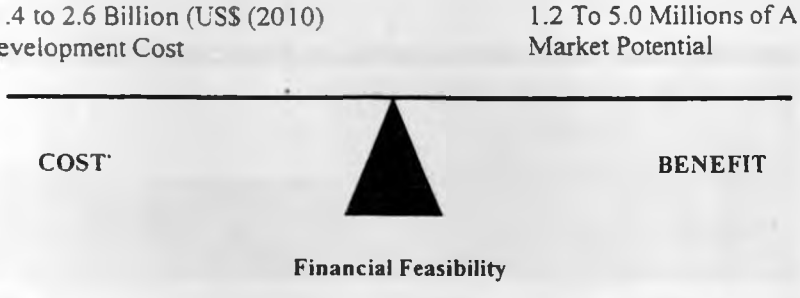
Neufville and Odoni (2003) published a book named "Airport systems: planning, design, and management". In this book they mentioned about problems and importance of forecasting before making investments and gave real life examples. Karlaftis (2008) published a paper about demand forecasting in regional airports. He studied Corfu Airport in Greece as case study. He studied time series for modeling traffic by choosing tourism and macro-economic indicators. Naude and Saayman (2004) investigated determinants of tourist arrivals in Africa using panel data regression analysis.

In 2007, the Federal Aviation Administration (FAA) completed an update of a study that looked at the future capacity of the nation's airports and metropolitan areas. The original study, completed in 2004, Future Airport Capacity Task (FACT) and the 2007 update is called FACT 2. The goal of these studies was to determine which airports would have the greatest need for additional capacity in the next twenty years. This analysis identified specific U.S. airports that are expected to require additional capacity in the future (2015 – 2025) and it identified Atlanta's Hartsfield-Jackson International Airport (ATL) from amongst 14 other as needing additional capacity. Based on these findings, the FAA initiated the Atlanta Metropolitan Aviation Capacity Study (AMACS) in 2008 to explore the methods and means by which short and long-term aviation capacity in the metropolitan Atlanta region could be enhanced.

The study focused on ways to reduce airfield related delays at ATL and identified capacity and delay improvements ranging from operational modifications to a new runway altogether.

Following AMACS, FAA saw the need to investigate the feasibility of a second commercial passenger service airport and collaborated with the City of Atlanta's Department of Aviation and the Atlanta Regional Commission (ARC) to develop this study. Feasibility with regard to a second airport at various sites in the greater Atlanta metropolitan area is complex, involving numerous aeronautical, market, environmental, economic, social, political, financial, and other factors. The study considered feasibility in four fundamental areas: aeronautical, environmental, market and financial.

The two most significant factors that contributed to their findings were the upfront development cost and the market potential. The two were weighed against one another as depicted on the scale below.



Based on the current cost-benefit analysis, none of the eight sites studied were found to be feasible at this time: however, given the growing population of the region, an ever changing economic climate, and the dynamic nature of aviation, the feasibility of

a second airport in the Atlanta metropolitan will need to be revisited periodically in the future and this is where proper forecasted data comes in practice.

2.5 Approach to the Problem:

GDP and air cargo have a strong statistical relationship with each other and it can be said that cargo transport itself is a socioeconomic activity. Kasarda and Green (2002) carried out a study and found out a well established relationship between air cargo growth and growth of GDP and GDP per capita measured annually between 1980 and 2000, for the world and within regions. The relationship was highlighted using coefficient of determination (r^2) which means that knowing either world GDP or world airfreight, you can predict the other with 98% accuracy. Since the two are mutually causal, they are highly interdependent. The same holds up well across international regions as is presented in Table T2 and Fig F4 below.

Table T2.

Relationship of Airfreight to GDP and GDP per capita by World Region, 1980-2000.

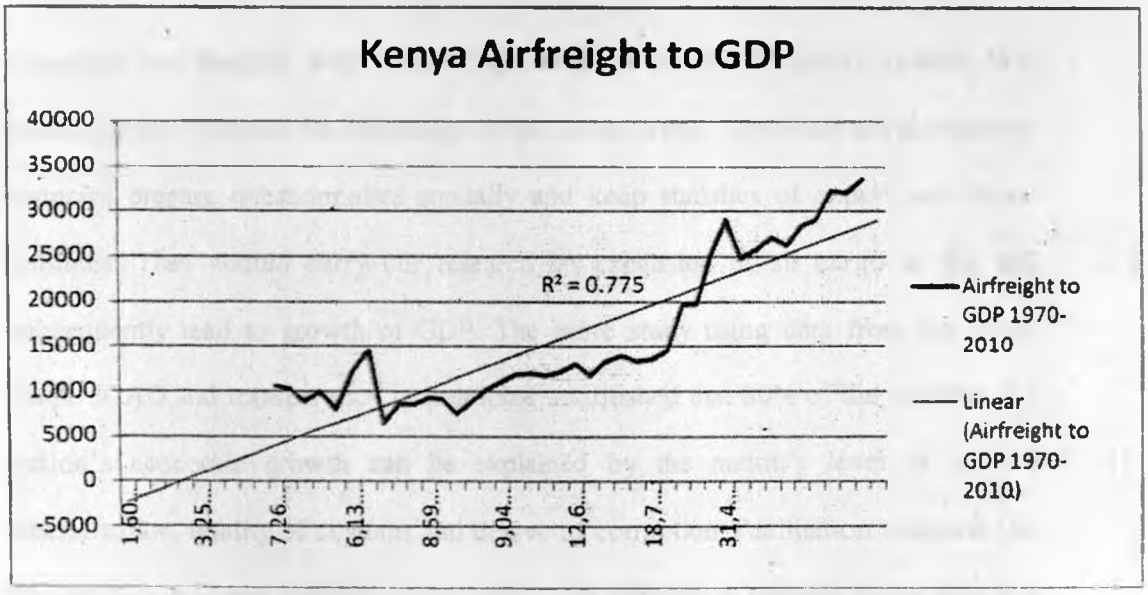
	r-square	
REGION	**GDP**	**GDP per capita**
World	0.981	0.982
North America	0.973	0.939
Latin America & Caribbean	0.968	0.813
Europe & central Asia	0.952	0.924
East Asia & Pacific	0.948	0.969

	r-square	
REGION	**GDP**	**GDP per capita**
Middle East & North Africa	0.874	0.682
Sub Saharan Africa	0.818	0.662
South Asia	0.643	0.666

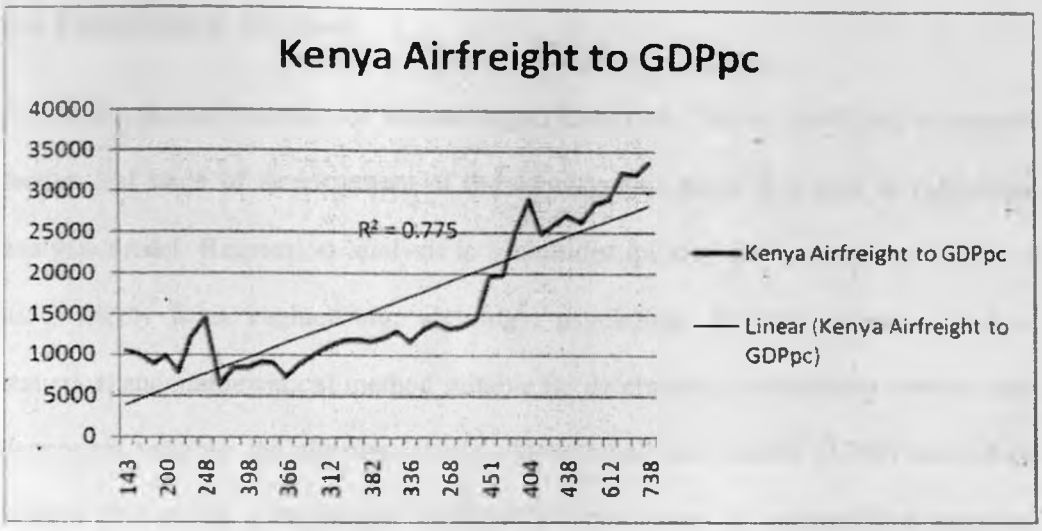
N=95

Source: World Bank, "World development Indicators", 2002.

Fig. F4. **Graphs of R^2 value of Airfreight to GDP for Kenya.**



Source: The World Bank, "World development Indicators", 2011.



Source: The World Bank, "World development Indicators", 2011.

Countries and Regions with World-Class Airports and Air Logistics Systems Will possess major competitive advantages in the global arena. Corporate and government agencies prepare questionnaires annually and keep statistics of export and import volumes. They should carry our research on expansion of air cargo as this will subsequently lead to growth of GDP. The same study using data from the World Bank, ICAO and transparency international established that 80% of the variance in a nation's economic growth can be explained by the nation's level of aviation liberalization, quality of customs and degree of corruption. Facilitation measures like liberalizing air cargo, improving on customs and reigning in corruption can only help drive air cargo development and subsequent economic growth.

Locally, air cargo mainly arises from: external demand for tropical and organic fruits, vegetables and flowers, high tech machinery and electronics, importation of Sensitive medical equipments, telecommunication equipments etc. All these answers point to socioeconomic activities growth trend.

2.6 Forecasting Method.

There are various methods of forecasting in literature. Due to prevailing economic factors and stage of development of the country, this paper will look at regression analysis model. Regression analysis is a multidisciplinary forecasting tool which is used widely from engineering, sociology, psychology to pure sciences. It is a statistical and mathematical method suitable for determining relationship between one dependent variable and altering other(s). Mendenhall and Sincich (1992) states that, models that relate a dependent variable "y" to a series of independent variables $x_1, x_2, \ldots, x_k$ are known as regression models.

Because of the nature of the problem, data expected to be used in this study should not show any particular linear and/or nonlinear properties, but show an increasing trend between variables. Usually, most stable developing economies tend to have an upward trend over a period of time. Data collected will be analyzed in detail in the preliminary studies to check for any other significant nonlinear or logarithmic relationships.

Forecasting air cargo volume accurately is the main aim of the study. Although the established model can be used for any time span, 10 year span of estimations will be used. Estimates of social economic indicators in the longer time intervals can be misleading and subjective. On the other hand a 10 year financial cash flow is tangible and sufficiently enough for financial forecasters and decision makers to decide on any investment plan.

Chapter Three: Research methodology.

3.0 Introduction

This chapter outlines steps to be taken in conducting this research. It introduces the research design, sampling and sampling process, data collection instruments, data collection procedure and data analysis method.

Quantitative modeling has been the basis of most of the initial research in operations and also formed most of the basis of initial management consulting. Historically, quantitative modeling in operational research was oriented very much towards solving real-life problems in operations management (OM) rather than towards developing scientific knowledge. Recently, this has changed, and the need to develop explanatory and predictive theory regarding operational processes has become apparent. Articles have been published that formulate requirements for theory development in OM (Schmenner and Swink, 1998; Wacker, 1998).

3.1 Research design

This is where application of applied research is carried out to address critical issue of airport capacity determination as addressed in problem statement. Descriptive research was used for this project. This included use of secondary data sources, observations and interviews with knowledgeable persons.

In order to explore our objectives, this study surveyed and identified independent factors that affect capacity at the airport and examine critical factors influencing capacity. It also looked at nature of cargo, bottlenecks and controls in this industry.

3.2 Population and Sampling

The traditional air cargo supply chain is composed of shippers, freight forwarders and airlines thus all will form the target group of the study. The freight forwarders secure capacity with airlines in order to accommodate shippers' demand. Facilities both on airside and landside are manned by KAA officers, Customs personnel and warehouse providers. Air cargo being a new field and especially locally, not much data has been collected and some are not readily available apart from physical area capacity. We collected primary data that address the freight forwarders' problems on capacity, exporter's preferences and feedback on the industry performance based on costs and quality. A survey study was conducted by administering up to 40 questionnaires in 4 different sections of the industry (25% each per Section (Carriers, exporters, forwarders & service providers/agencies)). Since most business transactions are done on the ground at JKIA, data collection was made easy. |From a statistical point of view this sample size is >30 and more than 5% of the total population, Israel (1992).

3.3 Sources of data:

Primary data was collected randomly from demand side sector that included fresh produce exporters, clearing and forwarding agents and through a questionnaire. Secondary data was collected from airlines operating at JKIA's web sites, exporting corporate companies' web sites, magazines and supply side regulators ICAO, KCAA & IATA. Observation and extrapolation was done and where data was not significantly unavailable other economic indicator data providers, e.g. the world bank database was used.

Objectivity of the data is important when the data cannot be presented in numeric form. For example indicators like success, failure, bad, good, too long, slow, quick differ from one person to another, hence were eliminated in this research. Correctness of the data was assured as all secondary data were obtained from official institutions in charge.

As mentioned earlier, forecasting method and the data used should be compatible with each other. Outliers in the data was removed and all relevant data tested for homoscedastic, normality and multicollinearity. Minitab 14 software package was used to analyze data.

3.4 Data analysis

The resultant independent variables (helping variables) which were used for estimating Capacity (dependent variable) in this study was derived from both questionnaire and secondary data. Export Volume data that would arise from these projections can be used in design improvement and expansion planning for any future investments.

Total supply capacity was investigated from international airlines working in this region. Most airlines currently make their stop here en route to and from surrounding large cities in East and South Africa. Majority of exports done now are on the outbound route to Europe, Middle East and Asia. We also limited our study to exports as this is the side of business that is basic to growth of GDP. On the other hand Import volume was observed as, not in totality, locally driven and this can form the basis of further parallel research.

Since it was apparent from start that the relationship between effecting and affected variable is unclear, forecasting volume was approached from trying to put too many variables that may have some impact on results and picked important variables from the list by use of statistical analysis. In this study, major potential indicators as listed below showed good forecasting potential and it was found necessary to place these variables in a pool and detect important ones. Selected key variables considered in this study were;

1. Nature and quantity available of main products of exports: Key statistic in this investigation and an indicator of trend. The higher the quantity for export the greater the need for air cargo and similarly perishables and high time-value goods results in high air exports. Questionnaire and Secondary data provided this stratum

2. No. of exporting companies: An increasing trend in this variable will lead to a higher growth in air freight volume. Current statistic available in literature regarding this variable is not enough. Secondary data approximations was employed.

3. Highway vs. Air Travel Duration time: Rengaraju and Arasan (2001) used such a statistic to predict number of passengers in airport designs. Collected data on highway travel distance to the airport acceptance point, warehousing duration in cold room and time to packaging for airlift.

4. Geographic Location of JKIA: Rengaraju and Arasan (2001) used a similar but simpler dummy variable which focuses only on proximity to big cities – In our case scenario, secondary road mileage figures of distance from JKIA to major exporting rival airports like Mombasa, Eldoret, Kampala, and Kigali.

5. Aviation Taxes: This indicator is a unique indicator for air transport. Alekseev and Seixas (2009) studied similar econometric Indicators unique to Brazil. Apply landing and parking fees from carrier point of perspective and compare with regional figures. – Data from KAA and comparative airport authorities.

6. Airliner Profitability: Alekseev and Seixas (2009) studied effect of tariff prices. This study is basic to the thought that airline tariff prices would be an effective variable for determining demand. It is obvious that if prices go down, demand increases. We'll identify why customers prefer which carriers in terms of price. Carriers also provide annual data. Profit/ton can be calculated – secondary data

7. GDP and GDP per capita: Almost all studies done in similar field investigated gross domestic product as a variable. GDP is defined as the amount of goods and the services produced within borders of a country in a year. It is obvious that per capita GDP for a given city will be affected by the labor supply and production possibilities and hence will indicate wealth and standards of living in the city. Additionally the level of GDPpc is a determining factor to the demand for the goods that are produced and have to be transported, hence, an importance factor in capacity demand. National bureau of statistics and World Bank data provided this information.

8. Price of petroleum: Profillidis and Botzoris (2006) and Abdullah, Ba-Fail, Jasimuddin (2001) studied this parameter in passenger capacity determination. High gas prices introduce higher export tariffs.

9. Airline frequency and schedule: critical in optimal capacity utilization. Though this is purely demand driven, gravitational data and comparative

analysis between major African cities proved important. – Secondary data from carriers provided the statistics.

Regression model used in the study was of the form:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots + \beta_n X_n + \varepsilon$$

Where: Y - Dependent Variable (Air Transport Freight Volume) – Proxy for capacity

X_i - Independent variables (See list above)

β_i - Constants of the model

n - Number of factors used in regression model, ε – Error residuals

Chapter Four: Data Analysis, Results and Discussion.

4.1 Introduction.

This chapter discusses data findings, analysis and interpretation of results. The main objectives of the research was to determine current and future capacity of aircargo exports at JKIA and develop a forecasting model for capacity. Data for the research was gathered from reputable sources and same was analyzed using statistical software package.

4.2 Data Analysis.

In previous chapter, important variables, data samples and collection for these variables were discussed. The next step is the testing and preparation of the data for use in forecasting process. Characteristics of data used in this research is shown in Table 4.1

4.3 Data Preparation.

Generally, forecasting can be considered as a generalization and a categorization process. In this respect, in order to carry out a successful forecasting process, data used in this process should be objective, correct, reliable and compatible within itself. Whenever necessary a sample set which would be easier to handle and more representative of the study is used and all outliers eliminated. Objectivity of the data is ensured as all data used are presented numerically and correctness of data guaranteed by making sure that all data used in this project was obtained from official

institutions from the relevant field. Accuracy of outcome of forecast study is as accurate as source of data.

Table 4.1 Units and Sources of the Used Data

Variable	Unit	Data type	Source
Volume of export	Tons	Numeric	Worldbank
No of exporting companies	No.	Numeric	FPEAK
Hwy Vs Air travel duration	Unit No./Ratio	Numeric	Ministry of roads
No of airline carriers	No.	Numeric	KAA
Aviation taxes	USD	Numeric	KAA
Airline profitability	USD/person	Numeric	Cargolux
GDP/ GDP per capita	US$	Numeric	Worldbank/KNBS
Airline frequency	No./year	Numeric	Lufthansa
Price of petroleum	US$/gal	Numeric	Index Mundi

4.2 Estimating Future Variables.

In this study, estimating Air cargo volume at JKIA is the main goal and in order to provide good estimates of future air-cargo volume and future socioeconomic

conditions, data should be estimated properly. Although the established model can be used for any time span, 10 year span of the estimations is studied.

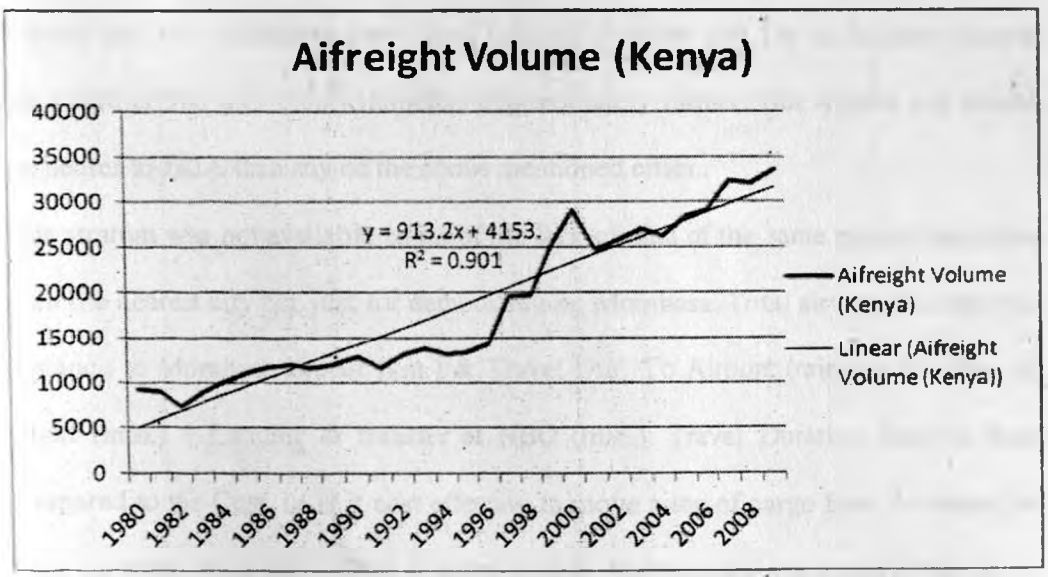
4.2.1 Air cargo volume.

According to World bank statistics airfreight data for the year 2020 is calculated from a 40 year extrapolations.

Airfreight Volume (Million Ton-Km), => $y = 913.2x + 4153$.

$R^2 = 0.901$.

Aifreight volume 2020 => 913.2*(2020-1980) + 4153 = 40681 million Ton-Km.



Source: Worldbank data.

4.2.2 No. of exporting companies.

Similar to previous section about export amounts, linear regression was used to predict future number of export companies. Regression equations and estimated results for 2020 is obtained by substituting "x" in the equation.

$Y = 2.66x + 26.26$, R^2 Value = 0.959

and estimated Number of Exporting Companies for 2020 => 79.49 ~ 80.

4.2.3 Travel Duration Comparison (Highway vs. Air Travel Duration).

JKIA is about will be 487 kilometers away from Mombasa, 311 kilometers away from Eldoret and 345 kilometers away from Kisumu. Entebbe and Dar es Salaam airports are a further 900 and 1000 kilometers approximately further. But Arusha and Moshi are nearer to JKIA than any of the above mentioned cities..

This stratum was not available cause of the lack of data of the same type of exporters from the nearest city but, just for demonstration; Mombasa. Total air travel is Approx; Distance to Mombasa airport (km.) & Travel Dur. To Airport (min.) + Duration of Flight (min.) + Landing & transfer at NBO (min.). Travel Duration Ratio is then compared to the Cost, i.e is it cost effective to move a ton of cargo from Mombasa to JKIA on road or via air? – This is not available. (Airlines approx speed 650km/h, 3-ton truck on highway max 90 km/h, 60km/h within city limits) ~ 2.38 (5hr/2.1hr)

4.2.4 No of Air carriers.

Similar to previous section about export amounts, linear regression was used to predict future number of export companies. Regression equations and estimated results for 2020 is obtained by substituting "x" in the equation.

$Y = 3.6090X + 34.8$, R^2 Value = 0.51

and estimated Number of Carriers for 2020 => 41.

4.2.5 Aviation tax/Charges.

It is assumed that current situation with aviation charges and tax support will continue and there would not be future changes in tax policy.

4.2.6 Airliner profitability.

It is not easy to predict carrier profitability for the future. During the last ten years, profitability showed great volatility for most airlines. It is assumed that the average of profitability in last 3 years will remain constant which is computed as 50 USD per ton per km in Appendix 6.

4.2.7 Airline frequency.

Similarly frequencies will be carrier dependent but all was a factor of profitability and client preferences and route dominance. Average of the best three was considered and from the past data regression equation and future estimate calculated.

4.2.8 GDP/pc.

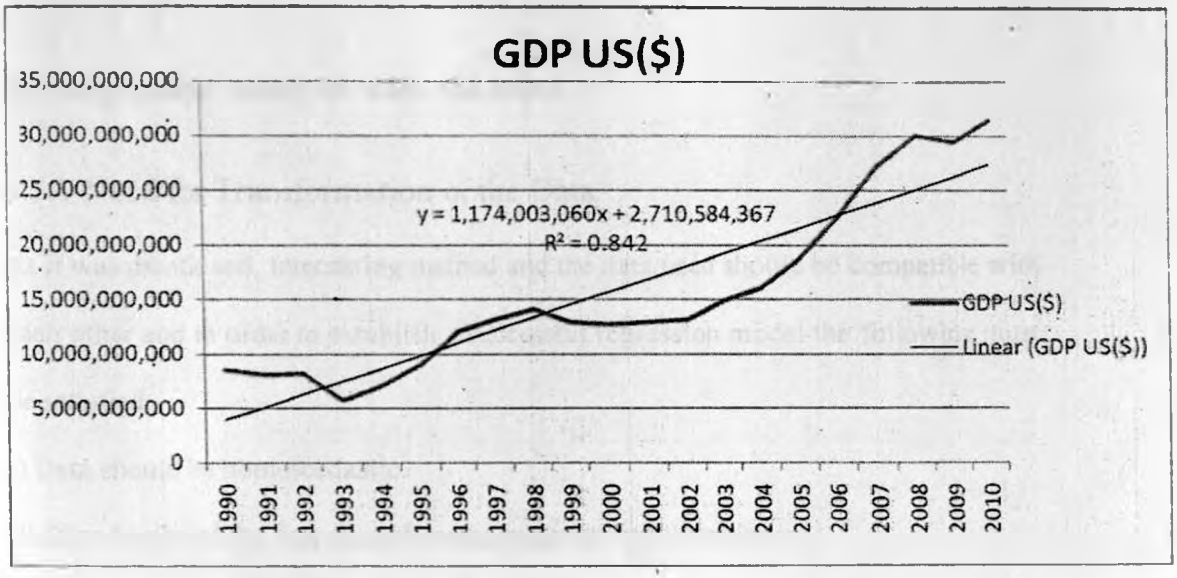
The latest record is for 2010. GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data is in current U.S. dollars. Dollar figures for GDP of Nairobi and surrounding towns which JKIA serves, is computed according to proportion of the cities respective populations.

GDPPC 2009 => USD $(2010) 31,408,632,915* (14,884,623/38,610,097) = $ 12,108,378,280

Population by county...KNBS 2009.

NAIROBI	3,138,369
MERU	1,356,301
THARAKA	365,330
EMBU	516,212
MACHAKOS	1,098,584
MAKUENI	884,527
NYANDARUA	596,268
NYERI	693,558
KIRINYAGA	528,054
MURANGA	942,581
KIAMBU	.1,623,282
NAKURU	1,603,325
NAROK	850,920

KAJIADO	687,312
Total	14,884,623



GDP 2020 => y = 1,174,003,060(x) + 2,710,584,367 = US$ 37,930,676,167

GDPPC (JKIA - 2020) => US$ 14.622,698.692

4.2.9 Fuel prices.

A significant part of the steady rise in oil prices over the past decade has been due to increasing demand and instability from the supply sector. Forecasts of economic growth have successively been revised higher – with the exception of Europe and the USA due to growing trend towards slipping back to repeat recession after a slight recovery from the banking sector crisis of the recent past. However, at least $10-15/barrel of the recent surge over $100/b($2.33 /gal). is due to geopolitical risk with

unrest in most of the oil producing countries and elsewhere. If tensions in this region diminish, oil prices are expected to fall below $100/b ($2.33 /gal).

From Appendix 7, Fuel Price for 2020 = $ 5.2/ gal

4.3 Regression Analysis with the Data.

4.3.1 Need for Transformation of the Data.

As it was mentioned, forecasting method and the data used should be compatible with each other and in order to establish a successful regression model the following must be satisfied:

i) Data should be homoscedastic.

ii) Distribution of the data should demonstrate normal distribution.

iii) Linearity should be accomplished within dependent and independent variables.

iv) Multicollinearity should be eliminated.

If the data does not conform as expected, it is always possible to further transform data in order to fit the requirements. The R^2 values of the transformation have data that is higher. The greater fit means, more linearity, which leads to linear distribution between variances, which leads to higher normality.

4.3.2 Applying Regression Analysis:

The data in Appendix 4 was the final form of the data which was free from outliers and unwanted variables. After applying transformations and adding estimated future variables to Minitab 14.0 software, the model was executed.

First step of the outcome was to pick out statistically significant variables and then minimize correlations between these variables.

Regression Analysis: Volume of export vs. Indicators

* Hwy Vs Air travel is (essentially) constant

* Hwy Vs Air travel has been removed from the equation.

* NOTE * All values in column are identical.

* Aviation charges has all values = 0

* Aviation charges has been removed from the equation.

The regression equation is

Volume of exports (Mil Ton-m) = 18004 + 8 (No. of Exporting Companies) + 188 (No. of carriers) + 0.6 (Airline profitability) - 2.20 (GDP /GDPpc) + 502 (Airline frequency) + 3313 (Fuel Prices $/gal)

Predictor	Coef	SE Coef	T	P
Constant	18004	15936	1.13	0.341
No. of Exporting Co	7.6	324.3	0.02	0.983
No. of carriers	187.6	148.7	1.26	0.296
Airline profitability	0.63	60.14	0.01	0.992
GDP /GDPPC	-2.196	4.215	-0.52	0.638
Airline frequency	502	2258	0.22	0.838
Fuel Prices $/gal	3313	4591	0.72	0.523

S = 2021.70 **R-Sq** = 84.9% **R-Sq(adj)** = 54.6%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	6	68724830	11454138	2.80	0.213
Residual Error	3	12261802	4087267		
Total	9	80986632			

Since p-values are high, the regression is rerun with 3 indicators and the result is as follows:

The regression equation is

Volume of exports (Mil Ton-m) = 20268 + 196 (No. of carriers) - 1.63 (GDP /GDPpc)

+ 2589 (Fuel Prices $/gal)

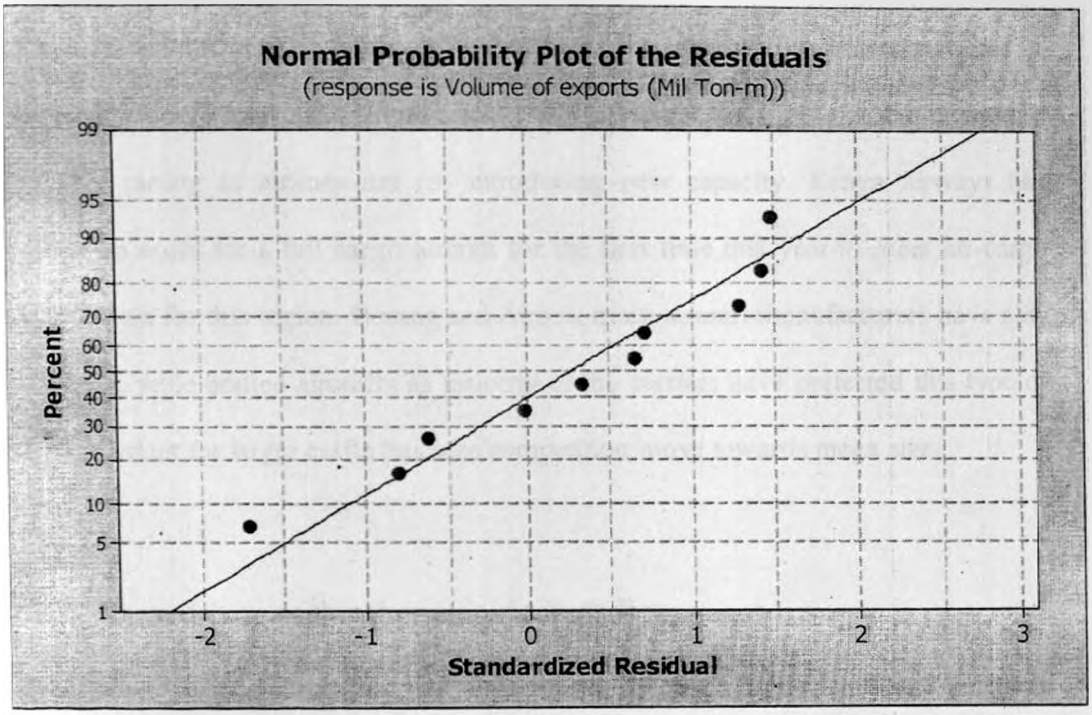
Predictor	Coef	SE Coef	T	P
Constant	20268	1644	12.33	0.000
No. of carriers	196.37	65.99	2.98	0.025
GDP /GDPPC	-1.633	0.8444	-1.93	0.101
Fuel Prices $/gal	2589	1102	2.35	0.057

S = 1458.44 **R-Sq** = 84.2% R-Sq(adj) = 76.4%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	3	68224403	22741468	10.69	0.008
Residual Error	6	12762230	2127038		
Total	9	80986632			

Normplot of Residuals for Volume of exports (Mil Ton-m)



4.4 Discussions.

4.4.1 Comparison with theory.

As mentioned in the first chapter their tends to be a nearly 1:1 ratio between GDP and airfreight growth as demonstrated by Kasandra *et al.*(2002). However, during the last decade, average airfreight growth rate has declined from 8-12% in the seventies, 7-8% in the eighties, 6-7% in the nineties, and 2-7% for the last decade. World GDP growth on the other hand has also declined but slightly slower. Despite the slight down-run, over the past decades, 1980-2000, GDP grew up by 72% and air cargo growth was 308% for over 70 countries around the globe. So despite challenges in the last decade which included major recession, twin wars with an oil producing country and a major

banking crisis, one is able to predict one factor by knowing the other with a fairly good accuracy.

Air cargo volume is expected to grow steadily in the coming Era as demonstrated in the result. Cargo load factors and aircraft utilization recovery post global economic crisis is raising as airlines are (re-)introducing new capacity. Kenya airways has placed an order for a full cargo aircraft for the first time this year to meet air-cargo volume just for this region. Boeing and Airbus, main aircraft manufacturers have also moved to wide bodied aircrafts as majority of the carriers have preferred this type of crafts. Orders for larger crafts has seen competition move towards mega size.

4.4.2 Comparison with other empirical studies

It has also been demonstrated that air cargo is not just a trade facilitator but trade creator. Many nations have understood this and have taken advantage and now hold high competitive advantage over others. The US has the leading top 3 out of 5 best air cargo companies and this drove them to the top as global economic power for over a long period now. The causal argument here is that air cargo enables nations to efficiently connect to distant markets in a speedy and reliable manner and in this era of fast-cycle logistics, nations with good air cargo connectivity have competitive trade and production advantage over those without. Such advantages as Michael Porter and others have documented is fundamental to economic development. Economic development in aggregate measure is basically GDP.

Chapter Five: Summary, Conclusion and Recommendation.

5.1 Introduction

The study was aimed at predicting future capacity level for air-cargo at JKIA and design and test a forecast model that will predict future capacity for expansion and growth strategies. From the analysis and data collected the following conclusions and recommendations were made.

5.2 Summary of the findings

Use of regression analysis is very common in almost all scientific disciplines and it provides useful tools for forecasters. Regression methods assume existence of strong linear or non-linear cause-effect relationship between indicators. Such strong relationship cannot be said for the data collected herein. During initial investigation it is observed that linear regression analysis resulted inconsistent predictions like negative volume of export with high statistical errors. Data transformations(natural logarithm) and elimination of some indicators were applied in order to prevent these inconsistencies.

The regression analysis and accompanying statistical tests showed that the indicators could be ranked according to their impact from highest to lowest so that emphasis is stresses in the same manner.

It is concluded that airline profitability, distance between cities and aviation taxes are statistically insignificant and they are not used in current regression model. It is also observed that there exist multi-collinearities between frequency and No. of carrier indicators which were also removed.

The final regression model has R^2 value of 84.2%. This coefficient is evaluated as satisfactory since a real-life situation with highly volatile and incomplete data is used. The model released the following predicted values of air passenger demands for the case study airports for years 2011 and 2020.

Air cargo volume Prediction

For 2010: 33593 million ton-km

For 2020: => 20268 + 196(41) - 1.63ln(14623) + 2589(5.2) = 41757.21

Although established models generated consistent results, they have some weak points. For example in order to predict future capacity volumes, socioeconomic indicators of the future conditions should be predicted. During last ten years, demographic indicators had a steady trend in Kenya and it is easy to obtain demographic information for the future than for the former. Economic and social indicators do change very rapidly and it is very difficult to predict future conditions of such dynamic variables. Because of these difficulties, it is best to use a model as of this study for medium range forecasts (i.e. 5 to 10 years) and use a different models or analysis for more than 10 years of forecast ranges.

5.3 Conclusion

The main aim of this project was to determine future air cargo volume and compare this with current and planned growth of the sector at JKIA. The projects aim was also to a certain whether or not air cargo growth is in line with the growth of GDP as expected or will the difference be very wide that the two cannot be used interchangeably to predict the growth or otherwise of the other. The project also tried to develop a methodology to predict the future demand for air cargo exports so as to

make an informed planning of such key national infrastructure in Kenya. Planning of national infrastructure requires good forecast to accurately employ time and money efficiently and effectively. Air transport systems and airports play a key role in growth of the economy and commerce as a whole.

Economic analysis is the main process required in making a decision during the planning stage for any investment. Air cargo volume being a major contributor to national economy as demonstrated should also be one of the basic inputs during any economic analysis in planning and designing of airports. Accurate estimate and precise future volume is what the project tried to demonstrate.

Data used in this project is based on quantitative records and actual observations during last ten years. Although the data is highly volatile, it is objective and certain. Using models based on such objective data increased validity of the research. Another important point to be mentioned is that although two different aspects of socio economic activities, and different methods used in forecasting approaches, the result produced similar predictions; which may be considered as the indication of success of the model. This study hopes to give an idea to governments and private sector decision makers about possible use of modern forecasting techniques as a critical planning tool before making any investments.

5.4 Recommendations

For the purpose of adding knowledge, this technique was a demonstration of just a methodology among many in the field of forecasting and a comparison to the estimate can be carried out with different methods and even add more indicators over this simpler case. Also just as a note, many more quantitative techniques exist like simulation which can be used in combination for better future predictions. Once again

establishing models for future demand forecasting is not only necessary but vital for management of capacity and expansion. Not to forget key to all predictions lies with constant and regular collection and storage of the past data. Mostly for the factors thought to be effective in domination of dependent variable. It is well known that numerous socioeconomic factors may be considered as effective in forecasting.

5.5 Limitations of the study and Suggestion for Further Studies

GDPPC, population, urban population etc. can be given as examples to such indicators. Also categorical indicators, such as geographical location, different aviation tax policies, were thought to be effective indicators and taken into consideration in this study. For a reliable forecasting study, the data should cover a considerably long period of time in the past. During data collection, many challenges arose in obtaining past records of most indicators. Due to lack of data and for obvious reasons like people keep records for themselves and have little trust, very little records was actually gathered from direct sources. Some indicators, though may be important for analysis were not used in this model as it was not possible to obtain any past records for them. For example, it was assumed that there is a link between communities' need for communication and need of transportation. It was also thought that a community with high use of internet and mobile phones may tend to export more and transact on a global scale. After digging for this data all over internet, very little public record was available for any use in substantive analysis. Similarly each airline kept its records of actual export volume as private.

Although some other records maybe more readily available than others like birth rate, computer ownership, number of university students which can be considered in such a

study, was disregarded until some research result can indicate that such parameters are significant enough for air cargo volume and that they will lead to a better forecast data vis a vis the amount of time and whether the same is readily available at minimal cost. For the available data, suitable forecasting methods should be selected in order to establish reliable models. There are many forecasting methods in the literature and each of them is unique and has its own strengths and weaknesses and use of quantitative modeling and simulation will add value and even give one a better insight into actual required capacity and even bring up the concept of just in time/real time expansion approach.

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Appendices

Appendix 1: Questionnaire

A survey of air cargo capacity and management at JKIA.

This research project tries to determine critical factors that affect capacity of airport and forecast future demand for an informed planning, design and investment of such a critical facility. Please complete the questionnaire with most informed response. Your cooperation is well appreciated and will be treated with utmost confidentiality. Thank you.

SECTION 1: GENERAL INFORMATION

Please respond to the dotting and tick accordingly.

1. Name of Company .....

2. No. of Employees.....

3. Length of service: how long have worked in this industry?

Less than 5 years	[ ]	16 –20 years	[ ]
6 – 10 years	[ ]	21 – 25 years	[ ]
11 –15 years	[ ]	More than 25 years	[ ]

4. Which department/section is your employer?

Airline	[ ]	Clearing & forwarding	[ ]
Handling agent	[ ]	Pack houses	[ ]
General warehousing	[ ]	Security Ops	[ ]

5. Nature of your industry?

Air Transport	[ ]	Road transport	[ ]
Flower	[ ]	fruits & Vegetables	[ ]
Warehousing	[ ]	Agency services	[ ]

6. Type of goods handled

Fresh vegetable	[ ]	Cut Flowers	[ ]
Machinery & spares	[ ]	Meat & poultry	[ ]
Precious stones/minerals	[ ]	Mails	[ ]

Others (Please specify).....

7. Volume of goods handled daily/weekly & periodicity.....

8. List of companies dealt with in the past year (if Agency/Carrier/Authority).....

9. Origin country of transhipments inside cargo shed/belly.....

10. Name and number of competitors in the same field.....

11. Comment on profitability of the company. Growth trends.....

12. If airline company, what is your flight frequency.....

13. What is prevailing rate of fuel surcharge.....

14. Rank the first three carriers in order of best first, why those carriers?

Quality of service: 1.).....2.).....3.).....

Tariff regime 1.).....2.).....3.).....

Customer service: 1.).....2.).....3.).....

Frequency of flights: 1.).....2.).....3.).....

Cargo Space: 1.).....2.).....3.).....

Minimum booking time: 1).....2.).....3.).....

Handling/surcharges: 1).....2.).....3.).....

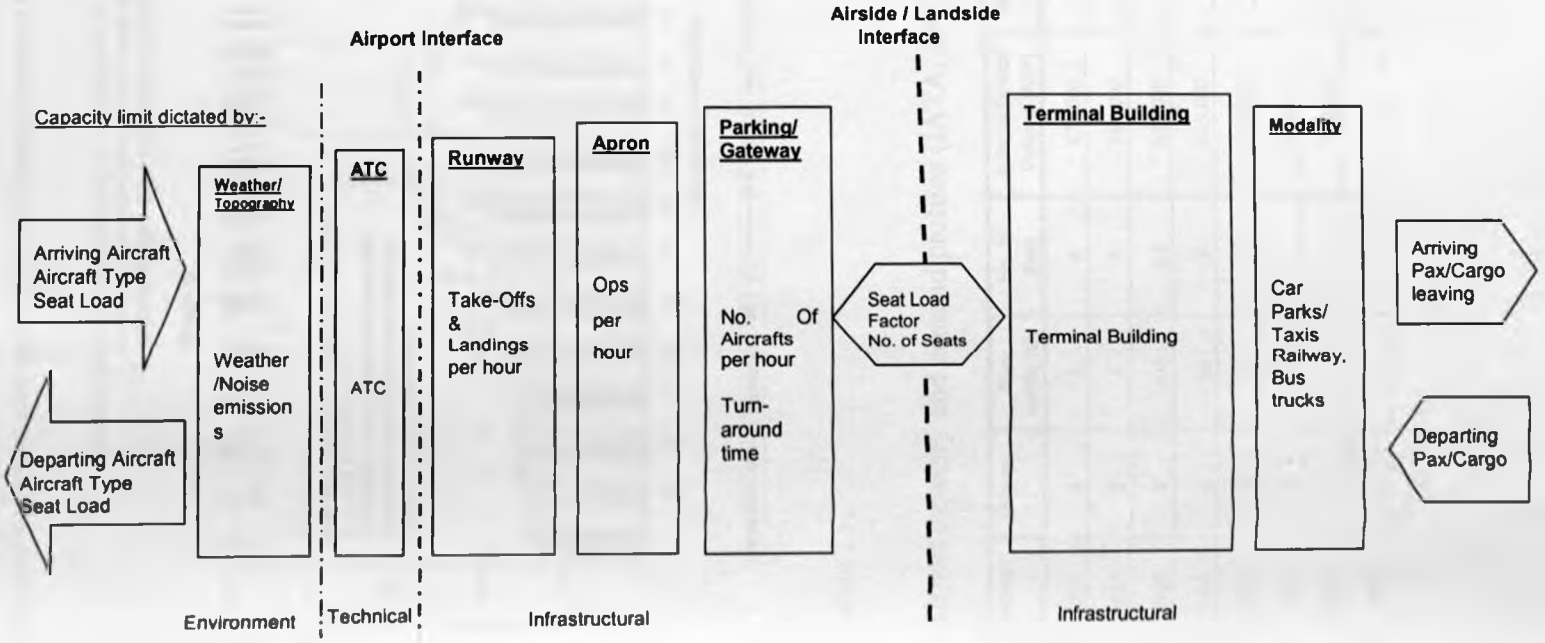
IATA Airline Codes:

Airline	Code	Airline	Code
British airways	BA	Kenya airways	KQ
Qatar cargo	QR	Emirates Skycargo	EK
Cargo lux	CV	Ethiopian airlines	ET
Lufthansa cargo	LH	Turkish airlines	TK
Brussels airlines	SN	Air France cargo	AF
South African airways	SA	Saudi Arabian cargo	SV
Astral Aviation	8V	Martin Air	MP
Egypt air	MS	Gulf air	GF

IATA – International Air Transport Association

Fig. 1

Limiting Factors for capacities and interdependencies at the Airport



Appendix 3

Fig F3.

ASV and Hourly Capacity by Runway-use Configuration and Groups (Source: FAA (1983)).

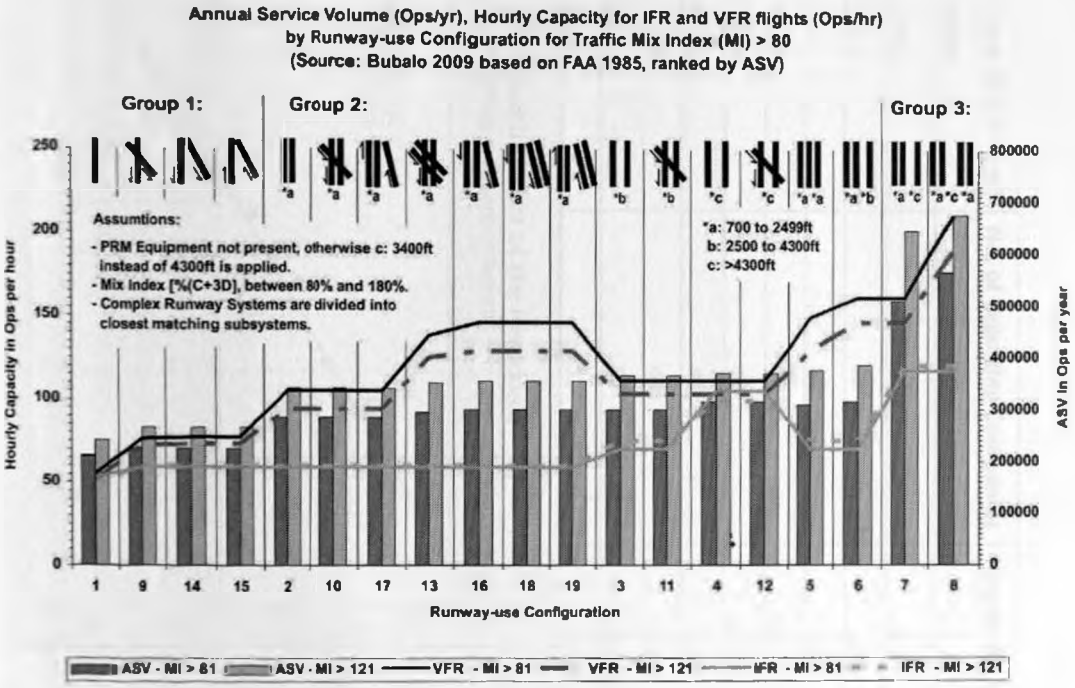


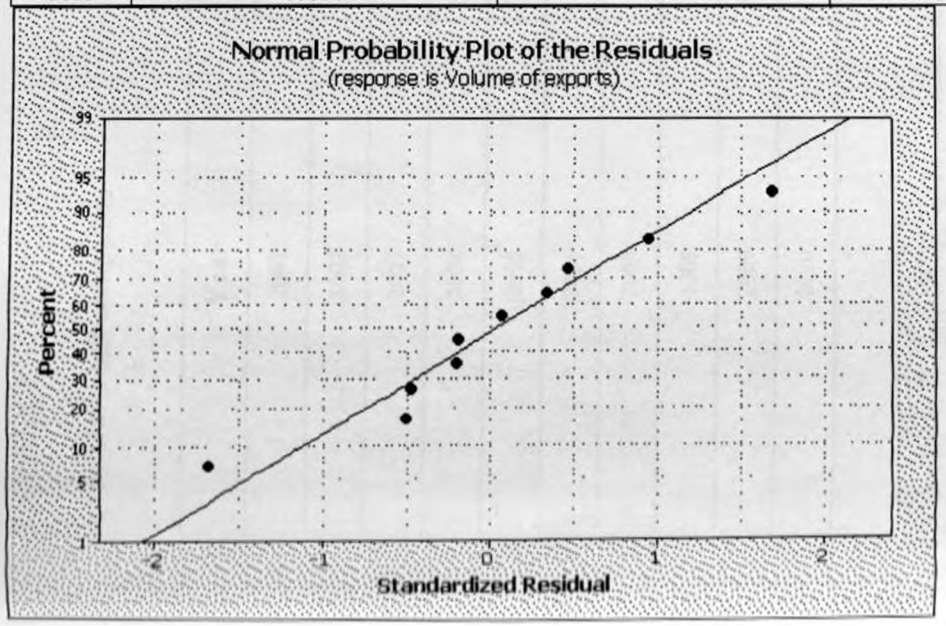
Table T1.

Airport capacity and demand profiles (IATA, 2007)

Airport	Group.	Rwy config No.	No. of Rwy	Annual Service Volume (ASV)	Annual Demand Ops *2007 EUROSTAT	Annual Demand/ ASV (Utilization rate)
CGD	3	8	4	675,000	569.281	84.3%
MAD	3	8	4	565,000	470,315	83.2%
AMS	3	4+9	5.5	635,000	443,677	69.9%
FRA	2	16	3	355,000	486,195	137.0%
LHR	2	4	2	370,000	475,786	128.6%
STN	1	1	1	210,000	191,520	91.2%
NBO	1	1	1	210,000	80,195	38.2%
JNB	1	3	2	-	-	-

Appendix 4

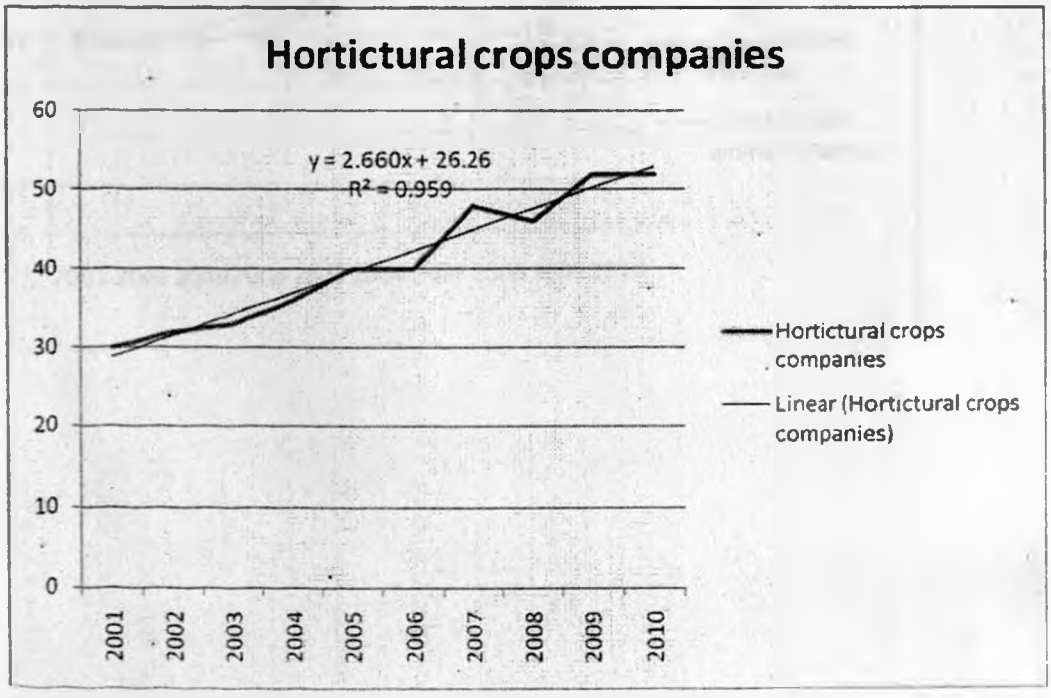
JKIA (Yr)	Volume of exports (Mil Ton-m)	No. of Exporting Companies	Hwy Vs Air travel	No. of carriers	Aviation charges	Airline profitability	GDP /GDPPC	Airline frequ
2001	29080	30	2.38	39	0	43	1806	6
2002	24741	32	2.38	47	0	49	2732	7
2003	25873	33	2.38	48	0	-12	3593	7
2004	27057	36	2.38	52	0	1	4575	8
2005	26218	40	2.38	52	0	13	5610	9
2006	28399	40	2.38	67	0	9	6099	9
2007	29039	48	2.38	85	0	4	7472	10
2008	32329	46	2.38	80	0	34	8438	9
2009	32045	52	2.38	92	0	58	6912	10
2010	33593	52	2.38	123	0	43	10554	15



Appendix 5

Horticultural crops companies

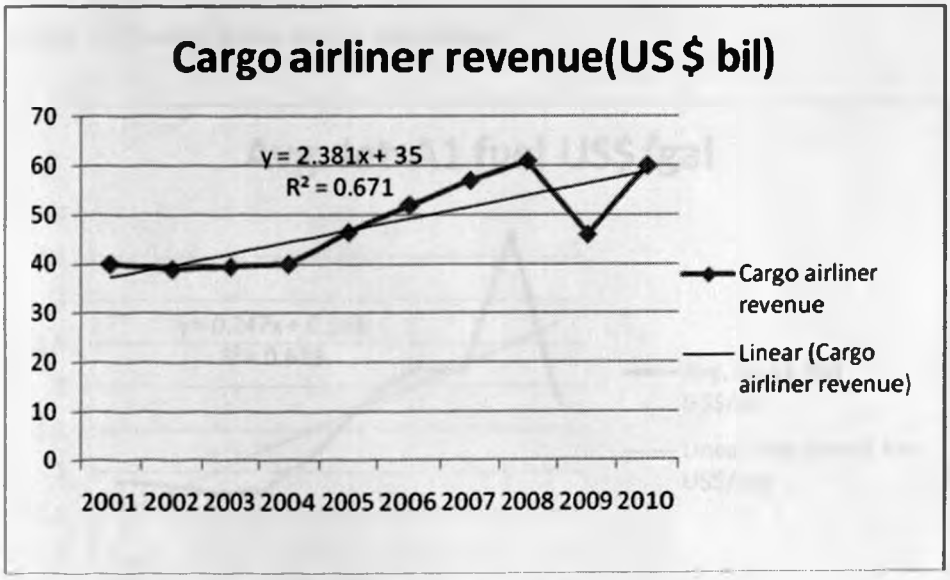
Year	No.
2001	30
2002	32
2003	33
2004	36
2005	40
2006	40
2007	48
2008	46
2009	52
2010	52



Appendix 6

Cargo airliner profitability.

Year	Avg. revenue bil$
2001	40
2002	39
2003	39.5
2004	40
2005	46.5
2006	52
2007	57
2008	61
2009	46
2010	60



Appendix 7

Fuel Price

Year	Avg. Jet-A1 fuel US$/gal
2001	0.85
2002	0.75
2003	0.79
2004	1.2
2005	1.8
2006	2.2
2007	2.19
2008	3.8
2009	1.81
2010	2.2

Source: US Energy Information Administration