6 CHAPTER SIX: MODEL APPLICATION

6.1 Overview

In this chapter, the applications of the cost model to the Africa network will be given. This model can be used to build the conventional 3-step transport-planning model composed of trip generation, trip distribution and trip assignment to get existing passenger data. The model requires on ground input data for distances and passengers for each O – D pair and the model can calculate the costs of running a service along all these routes, for 11 different aircraft types.

Since the model is based on airports within the African continent, country specific data relevant to this study is needed. The 50 countries within the continent, will be used to generate the trips specific to air travel at the major international airports. From this a 50x50 origin- destination matrix will be formed.

6.2 Trip generation

Under this section, the number of passenger trips who are currently using air transport needs to be calculated. The lack of adequate data resources within most African countries, made it difficult to compile this data, so available data had to be manipulated for this study.

6.2.1 Passenger data

Gross domestic product is defined by the World Bank as a measure of total output of goods and services for final use produced by residents and non-residents, regardless of allocation to domestic and foreign claims. Hanlon (1999) suggests an elastic relationship between the GDP per capita of each country and the number air travel passengers as seen in the literature.

Taneja (1978), suggests that since GDP is a measure of the economic well-being of people within a nation, it can be assumed that the higher the GDP, the greater the output of goods and services, the richer people are, therefore the more they will travel for business and pleasure purposes.

This relationship can be analysed, to relate GDP/capita and number of air passengers. To relate this to the number of air passengers, the rate would need to be multiplied by the population i.e. trips/person = f (GDP/capita)

World Bank data query is an online database that is used to find out data from different countries, spanning from 1997-2000 for various economic indicators. World Bank (2002) was used this for study. The database provides information for all African countries on population, GDP (US$) and aircraft departures/year. The aircraft departures for each country are shown in Appendix I.

6.2.2 Regression Analysis

Multiple Regression analysis was run on the aircraft departures, GDP or GDP per capita from each set of data, to create a multiple linear regression equation using the least squares technique, to confirm the relationship. Regressions were run using GDP, population and GDP/capita. Figure 12 shows the coefficients and the R^2 value for the regression equation for annual departures based on GDP.

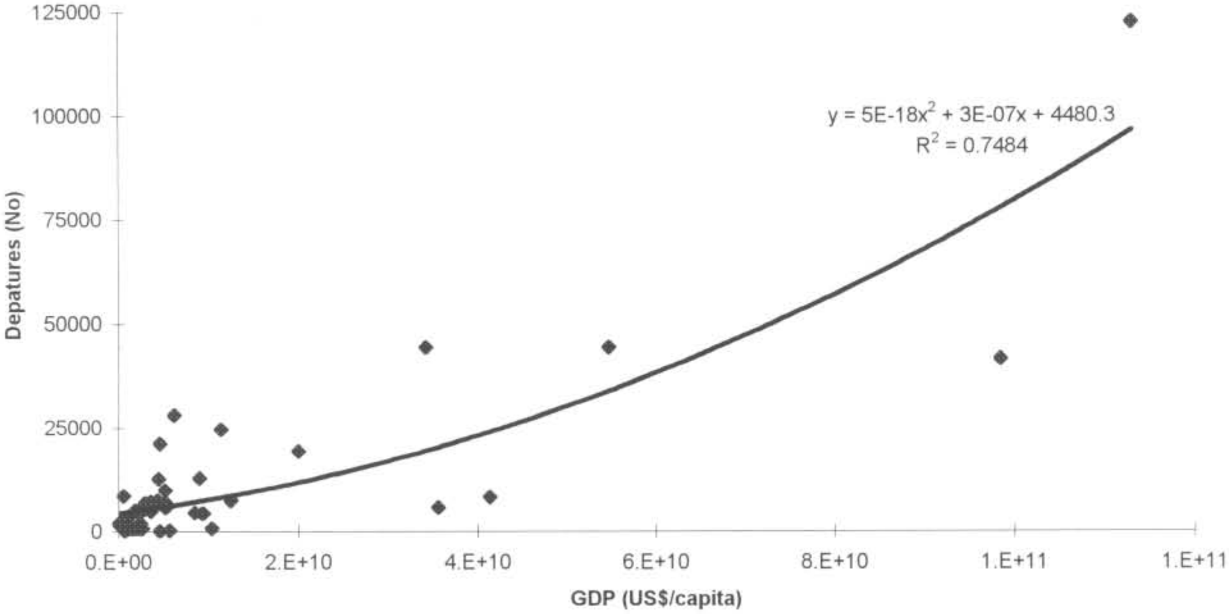

Figure 12: Graph showing GDP trend line with number aircraft departures

Linear regression analysis gives a correlation of 0.848, with an R^2 of 0,694 but it does not put into consideration exogenous factors like unemployment, route fare, tourism attractions, etc which in essence do affect the number of air travel passengers, and are all are function of GDP, but to an undefined exponential. That is why when the equation becomes a quadratic equation the R^2 increases and when a cubed power of GDP is used instead; the regression analysis gave an even better R^2 of 0,7484. This implies that there are many factors that are all functions of GDP, which result in the movement of people, from one country to another. The data has a few outliers, from countries like South Africa, Comoros, Ethiopia, etc, which countries have either booming tourism industry or act hubs for specific airlines.

6.3 Trip Distribution

Airport identification and the distances between each of these airports were collected to define the routes. The International Air Transport Association (IATA) is an association that gathers information for approximately 280 airlines and about 95% of international scheduled air traffic. It uses a three-letter code for each airport, that it has been registered with the association.
In order to get the information needed for this study, a website called I Travel You Travel, gives a list of web-based utilities, meant to simplify the life of the traveler or website user. The utilities that will be used include:

6.3.1 List of airports

This gives a list of all airports and their three letter codes as given by IATA. For convenience the airports are listed under their respective countries in alphabetical order, for this study only one major international airport is recorded. Appendix A shows a list of all African countries, one major international airport per country and its respective three-letter code.

6.3.2 Airport distances

The one-way airport distances for all airports is calculated from the same website with an online mileage calculator in which the origin and destination codes serve as input to provide to air distance in the user's choice of units. This was done for each of the airports to create a 50 X 50-distance matrix (in km) as shown in Appendix B.

6.3.3 Total trips

To generate passenger trips moving within each of the countries within the African continent, to build the passenger data matrix, the following process was followed; According to AFRAA (2000) the total aircraft departures are multiplied by a factor of 15% to get the departures moving within Africa. Thereafter the trips generated between each O – D pair is calculated using the Furness method for a doubly constrained matrix. By trial and error method the values of β be 0,14, and α was calculated to be 52,02.

The cost matrix for each O-D is calculated using the distance matrix assuming an average speed of 800km/hr for all aircraft. Passengers calculated from the product average aircraft capacity of assumed to be 200 seats and the number of aircraft, for the respective O- D pair. Appendix C gives the above data and tables for the final trip distribution matrix.

6.4 Cost comparisons

With all the input data for the distance and costs for a given route, a route network can be created for Africa. This means for a chosen aircraft fleet, application of the O-D pair specific passenger numbers and distances, the cost of running a given airline service can be computed, as well as other parameter values such as fleet size and frequency.

The model was applied to the route Entebbe, Uganda and Johannesburg, South Africa that has 599 weekly passengers with a route length of 2 942km, according to the databases. Table 4 is a compilation of the data for the most economically efficient aircraft that can be used on this route according to the model. This will be used to test the model's applicability to the present situation. Presently the airlines that run this direct route include: South African Airlines (SAA) thrice weekly using the Airbus A320-200 and East African Airlines (EAA) twice weekly using the Boeing 737-200. The average airfare is US$ 600 for a return ticket on this route.

Table 29 Most efficient aircraft for EBB-JNB route

Parameters	Embraer Erj 135-JET	Boeing B737-200	Boeing B737-400	Airbus A320-200
Minimum weekly flights to meet demand	17	5	4	4
Cost per aircraft-km (US$/ aircraft-km)	4	25	30	32
Cost per passenger assuming full capacity (US$/pass)	328	571	527	519
Cost per passenger flying (US$ / pass)	344	620	591	624
Cost per available seat-km (US$ / ASK)	0,11	0,19	0,18	0,18
Cost per passenger-km (US$ / pass-km)	0,12	0,21	0,20	0,21
Cost per hour utilised (cost / hr)	3 007	16 986	21 543	23 169
Weekly aircraft Efficiency (aircraft-km/aircraft)	50 014	14 710	11 768	11 768
Weekly service use intensity (pass/Aircraft-Km)	0,0120	0,0407	0,0509	0,0509
Weekly Aircraft fleet Utilisation (aircraft-hrs/aircraft)	68,54	21,86	16,44	16,13
Work utilisation coefficient (pass/seat)	0,95	0,92	0,89	0,83

The Embraer Erj 135-Jet is obviously a more economically efficient aircraft to run but the Boeing 737-200 will be a better choice because of the maximum ranges each aircraft can fly. The farthest distance an aircraft can fly without re-fueling dictates the maximum range of an aircraft. Embraer Erj 135–Jet has a maximum range of 3 019km as compared to the Boeing 737-00 whose range is 3700km. This makes Boeing 737-200 a safer choice in case of an emergency in situations where air traffic is high and the aircraft need to stay in the air longer, before landing at the destination airport.

The work utilisation coefficient, which is the load factor at which the aircraft would fly this route based on the existing passenger demand. The higher the load factor, the more favorable the route to break-even using the supply and demand for the route, especially when the costs per hour utilised are low. For this route, the load factor of the Embraer Erj 135-JET and the Boeing 737-200 aircraft are quite good.

6.5 Hubbing

From the comparison above and route analysis literature, the more passengers that are travelling for shorter routes, the cheaper it would be for airlines to run the service. The passenger matrix shows that the passenger demand is very low for example 3 passengers fly weekly from Uganda to Senegal. As a solution for the African continent, consolidating passenger traffic through hubbing could be a viable option to consider.

A hub is defined as an airport, which the airline would use as a terminus for routes: a point of concentrating arrivals and departures for passenger access to other flights. The proposal would be that for the African continent, four geographically located airport-hubs in the Northern, Southern Central and Eastern parts of Africa can be chosen and these alternative hubbing arrangements can be tested using the cost model

6.5.1 Justification

Kane (1996) writes that hubbing is a way in which airlines can save a lot of money, because hubbing reduces average sector lengths, and consolidates the number of passengers travelling over these short distances.

This implies therefore that a high proportion of its direct operating costs are incurred in take-off, landing, climb and descent. The effect of hubbing is shown in Table 30, giving the positive and negative effects on unit cost:

Table 30: Hubbing effects on cost of service

Positive	Negative
▪ Reduces the average sector distance flown ▪ Extra staff and handling equipment for shorter time intervals ▪ Intensive utilization of aircraft and crews, operating more flight hours per day.	▪ Additional Passenger Handling ▪ Places greater peak-load pressure on the hub airport

6.5.2 Hubbing models

Examples of models dealing with different aspect of airline services, and employing different methodologies, have been used as a basis for analysing hubs; for example:

1. Traffic demand forecasting

Dennis (2002) developed a methodology for assessing the future route network and flight schedule at a medium-sized European airport. The starting point is the existing origin and destination demand from the base airport across the world. This is expanded using growth rates by country or region for the period up to year 2015. The future origin and destination demand is then converted into route traffic, subject to a threshold for direct service. Where demand falls below this level, traffic is reallocated via various appropriate hubs.

2. Passenger demand model

Hensher (2002) develops a method which involves the development and estimation of an econometric model capable of explaining the influences on passengers carried by airline j between points A and B over a regional network. Passengers traveling between points A and B include those in which their origin and destination are A and B and those who are flow-through passengers with A and B being either commencing or final points or both are intermediate on-line or inter-line connection points. An important attribute in the approach is an explicit treatment of current hubbing activity.

Hubbing has both positive and negative effects on passenger demand. On the negative side, there are time penalties as well as the disutility associated with making a connection rather than flying non-stop. On the other hand, hubbing can significantly reduce the passengers' schedule wait and add many origin–destination pairs to the network. Costs can be reduced due to higher traffic densities, but they are offset to varying degrees by the circuitous routings sometimes involved in hub operations.

6.5.3 Cost analysis of hubbing option

Hubbing can be analysed using the model and by following the process outlined below:

1. Creation of a suitable hubbing arrangement within the African continent, as shown in Figure 13. This implies that the choice in hub locations needs to be justified.
2. The specific links will be defined in the model, in as far as average sector distance, airfares, minimum frequencies, etc.

3. Calculation of operating costs of aircraft modes, for the given links will be calculated using

the model,

4. Evaluation of each link, for economic analysis, choosing the least expensive link as the favorable option.
5. Repeat procedure for other hubbing arrangements, such that the least expensive hub and spoke network for Africa can be defined.

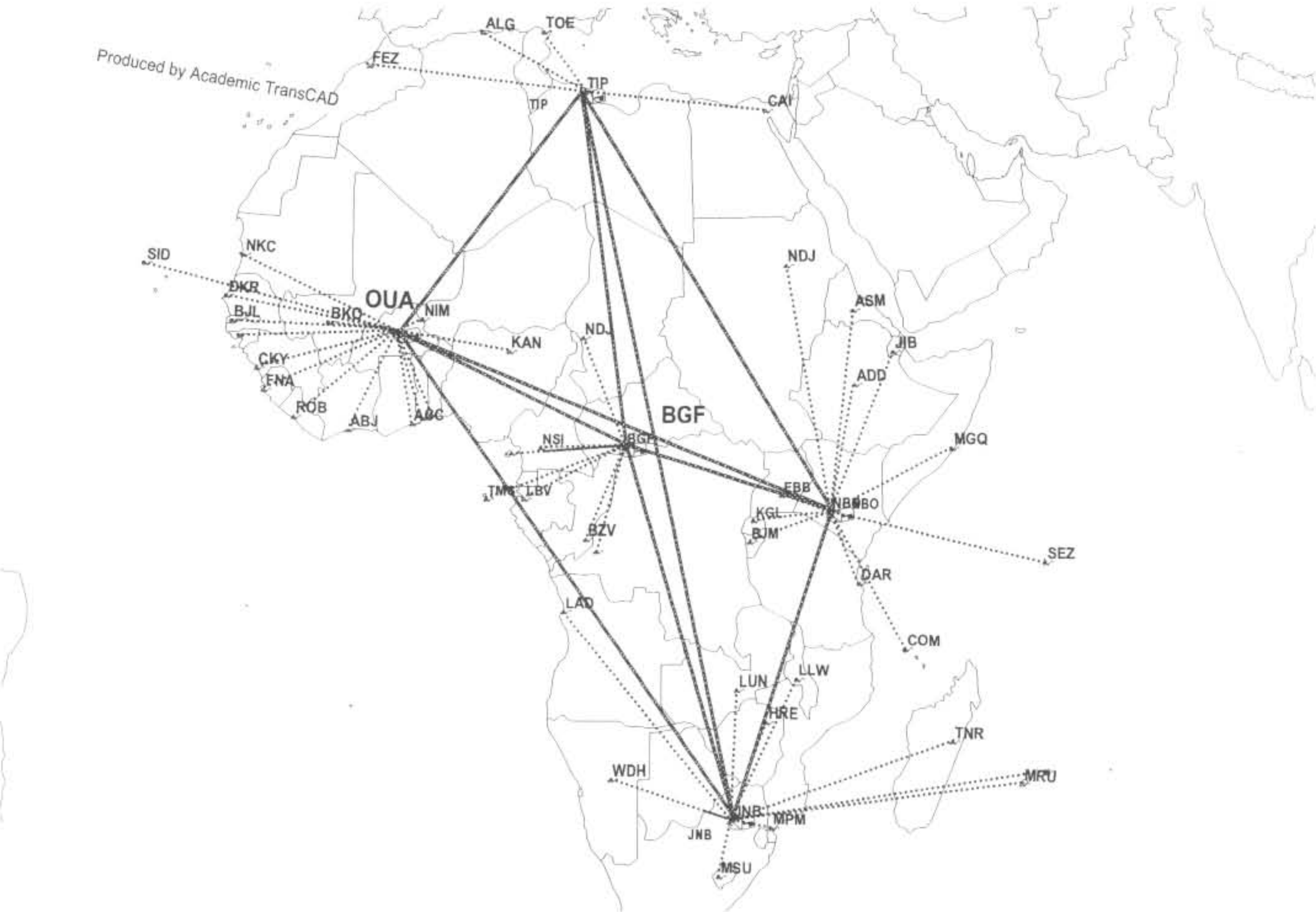

Figure 13: Proposed hub movements within the African continent

Due to time constraints the extent work involved in studying the hub network, could not be carried out but will be an interesting area for future research.