STRATEGIES TO DESIGN A COST-EFFECTIVE HUB NETWORK FOR SPARSE AIR TRAVEL DEMAND IN AFRICA

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THESIS SUMMARY

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The aviation industry worldwide is changing dynamically in reaction to trends such as globalisation and with the need to increase market share to remain competitive. The African aviation industry still faces many problems in the institutional, technical and operational areas. Despite its potential for enhancing economic development, air travel to and from Africa remains a small percentage of world air travel. The African air route network is characterised by sparse demand, with long sector distances, low frequencies and high fares.

This study investigates cost-effective hub-and-spoke (H&S) network design strategies for the African route network. An H&S network would minimise the cost of air transport and improve accessibility and connectivity. The study challenges the typical characteristics of H&S networks which are usually found in denser route networks. The design methodology used was the one most appropriate for the African region, using the datasets and tools available. As a first-cut analysis for Africa, the results of the research contribute to understanding the effectiveness of H&S networks in markets with sparse demand.

A cost model previously developed by the author to calculate operating costs on a route was used. It eliminated the need to assume discount coefficients on links, as passenger demand increases, in a field with limited data. The cost indicators derived from the model were used as criteria for choosing the most efficient hubs within a cluster. These were compared with the hub-location criteria in the literature which use distances and passengers. It was found that using the cost indicators gives a reasonably consistent method that lowers passenger travel time.

The optimum number of clusters and hubs was found to be four. The geo-political network design method yielded the lowest network costs. The hubs are centrally located within the clusters: Morocco in the north, South Africa in the south, Kenya in the east and Nigeria in the west. They are characterised by high passenger demand and short node-hub sectors. There are significant benefits to be gained from using this hub network design, resulting from the economies of scale with higher passenger densities on routes. Furthermore, the benefits of higher service frequencies and better connectivity outweigh the extra travel time when routing through hubs.

The study found that for sparse networks, the cheapest hub-location options have high passenger demand. The sector distance is crucial in lowering operating costs as smaller, more efficient short-range aircraft can be operated. It is therefore more efficient to assign nodes to the closest hub to lower node-hub costs. The optimum number of hubs/clusters is thus determined by the distance threshold for the efficient aircraft. The effect of changing the cluster boundaries on network costs also depends on the change in node-hub distances between the clusters. As sparsity reduces, the economies-of-scale benefits outweigh the increasing operating costs of longer distances, allowing efficient operation of larger-capacity aircraft. This means that the location of the hubs and the number of clusters becomes more flexible, implying that node-hub links can become longer, reducing both the clusters and the number of hubs.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

GLOSSARY OF TERMS

Aircraft kilometres are the distances flown by an aircraft. An aircraft's total flying is obtained by multiplying the number of flights performed on each flight sector by the sector distance.

Aircraft Utilisation is the average number of block hours that each aircraft is in use. This is generally measured on a daily or annual basis

Available seat-kilometres (ASKs) are obtained by multiplying the number of seats available for sale on each flight by the flight sector distance.

Average aircraft capacity is obtained by dividing an airline's total available tonne kilometres (ATKs) by aircraft kilometres flown.

Average sector length is obtained by dividing an airline's total aircraft kilometres flown in a year by the number of aircraft departures; it is the weighted average of sector/sector lengths flown by an airline.

Block time (hours) is the time for each sector flight or sector, measured from when the aircraft leaves the airport gate or stand (chocks off) to when it arrives on the gate or stands at the destination airport (chokes on). It can also be calculated from the moment an aircraft moves under it's own power until it comes to rest at its destination.

Break-even load factor (percent) is the load factor required to equate total traffic revenue with operating costs.

Flight crew refers to pilots, stewards and stewardesses.

Operating costs per ATK is a measure obtained by dividing total operating costs by total ATKs. Operating costs exclude interest payments, taxes and extraordinary items. They can also be measured per RTK.

Passenger load factor (per cent) is revenue passenger-kilometres (RPKs) expressed as a percentage of available seat kilometres (ASKs) on a single sector; this is simplified to a number of passengers carried as a percentage of seats available for sale.

Slot at an airport is the right to operate one take-off or landing at that airport within a fixed time period.
Sector/sector distance the air route or flying distance between two airports**.**

Regulation: This term is defined as a set of principles, rules or laws designed to control or govern conduct. In the airline industry, all air carriers and countries have set rules and regulations they are meant to adhere to according to international standards. The bodies set aside to govern and ensure this are the civil aviation agencies set up in most countries**.**

Deregulation: This is defined as the removal of government controls from an industry or sector, to allow for a free and efficient marketplace, which would encourage competition

Liberalisation: Liberalisation is the act of relaxing the laws governing an industry making them less strict or less severe.

Privatisation: If a government privatises an industry, company or service that it owns and controls, it sells it so that it becomes privately owned and controlled.

Open skies: These are agreements, which permit unrestricted service by the airlines of each side to, from and beyond the others territory, without restrictions on where carriers fly the number of flights they operate and the prices they charge.