5 CHAPTER FIVE: MODEL ANALYSIS

5.1 Introduction

This chapter deals with how the route cost model, can be applied to the following analyses for running an airline service:

- Route analysis
- Varying distance analysis
- Varying passenger analysis

5.2 Route analysis

The analysis that can be carried out along a route, will involve different aspects of the service being provided. They include: route cost analysis, service analysis, service efficiency and utilisation indicators, which are all calculated in the output sheet of the cost model.

5.2.1 Route cost analysis

The model calculates the cost involved in running an airline service along a route. The cost model can be applied to analyse the operating costs, for specified input components of distance and passenger numbers. For a given route, the output components are used to make a choice on the most suitable service, on the basis of the different cost indicators, the type of aircraft, etc.

Table 25 is a summary of annual flight cost indicators for the aircraft types that can provide a service along the specified route of sector distance 3 249 km and 30 000 passenger per year. Three aircraft within 10% of the least cost within the margin accuracy of the model will be highlighted. The conclusions inferred from Table 25, are only applicable to this specific route. The aircraft that are not included are eliminated by the model because of the maximum range they can fly.

Table 25: Cost indicators for given aircraft type (US$)

Aircraft type	Boeing 737-200	Boeing 737-400	Airbus A320-200	Airbus A340-200	Boeing 737-800	Boeing 767-200	Boeing 747-200	Boeing 767-300ER	Boeing 747-400
Cost per aircraft-km	23	27	29	130	32	64	164	208	199
Cost per passenger (At 100% load factor)	576	531	522	1 432	548	819	1 827	2 334	1 607
Cost per passenger (At ruling load factor)	650	618	652	1 465	719	1 086	1 843	2 347	2 236
Cost per available Seat-km	0,18	0,16	0,16	0,44	0,17	0,25	0,56	0,72	0,49
Cost per passenger-km	0,20	0,19	0,20	0,45	0,22	0,33	0,57	0,72	0,69
Cost per hour utilised	15 695	19 869	21 362	98 876	22 964	48 298	128 708	164 208	159 092

Costs per aircraft-km

On analysing Table 25, in terms of cost of the service per aircraft-km, the most cost-effective aircraft to run on the route include the Boeing 737-200 and 737-400 and the Airbus A320-200.

Costs per passenger (assuming full capacity)

This gives which aircraft is the cheapest to run when it is full during the peak season. In this case the aircraft that will be the cheapest to run is the Airbus A320-200, followed by the Boeing 737-400 and 737-800.

Costs per passenger flying

The annual cost for passengers flying i.e. the cost to meet demand, is done cheapest in the Boeing 737-400 followed by the Boeing 737-200 and the Airbus A320-200.

Cost per available seat-km

This gives the cost for the service provided, regardless of passenger numbers. In this case, the most economical aircraft to provide a service (supply) along this route is the Boeing 737-400; the Airbus A320-200 and Boeing 737-800 are also viable options.

Costs per passenger- km

The utilised output which is a measure of the service provided, in terms of the average distance moved by the passengers gives the Boeing 737-400 as the one with the lowest running costs, while both the Boeing 737-200 and the Airbus A320-200 compete favorably.

Cost per hour utilised

This is a measure to show which aircraft costs less for the hours utilised. The most economic aircraft type includes the Boeing 737-200, then the Boeing 737-400 and the Airbus A320-200.

From the above indicators, it can then be seen that for any specific route depending on what the target of the airline service provider is, there is choice of what aircraft that can be used, without negotiation the quality of service provided. For this route in particular, the aircraft that can be chosen include: Boeing 737-400, Boeing 737-200, Airbus A320-200, and the Boeing 737-800 in no particular order of preference.

5.2.2 Service analysis

For the same route of sector distance 3 249km and 577 weekly passengers, the type of service being provided can be analysed. Various performance indicators shown in Table 26 are used to analyse transport services. These indicators are a measure of how the transport service can be run to minimise the operating costs, to a minimum. In terms of aircraft efficiency, service use intensity, work utilisation and aircraft fleet utilisation, the higher the indicator value, the more favorable the aircraft type used.

Table 26: Service performance indicators for the airline service

Service Performance Indicators	Boeing 737-200	Boeing 737-400	Airbus A320-200	Airbus A340 200	Boeing 737-800	Boeing 767-200	Boeing 747-200	Boeing 767-300ER	Boeing 747-400
Weekly aircraft efficiency (Aircraft-km/aircraft)	16 245	12 996	12 996	6 498	12 996	9 747	6 498	6 498	6 498
Weekly service use intensity (pass/aircraft-km)	0,0355	0,0444	0,0444	0,0888	0,0444	0,0592	0,0888	0,0888	0,0888
Weekly aircraft fleet utilisation (aircraft-hrs/aircraft/wk)	23,88	17,95	17,60	8,55	18,05	12,97	8,26	8,24	8,11
Work utilisation co-efficient (pass/seat)	0,89	0,86	0,80	0,98	0,76	0,75	0,99	0,99	0,72

Service efficiency indicators

For a given transport service, the following indicators are a measure of how efficiently different items in the service are being run. This can be used to identify components where interventions can reduce costs. These indicators are obtained as ratios of various measures of output to resources consumed. Analyses for efficiency indicators that can be applied to the model are defined below:

1. **Aircraft efficiency**
   This is defined as the measure of efficiency of how the aircraft in a fleet is being used. It's computed by dividing the total annual aircraft-km by the fleet size, the units given as aircraft-km/ aircraft/ year. This performance indicator will come into play for routes with high passenger volumes, which will need larger fleet sizes to meet the demand. Its unit is aircraft-km/aircraft/year. The higher the value is, the more efficiently the aircraft being used.

2. Service use intensity

This is defined as the amount by which the passenger demand utilises the transport service. It is the ratio of the annual passengers to the annual aircraft-km travelled units is passengers/ aircraft-km. A high ratio implies that the service is being used optimally. This service intensity can also be measured by use of the load factor, which is calculated by calculating the ratio of the passenger-km to the seat-km.

Service utilisation indicators

The utilisation indicators can be applied to different items in transport service operations, to give a measure of how efficiently the service providers utilise these specific items. Some of these items include; fleet, capacity, work and labour. The indicators elaborated on below will only include those that will be reflected by the model; namely

1. Aircraft fleet utilisation

This gives the ratio of the sum of the operating hours of all aircraft to fleet size. It is further defined, as the average percentage of hours when aircraft are in use during an operational day, where the operational day period, is not 24 hours but the maximum number of hours an aircraft can be in use. The units of this indicator in the model are aircraft-hours/ aircraft/week.

2. Work utilisation coefficient

The Boeing 747-200 and 767-300ER have a high load factor of 0.99 in Table 4 due to fewer flights resulting from larger capacity aircraft. On the other hand, these aircraft have very high utilisation costs per aircraft-km in Table 3 of US$164 and US$208 respectively. This implies therefore that the load factor needs to be taken into consideration after evaluating the operating costs of the aircraft. For example the Boeing 737-200 costs US$ 23 per aircraft-km and has a relatively high load factor of 0,89 in Table 4 and would have cheaper operating costs.

5.3 Effect of distance

The model also allows the user to vary the length of the route while keeping the passenger numbers constant. This worksheet can be used to calculate how increasing distance affects airline service costs for each aircraft type.

5.3.1 Route service operations

Since distance and block time are directly related, an increase in distance will increase the block time for each flight. The effect of the increasing distances on an airline service is summarised in Table 27.

It shows the service characteristics, for a weekly passenger demand of 1000 with varying distances for the Embraer Erj 135-Jet with passenger capacity of 37. It shows that as the distance increases so does the block time for each flight, lowering the number of flights each aircraft can fly per week. Consequently, the fleet capacity needed to meet demand; increases with increasing distance, and the values calculated are rounded up for purposes of stand-by fleet.

Table 27: Service variations with Distance

Distance (km)	Block time (hrs)	Maximum weekly trips per aircraft (Capacity)	Minimum weekly aircraft trips (Demand)	Fleet size (No)
200	0,59	35	28	1
400	0,83	28	28	1
600	1,07	21	28	2
800	1,31	21	28	2
1 000	1,55	21	28	2
1 200	1,79	14	28	2
1 400	2,03	14	28	2
1 600	2,27	14	28	2
1 800	2,51	14	28	2
2 000	2,75	7/14	28	2/4
2 200	2,99	7	28	4
2 400	3,23	7	28	4
2 600	3,47	7	28	4
2 800	3,71	7	28	4
3 000	3,95	7	28	4

Inferences from Table 27

- *Maximum weekly trips per aircraft are calculated according to block time and available aircraft utilisation. Under utilisation of an aircraft implies that, the minimum weekly aircraft trips to meet the passenger demand will be less than the maximum trips each plane can fly.*

- *The fleet size along the route is calculated and rounded up to meet passenger demand and is inclusive of 2% stand-by fleet but can refer to cost of leasing a aircraft for short periods.*
- *For a aircraft flying less than 200 km there is no need to refuel in between flights for an operational day*

5.3.2 Effect of frequency specifications

In order to be able to choose the aircraft that can fly most efficiently in terms of costs along a given route, the worksheet for varying distances can be used to calculate costs along given routes. The costs for each aircraft type are plotted for constant distance and passenger numbers. This mode of application comes in handy when an airline service has various aircraft types and needs to choose which type flies more efficiently over the route.

Table 28 shows the fleet size, weekly trips and total operating costs that will be needed to run the airline service along the route length of 3 249km with a weekly passenger demand of 577 passengers.

Table 28: Service changes with varying aircraft types

Manufacturer	Aircraft type	Seat capacity	Fleet size	Weekly return trips	Operating costs (US$)
Embraer	Erj 135-JET	37	1	16	177 855
Fokker	F 50	56	No	No	No
Boeing	737-200	130	1	5	334 570
Boeing	737-400	168	1	4	323 336
Airbus	A320-200	180	1	4	341 816
Airbus	A340 200	295	1	2	781 282
Boeing	737-800	189	1	4	377 037
Boeing	767-200	255	1	3	572 249
Boeing	747-200	291	1	2	978 685
Boeing	767-300ER	290	1	2	1 256 390
Boeing	747-400	401	1	2	1 192 674

From Table 28 the following can be deduced:

- Because of the maximum range limitations, the Fokker F50 is not well suited for this journey type; its maximum range is 1 300 km.
- The more frequently an aircraft flies, the higher the operating costs. But in case of the 37-seater the Embraer Erj 135-Jet that flies 8 times more than the Boeing 747-400, has operating costs, which are one eighth of the larger aircraft. This is the basic principle used by low-cost air carriers flying low capacity planes over short distances at high frequencies.
- For flight frequencies that airport slots, airlines or governments could dictate, the choice of cheapest aircrafts can still be done. For a specific frequency of 2 flights a week, the A340-200 would be the cheapest aircraft to use, while for a frequency of 4 flights a week, the Boeing 737-400 would fly at the cheapest cost.

5.4 Effect of passenger numbers

The number of passengers can also be varied in a separate cost model sheet and the effect is generally that increasing the number of passengers, especially for the same route results in an increase in fleet size and operating costs.

5.4.1 Aircraft choice

The worksheet was set up to vary passenger numbers and then calculates operating costs for the different aircraft, allowing for a choice of the most economic aircraft to use, for specific passenger numbers. It doesn't take into consideration the maximum ranges the aircraft can fly.

Figure 10, shows the operating costs for flying a route length of 3 000 km with weekly passenger demand of 1 000 passengers. For the Erj 135 JET, a 37- seater, it can be seen that the operating costs are low, because even though the flight frequencies are high so as to meet passenger demand, cost per passenger is the lowest. The question then becomes whether or not the aircraft can fly the given route and at what frequency. For this particular route, the aircraft most suited for this route include the Boeing 737-400, 737-200 and the Airbus A320-200.

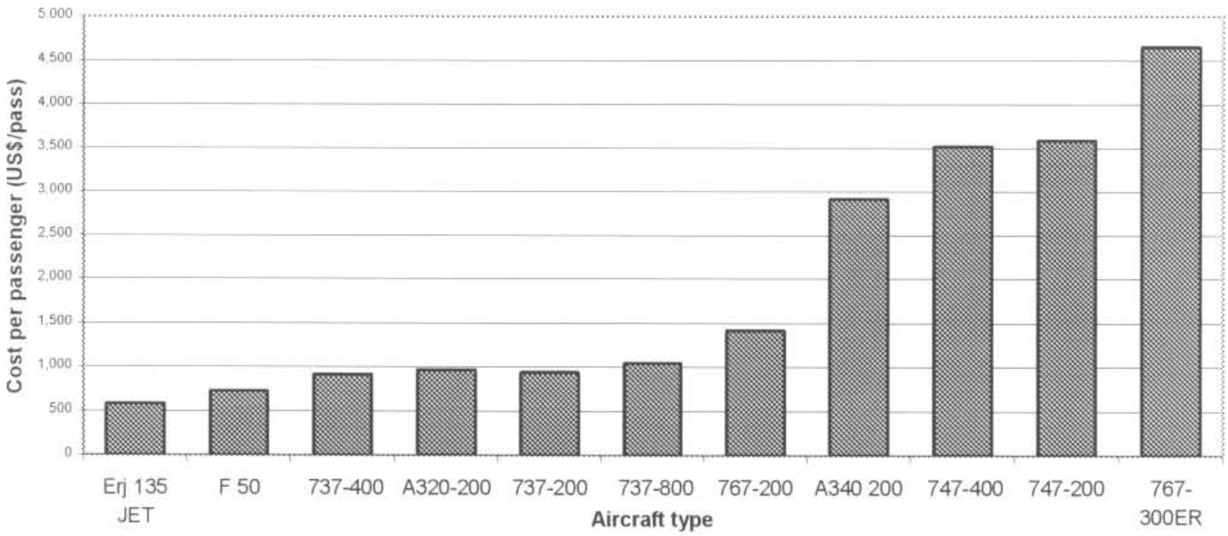

Figure 10 Operating cost per passenger for different aircraft types

5.4.2 Cost per passenger

Figure 11, shows that the cost per passenger for the different aircraft modes, decreases with increasing passenger demand. As verified in the literature review, the cost per passenger has a general trend of a decreasing exponential curve, as the passenger numbers increase. This is due to the fact that operating costs are incurred per passenger, so as passengers increase the operating cost reduces since it is spread over more people, who are paying for the service. The discontinuities in the curve are because of the cost of increasing fleet size, to meet demand.

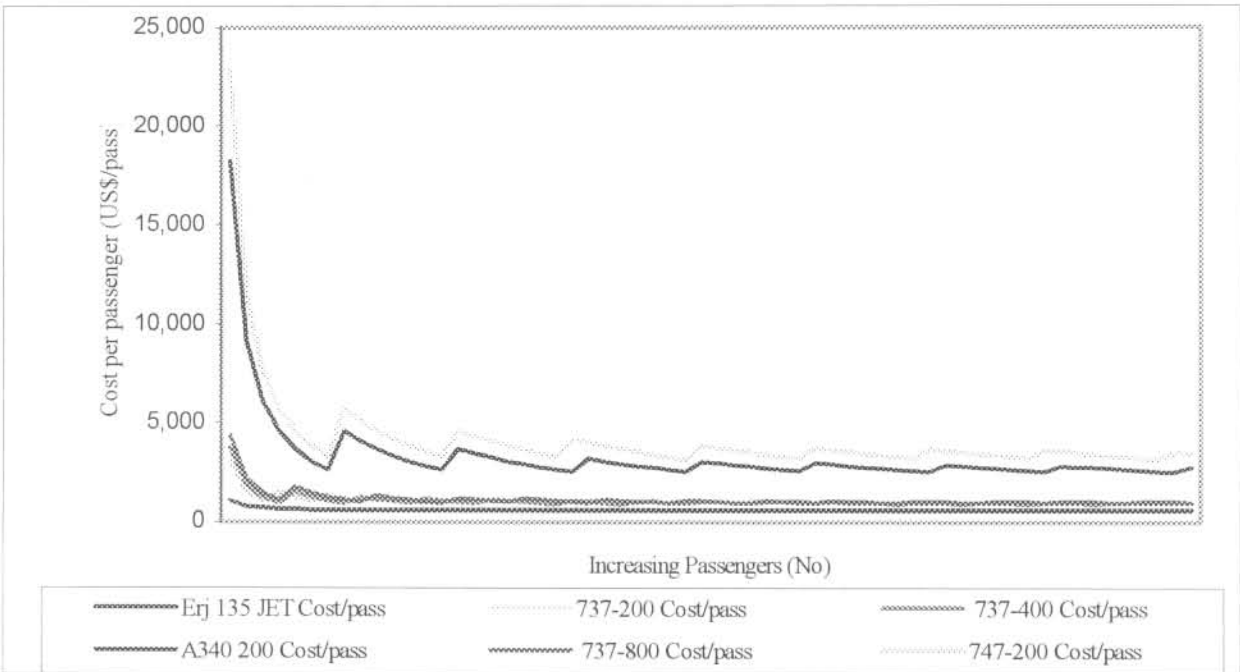

Figure 11: Operating costs per passenger for increasing passenger numbers