LIST OF REFERENCES

Abdinnour-Helm, S., Venkataramanan, A.M. 1992. Using Simulated Annealing to Solve ρ-Hub Location Problem. Working Paper No. 9304, IRMIS.

Abdinnour-Helm, S., Venkataramanan, A.M.. 1993. Solving the Hub Location Problem using Genetics Research. Working Paper No. 9304, IRMIS.

Abdinnour-Helm, S. 1998. A hybrid heuristic for the uncapacitated hub location problem. *European Journal of Operational Research*, Vol 106, pp 489-499.

Abdulaziz, A.K. 1994. Designing Air Transport Networks that Serve Sparse Demands. PhD thesis, University of British Columbia, Canada.

AFRAA. 2000. African Airlines Association: Traffic Highlights, www.afraa.net/docs/annualreportofthesecretarygeneral.doc accessed: 3/3/2003.

Airline Deregulation: Definition. 2004. Encyclopedia/Dictionary, http://encyclopedia.thefreedictionary.com/Airline deregulation accessed: 26/08/2004.

Airclaims CASE Database. 2000. Aircraft fleets in Africa: Who operates what? *African Aviation*, Vol 2.

Akpoghomeh, O. 1999. The Development of Air Transportation in Nigeria. Elsevier Science Ltd, Amsterdam.

Andersson, AE. 2001., Transportation in Sparely Populated Regions. Handbook of Transport Systems and Traffic Control. Chapter 18, Elsevier Science Ltd, Amsterdam.

ATA. 1963. Air Transport Association of America Inc: ATA Cost Method, http://adg.stanford.edu/aa241/cost/atamethod.html accessed: 21/11/02.

Aykin, T. 1990. On a quadratic integer program for the location of interacting hub facilities. *European Journal of Operational Research*, No 46, pp 409-411.

Aykin, T.. 1995. The hub location and routing problem: Theory and methodology. *European Journal of Operational Research*, No 83, pp 200-219.

Balfour, J. 2004. EC competition and airline alliances. *Journal of Air Transport Management*, No 10, pp 81 –85.

Barrett, S.D. 2004. How do demands for airport services differ between full-service carriers and low-cost carriers? *Journal of Transport Geography*, No 10, pp 33-39.

Barla, P. and Constantos, C. 2000. Airline network structure under demand uncertainty. *Transportation Research Part E: Logistics and Transportation Review*, Vol 36, No 3, pp 173-180.

Boland, N., Krishnamoorthy, M., Ernst, A.T. and Ebery, J. 2004. Preprocessing and cutting for multiple allocation hub location problems. *European Journal of Operational Research*, Vol 155, Issue 3, pp 638-653.

Bowen, J. 2000. Airline hubs in Southeast Asia: National economic development and nodal accessibility. *Journal of Transport Geography*, No 8, pp 25-41.

Bryan, D.L. and O'Kelly, E.M. 1999. H&S networks in air transportation: An analytical review. *Journal of Regional Science*, Vol 39, No 2, pp 275-295.

Button, K., Lall, S., Stough, R. and Trice M. 1999. High technology employment and hub airports. *Journal of Air Transport Management*, No 5, pp 53 –59.

Button, K., Lall, S., Stough, R. and Trice M. 2002. Debunking some common myths about airport hubs. *Journal of Air Transport Management*, Vol 8, pp 177-188.

Button, K., Lall, S., Stough, R. and Trice M. 2006. The Effects of Air Transportation on Economic Development: The Potential Impacts on the Europe Economy of Further Liberalization of the Transatlantic Air Market. Paper presented at the National Conference on Transportation and Economic Development, 29 to 30 March 2006.

Campbell, J.F. 1994a. A survey of network hub location. *Studies in Locational Analysis* Vol 6, pp 31-49.

Campbell, J.F. 1994b. Integer programming formulations of discrete hub location problems. *European Journal of Operational Research* Vol 72, pp 387-405.

Campbell, J.F. 1996. Hub location and the ρ-hub median problem. *Operations Research*, Vol 44, pp 923-935.

Chingosho, E. 2005. *African Airlines in the Era of Liberalization; Surviving the Competitive Jungle.* E-Book, ISBN 9966-05-011-6.

CMISRO (Center for Mathematical and Information Sciences). 2003. Operations Research – Hub Location Report. Australia, http://www.cmis.csiro.au/or/hubLocation/ accessed: 3/02/04.

Doganis, R. 1989. *The Economics of International Airlines.* 4th edition, Routledge, London.

Doganis, R. 2001. *The Airline Industry in the 21st Century*, 1st ed., Routledge, London.

Dolan, M. 2003. Aviation in transition: Challenges and liberalisation. Paper presented at the 5th Worldwide Air Transport Conference, 22-23rd March 2002.

Ebery, J., Krishnamoorthy, M., Ernst, A. and Boland, N. 1998. The capacitated multiple allocation hub location problem: Formulation and algorithms. CSIRO, Australia, Division of Mathematics and Statistics.

Edwards, A. 2004. Lecture notes on the international legal framework for aviation regulation. Purdue University http://www.tech.purdue.edu/at/courses/at300/coursematerials/unitdocuments/bilateralvsmultilateralagreements.htm accessed: 6/09/2004.

ECA (United Nations Economic Commission for Africa) 2003. Report on the implementation of the Yamoussoukro Declaration: Meeting of the Committee on Regional Integration, Addis Ababa, Ethiopia, October 2003, http://www.uneca.org/itca/yamoussoukro/Yamoussoukro%20Decision-Engl.doc accessed: 14/09/04.

ECA. 1994. Progress Report on the implementation of the Yamoussoukro Declaration on a New African air transport policy, Mauritius 1994, http://www.uneca.org/itca/yamoussoukro/Progress%20Report%20On%20The%20Implementation%20Of%20The%20YAMOUSSOUKRO%20Declaration%20On%20a%20New%20African%20Air%20Transport%20Policy.htm accessed: 12/03/04 09.

Ernst, A. and Krishnamoorthy, M. 1996. Efficient algorithms for the uncapacitated single allocation ρ-hub median problem. *Location Science*, No 4, pp 135-154.

Ernst, A. and Krishnamoorthy, M. 1998. Exact and heuristic algorithms for the uncapacitated multiple allocation ρ-hub median problem. *European Journal of Operational Research*, Vol 104, pp 100-112.

Flight Safety Foundation. 2005. Airport operations: Commercial air navigation services aim to combine operational efficiency with safety. *Journal of the Flight Safety Foundation*, Vol 31, No 6, November-December.

Hanlon P. 1999. *Global Airlines. Competition in a Trans-national Industry*. 2nd edition, Butterworth-Heinemann, Oxford, England.

Hensher, D.A. 2002. Determining passenger potential for a regional airline hub at Canberra International airport. *Journal of Air Transport Management*, No 8, pp 301-311.

Jaillet, P., Song, G. and Yu, D. 1996. Airline network design and hub location problems. *Location Science*, Vol 4, No 3, pp 195-212.

Jackson, P. 1997. *Janes' All the World's Aircraft 1996-1997.* Janes' Information Group, UK.

Jenkinson, L., Simpkin, P. and Rhodes D. 2001. *Civil Jet Aircraft Design.* Butterworth-Heinemann, Oxford, England.

Kane, R.M. 1996. *Air Transportation.* 12th edition, Kendall/Hunt Publishing Company, Iowa, USA.

Klincewicz, J.G. 1991. Heuristics for the p-hub location problem. *European Journal of Operational Research*, Vol 53, pp 25-37.

Klincewicz, J.G. 1992. Avoiding local optima in the ρ-hub location problem using Tabu-search and Grasp. *Annals of Operations Research*, Vol 40, pp 283-302.

Klincewicz, J.G. 1996. A dual algorithm for the uncapacitated hub location problem. *Location Science*, Vol 4, pp 173-184.

Kulula Airlines. 2003. Flight schedule: Johannesburg-Cape Town route, www.kulula.com/cgi-bin/kulula/I8/171015 accessed: 19/04/03.

Levine, M. 1987. Airline competition in deregulated markets: Theory, firm strategy and public policy. *Yale Journal of Regulations*, No 8, pp 393-494.

Mandel, B. and Schnell, O. 2001. An 'Open Sky' scenario for Hamburg airport and Germany. *Journal of Air Transport Management*, No 7, pp 9-24.

Marianova, V. and Serra, D. 2003. Location models for airline hubs behaving as M=D=c queues. *Computers & Operations Research*, No 30, pp 983-1003.

McShan, S. and Windle, R. 1989. The implications of hub-and–spoke routing for airline costs and competitiveness. *The Logistics and Transportation Review* Vol 25, pp 205-230.

Morrell, P. and Lu, C., 2007, The environmental cost implication of hub-hub versus hub by-pass flight networks, *Transportation Research Part D*, Vol 12, pp143-157.

Morrison, J.T. 2004. The current state of the airline industry in Southern Africa. Paper presented at the 23rd Annual Southern African Transport Conference 12–15 July 2004.

NDoT (National Department of Transport, South Africa). 1998. Airports Amendment Act, Act No 2 of 1998.

Nero, G. 1999. A note on the competitive advantage of large hub-and-spoke networks. *Transportation Research Part E*, Vol 35, pp 225-239.

O'Kelly, M.E. 1987. A quadratic integer program for the location of interacting hub facilities. *European Journal of Operational Research* Vol 32, pp 393-404.

O'Kelly, M.E. 1992. Hub facility location with fixed costs. *Papers in Regional Science: The Journal of the Regional Science Association International*, Vol 71, pp 293-306.

O'Kelly, M., Morton, E., Skorin-Kapov, D. and Skorin-Kapov, J. 1995. Lower bounds for the hub location problem. *Management Science* Vol 41, pp 713-721.

O'Kelly, M., Morton, E., Bryan, D., Skorin-Kapov, D. and Skorin-Kapov, J. 1996. Hub network design with single and multiple allocation: A computational study. *Location Science* Vol 4, pp 125-138.

O'Kelly, M.E. and Bryan, D. 1998. Hub location with flow economies of scale. *Transportation Research Part B*, Vol 32, No. 8, pp 605-616.

Ortúzar, J.D. and Willumsen, L.G. 1994. *Modelling Transport.* 2nd edition, Wiley, UK.

Oum T., Yu, C. and Zhang A. 2001. Global airline alliances: International regulatory issues. *Journal of Air Transport Management*, No 7, pp 57-62.

Peeters, P., Rietveld, P., Schipper, Y., 2001. Environmental Impact of hub and spoke networks in European aviation. http://www.flygforsk.lu.se/files/Environmental_impacts.pdf accessed 11/08/2004.

Pyramid Media Group. 2003. Commercial airline prices. www.pyramid.ch/aircr_prices.htm accessed: 10/4/2003.

Rolls–Royce. 2003. Civil aerospace turbofan range. www.rolls-royce.com/civil/products/turbofans/Default.htm accessed: 4/24/03.

Schnell, M.C.A. and Huschelrath, K. 2004. Existing and new evidence on the effects of airline hubs. *International Journal of Transport Economics*, Vol XXXI, No 1, pp 99-121.

Schlumberger, C.E. 2004. Implementation of the Yamoussoukro Decision on Liberalisation of Access to Air Transport Markets in West and Central Africa. Business briefing: Aviation strategies: Challenges and opportunities of liberalisation. http://www.bbriefings.com/pdf/12/avia031_r_schlumberger.pdf accessed: 12/09/04.

Skorin-Kapov, D. and Skorin-Kapov, J. 1994. On Tabu search for the location of interacting hub facilities, *European Journal of Operational Research*, Vol 73, pp 502-509.

Skorin-Kapov, D., Skorin-Kapov, J. and O'Kelly, M. 1996. Tight linear programming relaxations of uncapacitated ρ-hub median problems. *European Journal of Operational Research*, Vol 94 pp 582-593.

Smith, K., Krishnamoorthy, M. & Palaniswami, M. 1996. On the location of interacting hub facilities: Neural versus traditional approaches. *Location Science*, No 4, pp 167-183.

Ssamula, B. 2004. Developing a cost model for running an airline service. MEng Dissertation, University of Pretoria, South Africa.

Ssamula, B. 2006. Analysing aircraft selection for route operating cost for short-haul routes. *Journal of the South African Institute for Civil Engineers (SAICE)*, Vol 48, No 2.

Stratford, A.H. 1973. *Air Transport Economics in the Supersonic Era.* 2nd edition, Martins Press, Macmillan, London.

Taneja, N.K. 1978. *Airline Traffic Forecasting: A Regression Analysis Approach.* Lexington Books, Massachusetts, USA.

Topcuoglu, H., Corut, F., Ermis, M. and Yilmaz, G. 2005. Solving the uncapacitated hub location problem using genetic algorithms. *Computers & Operations Research*, Vol 32, Issue 4, pp 967-984.

Turbo Jet Technologies. 2003. Turbine Guide: Chapter 6. http://www.tjt.bz/pdf/turbine_maint.pdf accessed 4/11/2003.

Wojahn, W.O. 2001. Airline structure and the gravity model. *Transportation Research Part E*, No 37, pp 267-279

Wolf, H. 2001. Network effects of bilaterals: Implications for the German air transport policy. *Journal of Air Transport Management*, No 7, pp 63-74.

World Bank. 2003. World Bank Development Indicators: 2002, Data Query. http://devdata.worldbank.org/data-query accessed: 3/6/03.

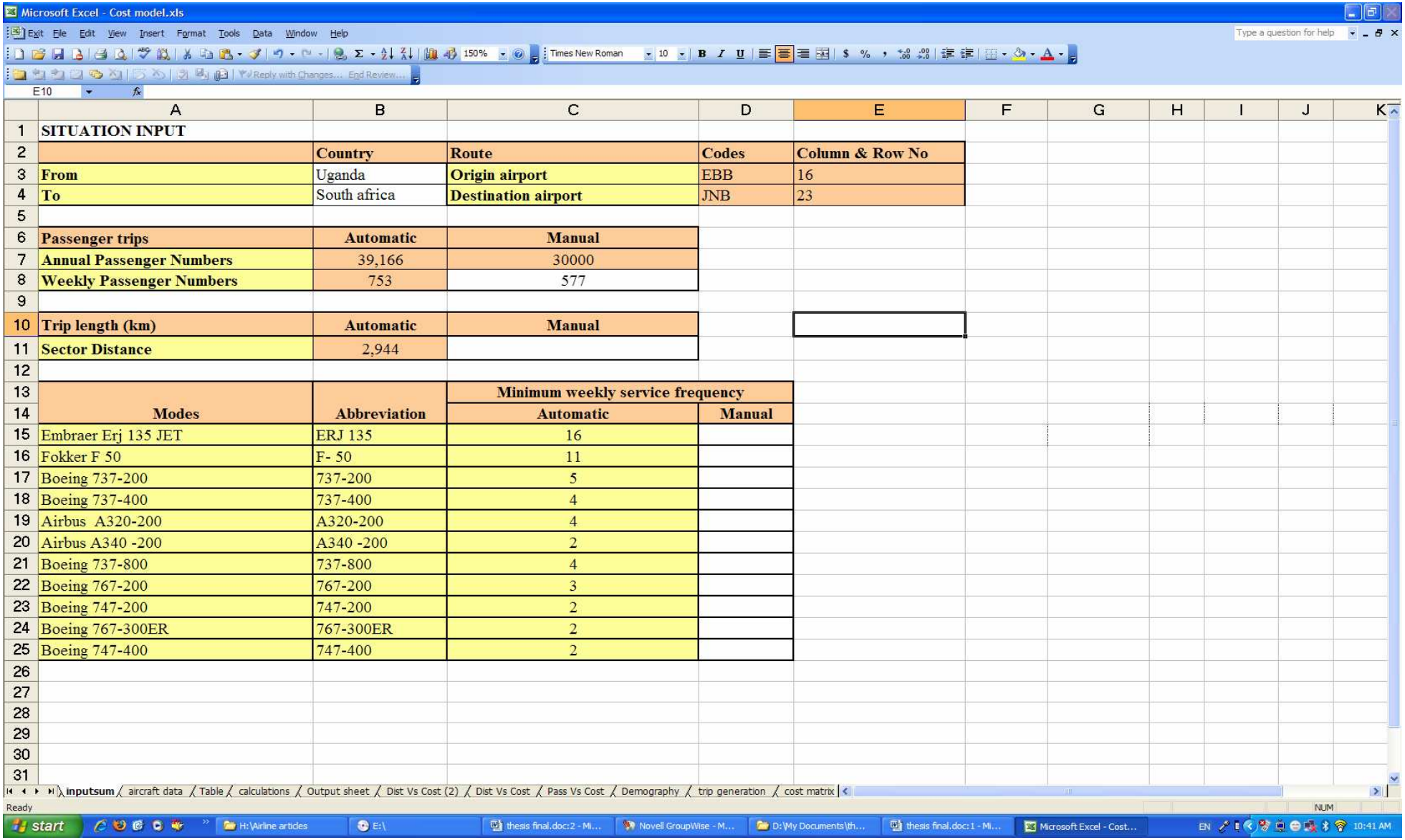
Zollinger, H.P. 1995. Open Forum: Can hubbing dent the bottom line? *Journal of Air Transport Management*, Vol 2, No 1, pp 55-57.

APPENDICES

Appendix I: Demographical details of all African countries.

	COUNTRY	CAPITAL	INT'L AIRPORTS	CODE
1	Algeria	Algiers	Algiers	ALG
2	Angola	Luanda	Luanda	LAD
3	Benin	Porto Novo	Porto Novo(Cotonou)	COO
4	Botswana	Gaborone	Gaborone	GBE
5	Burkina Faso	Ouagadougou	Ouagadougou	OUA
6	Burundi	Bujumbura	Bujumbura	BJM
7	Cameroon	Yaounde	Nsimalen International	NSI
8	Cape Verde Islands	Prata	Amil Cabral Int'l Airport	SID
9	Central African Republic	Bangui	Bangui (M'poko)	BGF
10	Chad	N'Djameni	N'Djameni	NDJ
11	Comoros	Comoros	Comoros International airport	COM
12	Congo Dem. Rep	Kinshasa	Kinshasa(Ndjili)	FIH
13	Congo. Rep.	Brazaville	Brazaville(MayaMaya)	BZV
14	Cote D'Ivoire	Abidjan	Abidjan (Port Bouet)	ABJ
15	Djibouti	Djibouti	Djibouti- Ambouli	JIB
16	Egypt	Cairo	Cairo	CAI
17	Equatorial Guinea	Malabo	Malabo Airport	SSG
18	Eritrea	Asmara	Asmara(Yohannes IV)	ASM
19	Ethiopia	Addis Ababa	Addis Ababa	ADD
20	Gabon	Libreville	Libereville	LBV
21	Gambia, The	Banjul	Banjul	BJL
22	Ghana	Accra	Accra	ACC
23	Guinea	Conakry	Conakry-Gbeissa	CKY
24	Guinea Bissau	Bissau	Bissau - Osvaldo	BXO
25	kenya	nairobi	Nairobi	NBO
26	Lesotho	Maseru	Maseru- Moshoeshoe	MSU
27	Liberia	Monrovia	Roberts Int'l	ROB
28	Libya	tripoli	Tripoli(Idris)	TIP
29	Madagascar	Antananarivo	Antananarivo(Ivato)	TNR
30	Malawi	Lilongwe	Lilongwe-senou	LLW
31	Mali	Bamako	Bamako	BKO
32	Mauritania	Nouakchott	Nouakchott	NKC
33	Mauritius	Mauritius	Mauritius	MRU
34	Morocco	Rabat	Fes Saiss Int'l airport	FEZ
35	Mozambique	maputo	Maputo	MPM
36	Namibia	Windhoek	Windhoek(eros)	WDH
37	Niger	Niamey	Niamey	NIM
38	Nigeria	Abuja	Kanu-Mallam Amim	KAN
39	Rwanda	Kigali	Kigali	KGL
40	Sao Tome & principe	Sao Tome	Sao Tome	TMS
41	Senegal	Dakar	Dakar	DKR
42	Sierra Leone	Freetown	Freetown(lungi Airport)	FNA
43	Somalia	Mogadishu	Mogadishu	MGQ
44	South Africa	Pretoria	Johannesburg	JNB
45	Sudan	Khartoum	Khartoum	KRT
46	Tanzania	Dar es salaam	Dar es salaam	DAR
47	Togo	Lome	Lome- Tokoin	LFW
48	Tunisia	Tunis	Tunis(Carthage Airport)	TOE
49	Uganda	Kampala	Entebbe	EBB
50	Zambia	Lusaka	Lusaka	LUN
51	Zimbabwe	Harare	Harare	HRE

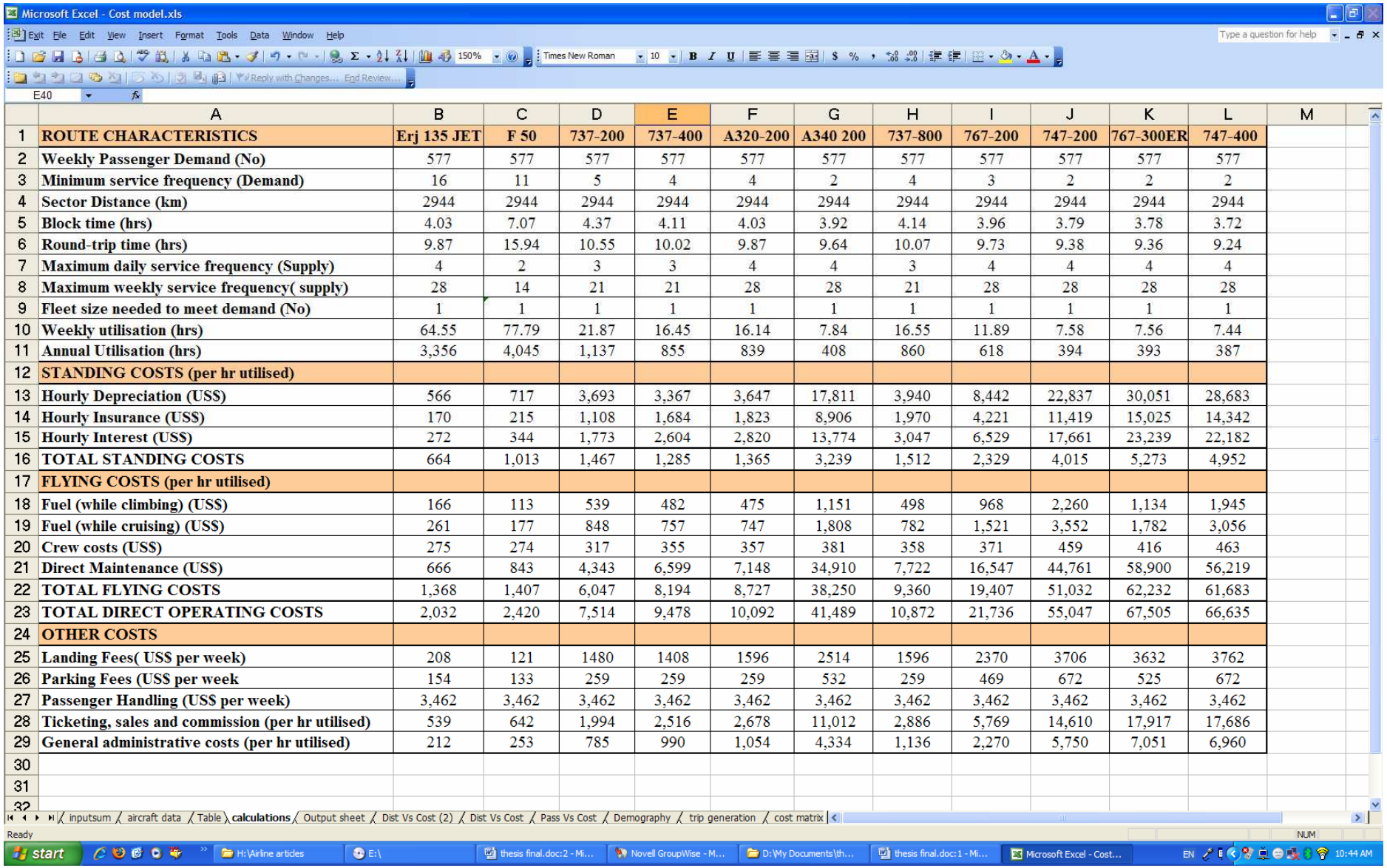
Appendix II: Input Sheet for a 2944km route with weekly passenger demand of 577 (Route Cost Model)



Microsoft Excel - Cost model.xls

	A	B	C	D	E
1	**SITUATION INPUT**				
2		**Country**	**Route**	**Codes**	**Column & Row No**
3	**From**	Uganda	**Origin airport**	EBB	16
4	**To**	South africa	**Destination airport**	JNB	23
5					
6	**Passenger trips**	**Automatic**	**Manual**		
7	**Annual Passenger Numbers**	39,166	30000		
8	**Weekly Passenger Numbers**	753	577		
9					
10	**Trip length (km)**	**Automatic**	**Manual**		
11	**Sector Distance**	2,944			
12					
13			**Minimum weekly service frequency**		
14	**Modes**	**Abbreviation**	**Automatic**	**Manual**	
15	Embraer Erj 135 JET	ERJ 135	16		
16	Fokker F 50	F- 50	11		
17	Boeing 737-200	737-200	5		
18	Boeing 737-400	737-400	4		
19	Airbus A320-200	A320-200	4		
20	Airbus A340 -200	A340 -200	2		
21	Boeing 737-800	737-800	4		
22	Boeing 767-200	767-200	3		
23	Boeing 747-200	747-200	2		
24	Boeing 767-300ER	767-300ER	2		
25	Boeing 747-400	747-400	2		
26					
27					
28					
29					
30					
31					

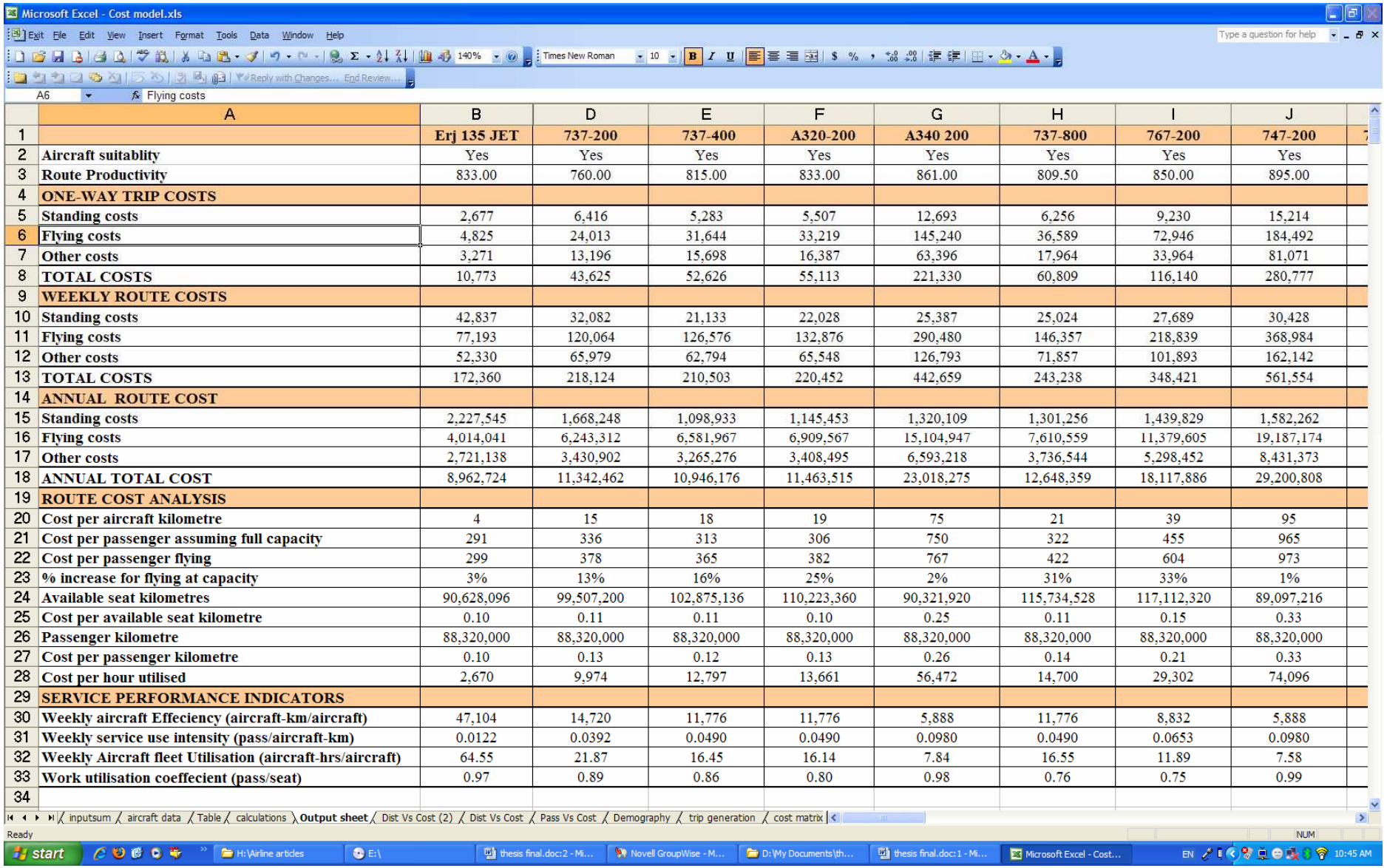
Appendix III: Calculation Sheet for a 2944km route with weekly passenger demand of 577 (Route Cost Model)



Microsoft Excel - Cost model.xls

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	ROUTE CHARACTERISTICS	Erj 135 JET	F 50	737-200	737-400	A320-200	A340 200	737-800	767-200	747-200	767-300ER	747-400	
2	Weekly Passenger Demand (No)	577	577	577	577	577	577	577	577	577	577	577	
3	Minimum service frequency (Demand)	16	11	5	4	4	2	4	3	2	2	2	
4	Sector Distance (km)	2944	2944	2944	2944	2944	2944	2944	2944	2944	2944	2944	
5	Block time (hrs)	4.03	7.07	4.37	4.11	4.03	3.92	4.14	3.96	3.79	3.78	3.72	
6	Round-trip time (hrs)	9.87	15.94	10.55	10.02	9.87	9.64	10.07	9.73	9.38	9.36	9.24	
7	Maximum daily service frequency (Supply)	4	2	3	3	4	4	3	4	4	4	4	
8	Maximum weekly service frequency(supply)	28	14	21	21	28	28	21	28	28	28	28	
9	Fleet size needed to meet demand (No)	1	1	1	1	1	1	1	1	1	1	1	
10	Weekly utilisation (hrs)	64.55	77.79	21.87	16.45	16.14	7.84	16.55	11.89	7.58	7.56	7.44	
11	Annual Utilisation (hrs)	3,356	4,045	1,137	855	839	408	860	618	394	393	387	
12	STANDING COSTS (per hr utilised)												
13	Hourly Depreciation (US$)	566	717	3,693	3,367	3,647	17,811	3,940	8,442	22,837	30,051	28,683	
14	Hourly Insurance (US$)	170	215	1,108	1,684	1,823	8,906	1,970	4,221	11,419	15,025	14,342	
15	Hourly Interest (US$)	272	344	1,773	2,604	2,820	13,774	3,047	6,529	17,661	23,239	22,182	
16	TOTAL STANDING COSTS	664	1,013	1,467	1,285	1,365	3,239	1,512	2,329	4,015	5,273	4,952	
17	FLYING COSTS (per hr utilised)												
18	Fuel (while climbing) (US$)	166	113	539	482	475	1,151	498	968	2,260	1,134	1,945	
19	Fuel (while cruising) (US$)	261	177	848	757	747	1,808	782	1,521	3,552	1,782	3,056	
20	Crew costs (US$)	275	274	317	355	357	381	358	371	459	416	463	
21	Direct Maintenance (US$)	666	843	4,343	6,599	7,148	34,910	7,722	16,547	44,761	58,900	56,219	
22	TOTAL FLYING COSTS	1,368	1,407	6,047	8,194	8,727	38,250	9,360	19,407	51,032	62,232	61,683	
23	TOTAL DIRECT OPERATING COSTS	2,032	2,420	7,514	9,478	10,092	41,489	10,872	21,736	55,047	67,505	66,635	
24	OTHER COSTS												
25	Landing Fees(US$ per week)	208	121	1480	1408	1596	2514	1596	2370	3706	3632	3762	
26	Parking Fees (US$ per week	154	133	259	259	259	532	259	469	672	525	672	
27	Passenger Handling (US$ per week)	3,462	3,462	3,462	3,462	3,462	3,462	3,462	3,462	3,462	3,462	3,462	
28	Ticketing, sales and commission (per hr utilised)	539	642	1,994	2,516	2,678	11,012	2,886	5,769	14,610	17,917	17,686	
29	General administrative costs (per hr utilised)	212	253	785	990	1,054	4,334	1,136	2,270	5,750	7,051	6,960	
30													
31													
32													

Appendix IV: Output Sheet for a 2944km route with weekly passenger demand of 577 (Route Cost Model)



	A	B	D	E	F	G	H	I	J
1		Erj 135 JET	737-200	737-400	A320-200	A340 200	737-800	767-200	747-200
2	Aircraft suitablity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3	Route Productivity	833.00	760.00	815.00	833.00	861.00	809.50	850.00	895.00
4	ONE-WAY TRIP COSTS								
5	Standing costs	2,677	6,416	5,283	5,507	12,693	6,256	9,230	15,214
6	Flying costs	4,825	24,013	31,644	33,219	145,240	36,589	72,946	184,492
7	Other costs	3,271	13,196	15,698	16,387	63,396	17,964	33,964	81,071
8	TOTAL COSTS	10,773	43,625	52,626	55,113	221,330	60,809	116,140	280,777
9	WEEKLY ROUTE COSTS								
10	Standing costs	42,837	32,082	21,133	22,028	25,387	25,024	27,689	30,428
11	Flying costs	77,193	120,064	126,576	132,876	290,480	146,357	218,839	368,984
12	Other costs	52,330	65,979	62,794	65,548	126,793	71,857	101,893	162,142
13	TOTAL COSTS	172,360	218,124	210,503	220,452	442,659	243,238	348,421	561,554
14	ANNUAL ROUTE COST								
15	Standing costs	2,227,545	1,668,248	1,098,933	1,145,453	1,320,109	1,301,256	1,439,829	1,582,262
16	Flying costs	4,014,041	6,243,312	6,581,967	6,909,567	15,104,947	7,610,559	11,379,605	19,187,174
17	Other costs	2,721,138	3,430,902	3,265,276	3,408,495	6,593,218	3,736,544	5,298,452	8,431,373
18	ANNUAL TOTAL COST	8,962,724	11,342,462	10,946,176	11,463,515	23,018,275	12,648,359	18,117,886	29,200,808
19	ROUTE COST ANALYSIS								
20	Cost per aircraft kilometre	4	15	18	19	75	21	39	95
21	Cost per passenger assuming full capacity	291	336	313	306	750	322	455	965
22	Cost per passenger flying	299	378	365	382	767	422	604	973
23	% increase for flying at capacity	3%	13%	16%	25%	2%	31%	33%	1%
24	Available seat kilometres	90,628,096	99,507,200	102,875,136	110,223,360	90,321,920	115,734,528	117,112,320	89,097,216
25	Cost per available seat kilometre	0.10	0.11	0.11	0.10	0.25	0.11	0.15	0.33
26	Passenger kilometre	88,320,000	88,320,000	88,320,000	88,320,000	88,320,000	88,320,000	88,320,000	88,320,000
27	Cost per passenger kilometre	0.10	0.13	0.12	0.13	0.26	0.14	0.21	0.33
28	Cost per hour utilised	2,670	9,974	12,797	13,661	56,472	14,700	29,302	74,096
29	SERVICE PERFORMANCE INDICATORS								
30	Weekly aircraft Effeciency (aircraft-km/aircraft)	47,104	14,720	11,776	11,776	5,888	11,776	8,832	5,888
31	Weekly service use intensity (pass/aircraft-km)	0.0122	0.0392	0.0490	0.0490	0.0980	0.0490	0.0653	0.0980
32	Weekly Aircraft fleet Utilisation (aircraft-hrs/aircraft)	64.55	21.87	16.45	16.14	7.84	16.55	11.89	7.58
33	Work utilisation coeffecient (pass/seat)	0.97	0.89	0.86	0.80	0.98	0.76	0.75	0.99
34									

Appendix: V: Node-Hub Calculation Sheet for the 5 mid-point cluster network (Network Cost Model)

Microsoft Excel - midpoint network2.xls

Exit File Edit View Insert Format Tools Data Window Help

F10 =E10*D10

	A	B	D	E	F	G	H	I
1	Code	Cluster	Pass No	Cost per pass (US	Total costs(US	Travel time (hr	Pass travel time (pass-hr)	
2	ABJ	WEST	204,026	71	14,485,846	0.71	144,858	
3	ACC	WEST	177,022	83	14,692,826	1.02	179,677	
4	ADD	EAST	843,027	34	28,662,918	0.77	645,969	
5	ALG	NORTH	1,329,028	33	43,857,924	1.04	1,377,205	
6	ASM	EAST	93,592	134	12,541,328	1.58	148,226	
7	BGF	CENTRAL	84,024	108	9,074,592	0.96	80,453	
8	BJL	WEST	76,643	136	10,423,448	1.51	115,444	
9	BJM	EAST	93,653	130	12,174,890	1.41	132,285	
10	BKO	WEST	114,026	76	8,665,976	0.44	50,457	
11	BZV	CENTRAL	156,022	83	12,949,826	0.79	123,842	
12	CAI	NORTH	1,242,026	59	73,279,534	3.54	4,393,667	
13	CKY	WEST	209,364	75	15,702,300	1.02	213,813	
14	COO	WEST	72,027	129	9,291,483	1.27	91,564	
15	DAR	EAST	135,026	108	14,582,808	1.56	210,472	
16	DKR	WEST	195,022	92	17,942,024	1.68	327,393	
27	KRT	EAST	228,025	87	19,838,175	1.70	386,502	
28	LAD	CENTRAL	132,024	106	13,994,544	1.35	177,902	
29	LBV	CENTRAL	225,026	58	13,051,508	0.45	100,980	
30	LFW	WEST	177,023	86	15,223,978	1.14	202,027	
31	LLW	SOUTH	141,023	99	13,961,277	1.21	170,814	
32	LUN	SOUTH	147,024	94	13,820,256	1.16	170,548	
33	MGQ	EAST	53,695	142	7,624,690	1.27	67,924	
34	MPM	SOUTH	219,023	61	13,360,403	0.48	105,952	
35	MRU	SOUTH	384,022	83	31,873,826	3.20	1,229,350	
36	MSU	SOUTH	99,684	118	11,762,712	1.19	118,126	
37	NBO	EAST	741,025	37	27,417,925	0.74	549,285	
38	NDJ	CENTRAL	65,519	149	9,762,331	1.61	105,240	
39	NIM	WEST	99,674	120	11,960,880	1.24	123,596	
40	NKC	NORTH	66,022	195	12,874,290	2.76	182,138	
41	NSI	CENTRAL	141,029	70	9,872,030	0.43	60,466	
42	OUA	WEST	93,594	94	8,797,836	0.72	67,505	
43	OXB	WEST	65,513	137	8,975,281	1.33	86,805	
44	ROB	WEST	84,264	99	8,342,136	0.77	64,673	
45	SID	NORTH	261,025	98	25,580,450	3.63	946,216	
46	SSG	CENTRAL	155,187	78	12,104,586	0.68	105,333	
47	TIP	NORTH	177,025	91	16,109,275	1.41	248,720	
48	TMS	CENTRAL	30,026	169	5,074,394	0.82	24,734	
49	TNR	SOUTH	636,024	53	33,709,272	1.95	1,238,657	
50	TUN	NORTH	582,023	50	29,101,150	1.42	825,018	
51	WDH	SOUTH	153,023	110	16,832,530	1.99	305,090	
52	Total				977,704,093		26,020,100	

Xik,Cik,O+D | element I | Hub-Hub cost calculations | Node-Hub calculations | Xjl | Ckl | Wij | element II | total cost

Ready Circular

start H:\Airline articles E:\ thesis final.doc:2 -... Novell GroupWise ...

Appendix: VI: Hub-Hub Calculation Sheet for the 5 mid-point cluster network (Network Cost Model)

Microsoft Excel - midpoint network2.xls

Exit File Edit View Insert Format Tools Data Window Help

H9

Passenger numbers

	North	South	East	West	Central	
North	1,755,442	1,553,632	688,483	629,050	359,623	
South	1,553,622	2,130,776	1,105,830	630,557	510,898	
East	688,739	1,106,371	359,403	219,678	174,846	
West	628,739	630,207	220,462	249,645	151,237	
Central	359,630	510,909	174,779	151,319	92,250	
	4,986,172	**5,931,895**	**2,548,957**	**1,880,249**	**1,288,854**	**16,636,127**

Distance matrix (km)

	North	South	East	West	Central
North	0	6,452	4,651	2,337	3,343
South	6,452	0	2,967	5,400	3,442
East	4,651	2,967	0	4,767	2,664
West	2,337	5,400	4,767	0	2,321
Central	3,343	3,442	2,664	2,321	0

Cost per passenger(US$)

		1	2	3	4	5
		North	South	East	West	Central
1	North	0	113	79	52	73
2	South	113	0	55	90	68
3	East	79	55	0	108	86
4	West	52	90	108	0	84
5	Central	73	68	86	84	0

Time(hr)

	North	South	East	West	Central
North	0.00	8.07	5.81	2.92	4.18
South	8.07	0.00	3.71	6.75	4.30
East	5.81	3.71	0.00	5.96	3.33
West	2.92	6.75	5.96	0.00	2.90
Central	4.18	4.30	3.33	2.90	0.00

Total H-H costs(US$)

	North	South	East	West	Central	
North	0	175,560,416	54,390,157	32,710,600	26,252,479	
South	175,559,286	0	60,820,650	56,750,130	34,741,064	
East	54,410,381	60,850,405	0	23,725,224	15,036,756	
West	32,694,428	56,718,630	23,809,896	0	12,703,908	
Central	26,252,990	34,741,812	15,030,994	12,710,796	0	
Total	**288,917,085**	**327,871,263**	**154,051,697**	**125,896,750**	**88,734,207**	**985,471,002**

Passenger travel time expenditure (Pass-hr)

	North	South	East	West	Central	Total
North	0	**12529961**	4,004,156	1,836,704	1,502,804	19,873,625
South	12530042	**0**	4,103,253	4,253,897	2,198,186	23,085,379
East	4002668	**4101247**	0	1,313,678	582,014	9,999,607
West	1837612.3	**4256259.8**	1,309,006	0	439,014	7,841,893
Central	1502774.6	**2198138.6**	582,237	438,776	0	4,721,927
						65522430.6