The Effect of Hierarchical Change of the Regional Airport Systems to the Number of Passenger. A Case Study North Borneo Province, Indonesia

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Abstract: The objective of the study was to investigate the effect of hierarchical change of the regional airport system in North Borneo to the number of passengers. In 2020, the Government will change the operational systems of the airports in the area. This change needs to be anticipated particularly its effect to the number of passengers. To achieve the objective passenger and airfare data from previous years were secured. To predict the number of passnegers in 2020 a transportation modeling using Furness methods were employed. The results showed that overall hierarchical change may lower the airfare thus increase the number of passengers. There will be about 19.95% increase in passengers due to the operational change system.

Keywords: Airport Hierarchy, hub-spoke airport, airfare and passenger, air transport modeling

1. INTRODUCTION

North Kalimantan Province is one of the outermost Indonesian province. It consists of 4 Districts (Malinau, Nunukan, Bulungan, and Tana Tidung) and 1 municipality (City of Tarakan), in which each district has its own airports, except for Tana Tidung. The four airports are operated in a hub-spoke pattern. In this system, one bigger airport serves as hub while other smaller ones serve as the spokes (Bae, 2010). The Government of Indonesia has managed to apply the hub and spoke system for most of airports operating in Indonesia. As in the case of North Borneo regional airport system, Juwata Airport in Tarakan acts as the hub and the others as spokes. One of the disadvantages of this system is that passengers would have longer travel time since they have to transit, which may end up in higher travel cost (Bae, 2010).

Aviation network usually operates in several forms: line network, grid network pattern, hub-spoke network, and point-to-point (Haryanto et.al, 2014). Hub-and-spoke (HS) networks are found in several areas of modern society, including transportation, telecommunications and logistics (Horner & O'Kelly, 2001). Figure 1 presents the schematic of the two systems. In a point-to-point system, each airport operates in a network system independently.

Decree No 69 (2013) of the Minister of Transport stated that by 2020 the operational system of these regional airports will be changed into that as presented in Table 1. This Change may affect to the operational of the airports, particularly to the number of passengers using the airports. Bahrawi et al. (2007) found that and source of travel funds negatively affect growth in the number of passengers. Amin (2011) also showed that an increase in passenger fares had a negative impact on the number of passengers.

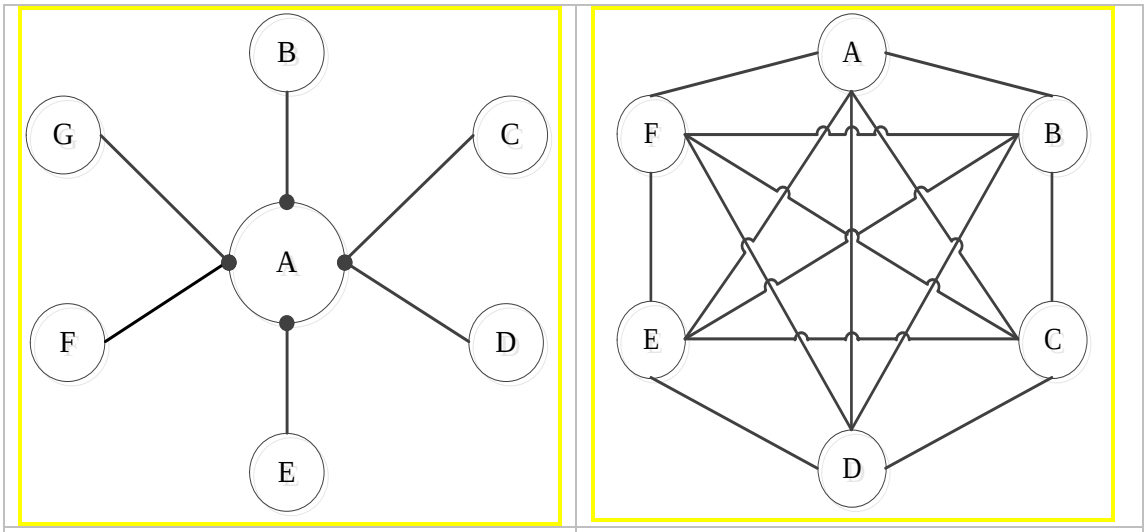

Figure 1. Airport systems: (a) hub and spokes; (b) line to line (Bae, 2010)

Table 1. Planned change of the hierarchical airport system in North Borneo Province

No	Airports	IATA Code	Location	Hierarchical system	
				Existing condition	2020
1	R. A Bessing	MLN	Malinau	*Spoke*	*Spoke*
2	Tanjung Harapan	TJS	Tanjung Selor	*Spoke*	*Tertiary Hub*
3	Nunukan	NNX	Nunukan	*Spoke*	*Tertiary Hub*
4	Juwata	TRK	Tarakan	*Tertiary Hub*	*Secondary Hub*

Paulley, et.al (2006) have found that fares are fundamental to the operation of public transport since they form a major source of income to operators. If fares increase, patronage will decrease. Martijn et.al (2002) found that demand for air transport was largely determined by the spending capacity of customers. Similar findings were also reported by Jorge-Caldero (1997). Reviewing that the planned changes to be applied to the airport system in North Borneo in 2020 may have effects to the operational of the airport, then it becomes essential to anticipate and to predict the effects.

2. OBJECTIVE OF STUDY

The objective of the study was to identify and to anticipate the effect of the operational change to the increase of the number of passengers.

3. METHODS

To achieve the objectives, the following analytical methods were pursued. First, data on tariff and number of passengers in current condition were secured. The data were used to generate a relationship model between airfare and number of passengers. Based on the model, one may predict the number of passengers based on airfare simulation. Passenger origin-destination data

were secured from the airport management. The data were used to form O-D matrix with existing condition (no hierarchical change) using Analogy or Furness Method the base data was 2015. Using the growth factor determined from previous analysis, the predicted condition in 2020 can be analyzed. Using similar analogy, a O-D matrix was also computed using operational change scenarios.

Table 2 presents the airport fares for each destination, while Tables 3 and 4 depict the change of airfare and its effect to the number of passengers from 2002 to 2004. The reasons behind the use of 2002 – 2004 data was due to during the time there was a significant change in the air transport regulation that affected the air transport industry.

Table 2. Airfare for each destination (2015), in Indonesian Rupiah

	To			
From	TRK	TJS	MLN	NNX
TRK	-	217.998	353.421	416.178
TJS	217.998	-	571.419	634.176
MLN	353.421	571.419	-	769.599
NNX	416.178	634.176	769.599	-

Table 3. Airfare change (%) in 16 Indonesian busiest airports

No	**Rute**	**2002**	**%**	**2003**	**%**	**2004**	**%**
1	CGK-BPN	1.037.250	-25	494.174	-52	396.092	-20
2	CGK-BDJ	791.950	-25	456.791	-42	324.600	-29
3	CGK-BTH	684.750	-30	434.159	-37	348.724	-20
4	CGK-DPS	733.933	-36	542.420	-26	386.872	-29
5	CGK-DJB	914.600	27	305.281	-67	245.785	-19
6	CGK-JOG	456.950	-19	270.654	-41	236.080	-13
7	CGK-UPG	1.085.889	-31	549.487	-49	422.500	-23
8	CGK-MES	1.060.350	-32	519.332	-51	436.255	-16
9	CGK-PDG	797.000	-26	364.299	-54	332.447	-9
10	CGK-PLM	451.000	-18	292.143	-35	260.704	-11
11	CGK-MDC	1.250.988	-45	629.029	-50	598.477	-5
12	CGK-PGK	453.475	-17	296.611	-35	272.807	-8
13	CGK-PNK	634.311	-25	349.414	-45	324.050	-7
14	CGK-SRG	377.250	-19	299.799	-21	290.312	-3
15	CGK-SOC	443.200	-25	334.338	-25	296.119	-11
16	CGK-SUB	602.756	-25	290.504	-52	265.831	-8
Rata-rata			-23		-43		-14

Table 4. Passengers in 16 Indonesian busiest airports

No	Rute	2002	%	2003	%	2004	%
1	CGK-BPN	488.014	43	635.132	30	752.598	18
2	CGK-BDJ	201.873	34	337.515	67	479.508	42
3	CGK-BTH	885.893	173	722.848	-18	973.638	35
4	CGK-DPS	1.098.005	1	1.062.866	-3	1.550.279	46
5	CGK-DJB	238.137	73	383.417	61	517.032	35
6	CGK-JOG	538.337	36	1.029.555	91	1.466.958	42
7	CGK-UPG	457.693	59	769.165	68	1.164.500	51
8	CGK-MES	1.108.985	59	1.616.972	46	2.073.827	28
9	CGK-PDG	337.461	70	695.454	106	944.778	36

10	CGK-PLM	431.307	20	745.542	73	936.054	26
11	CGK-MDC	210.303	53	311.236	48	316.280	2
12	CGK-PGK	245.716	41	350.312	43	462.842	32
13	CGK-PNK	287.579	-37	685.578	138	810.178	18
14	CGK-SRG	484.426	14	659.904	36	806.650	22
15	CGK-SOC	137.295	-6	241.323	76	295.428	22
16	CGK-SUB	1.726.004	55	2.654.677	54	3.399.994	28
Average			43		57		30

To build the airfare-passenger relationship using regression analysis, the data was obtained from the data above, but taken only the average of airfare and passenger growth, as shown in Table 5.

Table 5. Airfare and passenger growth

Year	Airfare change (%)	Passenger growth (%)
2002	-23	43
2003	-43	57
2004	-14	30

The O-D matrix for 2015 base data is presented in Table 6. The data was compiled from each airport.

Table 6. Passenger O-D matrix in North Province airport system

	TRK	**TJS**	**MLN**	**NNX**
TRK	-	6.566	16.265	17.453
TJS	7.145	-	1.252	2.136
MLN	15.062	945	-	856
NNX	15.831	2.006	1.066	-

4. RESULT AND DISCUSSION

Regression analysis was conducted using data in Tables 5 and 6, which came up with the following model:

$$PassengerGrowth = 19.531 - 0.893 \times AirfareGrowth$$

with $R^2 = 0.963$. Note that the simplification of the model building was due to limited available data. However, the authors is confident that these model would still give a reasonable accuracy.

Using this model, the predicted airfare due to hierarchical change can be determined using the passenger data. Table 7 presents the predicted airfare due to hierarchical change.

Table 7. Predicted airfare (IDR) due to hierarchical change (2015)

From	**To**			
	TRK	TJS	MLN	NNX
TRK	-	217.998	353.421	416.178
TJS	217.998	-	524.450	486.532
MLN	353.421	524.450	-	429.060
NNX	416.178	486.532	429.060	-

Using this analogy, the percentage of airfare change can be determined, as shown in Table 8. The passenger growth can then be determined as shown in Table 9. Using this growth factor, the predicted number of passengers due to hierarchical can then be determined, as shown in Table 10.

Table 8. Percentage of airfare change in 2015

% Change (2015)		TRK	TJS	MLN	NNX
		%	%	%	%
TRK	%	-	0	0	0
TJS	%	0	-	-9	-30
MLN	%	0	-9	-	-79
NNX	%	0	-30	-79	-

Table 9. Predicted passenger growth (%)

Route	% Airfare Change (%)	Passenger Growth (%)
MLN-TJS atau TJS-MLN	-9	27,52
NNX-TJS atau TJS-NNX	-30	46,62
NNX-MLN atau MLN-NNX	-79	90,37

Table 10. Predicted number of passengers due to hierarchical change (2015)

Zone	TRK	TJS	MLN	NNX	o_i
TRK	-	6.566	16.265	17.453	40.284
TJS	7.145	-	1.597	4.272	13.014
MLN	15.062	1.205	-	1.630	17.897
NNX	15.831	2.941	2.030	-	20.802
d_d	38.038	10.711	19.892	23.356	91.997

To determine the predicted number of passengers in 2020 due to hierarchical change, a transportation modeling using Furness method as discussed in Tamin (2011) was employed using growth factor presented in Table 11. These growth factors were based on growth data from each airport during the last 10 years. Table 12 presents the origin and destination data. The result of the transport modeling using Furness was presented in Tables 13, 14 and 15. These results show that hierarchical change did not have significant effect to the Tarakan Airport (hub). However, it did affect the other airports (spoke).

Table 11. Growth factor for each zone

Zone	Growth factor
TRK	0.107
TJS	0.327
MLN	0.283
NNX	0.187

Table 12. O-D data

Zona	Production (Origin)	Attraction (Destination)
	Oi	*Dd*
TRK	67,358	63,105
TJS	43,589	29,073
MLN	58,876	64,375
NNX	44,719	47,989
Total	**214,542**	**214,542**

Table 13. 2015 O-D matrix without hierarchical change

Zone	TRK	TJS	MLN	NNX	o_i	O_i	E_i
TRK	-	6,566	16,265	17,453	40,284	67,358	1,672
TJS	7,145	-	1,252	2,136	10,533	43,589	4,138
MLN	15,062	945	-	856	16v863	58,.876	3,491
NNX	15,831	2,006	1v066	-	18,903	44,719	2,366
d_d	38,038	9,516	18v583	20,445	86,583		
D_d	63,105	39,.073	64,375	47,989		214,542	
E_d	1,659	4,106	3,464	2,347			

Table 14. 2020 O-D matrix without hierarchical change (after 30th iteration)

Zone	TRK	TJS	MLN	NNX	*oi*	Oi
TRK	-	10.021	35.849	21.489	67.358	67.358
TJS	10.355	-	17.018	16.216	43.589	43.589
MLN	34.529	14.061	-	10.285	58.876	58.876
NNX	18.221	14.991	11.508	-	44.719	44.719
dd	63.105	39.073	64.375	47.989	214.542	
Dd	63.105	39.073	64.375	47.989		214.542

Table 15 2020 O-D matrix with hierarchical change

	TRK	TJS	MLN	NNX	*oi*	Oi
TRK	-	10.021	35.849	21.489	67.358	67.358
TJS	10.355	-	**21.702**	**23.775**	55.832	55.832
MLN	34.529	**17.932**	-	**19.581**	72.042	72.042
NNX	18.221	**21.979**	**21.908**	-	62.108	62.108
dd	63.105	49.932	79.459	64.844	257.340	
Dd	63.105	49.932	79.459	64.844		257.340

5. CONCLUSION

Based on the analysis, the following conclusion can be drawn:

1. Hierarchical change affected to the airfare, that subsequently affected the passenger, particularly on smaller airports.

2. Significant increase was predicted to occur for Malinau – Nunukan Airports since it affected significantly to the airfare.
3. Overall, the passenger increase was predicted to about 19.95% in 2020.
4. The hierarchical change will bring a positive effect to the smaller airports in North Borneo Province.

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