

4th International Conference on Rehabilitation and Maintenance in Civil Engineering (ICRMCE)

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“Smart Rehabilitation and Maintenance in Civil Engineering
for Sustainable Construction”

Evaluation of Hub-Spoke Airport Networks in Sumatra Island, Indonesia to Increase Efficiency of Air Transportation

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➤ Introduction and Background

Kualanamu International Airport in Deli Serdang, North Sumatra is the 5th busiest airport in Indonesia and the busiest airport in Sumatra Island.

Kualanamu International Airport has served 6,374,897 pass. and 37,413,257 kgs of cargo for domestic and 1,629,894 pass. and 4,215,927 kgs of cargo for international flights.

Transport logistics service problems: insufficient number of infrastructures, transportation costs that lead to high economic costs, limited network and capacity of nationwide logistics service provider.

The alternative solution is to evaluate the hub-and-spoke airport networks.

The methods to analysis air transportation (Et) efficiency is Herfindahl-Hirschmann Index (HHI).

After the Airline Deregulation Act in 1978, domestic carriers have developed the hub and spoke structures to reduce the overall costs of air travel and to increase travel demand (S. Wei and M. Yanji, 2006).

► Research Aim and Study Location

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To evaluate the hub and spoke airport networks in Sumatra Island, Indonesia in existing conditions based on Herfindahl-Hirschmann Index (HHI) to identify air transport efficiency.

The HHI analysis:
10 airports for domestic flight
6 airports for international flight.



Deregulation Hub and Spoke Network

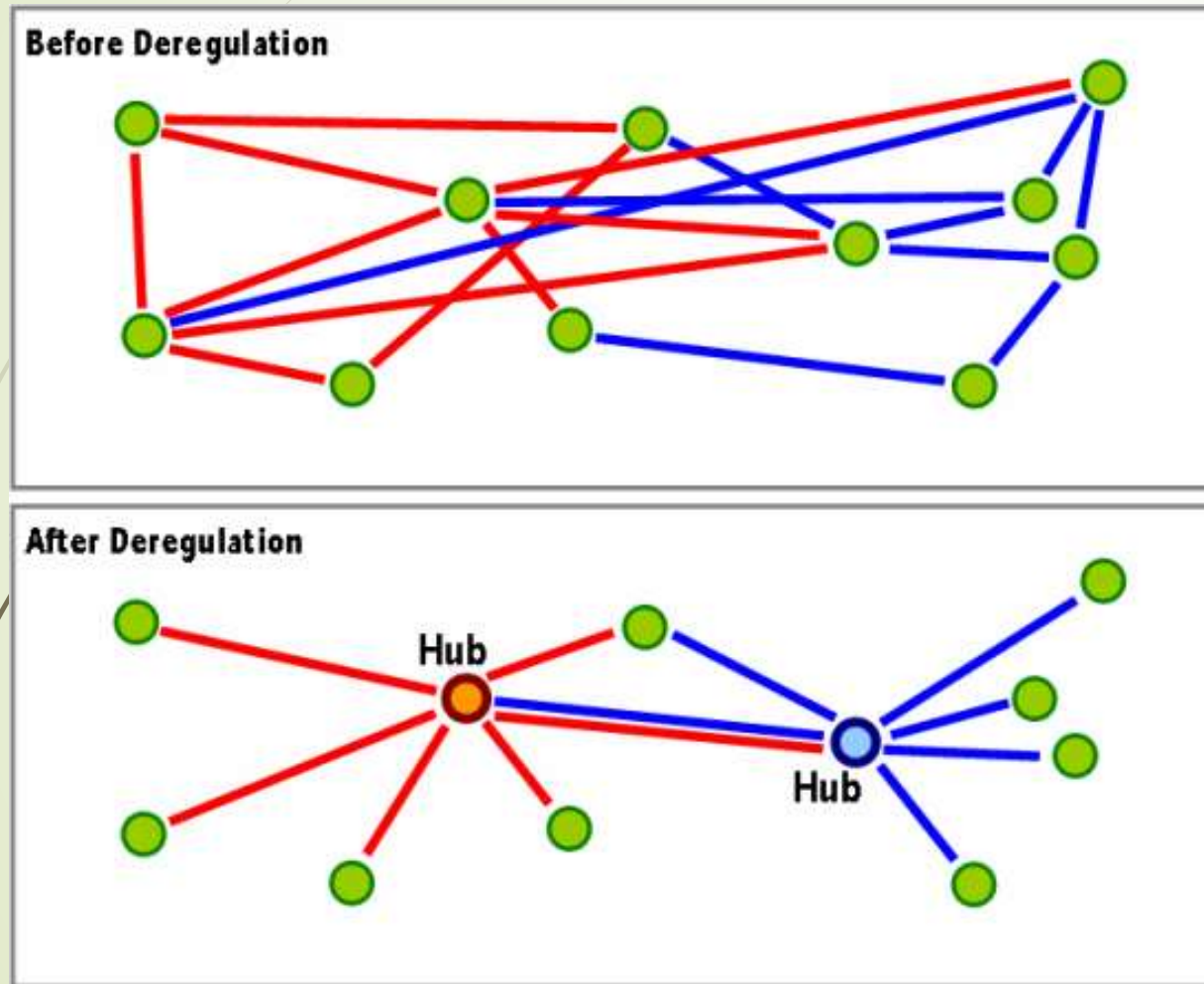


Fig. 1-Hub and Spoke (Before and After Deregulation)

Hub and Spoke

Before Deregulation, seen its routes, with patterns point to point, where there are two airline (red and blue), which operates in 10 cities. With these restructuring and by using a hub and spoke pattern (Fig. 1 **After Deregulation**), the distribution of the second route each airline operating at a particular area and the main hub and make other destinations as spokes.

Herfindahl-Hirschmann Index (HHI) for domestic flights

No.	Airport (IATA Code)	Cargo production (kg)	P_i	P_i^2
1.	Sultan Iskandar Muda (BTJ)	3,572,254	0.02886	0.00083
2.	Kualanamu (KNO)	37,413,257	0.30224	0.09135
3.	Minangkabau (PDG)	9,372,979	0.07572	0.00573
4.	Sultan Syarif Kasim II (PKU)	9,308,292	0.07520	0.00565
5.	Hang Nadim (BTH)	33,035,468	0.26687	0.07122
6.	Depati Amir/Pangkal Pinang (PGK)	6,671,234	0.05389	0.00290
7.	Sultan Thaha (DJB)	6,088,310	0.04918	0.00242
8.	Fatmawati Soekarno (BKS)	2,034,146	0.01643	0.00027
9.	Sultan Mahmud Badaruddin II (PLM)	11,854,587	0.09576	0.00917
10.	Radin Inten II/Branti (TKG)	4,437,830	0.03585	0.00129
	$\sum X_i$	123,788,357	1.00000	0.19084
	HHI	0.1908		
	n_e	5.2401		
	n	10		
	$n - (n^2 - n_e \cdot n)^{0.5}$	3.1008		
	$0.5 (n - (n^2 - n_e \cdot n)^{0.5})$	1.5504		
	Number of hub airport	2		

Based on the calculation of the Herfindahl-Hirschmann Index (HHI), the number of effective airport (n_e), and the number of hub airports (h).

$$HHI = \sum P_i^2$$

$$P_i = x_i / \sum x_i$$

With x_i is the production of an airport

$$h = 0.5 \{n - (n^2 - n \cdot n_e)^{1/2}\}$$

$$n_e = 1 / HHI$$

Hub airports that serve as a cargo hub are Kualanamu International Airport in North Sumatra and Hang Nadim International Airport in Batam.

Herfindahl-Hirschmann Index (HHI) for international flights

No.	Airport (IATA Code)	Cargo production (kg)	P_i	P_i^2
1.	Sultan Iskandar Muda (BTJ)	80,241	0.00972	0.00009
2.	Kualanamu (KNO)	4,215,927	0.51044	0.26055
3.	Minangkabau (PDG)	784,875	0.09503	0.00903
4.	Sultan Syarif Kasim II (PKU)	1,179,191	0.14277	0.02038
5.	Hang Nadim (BTH)	1,762,264	0.21337	0.04552
6.	Sultan Mahmud Badaruddin II (PLM)	236,881	0.02868	0.00082
	$\sum X_i$	8,259,379	1.00000	0.33641
	HHI	0.3364		
	n_e	2.9726		
	n	6		
	$n^2 - n_e \cdot n$	17.8356		
	$(n^2 - n_e \cdot n)^{0.5}$	4.2619		
	$n - (n^2 - n_e \cdot n)^{0.5}$	1.7380		
	$0.5 (n - (n^2 - n_e \cdot n)^{0.5})$	0.8690		
	Number of hub airport	1		

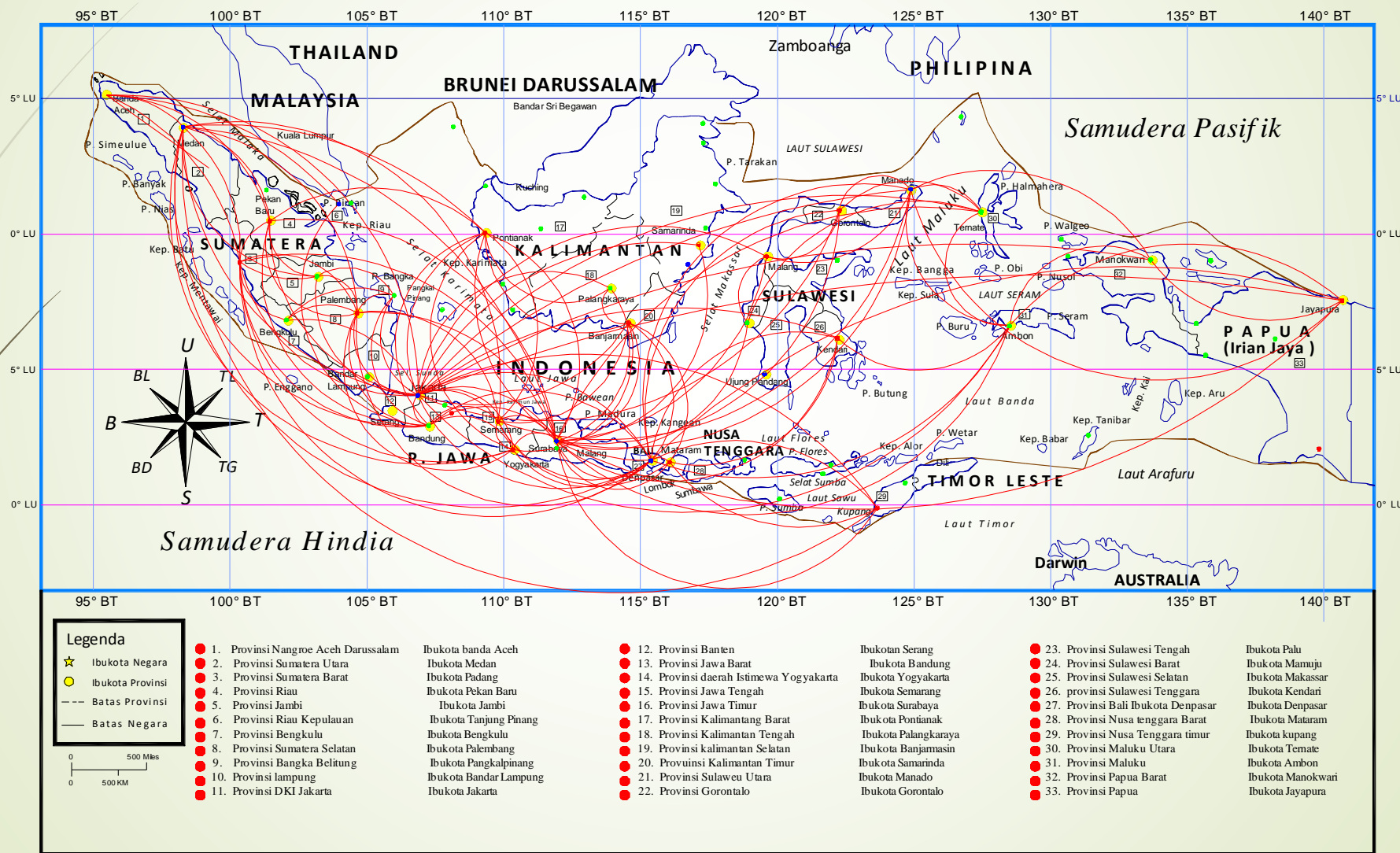
Only one hub airport for the international flights in Sumatra Island: Kualanamu International Airport.

Kualanamu International Airport has the highest quantity of cargo production.

The percentage of cargo volume in Kualanamu International Airport is 30.22% for domestic and 51.04% for international flights.

The second is Hang Nadim International Airport in Batam with a total cargo production of 33,035,468 kg (26.68%) for domestic and 1,762,264 kg (21.33%) for international flights.

Flight Route in Indonesia



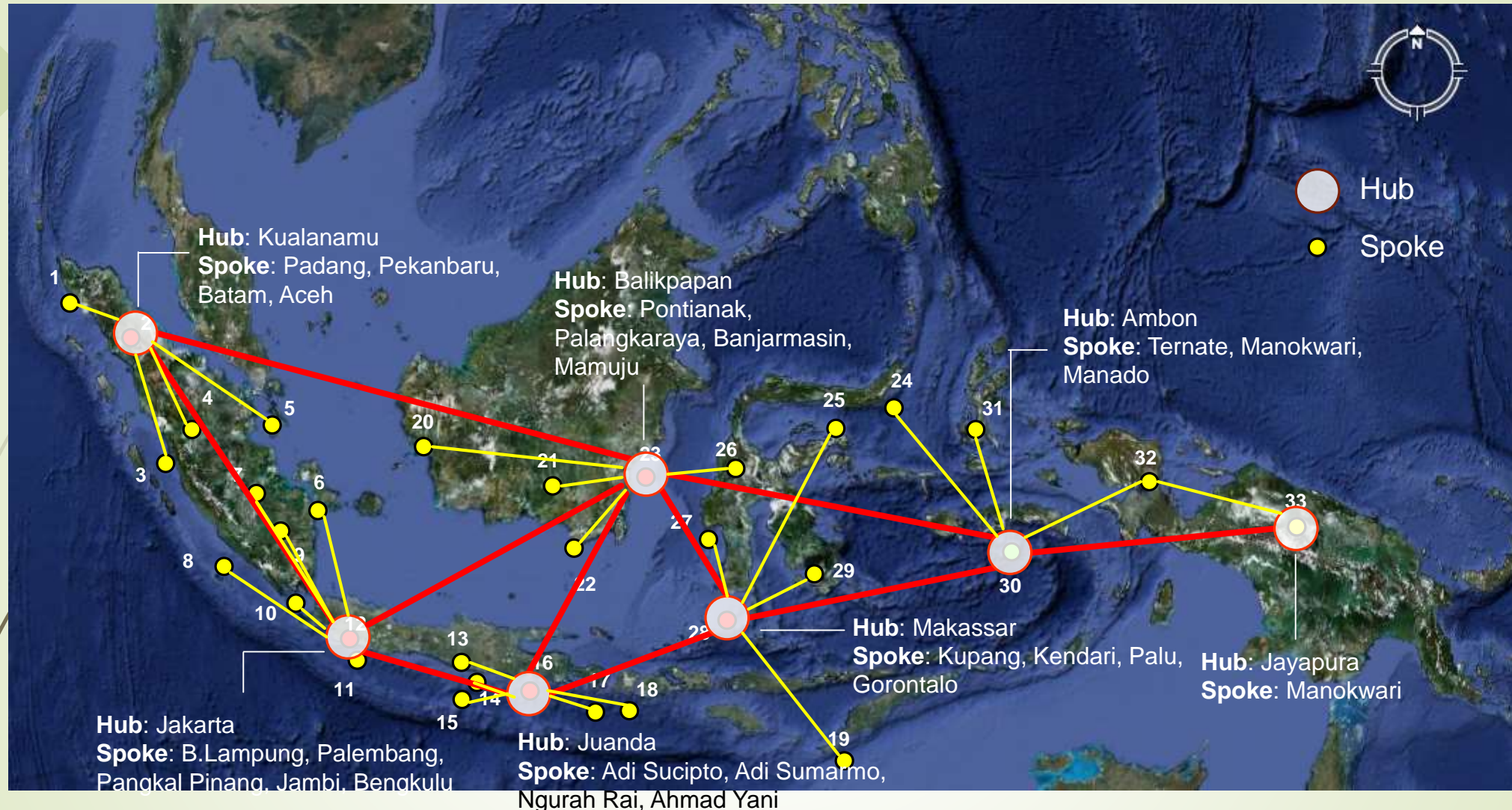


Fig. Hub and Spoke with 7 hub

Distribution of air transport logistic in Indonesia with 7 hub is not efficient, the value of air transportation (Et) efficiency is 70.28% (Sugiyanto, et al., 2015).

➔ Conclusions

The Herfindahl-Hirschmann Index (HHI) analysis, indicates 2 hubs for domestic flights and 1 hub (Kualanamu) for international flights. Kualanamu International Airport and Hang Nadim International Airport are indicated as hub airports in Sumatra Island for domestic flights.

The efficiency of air cargo transportation in the existing condition scheme with 2 hub airports and 8 spoke airports generates a transport efficiency (E_t) of 68.37%, which is still far above the efficient range of 49-52%.

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Thank You very much.