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MAPPING PRIORITIES FOR THE DEVELOPMENT OF THE TRANSPORTATION INFRASTRUCTURE IN THE PROVINCIAL CAPITALS OF INDONESIA

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ABSTRACT

The infrastructure of the transportation system plays an important and strategic part in the development of a country and serves to support economic progress by enabling the mobility of citizens and the distribution of goods from one region to another. However, communities have unequal access to the system and there are gaps in the regional infrastructure in Indonesia, leading to the requirement for a mapping of all 33 provincial capitals. In this study, we reviewed provisions for road, sea, air, and rail travel. The mapping result is expected to determine the pattern and the prioritization needed for future infrastructure development. A literature review was performed to establish assessment indicators for the mapping. The weighting of each indicator was based on a survey of stakeholders in transportation sectors, which was then analyzed using the Analytical Hierarchy Process. After weighting was completed, the infrastructure of each provincial capital was assessed to determine ratings from the highest to the lowest rank. Jakarta, Medan, Bandung, Surabaya, and Semarang obtained the highest rankings, while Manokwari, Serang, Mamuju, Ternate, and Palangkaraya were at the bottom. This result shows that provincial capitals in western Indonesia had better assessment results than those in the east. Therefore, improvements to the transportation infrastructure of the latter cities should be prioritized.

Keywords: Indonesia; Infrastructure; Provincial capitals; Rank; Transportation

1. INTRODUCTION

A comprehensive and efficient infrastructure is very important for ensuring effective economic functions, such as determining locations for economic activities, types of activities, or sectors, which can contribute to the development of a country. Economic development creates an increasing need for mobility, which might exceed the capacity of the existing facilities and infrastructure. Put simply, the development of cities and their transportation infrastructure influence each other heavily. According to the Minister of National Development Planning and the Head of the National Development Planning Agency (Bappenas), the quantity and quality of infrastructure needs to be vastly improved to support development by accelerating its provision. Air, sea, and land transportation is a major component of economic activities and a highly

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significant aspect of community lives. A reliable transportation system is conducive to economic progress because it enhances people's mobility and enables wider goods distribution from one region to another (Lemhanas, 2013). However, according to the Public Works Performance Review of the Provincial Government (2010-2014), the servicing and provision of Indonesia's infrastructure is not optimum and there are huge inconsistencies in achievement between different regencies/cities, due to differences in perception, the socio-cultural situation, and the characteristics of each area. Some of the challenges are limited services and a smaller infrastructure network in areas outside Java Island that are less developed. Meanwhile, crucial issues in regional development include the concentration of economic activities in Java and certain areas outside it, communities' unequal access to the utilization of regional resources, high poverty rates in villages, and large development gaps between regions (Zaini, 2015).

In order to comprehensively evaluate the transportation infrastructure of Indonesia's provincial capitals, it is necessary to develop transportation infrastructure mapping. This could be achieved by providing ratings for the 33 Indonesian provincial capitals, consisting of assessments for air, land, and sea transportation indicators. This mapping would also provide information and recommendations to the government and investors, to determine which areas require further development. The aim of this paper is to define the indicators used in such assessments; it will also present the mapping results for each province.

2. LITERATURE REVIEW

The Associated General Contractors of America (Hudson et al., 1997) defined infrastructure as follows: "The nation's infrastructure is its system of public facilities, both public and privately funded, which provide for the delivery of essential services and a sustained standard of living." According to Grigg (2010), infrastructure refers to a system that provides transportation, irrigation, drainage, buildings, and other public facilities required to fulfill basic human needs in a social and economic scope. Basic infrastructure facilities are an important feature in relation to economic performance (Torrisi, 2009) and overall development of a country (Iniestra & Gutierrez, 2009). In addition, more public infrastructure facilities are required to be developed to gain optimum benefits through maximizing their functions (Berawi & Woodhead, 2008) and quality (Abdul Rahman et al., 2007).

Aligned with World Bank (2012), the Ministry of National Development Planning Agency Regulation No. 6 (Year 2012, Article 5) classifies the types of infrastructure consist of transportation infrastructure, irrigation networks, drinking water, sanitation, telecommunication and informatics, electricity, oil, and gas.

In terms of transportation, Fricker and Whitford (2005) stated that this refers to everything involved in the transfer of both people and goods from one place to another. Transportation, in regional development, functions as a support toward the development of activities in other sectors, and also connects isolated areas with nearby developed locales in order to generate interactions between the two regions, which will, in turn, encourage synergic growth and development (Adisasmita, 2007). The major components of infrastructure that provide the functions of a transportation system are seaports and the marine navigation system, airports and the air traffic management system, rail services, and roads (Small et al., 2013). A reliable transportation system will support economic progress by enabling the population to be mobile between regions and distribute goods widely (Lemhanas, 2013). The existing conditions of the transportation infrastructure in Indonesia has been reported as having gaps between provinces, and there are issues in developing the facilities, such as funding limitations in the transportation sector, lack of quality of institution and its human resources, and a maintenance backlog in the transportation facilities (Bappenas, 2012).

Several studies have provided indicators for the evaluation and assessment of the transportation infrastructure. In 2011, the US Chamber of Commerce established a transportation performance index; such an index can be used for each mode of transportation (highway, air, rail, marine, and intermodal transportation). Each mode has specific indicators, such as density, access, and capacity, with specific measures. In addition, Bappenas provided transportation performance indicators for road availability, assets, and traffic volume for seaports and airports.

3. RESEARCH METHOD

In this research, both primary and secondary data was used, as described in Figure 1. The literature review used secondary data to establish the indicators for the mapping of the transportation infrastructure of the 33 provincial capitals in Indonesia, while questionnaires and in-depth interviews were used as primary data to establish the weighting of indicators and to validate the research results.

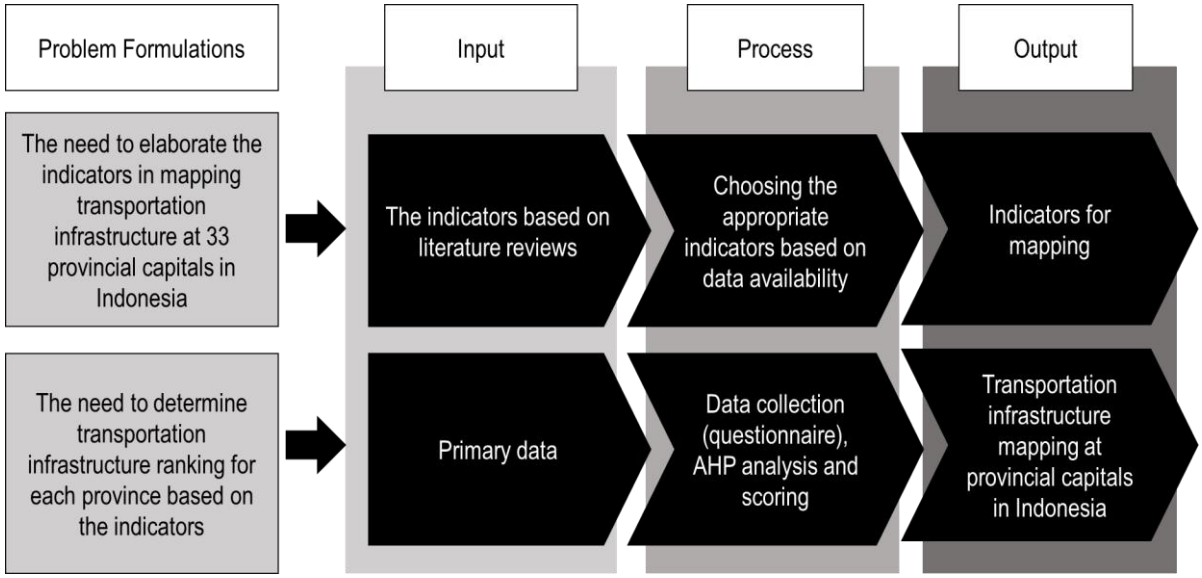

Figure 1 Research operational method

Secondary data was collected as follows:
The selection of the indicators to be used as the criteria to determine the mapping of the transportation infrastructure of Indonesian provincial capitals was based on the literature review. The variables are listed in Table 1. A compilation of data related to the selected criteria is also shown in Table 1.

The compiled data was subsequently recapitulated and a hierarchical structure for each element of transportation infrastructure created. The next step was to create a closed or structured questionnaire. This questionnaire, consisting of multiple-choice questions, was distributed to more than 30 respondents from relevant institutions. The answers would significantly influence the weight given to the selected indicators.

The data was then processed using the Analytical Hierarchy Process (AHP) to determine the weight of each indicator. Subsequently, scoring for the infrastructures of each of the 33 provincial capitals was assigned. After the mapping was completed, the results were validated by selected experts, who were highly reputable with a minimum of 10 years of experience in the field of transportation and a bachelor's degree.

Table 1 Research variables and source of data

Dependent Variables	Independent Variables	Indicators	Description	Sources	Source of Data
Mapping of Transportation Infrastructure of 33 Provincial Capitals in Indonesia	Road	Road availability (including total roads, national roads, and provincial and city roads)	Length of road/ 1000 km^2 area (km/km^2)	Department of Housing and Infrastructure, Bappenas (2004)	Statistics Indonesia, Transportation Statistics
		Performance of road network in good condition	Length of roads in good condition/total length of roads (%)	Directorate General of Highways, Ministry of Public Work (2010-2014)	Statistics Indonesia
	Rail	Availability of rail lengths	Length of rails (km)/1000 population (km/people)	US Transport Performance, Bappenas (2004)	Geographical Information System in Transportation Facilities (Ministry of Transportation)
		Total passenger capacity	Passengers/year	US Transport Performance	Statistics Indonesia
		Total goods capacity	Tons of goods/year	US Transport Performance	Statistics Indonesia
	Sea	Number of ports according to hierarchy		Bappenas (2004)	Geographical Information System in Transportation Facilities (Ministry of Transportation)
		Flow of passengers	Passengers/year	Bappenas (2004)	Statistics Indonesia, Transportation Statistics
		Flow of goods	Tons/year, TEUS/year	Bappenas (2004)	Statistics Indonesia, Transportation Statistics
	Air	Number of airports according to hierarchy		Bappenas (2004)	Geographical Information System in Transportation Facilities (Ministry of Transportation)
		Number of passengers	Passengers/year	Bappenas (2004)	Transportation Statistics
		Volume of cargo	Kg of goods/year	Bappenas (2004)	Transportation Statistics

4. RESULTS AND DISCUSSION

Several assessment variables were obtained from the literature review, which were used to develop the rating of the transportation infrastructures of the 33 provincial capitals, as displayed in Table 2.

The weight of ratings for each variable was obtained by distributing a questionnaire to 30 respondents. There were five parts to the questionnaire: namely, the overall comparison of transportation infrastructure variables (level I), road infrastructure, rail infrastructure, sea transportation infrastructure, and air transportation infrastructure variables (level II). The answers were analyzed using the AHP method. The results of variable-weighting from questionnaire distribution and comparison analysis are shown in Table 3.

Table 2 Assessment variables of transportation infrastructure

No	Criteria	
1	*Road Transportation Infrastructure:*	
	Total Availability of Road Length	
	Length Availability of National Roads	
	Length Availability of Provincial Roads	
	Length Availability of Regional/City Roads	
	Length Availability of Toll Roads	
	Performance of Roads in Good Conditions	
2	*Rail Transportation Infrastructure:*	
	Length Availability of Rails	
	Total Passenger Capacity	
	Total Goods Capacity	
3	*Sea Transportation Infrastructure:*	
	Major Ports	Number of Ports
		Flow of Passengers
		Flow of Goods
	Hub Ports	Number of Ports
		Flow of Passengers
		Flow of Goods
	Regional Feeder Ports	Number of Ports
		Flow of Passengers
		Flow of Goods
	Local Feeder Ports	Number of Ports
		Flow of Passengers
		Flow of Goods
4	*Air Transportation Infrastructure:*	
	Hub Airports	Number of Airports
		Number of Passengers
		Number of Cargo
	Feeder Airports (Spoke)	Number of Airports
		Number of Passengers
		Number of Cargo

Based on the weighting of respondents' answers, the highest-scoring variable for the road transportation infrastructure was the performance of roads in good conditions with 30.85%. According to experts, good road conditions play an important role in supporting economic activities because the better the road quality and performance, the more the roads can sustain higher loads and other economic activities. This statement was validated by the *Committee* Monitoring the Implementation of Regional *Autonomy's statement* in 2012 that the availability of roads would be very helpful in terms of the development of a community in an area; in addition, business activities would develop as road performance improves access to the area.

For rail infrastructure, the highest variable was total passenger capacity at 45.02%. This is understandable, since trains are mass transport vehicles capable of accommodating a large of number of passengers. Increased use of trains can reduce road load and congestion, which will positively affect the economic growth of a city.

For the sea transportation infrastructure indicator, the highest variable was found to be the flow of goods at major ports (40.85%). The flow of goods at these ports is regulated by the Ministry of Transportation Regulation No. KM 53 (Year 2002) on Order of the National Ports. However, the regulation does not include provisions on passengers, because ports prioritize the movements of goods over passengers. The sea infrastructure can accommodate a large volume of goods and is therefore most efficient for this purpose. As such, the movement of goods

between islands is mostly done via sea as an extension of both international and domestic trade. In the sea line, the shipping of goods follows clearer patterns than passenger movements (Sislognas, 2012). The flow of goods at major ports has become the most important criterion, since they are the busiest and largest ports.

Table 3 Weighting of variables based on AHP

No	Criteria		1st Level	2nd Level	Ranking
1	*Road Transportation Infrastructure:*		*17.36%*		*3*
	Total Availability of Road Length			9.64%	
	Length Availability of National Roads			22.26%	
	Length Availability of Provincial Roads			12.75%	
	Length Availability of Regional/City Roads			12.67%	
	Length Availability of Toll Roads			11.84%	
	Performance of Roads in Good Conditions			30.85%	
2	*Rail Transportation Infrastructure:*		*47.30%*		*1*
	Length Availability of Rails			28.92%	
	Total Passenger Capacity			45.02%	
	Total Goods Capacity			26.06%	
3	*Sea Transportation Infrastructure:*		*22.97%*		*2*
		Number of Ports		9.73%	
	Major Ports	Flow of Passengers		14.16%	
		Flow of Goods		40.85%	
		Number of Ports		2.67%	
	Hub Ports	Flow of Passengers		3.88%	
		Flow of Goods		11.19%	
		Number of Ports		1.69%	
	Regional Feeder Ports	Flow of Passengers		2.46%	
		Flow of Goods		7.10%	
		Number of Ports		0.95%	
	Local Feeder Ports	Flow of Passengers		1.37%	
		Flow of Goods		3.97%	
4	*Air Transportation Infrastructure:*		*12.37%*		*4*
		Number of Airports		8.03%	
	Hub Airports	Number of Passengers		45.82%	
		Number of Cargo		13.66%	
		Number of Airports		3.87%	
	Feeder Airports (Spoke)	Number of Passengers		22.06%	
		Number of Cargo		6.58%	

The air transportation infrastructure indicator showed the highest variable for the flow of passengers at hub airports (HUB); namely, 45.82%. The flow of passengers at airports is regulated by the Ministry of Transportation Regulation No. PM 69 (Year 2013) on Order of National Airports, but does not include provisions for the flow of cargo. This is because the flow of passengers is prioritized over that of goods, since it is more profitable and has a greater impact on the economic growth of a city. Unlike sea transportation, the air infrastructure cannot carry a large volume of goods since its own capacity is small; therefore, it understandably prioritizes passengers for reasons of time and financial efficiency. The volume of goods carried via air transportation is relatively small (Sislognas, 2012). The flow of passengers at hub airports (HUB) has become the most important criterion, since these airports are the busiest and largest in the air hierarchy.

Overall, the rail infrastructure has the highest percentage at 47.30%, while the sea transportation infrastructure comes in second at 22.97%. Road transportation at 17.36%, and air transportation infrastructure at 12.27%, came in third and fourth respectively. Rail is a mass

transportation system that can carry passengers and goods in large numbers, and therefore significantly boosts the economy. In line with 'Energy and Infrastructure Sovereignty RPJMN 2015-2019,' one of the strategic issues in infrastructure development is the provision of an inner city mass transport system (Bappenas, 2014). Rail is effective in carrying goods and passengers in large volumes, thereby reducing traffic congestion (Sislognas, 2012). According to experts, this weighting is valid because it agrees with the fact that the biggest allocation in the infrastructure budget of 2015 in RPJMN 2015-2019 was given to rail transportation to the tune of IDR 18,554,441,000,000, while sea transportation was allocated IDR 18,123,372,000,000, followed by air and road transportation.

The selection of respondents for the questionnaire appeared to highly influence the weighting result of each variable. In this study, rail transportation received the highest weighting because there were more respondents from land transportation institutions.

The next step was to map the cities by multiplying the weight of variables to obtain the scoring, according to the data, of each of the 33 provincial capitals. The resulting scores were then listed from the highest to the lowest ratings. These cities and their scores were subsequently grouped into four quadrants, based on their ratings.

The compilation, processing, and analysis of the data resulted in the rankings shown in Table 4. In Quadrant I, Jakarta is in first position, followed by Medan, Bandung, Surabaya, Semarang, Padang, Palembang, and Makassar. In Quadrant II, Yogyakarta is in ninth position, followed by Ambon, Pontianak, Denpasar, Banjarmasin, Mataram, Banda Aceh, and Samarinda. In Quadrant III, Jambi is in 17th position, followed by Manado, Kendari, Bengkulu, Pangkal Pinang, Kupang, Pekanbaru, and Bandar Lampung. In Quadrant IV, Gorontalo is in 25th position, followed by Jayapura, Tanjung Pinang, Palu, Manokwari, Serang, Mamuju, Ternate, and Palangkaraya.

The mapping, as based on the transportation infrastructure, resulted in three major cities scoring the highest, namely Jakarta, Medan, and Bandung. The three with the lowest scores were Mamuju, Ternate, and Palangkaraya. After expert validation, this mapping is considered representative of the existing conditions. The validation was supported by the classification of cities according to the number of population, as conducted by the National Development Planning Agency (Bappenas), in which it is stated that there are four megapolitan cities, Jakarta, Surabaya, Bandung, and Medan, with a population of more than 5 million each (Bappenas, 2005). These four cities are rank with the highest infrastructure scores in the mapping. One of the experts stated that a megapolitan city with a population of more than 5 million will have higher regional revenues from taxes, which makes it possible to develop greater infrastructures to fulfill the needs of the population.

The three cities with the lowest-scoring transportation infrastructures, namely Mamuju, Ternate, and Palangkaraya, are classified as medium cities with populations of around 100,000–500,000 people each. Their regional revenues are understandably lower, which subsequently affects the development of their infrastructure. The mapping of this research was also influenced by the limited availability of data and information from each area; therefore, the results should be considered flexible. The bottom three cities do not have rail infrastructure, the aspect that received the highest scoring. This explains why most cities in western Indonesia (Java and Sumatera) obtained better scoring than cities in eastern Indonesia, indicating that the latter are in need of transportation infrastructure improvement.

Table 4 The mapping results for each province

No.	Province	City	Score					Rank				
			Road	Rail	Sea	Air	Overall	Road	Rail	Sea	Air	Overall
1	DKI Jakarta	Jakarta	8.1	7.21	7.92	6.98	7.50	1	1	1	1	1
2	Sumatera Utara	Medan	6.26	4.09	3.33	4.58	4.35	4	2	3	5	2
3	Jawa Barat	Bandung	4.58	2.54	0.32	3.23	2.47	11	3	26	16	3
4	Jawa Timur	Surabaya	5.83	1.26	2.07	2.90	2.44	5	4	8	21	4
5	Jawa Tengah	Semarang	4.29	0.45	2.90	3.58	2.07	12	8	4	10	5
6	Sumatera Barat	Padang	3.40	1.06	2.14	3.30	1.99	24	6	6	12	6
7	Sumatera Selatan	Palembang	2.50	1.18	2.06	3.74	1.93	30	5	9	8	7
8	Sulawesi Selatan	Makasar	4.11	0.00	2.50	4.71	1.87	13	--	5	3	8
9	DI Yogyakarta	Yogyakarta	4.01	0.96	0.00	4.66	1.73	17	7	--	4	9
10	Maluku	Ambon	5.00	0.00	1.91	3.20	1.70	8	--	11	18	10
11	Kalimantan Barat	Pontianak	5.52	0.00	1.42	3.22	1.68	6	--	14	17	11
12	Bali	Denpasar	4.97	0.00	0.60	5.12	1.63	9	--	22	2	12
13	Kalimantan Selatan	Banjarmasin	3.57	0.00	2.02	3.91	1.57	21	--	10	7	13
14	Nusa Tenggara Barat	Mataram	6.43	0.00	0.00	3.47	1.55	3	--	--	11	14
15	Aceh	Banda Aceh	6.80	0.00	0.00	2.63	1.51	2	--	--	23	15
16	Kalimantan Timur	Samarinda	2.18	0.00	4.14	1.37	1.50	31	--	2	30	16
17	Jambi	Jambi	4.10	0.00	1.52	3.28	1.47	14	--	13	15	17
18	Sulawesi Utara	Manado	4.77	0.00	0.81	3.58	1.46	10	--	20	9	18
19	Sulawesi Tenggara	Kendari	4.02	0.00	1.19	2.95	1.34	16	--	17	20	19
20	Bengkulu	Bengkulu	3.03	0.00	2.12	2.32	1.30	26	--	7	24	20
21	Kepulauan Bangka Belitung	Pangkal Pinang	3.68	0.00	1.07	3.28	1.29	20	--	19	14	21
22	Nusa Tenggara Timur	Kupang	3.47	0.00	1.20	3.29	1.28	23	--	16	13	22
23	Riau	Pekanbaru	3.80	0.00	1.58	1.84	1.25	19	--	12	27	23
24	Lampung	Bandar Lampung	4.03	0.31	0.64	1.59	1.19	15	10	21	28	24
25	Gorontalo	Gorontalo	5.18	0.00	0.07	1.95	1.16	7	--	28	26	25
26	Papua	Jayapura	2.88	0.00	0.43	4.17	1.11	28	--	25	6	26
27	Kepulauan Riau	Tanjung Pinang	3.35	0.00	1.37	1.37	1.07	25	--	15	29	27
28	Sulawesi Tengah	Palu	3.89	0.00	0.00	2.97	1.04	18	--	--	19	28
29	Papua Barat	Manokwari	2.66	0.00	1.18	2.02	0.98	29	--	18	25	29
30	Banten	Serang	3.55	0.41	0.00	0.00	0.81	22	9	--	33	30
31	Sulawesi Barat	Mamuju	3.01	0.00	0.58	0.48	0.71	27	--	23	32	31
32	Maluku Utara	Ternate	1.90	0.00	0.50	0.78	0.54	32	--	24	31	32
33	Kalimantan Tengah	Palangkaraya	0.46	0.00	0.07	2.64	0.42	33	--	27	22	33

5. CONCLUSION

This mapping of transportation infrastructure showed that major cities in the western part of Indonesia obtained higher assessment results than those in eastern Indonesia, indicating that the latter are in need of improvement. The resulting ranking and priorities are flexible, since they are influenced by the availability of data and information from each area. The mapping of these 33 provincial capitals shows that research is required to improve the rankings of cities in each quadrant. It is expected that reviews of various aspects could be carried out in greater detail, by taking into consideration input from stakeholders to produce indicators that can represent all components of transportation infrastructure. The weighting and mapping must then be supported with more comprehensive data for all selected indicators.

6. ACKNOWLEDGEMENT

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