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Measuring City Readiness In Implementing PublicTransportation Based On Railway

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ABSTRACT
The increase in the number of urban population caused by births and urbanization has increased economic activity and citizen mobility. This has led to an increase in the demand for transportation services. The increasing number of requests for transportation services has not been matched by the provision of adequate transportation services. Cities with a population of more than 1 million are advised to have mass public transport, but in reality this has not been implemented. More than 10 cities in Indonesia with a population of over 1 million do not have urban mass public transport, especially those based on railways. Research is carried out in 3 stages. First, literature and comparative studies were carried out in 20 countries. Secondly, an important factor in public transportation based on railways was analyzed using the Analytical Hierarchie Process (AHP) method to obtain the order of important factors according to their importance. The third stage was validated with discussions at the Jakarta City Transportation Council (DTKJ) and at the City Development Planning Agency (Bappeko) Surabaya. Furthermore, the readiness formula / model obtained, applied to the city chosen to see the readiness level of the city and the results accordingly.
Keywords: urbanization, validation, AHP, DTKJ, Bappeko.

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I. INTRODUCTION

One of the main issues of big cities in Indonesia today is the mobility and traffic congestion barriers. Along with population growth and urban economy in developing countries including Indonesia [1] [2] cities will expand and tend to occur agglomeration with surrounding cities, for exampleJabodetabekjur which covers the cities of Jakarta, Bogor, Depok, Tangerang, Bekasi and Cianjur or Gerbangkertosusila, namely Gersik, Bangkalan, Mojokerto, Surabaya, Sidoarjo and Lamongan. Furthermore, the number of trips will increase, which also means an increase in mobility in the urban area. This condition requires readiness to provide transportation to support the movement (mobility) of citizens in activities and support the mobility of the urban economy (urban economic mobility). It was noted that the role of public transportation in Indonesia is only 23% on average, while in developed countries the role of public transport is more than 50%, even public transportation in Singapore reaches 60% and Hong Kong reaches 90% [3].

Urban mass public transport that currently exists is more likely to be Road-based, such as Transjakarta, Transjogja. Unfortunately the development of this transportation has not been as expected. Transjakarta passengers are declining [4], as well as Transjogja, not yet / not developing, even the factor is only 35% [5], whereas to be able to grow, the load factor is at least 70%. City buses in Surabaya during the period 2010-2015 are reduced 25% [6] Another alternative is the railway-based mode that is integrated with other modes so that it can service door to door movements. Unfortunately the rules of the existing transportation department are indicated not to be able to answer the challenges of developing a mass transportation based on railways because there is only one factor, namely the size of the city. Even though there are other main factors that determine the selection of railways-based mass public transportation. Therefore, it is necessary to look for other factors especially for those railroad-based. In addition, the model that will be obtained is simple, so that it is easy to apply.

1.1 Theory

According to Zuhdy [7] public transport can be grouped into three, namely road-based, rail-based and others. Common rail and road-based public transport that are included in fast mass public transport are metro, monorail and commuter line.

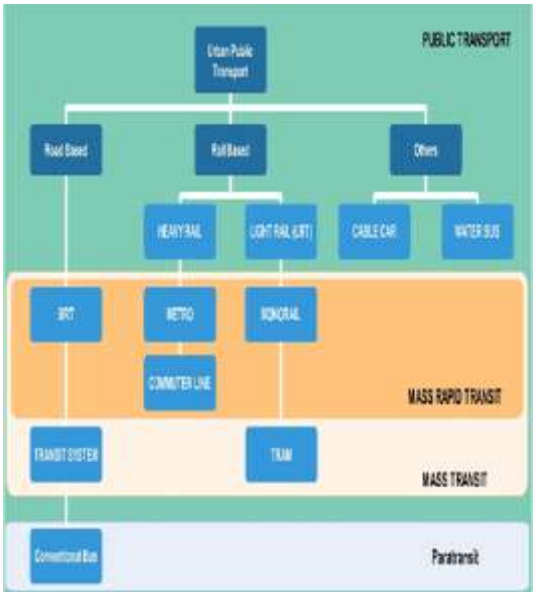

Figure 1. Types of public transport (Zuhdy,2017)

Furthermore, according to Munawar [8] and Haring [9], urban mass public transport based on railways is considered to be several types, namely: a). HRT (Heavy Rail Transit), a train that is operated on a special road and does not cross a highway; b). LRT (Light Rail Transit), an electric tram that operates in the city, generally operates on the highway with other vehicles (mix traffic), but can also be operated underground or on highways; c). Metro, a type of HRT, is an urban train with a separate track and is not in line with the highway, better known as Mass Rapid Transit (MRT); d). Commuter trains, a type of train operated in urban areas.

This LRT and tram does not require wide space so that it can be operated in various city conditions, such as [9]: a). along with other vehicles on the highway; b). together with the bus, on the tram and lane bus; c). pedestrian; d). green lane on wide roads. If there is no place on the road surface, it can be operated underground or elevated as in Palembang and Jakarta.

1.2 **The main factor**

1.3 The results of the literature study found that there were other ain factors that determine the choice of public transport besides the factor of city size / population. There were at least 9 main factors [3], namely:

1. City size / population
2. City function
3. Land use
4. Cost / fare and travel time
5. Existing public transportation / integration
6. Technology used
7. Regional and community / Fiscal economic capabilities
8. Transportation Policy
9. Infrastructure.

1.3 Analytical Hierarchie Process (AHP)

Analytical Hierrarchie Process (AHP) is one method for making decisions with diverse criteria and considering the complexity of the problem in a simple way, but still ensures the consistency of decisions taken [10]. This method utilizes the perception of respondents who are considered experts as the main input. The criteria of the experts here are not geniuses or smart but rather refer to people who understand the problem correctly, feel the consequences of a problem, or have an interest in the problem. This method was chosen because it is simple, easy to understand, provides a scale of measurement and methods to get priority. AHP also considers logical consistency in assessments that are used based on priority.

II. METODE

To get a good formula, the research was carried out in 3 stages, namely: 1. Literature and comparative study, 2. Analytical Hierrarchie Process (AHP), 3. Focus Group on Discussion (FGD) [11]. The research flowchart is as follows.

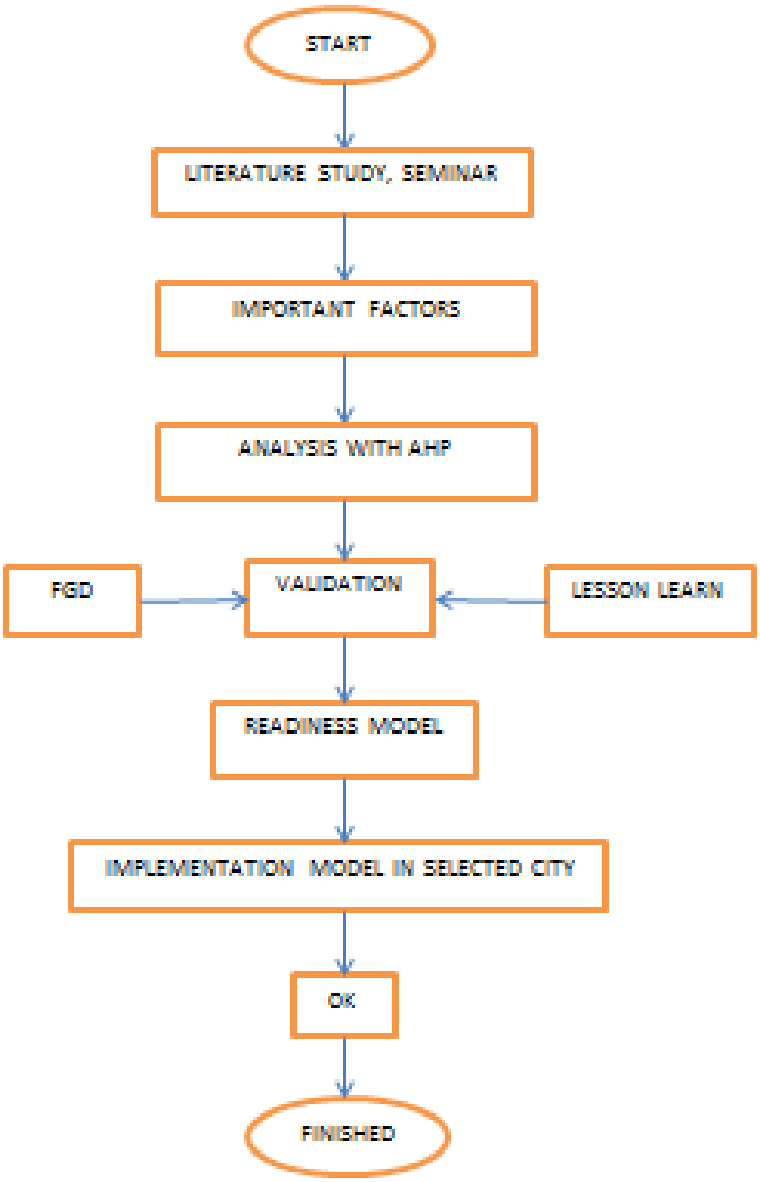

Figure 2. Research flow chart

Comparative studies were carried out on 20 selected cities in the world that have implemented public transportation based on railways. 10 cities in Europe were chosen to represent established cities and 10 cities in Asia, representing developing cities, so that it can be seen how far the main factor plays a role. The results of comparative studies from some of the cities are as shown in Table 1. below.

Tabel 1. Hasil komparasi 20 Kota Terpilih

NO	CITY	POPULATION (million)	CITY FUNCTION	LANDUSE	INTEGRATION	FISCAL	POLICY	INFRASTRUCTURE
1	AMSTERDAM	1,317	Business&culture	Compact	Good	US 46.440/cpt	Good, TOD	Good
2	DEN HAAG	0,510 city 0,657 urban	Government, Business and Culture, Tourism	Compact	Good, integrated	US 52.249/cpt	Good, TOD, rede-velopment	Good, route through residential and activity center
3	UTRECHT	0,330	Business&culture, And education	Compact	Good, integrated	n.a	Good, station open 24 hours	Good, at every end of the road there is halte
4	PARIS	2,241	Government, Business, Tourism, Cultute, Sport	Old cityand sub urban	Good, integrated	US 46.800/cpt, GDP Paris 30% French	Good, PnR, City entry restriction	Good, route passes throguh all part of the city
5	PRAHA	1,259 city 2,156 urban	Government, Business, art and Education	Old and new city	Good, integated, Bus, Tram, taxi, subway	US 49.384/cpt	Good, there is a path for diffables	Good, 2/3 of population uses publick transport
6	BEIJING	21,5 city 18,59 urban	Government, Business	Old and new city	Good, integrated	US 16.150/cpt	Good, sub urban, PnR	Good, reach all city areas
7	DHAKA	14,3	Government, Business, Industri	Sprawl	Rickshaw, taxi	US 3.100/cpt	Good, there is planning a head	Not good, not all area affordabale
8	SINGAPURA	5,399	Government, Business	Compact, City State	Good, integrated	US 56.319/cpt	Good, ERP,TOD	Good, in 2020 10 minuteto halte
9	FREIBURG	0,22	Tourism and Art	Old city, Agricultute, education	Integrated, trem, bus n commuter rail, also car share	US 33.353/cpt	Good, priority For public transport	Good, reach all cityareas
10	ZURICH	0,400 kota 1,315 urban 1,83 metro	Business, culture	Compact, development around the citty	Good, integrated		Good, priority for public transport	Good, reach all cityareas
11	HONGKONG	7,2	Government, Business	Compact	Good, integrated	US 42.437/cpt	Good, TOD	Priority for Public Transport
12	TOKYO	13,682	Government, Business, Culture, Education	Compact	Integrated	US 54.285/cpt	Good ,TOD	Priority for Public Transport
13	ROTERDAM	0,624 city 1,015 urban	Business	Compact	Good, integrated		Good, TOD	Good, reach all city areas
14	MANCHESTER	2,48	Industri	Compact	Good, integrated	US 35.029/cpt	Good, greenbelt,	Good, reach all city areas
15	LONDON	8,6 city 9,787 urban 13,879metro	Government, business, Education	Compact, Satellite town	Good, integrated	US 51.680/cpt	Good, greenbelt, Satellite, PnR	Good, all connected
16	BANGKOK	8,28 city 14,5 metro	Government, Business,Ttourism, Art	Sprawl	Multimoda	US 14.301/cpt	Good, integrated	Good, there is water transportation
17	NEW DELHI	0,250 city 21,753 metro	Government, Business, Culture	Compact, Satellite town	multimoda, integrated	US 6.860/cpt	Good, Satellite town	Good, highway, rail, and airport
18	SEOUL	10,117 city 25,620 metro	Government, Business, Tourism, Culture	Compact	Multimoda, integrated	A city with the world's 6th competitive finance, US 34.355/cpt	Good, Public Transport is a mainstay	Good, rail domination
19	MANILA	1,652 city 11,855 urban 22,710 metro	Government, Business, Tourism, Culture	Compact, Developing	Multimoda, jeepney, auto rickshaw, bus		Integrated	Good, reach the city area
20	KUALA LUMPUR	1,627 city 7,200 metro	Center culture, economic, finance , capital city	Compact, Developing	Multimoda	US 25.726/cpt	Integrated	Good, reach the city area

Sumber:

Table.1. above shows that cities that have implemented rail-based mass public transport have high capita income,integration between public transport is goodbesides that the population is densely populated. Furthermore, the major role is the government's policy to prioritize public transport rather than private vehicles and have integrated urban spatial planning with transportation. Freiburg and Zurich as a city-based urban public transport pilot city have succeeded in raising public transport passengers and reducing private vehicle ownership [11].

Furthermore, the main factors obtained were analyzed and searched for the sequence using the Analytical Hierarchie Process (AHP) method. The compiled questionnaire is sent to respondents spread in several cities in Indonesia. Respondents are experts, academics, practitioners, bureaucrats, consultants and all those involved in the world of transportation, especially railways. AHP used is an expert system from K.D. Goespel version 2014 with a maximum number of criteria 10, consistency ratio (CR) max 10%. The scale used from 1 to 7 is:

linear, logaritchmic, Root Square, Inverse linear, Balanced, Power and Geometric.

The results of the questionnaire obtained were analyzed by AHP K.D. Goespel 2014 version scales 1 to 7 to be seen as the most consistent or the lowest consistent value. In Table 2 below, the results of the analysis with AHP which has the most consistent value is AHP with a scale of 4 which is linear inverse with a CR value of 0.3% far below the CR value of max 10%

Table 2. Recapitulation of CR scale 1-7

No	Skala	alpha	GCI	CR	Lambda
1	Skala 1, linier	0,1	0,005	1,4 %	9,158
2	Skala 2, logaritma	0,1	0,02	0,5 %	9,057
3	Skala 3, root square	0,1	0,01	0,3 %	9,039
4	Skala 4, inverse linear	0,1	0,01	0,3 %	9,037
5	Skala5, balanced	0,1	0,02	0,5 %	9,053
6	Skala 6, power	0,1	0,2	5,7 %	9,660
7	Skala 7, Geometrik	0,1	0,16	4,3 %	9,50

Thus, the next calculation used is the results of the scale 4 AHP analysis. To further strengthen the results of the analysis, then the results of the analysis obtained are validated by discussions in the Focus Group on Discussion (FGD) in the Jakarta Transportation Board (DTKJ) and the City Development Planning Board (Bappeko) Surabaya. In the FGD in Jakarta and Surabaya, the FGD participants agreed with the results of the analysis obtained.

The results of the preliminary of the study, the order of important factors with the AHP K.D. Goespel 2014 version of scale 4, as in table 3 below:

Table.3. Result of analysis AHP scale 4

Criterion	Comment	Weights (%)	Ranking
1.Fiscal	Regional economic capacity and society	16.7	1
2.Policy	Transportatio policy	13.8	2
3.Land use	Compact, Sprawl, Satellite city	11.2	3
4.Public transport	Integration wiyh existing public transport	11.1	4
5.Cost and time	Cost/ticket and travel time	10.7	5
6.Infrastructure	Infrastructure of transportation	10.7	6
7.City function	Business, Government, Education, Tourism	9.5	7
8.City size	Based on population	9.3	8
9.Technology	Vecicle used, MRT, LRT, Tram	7.1	9

The order of these important factors is:
1) Fiscal (regional and community economic capacity) 16.7%
2) Transportation Policy 13.8%
3) 11.2% land use
4) Integration with existing public transport 11.1%
5) Costs (rates) and length of travel time 10.7%
6) Infrastructure 10.7%
7) City function (business, tourism, education, government)) 9.5%
8) City size (small, medium, large, metropolitan) 9.3%
9)Ttechnology 7.1%

III. RESULT AND ANALYSIS

The results of the three stages, namely comparative studies, analysis with AHP and FGD can be drawn conclusions about the level of readiness of the city in carrying out urban mass public transportation based on railways. It turns out that the city readiness level (Y) is a function of important factors (X). Thus it can be written Y = f (X_1, X_2, X_3 …… .X_9

Furthermore, the city readiness model can be written;

$Y= aX_1+bX_2+cX_3+dX_4+eX_5+fX_6+gX_7+hX_8+iX_9$, with:

Y= Indicator of the readiness of the city in conducting railroad-based urban mass transportation.

X_1, X_2, X_3 ……X_9=important factors (economic capacity, transportation policy, etc)

a, b, c ……..…i = constants are taken from the weight of the results of the analysis with AHP

So that the equation can be written:

$Y=0,167X_1+0,138X_2+0,112X_3+0,111X_4+0,107X_5+0,107X_6+0,095X_7+0,093X_8+0,071X_9$

Y count results are grouped into 5 categories, as shown in table 4.

Table4. City readiness

Y	Explenation
< 0.5	The city is not ready yet
Between 0.5-0.6	The city is not yet fully ready
Between 0.6-0.7	The city is ready
> 0.7 until<1	The city is better prepared
= 1	The city is very ready

The scale of values for each important factor is also divided into 5 value scales, namely: 0; 0.25; 0.5; 0.75; 1 according to the conditions of each important factor. The value / weight scale table of each important factor as in table 5 and so on below.

Tabel 5. Scale of importan factors 1

Weight	**Income per capita/ year (million)**
0	≤ 65
0.25	65 –109
0.5	>109 – 153
0.75	>153 – 198
1	≥ 198

Tabel 6. Scale of important factor 2

Weight	**Policy and implementation process**
0	There are no rules and planning
0.25	Incomplete rules are partially implemented
0.5	Incomplete rules are implemented, there is planning
0.75	Complete rules are partially implemented, there is planning
1	Complete rules are implemented

Tabel 7. Scale of important factor 3

Weight	**Land use**
0	Sprawl, uncontrollable
0.25	Compact and sprawl, distance transit point>400 m
0.5	Compactand sprawl, have a satellite city, transit point<400 m
0.75	Compact, distance to transit point maximum 10 minute by walk
1	Compact, distance to transit point<400 m

Tabel 8. Scale of important factor 4

Weight	**Integration with existing public transport**
0	Not integrated
0.25	Systemic integrated, incomplete
0.5	Systemic integrated, complete
0.75	Physically integrated, incomplete
1	Physically integrated, complete

Tabel 9. Scale of important factor 5

Weight	**Cost and travel time**
0	More expensive and longer/ same
0.25	More expensive and faster
0.5	Cheaper and faster, compatibility with the schedule 71-80%
0.75	Cheaper and faster, compatibility with the schedule 81-100%
1	Cheaper and faster

Tabel 10. Scale of important factor 6

Weigh t	**Transfe r facility**	**Par k n Ride**	**Halt e**	**Route informa tion and schedule**
0	No	No	No	No
0.25	Yes	Yes	Less	No
0.5	Yes	Yes	Less	No
0.75	Yes	Yes	Yes	incomplet e
1	Yes	Yes	Yes	Yes

Tabel 11. Scale of important factor 7

Weight	**City function**
0	Not a city of tourism, education, business or government
0.25	Tourism
0.5	Tourism, education
0.75	Tourism, education, business
1	tourism, education, business or government

Tabel 12. Scale of important factor 8

Weigh t	**Size of city/population**
0	Population<500.000 person
0.25	500.000 – 750.000 person
0.5	750.000 – 1.000.000 person
0.75	1.00.0 2.500.000 person
1	>2.500.000

Tabel 13. Scale of important factor 9

Population (thousand)	**Technology**
<500	Trem
500-700	Trem/monorel/LRT
750-1.000	Trem+monorel/ LRT
1000-2500	MRT atau LRT+Trem
>2500	MRT+Trem/Monorel/LRT

Furthermore, the model obtained was tried to be applied to see the readiness of the city of Semarang. Important factors in the city of Semarang in accordance with the conditions, as follows.

Tabel.14 Data importan factor of Semarang city

Factor	Explanation	Weight
X_1	Income percapita/year Rp.72. 483 million	0.25
X_2	Policy, complete rules are implemented	1
X_3	Land use, compact and sprawl	0.5
X_4	Public transport, systemic rintegrated	0.5
X_5	Cheaper and faster	1
X_6	Infrastructure of transportation incomplete	0.5
X_7	City of tourism, education, business and goverment	1
X_8	Size of city, population> 1 million	0.75
X_9	Technology, MRT, LRT, Trem	1

entered into the equation

Y = (0.167 x 0,25) + (0,138 x 1) + (0,112 x 0,5)+ (0,111 x 0,5) + (0,107 x 1) + (0,107 x 0,5) + (0,095 x 1) + (0,083 x 0,75) + (0,071 x 1)

Y = 0,687 atau 68,7 %

The value of Y = 0.6 - 0.7, according to Table 4. it means that the city of Semarang is ready to hold a railway-based public transport. Semarang is categorized as ready because more than 60% of the important factors that influence the procurement of railroad-based urban mass public transport are ready.

Furthermore, the results of the preparedness model obtained were tried to see the readiness to implement urban mass-based public transportation based on railways in selected cities, namely: Surabaya, Bandung, Yogyakarta and Magelang as shown in table 3 below.

Table 3. Readiness of selected city.

No.	**City**	**Y**	**Explanation**
1	Surabaya	0,714	City is better prepared
2	Bandung	0,687	ready
3	Yogyakarta	0,569	City is not yet fully ready
4	Magelang	0,420	Not ready yet

As a result, Surabaya is better prepared, Bandung is ready, Yogyakarta is not fully prepared and Magelang is not ready. Furthermore, the results of the readiness model obtained are validated with the local government (Bappeda / Bappeko / Department of Transportation) and the results are in accordance with reality. That is, this model can be used as an early detection of the readiness of the city in implementing railroad-based urban mass public transportation.

IV. CONCLUSION

4.1.Conclusion

1. To carry out an urban mass public transportation based on railways, there are several important factors that need to be considered, namely: Fiscal, Transportation Policy, Existing public transportation, Land use, Cost and travel time , Infrastructure, City functions, City size and Technology.
2. The equation model obtained can be used to detect early on the readiness of the city in carrying out urban mass transportation based on railways.

4.2.Recomendation

After the city is declared ready to implement railway-based public transport, it is necessary to check further with economic and financial feasibility studies.

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