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Research Paper

Development of Transport System to Support Sustainable City (Case study in Batu City, East Java Indonesia)

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Abstract: *Batu City is a significant icon of tourism development in East Java. Based on 2019 tourism data, more than 6 million tourists were visiting Batu City. A Green City concept is needed as part of a solution to overcome transportation and pollution problems in the city. One of the modes it wants to develop is the Ropeway. The Ropeway increases connectivity between tourist objects and can be an innovation for tour sites in Batu city. The route selection of Ropeway used several aspects of evaluation, which are then analyzed and selected from the results of the assessment criteria. The route includes Kusuma Agro – Cilik mount, Jatim Park 3 – Panderman mount, and Selecta Park – Jengkoang Hill. In addition, to realize the Green City concept of Batu, it is also recommended that the Electric Bus transportation mode for an arterial route, and Microbus electric transportation modes for non-arterial routes. The development of sustainable transportation is an alternative solution to reduce the number of vehicles and pollution to create an Eco-Tourism City. A buffer area serves as a parking area and as an Electric Bus pick-up point. The buffers are Karangploso-, Sengkaling UMM, Pujon buffer, and Selecta buffer.*

Keywords: *Ropeway, electric bus, buffer, transportation mode.*

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I. INTRODUCTION

The Batu City area consists of 3 (three) sub-districts, Batu, Junrejo, and Bumiaji sub-districts Batu City is in 122°17'-122º57'E and 7°44'-8º26'S with an area of 199.09 km2 or 0.42 percent of the total area of East Java (BPS Batu City, 2020). Slope and hilly areas have more expansive proportions than plain areas. Overall land use includes; public facilities forest, protected forest, production forest, industry and warehousing, tourism area, trade and service area, agriculture, housing, Open Space (RTH), Grand Forest Park, River Border, and SUTT Border.

The existing climate is the rainy season and the dry season. The rainfall that occurs based on 2019 BMKG data from the Karangploso Climatology Station reaches an average of 103 mm/month with a total of 149 rainy days. And the highest average humidity occurs in June, which is 94%. Batu City became one of the greatest icons in tourism development in East Java. Based on Batu City Tourism data 2019, more than 6 million tourists visited Batu City, where there was a 50% increase in tourists from the previous year, which was about 3 million tourists in 2018.

To offset the development of the number of tourists who come to the city of Batu and cause transportation problems and air pollution, the concept of Green City is one of the solutions to overcome transportation and air pollution problems. One of the modes it wants to develop is Ropeway. Ropeways plan to serve to improve connectivity between tourist attractions. In addition to being a problem solver of transportation and tourist pollution in Batu, Ropeway, also an innovation for tour sites of Batu City, which is quite promising.

1.1 Aims of Research

The aims of this research include:

1. Description of the location planning point for green transportation modes.
2. Recommendations for green transportation routes/traces based on the results of the study
3. Provide an initial description of the Socio-Economic study and other aspects to support recommendations.

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4. Obtain the initial concept for the development of Integrated Transportation Modes towards the Green City of Batu City.

1.2 Benefits of The Research

The benefits derived from this research include:

1. As a source of information and knowledge regarding the development of transportation systems to support sustainable cities
2. As an additional reference for learning on transportation system studies,
3. As a recommendation for an alternative transportation system towards Sustainable City.

II. METHOD AND MATERIALS

This research has conducted several things, including surveys of the location of trace plan points, studies, and analysis of interrelated aspects. Has conducted a site survey of planned points and traces, especially strategic location points that intersect with tour sites, considering several aspects such as view/panorama, land area, population density and accessibility of location points, connectivity with the tour sites, and others. From these points are further planned a line/trace that connects between points as a line/trace plan for Ropeway transportation modes.

The results of this study are in the form of recommendations of pathways/traces that can use in the next stage. The recommended routes are the North Brantas Line and the South Brantas Line. The purpose of the division of the line with consideration of regional development, the northern line to increase tourism potential tends to still be very minimal compared to the southern line. In addition to being tourist attractions, the southern lanes are also intended for tourist mobility facilities so that there is a reduction in the use of private modes, and the hope is to reduce the level of congestion during peak hours. The South Brantas Line is a path that connects Jatim Park 3 to Panderman mount Tourism. This path through strategic tour sites of Batu City such as Jatim Park 2, Kusuma Agro, and Seruk mount, and a maneuver mode of transportation access to Batu City from the direction of Malang City in the subsequent development.

The selection of this path, in general, has taken into account tangent points with tour sites considering that this path is in the center of Batu City. At the same time, the North Brantas line connects Selecta Recreation Park Tourism to Coban Talun Tourism. The selection of recommendations 3 (three) of this path has strengthened several aspects and studies, including Economic and Social Studies and strategic points with expected to grow new tourist activity points so that the concentration of activity divide and not concentrate in the city center that causes congestion.

III. RESULTS AND DISCUSSIONS

3.1 Trace selection

The selection of the route used on several essential aspects. As the rationale for decision-making is carrying capacity and consideration. Besides, direct observation and investigation are needed to consider other possibilities in decision-making.

3,2 Carrying Capacity

Traces selection used on the results of scalogram of analysis rankings consisting of several aspects of assessment, from 6 (six) routes that have established at the beginning of the analysis and further consideration of carrying capacity, which includes aspects of Attraction, Facilities, and Pre-Tourism Facilities, Infrastructure, and Socio-culture. Then all aspects in approving as a consideration material included in the assessment criteria. The assessment is:

Attraction (Covering Beauty, Climate, Naturalness, Uniqueness, Attractiveness, and Environmental Preservation); Tourist Facilities (Includes Transportation, Travel Bureaus and Communication Tools); Tourist Infrastructure (Includes Accommodation: Inn/Hotel/ Rest, Restaurant/ Restaurant); Infrastructure (Includes Irrigation, Power Sources, Communication Systems, and Security Systems); Social and Cultural (Covering Society, Environment, and Culture)

From the Assessment Criteria then performed scoring/assessed scale 1-5 then sorted from the highest value to the lowest value as follows:

Table 1: Results of Scalogram Analysis

Trace	Consideration Aspects					Total	Rank	Route
	A	TI	TF	I	SC			
Route 1	69	10	25	37	21	162	3	South
Route 2	90	11	19	33	21	174	1	South
Route 3	54	15	28	41	21	159	4	South
Route 4	36	18	36	45	21	156	5	South
Route 5	102	5	12	29	21	169	2	North
Route 6	90	4	6	25	21	146	6	North

Notes : A = Attractiveness, TI = Tourist Infrastructure, TF = Tourist Facilities, I = Infrastructure, SC = Social Culture
Source: Analysis result

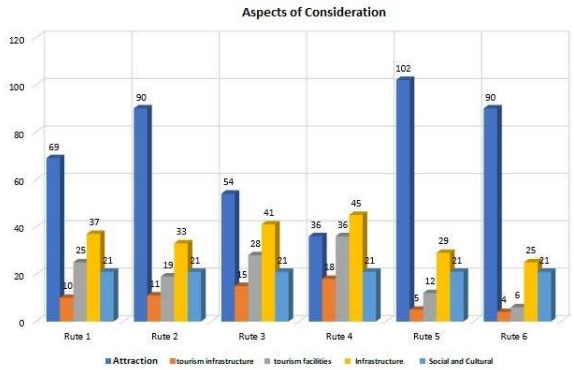

Figure 1. Scoring Results of Carrying Capacity of trace (Source: Analysis result)

From the results of scoring obtained trace rating 1-6, Trace 2, 5, 1 and others, from the results of scoring, this is the basis of selecting the following stage trace.

Trace selection results

The determination of trace chosen after a long process was then determined as follows:

1. Route South of Brantas river
   - ✓ Trace 1: Kusuma Agro – Cilik Mount.
   - ✓ Trace 2: Jatim Park 3 – Panderman Mount.
2. Route North of Brantas river
   - ✓ Trace 3: Selecta Park – Jengkoang Hill.

The description of the trace path is as follows:

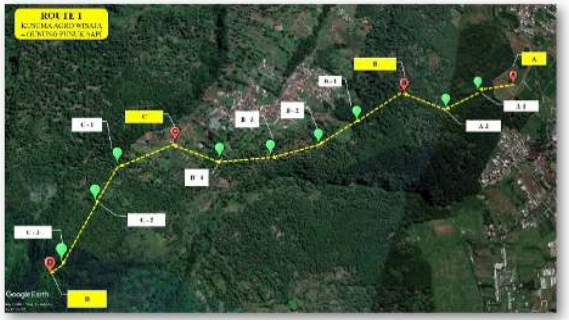

Figure 2. Trace 1 (Source: Survey and Analysis result)

Figure 3. Trace 2 (Source: Survey and Analysis result)

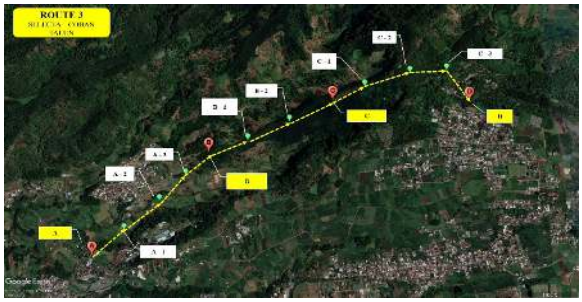

Figure 4. Trace 3 (Source: Survey and Analysis result)

Buffer Area

Buffer area plan for parking vehicles enters the Batu city area according to the public transportation lanes to Batu City, which was in Karangploso UMM, Sengkaling UMM, Selecta, and Pujon.

✓ *Buffer area (Karangploso UMM)*

The parking area plan for the Karangploso UMM area is intended for vehicles from Karangploso, Singosari, Lawang and for public vehicles exiting the Singosari toll gate. There are 3 (three) options for buffer area in the Karangploso UMM, option A with an elevation of ± 565 m-MSL and a land area of 65,322 m2, option B with an elevation of ± 617 m-MSL, and a land area of 39,658 m2, and option C with an elevation of 636 m-MSL and a land area of 10,538 m2. For the buffer area distance option A to Sengkaling UMM as far as 8.12 km and options A to WESB or Jatim Park 3 as far as 6.88 km.

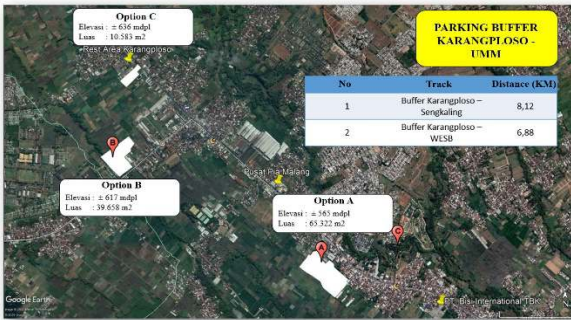

Figure 5. Buffer Plan of Karangploso UMM (Source: Survey and Investigation result)

✓ *Buffer area (Sengkaling UMM)*

The parking area plan of the Sengkaling UMM area is intended for vehicles from Malang City and Malang District area. There are 3 (three) options for buffer plans in the Sengkaling UMM area; option A is behind the waterpark with an elevation of ± 565 m-MSL and a land area of 15,305 m2, option B is next to the Dome before the new bridge with an elevation of ± 558 m-MSL and a land area of 7,318 m2, and option C is after the new bridge with an elevation of ± 555 m-MSL and a land area of 5,016 m2. For the distance of the buffer plan of Sengkaling UMM to WESB or Jatim Park 3 as far as 6.22 km.

Figure 6. Buffer Plan of Sengkaling UMM (Source: Survey and Investigation result)

✓ *Buffer area (Pujon)*

The parking area plan for the Pujon region is intended for vehicles from the Pujon area, Blitar region, and Kediri region. There are 3 (three) options for buffer plans in the Pujon area, option A is around Santera De Laporte with an elevation of ± 1180 m-MSL and a land area of 33,185 m2, option B with an elevation of ± 1156 m-MSL and a land area of 15,744 m2, and option C is around the Rest Area of Pujon Paragliding with an elevation of 1192 m-MSL and a land area of 12,392 m2. The buffer plan Pujon option C to the center of Batu City is as far as 7.78 km, and the distance to WESB or Jatim Park 3 is as far as 12 km.

Figure 7. Buffer Plan of Pujon (Source: Survey and Investigation result)

✓ *Buffer area (Selecta)*

The parking area plan for the Selecta area is intended for vehicles from Cangar area, Mojokerto region, and vehicles exiting the new tollgate later planned around Cangar/Mojokerto. There is 1 (one) option for a buffer plan in the Selecta area, namely option A is around Selecta Park with an elevation of ± 1080 m-MSL and a land area of 21,373 m2, For the distance of Selecta buffer plan options A to Batu City Square as far as 5.78 km.

Figure 8. Buffer Plan of Selecta (Source: Survey and Investigation result)

Lines and Stops of Electric Bus/Electric Microbus

The plan of the Ropeway mode can not be separated from the development of supporting facilities. To realize the concept of Green City Batu City, other modes of transportation as a support for transportation in the city are fundamental. One recommended transportation plan is The Electric Bus mode of transportation for arterial lines (main lines) and Electrical Microbus modes of transportation for non-arterial (Secondary) roads.

Recommendations this Electric Bus mode and Microbus has considered various aspects. Here are the advantages of electric buses with ultrafast battery charging system configuration and equipped with battery reuse system;

1. Use an ultra-fast charging system (smart battery + extra fast charger) and significantly reduce charging time;
2. The battery can be reused after going through a direct analysis of the remaining performance data of sCib™ (depending on the extent of battery damage).

In addition, this electric bus also has a sensing operating system for traffic conditions. The advantages are:

1. Provide predictive information about traffic density and free roads;
2. Monitor traffic conditions directly through Visconti2™, i.e., cameras equipped with image processing chips;
3. Provide satellite monitoring results in information depiction of traffic conditions and estimate the accessible route through the map screen inside the bus.

Figure 9. Electric Bus Route Plan and Sengkaling Line Microbus
(Source: Survey and Investigation result)

Table 2. Points of Sengkaling Line Electric Bus Stop

SENGKALING LINE			
Departure	**Arrival**	**Mode of Transportation**	**Distance (Km)**
Buffer of Sengkaling	Dadaprejo	*Electric Bus*	0,5
Dadaprejo	Pendem	*Electric Bus*	1,6
Pendem	Junrejo Directions	*Electric Bus*	1,7
Junrejo Directions	Jatim Park 3	*Electric Bus*	0,9
Jatim Park 3	Beji	*Electric Bus*	.,M
Beji	Batu Market Intersection	*Electric Bus*	.,M
Batu Market Intersection	Batos	*Electric Bus*	0,4
Batos	Pattimura	*Electric Bus*	0,7
Pattimura	KWB Square	*Electric Bus*	0,5
KWB Square	Bhayangkara Hospital	*Electric Bus*	0,6
Bhayangkara Hospital	Suropati Junction	*Electric Bus*	0,5
Suropati Junction	Transport Museum	*Electric Bus*	0,4
Transport Museum	Jatim Park 1	*Electric Bus*	0,5
Jatim Park 1	Imam Bonjol	*Electric Bus*	0,7
Imam Bonjol	Batos	*Electric Bus*	0,5

Source: Analysis results

Table 3. Points of Microbus Stop Sengkaling Line

SENGKALING LINE			
Departure	**Arrival**	**Mode of Transportation**	**Distance (Km)**
Pendem	Arhanud 2	*Microbus*	1,0
Arhanud 2	Arhanud 1	*Microbus*	1,0
Arhanud 1	Karangploso Market	*Microbus*	1,0
Jatim Park 1	Junrejo	*Microbus*	1,7
Junrejo	Predator Fun Park	*Microbus*	1,3
Predator Fun Park	Oro-Oro Omdo	*Microbus*	2,2
Oro-Oro Omdo	BNS	*Microbus*	1,7
BNS	Jatim Park 2	*Microbus*	1,0
Transport Museum	Kusuma Agro	*Microbus*	1,1
Kusuma Agro	Jalibar	*Microbus*	2,6
Jalibar	Coban Rais	*Microbus*	1,7
Transport Museum	Kusuma Agro	*Microbus*	1,1
Kusuma Agro	Jalibar	*Microbus*	2,6
Suropati Junction	Srebet	*Microbus*	1,3
Srebet	Seruk	*Microbus*	2,6
Seruk	Panderman Hill	*Microbus*	2,0

Source: Analysis results

Figure 10. Electric Bus Route Plan and Karangploso Line Microbus
(Source: Survey and Investigation result)

Table 4. Points of Karangploso Line Electric Bus Stop

KARANGPLOSO LINE			
Departure	**Arrival**	**Mode of Transportation**	**Distance (Km)**
Buffer of Karangploso	Karangploso Market	*Electric Bus*	1,0
Karangploso Market	Karangploso 1	*Electric Bus*	1,0
Karangploso 1	Karangploso 2	*Electric Bus*	1,5
Karangploso 2	Karangploso 3	*Electric Bus*	1,6
Karangploso 3	Karangploso 4	*Electric Bus*	.,M
Karangploso 4	Karangploso 5	*Electric Bus*	2,1
Karangploso 5	Alternative Junctions	*Electric Bus*	1,3
Alternative Junctions	KWB Square	*Electric Bus*	.,M

Source: Analysis results

Figure 11. Electric Bus route plan and Pujon Line Microbus
(Source: Survey and Investigation result)

Table 6. Points of Pujon Line Electric Bus Stop

PUJON LINE			
Departure	**Arrival**	**Mode of Transportation**	**Distance (Km)**
Buffer of Selecta	Coban Talun	*Microbus*	4,7
Coban Talun	Sumber Brantas 1	*Microbus*	5,3
Sumber Brantas 1	Sumber Brantas 2	*Microbus*	1,3
Sumber Brantas 2	Cangar	*Microbus*	1,45
Buffer of Selecta	Jengkoang	*Microbus*	0,0
Buffer of Selecta	Punten Rest Area	*Electric Bus*	3,5
Punten Rest Area	Alternative Junctions	*Electric Bus*	1,1
Alternative Junctions	AlunAlun KWB	*Electric Bus*	1,28

Source: Analysis results

Figure 11. Electric Bus Route Plan and Selecta Line Microbus
(Source: Survey and Investigation result)

Table 7. Selecta Line Electric Bus Stop points

SELECTA LINE			
Departure	**Arrival**	**Mode of Transportation**	**Distance (Km)**
Buffer of Selecta	Coban Talun	*Microbus*	4,7
Coban Talun	Sumber Brantas 1	*Microbus*	5,3
Sumber Brantas 1	Sumber Brantas 2	*Microbus*	1,3
Sumber Brantas 2	Cangar	*Microbus*	1,45
Buffer Selecta	Jengkoang Hill	*Microbus*	0,0
Buffer Selecta	Punten Rest Area	*Electric Bus*	3,5
Punten Rest Area	Alternative Junctions	*Electric Bus*	1,1
Alternative Junctions	AlunAlun KWB	*Electric Bus*	1,28

Source: Analysis results

IV. CONCLUSIONS

1. Batu City has many potentials that can be developed, including the icon of Batu City as a tourism city. Starting from the environmental conditions of Batu city related to climate change and changes in community activities that mostly switched from the traditional agricultural sector shifted in the trade sector to switch to the tourism industry sector. Many artificial attractions in Batu cause a shift in tourist orientation, causing congestion and increasing air pollution due to the increasing number of visitor vehicles. With its cold air and cool climate, the Batu City memories are now slowly starting to disappear. It needs to be followed up immediately not to cause more severe problems.
2. Selected trace after through a long process set as follows: Route South of Brantas (Trace 1, Kusuma Agro–Cilik mount; Trace 2, Jatim Park 3– Panderman mount); Route North of Brantas (Trase 3, Selecta Park – Jegkoang Hill).
3. Based on Scalogram analysis of Ropeway trace with consideration of attractiveness, facilities, and infrastructure of the tour, infrastructure and socio-culture consecutive trace 1, 2, 3 gained points 174, 169, and 162. As for the arterial path using Electric Bus and non-arterial Electric Microbus.
4. The solution is to realize the concept of Green City Batu City, supported by the tourism icon of Batu city, then the concept of Green City can be achieved through Eco-Tourism City. As a real action in parsing problems, the transportation system's efficiency becomes very important and requires special attention. Sustainable transportation can be an alternative solution that can suppress the growth of vehicle numbers and pollution arising in Batu City. One mode of transportation development for sustainable cities is the Ropeway Mode and Electric Bus/Microbus.

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