

# Analysis of Rapid Transit (Brt) Bus Network Development in Ternate City

Mega Safitri Ajwan<sup>a,1\*</sup>, Dr. Ir. Endang Sugiharti M.Si<sup>b,2</sup>, Drs Suripno MSTR<sup>b,3</sup>.

<sup>a,b</sup> Trisakti Institute of Transportation and Logistics,  
Jakarta, Indonesia

**Abstract:-** Currently the City of Ternate is served by several public transportations, including In-Route Public Transportation served by urban Transport, while Non-Route Public Transportation is served by ojek. Based on the Decree of the Mayor of Ternate No. 86/IL.9/KT/2015 concerning route routes, there are 15 route permits, but the lack of demand for transportation users on one route leaves 14 urban transportation routes operating. The high use of private transportation in Ternate City causes a lack of use of public transportation, the results of the existing survey of private transport users reached 88% in 2020, and there are 5% of people who still use public transportation. The absence of adequate urban services has resulted in people choosing to use private vehicles. In addition, there is an overlapping level of routes that are above the tolerance based on the LLAJ SPM (50%), as well as route deviations which exceed the tolerance, which is 25% based on the LLAJ SPM. The behavior of public transport passengers in any place that causes side disturbances, traffic queues, congestion and accidents. So there needs to be a solution by developing a Bus Rapid Transit (BRT) Route Network in Ternate City. This research was conducted by analyzing the existing route network and transportation operations in the city of Ternate based on the LLAJ SPM, predicting the actual demand and potential passengers, planning the route network based on the potential demand for public transport service users using the Four Steps Model method, comparing the performance of the existing route network with the existing network. proposed route, determine alternative route network for Bus Rapid Transit (BRT) and analyze the Operational Performance of each alternative route network. In what was done, 9 route networks were offered according to the requests of users of public transport services for each route, which was then determined by alternative Bus Rapid Transit (BRT) route networks based on high demand and road network performance, as well as analysis of appropriate modes in the development of the route network. BRT in order to obtain the Best Alternative for the Development of the BRT Route Network in the City of Ternate.

**Keywords:-** Route Network Performance, Transportation Operational Performance, Road Network Performance, Bus Rapid Transit (BRT) Route Network.

## I. INTRODUCTION

At this time the City of Ternate is served by several public transportations including public transportation on route and public transportation not on route. Based on the Law of the Republic of Indonesia Number 22 of 2009, concerning Road Traffic and Transportation, article 37 paragraph (1), public transportation on routes in the city of Ternate is served by urban transportation, while public transportation not on routes in the city of ternate is served by motorcycle taxis. Based on the Decree of the Mayor of Ternate No. 86/IL.9/KT/2015 concerning city transportation routes in the city of Ternate, there are 15 routes that are allowed, but due to the lack of demand for transportation users on one route, some vehicles choose to change routes so that there are 14 transportation routes left. Operating city. Along with the rapid development that occurred in the City of Ternate and in line with the needs of the community to support activities and/or businesses related to offices, development centers, education, and so on. So it is necessary to have an appropriate public infrastructure development planning strategy in dealing with this, one of which is the development of land transportation, especially road transportation.

Based on data from a preliminary survey conducted in the City of Ternate, the use of private transportation reached 88% in 2020, on the other hand the number of public transportation uses continues to decline. Based on a survey, it is known that only 5% of the people of Ternate City are currently still using public transportation. The absence of adequate transportation services, resulting in people preferring to use private vehicles. In addition, there is an overlapping level above the route which is within tolerance, which is 50% based on the LLAJ SPM. And the deviation of the route which exceeds the tolerance is 25% based on the LLAJ SPM. (Source: Ternate City Transportation Service).

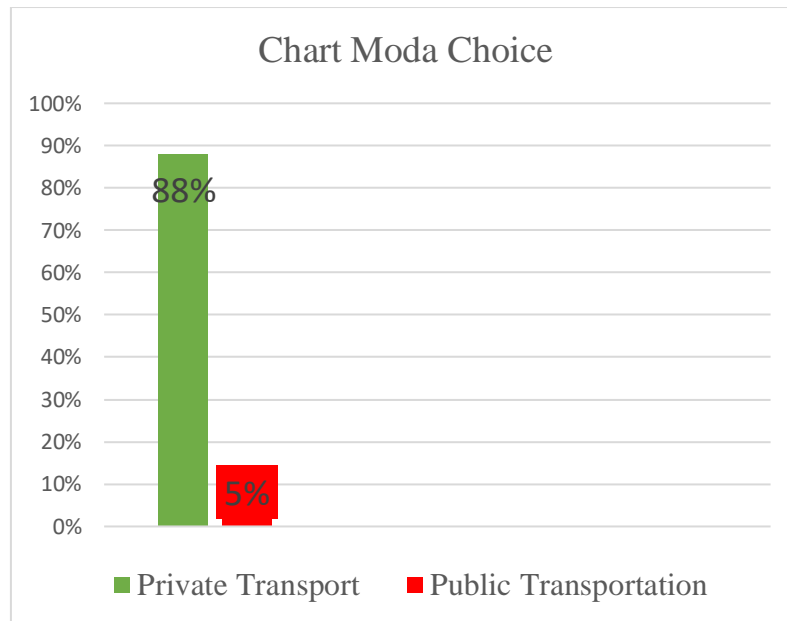


Fig. 1: Graph of Transportation Mode Users

Source: Survey Results (2020)

## II. METHODS

In this study, the author uses a descriptive method with a qualitative approach. Qualitative research is used by researchers as a scientific method to examine various problems such as in the fields of social science and education. Because qualitative research itself enriches the results of qualitative research. Qualitative research is carried out to build knowledge through understanding and discovery.

Basically the theoretical foundation in qualitative research rests fundamentally on phenomenology, according to Meoleong (2010:14 that, "Phenomenology is defined as a subjective experience or an awareness of a person's principal prefers". Observing the definitions above, the writer can conclude that the descriptive research method using a qualitative approach is a research method that provides a natural description and a clear, systematic, factual and accurate description in a study. Then the key instrument in research that prioritizes data quality, which means that the data is presented in the form of data or words obtained from the calculation of the statistical model used.

The research method used in this study is a descriptive research method with a qualitative approach that examines the Analysis of the Development of the Bus Rapid Transit (BRT) Route Network in Ternate City. The development of the Bus Rapid Transit (BRT) route network in the City of

Ternate itself is carried out by analyzing the performance of the existing public transport route network and proposals based on the LLAJ and World Bank SPM, and Route Network Loading using the VISSIM application, VISSIM is a transportation modeling program to analyze traffic conditions. existinglitas, forecasting that supports GIS data. VISSIM is used for (macroscopic planning). VISSIM is a transportation modeling development software used by Transportation Planners, which is then described using data and words or sentences.

## III. RESULT AND DICCUSSION

### A. Analysis of the performance of the route network and the existing operation of public transportation in Ternate City

The performance measure of the transportation service network emphasizes more on the efficiency of the service system and must be viewed at a macro level, performance indicators and standards that allow for an effective evaluation of a service system. From the results of the survey that has been carried out, the results of the analysis of the performance of the existing network are as follows:

- a. Evaluation of the Performance of the Existing Transport Network Based on (Decree of the Director General of Land Transportation No. 687 of 2002)

ANALISIS KINERJA JARINGAN					
TRAYEK	CAKUPAN PELAYANAN	TUMPANG TINDIH		PENYIMPANGAN TRAYEK	
1	0,88	70%	TM	20%	M
2	1,2	57%	TM	29%	TM
3	2,4	13%	M	55%	TM
4	0,4	75%	TM	50%	TM
5	1,2	11%	M	44%	TM
6	1,4	30%	M	48%	TM
7	0,4	91%	TM	22%	M
8	0,88	83%	TM	50%	TM
9	0,8	91%	TM	0%	M
10	3,28	71%	TM	0%	M
11	14,4	78%	TM	0%	M
12	17,6	78%	TM	0%	M
13	6,72	36%	M	0%	M
14	1,6	80%	TM	20%	M
TOTAL	52,16	4 M	10 TM	8 M	6 TM
	32%				

Table 2: Analysis of Existing Network Performance

Source: Data Review, Safitri Ajwan 2018

b. Evaluation of Existing Transport Operational Performance Based on (World Bank) – World Bank

ANALISIS KINERJA OPERASIONAL								
TRAYEK	FREKUENSI		LOAD FAKTOR		HEADWAY		WAKTU PERJALANAN	
1	17	M	40.71%	TM	3	M	23	M
2	11	TM	41.44%	TM	5	M	28	M
3	2	TM	79.69%	M	6	M	77	M
4	7	TM	40.36%	TM	8	M	36	M
5	10	TM	41.09%	TM	6	M	35	M
6	6	TM	55.65%	TM	9	M	36	M
7	13	M	45.51%	TM	4	M	48	M
8	15	M	37.58%	TM	4	M	47	M
9	9	TM	43.66%	TM	6	M	43	M
10	6	TM	49.52%	TM	9	M	32	M
11	1	TM	58.33%	TM	50	TM	59	M
12	1	TM	38.19%	TM	149	TM	56	M
13	1	TM	56.39%	TM	51	TM	48	M
14	4	TM	47.62%	TM	14	TM	37	M
TOTAL	3 M	11 TM	1 M	13 TM	10 M	4 TM	14 M	0 TM

Table 3: Analysis of Existing Transport Operational Performance

Source: Data Review, SafitriAjwan 2018

*B. Travel Request Analysis*

Analysis of the demand for travel on the proposed route network is carried out by considering the demand for public transportation (by Demand) throughout the Ternate City Region. The steps to determine the demand for public transportation are carried out by making a transportation model which is carried out with 4 modeling stages. After the model is formed, the proposed route can be proposed in several scenarios to choose the route with the best performance. Demand Potential is the potential for increasing the use of public transportation from private vehicles using public transportation, if improvements are

made to public transportation services which are considered a problem. Where this potential demand is obtained from interviews with people who have private vehicles. Based on the results of a survey of the interest of people who have private vehicles to move to public transportation if repairs are made, both improvements to facilities, infrastructure and services, it is obtained that the potential for private transportation users who have the desire to move using public transportation is obtained. Where the number of samples used is in accordance with the number of home interview survey samples in the study area, as shown in the following table,

Zone	Taxibike	Motorcycle	Car	Total
1	4	21	2	27
2	5	25	2	32
3	28	51	8	87
4	19	111	23	153
5	28	120	25	173
6	25	32	10	67
7	19	23	12	54
8	6	18	6	30
9	8	9	6	23
10	6	8	7	21

Table 4: List of Ternate City Moving Interest Survey Samples

Source: Processed data, Author 2021

To clarify the total distribution of people's interest in moving from private vehicles to public transportation, it can be seen in Table 5 as follows.

The following is the potential demand for public transportation in Ternate City:

O\D	1	2	3	4	5	6	7	8	9	10	Total
1	0	386	222	120	164	244	354	75	22	31	1617
2	189	0	1221	999	877	476	778	405	113	75	5134
3	142	787	0	1112	886	1037	1242	387	96	59	5748
4	286	1036	1531	0	1059	1376	2002	704	178	186	8357
5	372	693	1586	1078	0	1823	2927	790	270	167	9706
6	177	414	828	462	833	0	1179	767	240	192	5092
7	186	504	565	267	832	1228	0	489	275	245	4591
8	81	176	456	292	382	477	689	0	20	15	2589
9	22	44	22	55	127	149	309	695	0	18	1441
10	21	39	90	9	26	116	270	365	326	0	1262
<b>Total</b>	1476	4078	6520	4393	5186	6927	9752	4677	1540	988	45.536

Table 5: Potential Demand for Public Transport in Ternate

Source: Processed data, Author 2021

*C. Traffic Loading Analysis*

The analysis was carried out using the help of the Vissum Software. Based on the results of plotting Demand for each segment on the road network map, then Demand on the segment is connected based on the amount of Demand so as to form a route network that is made as a proposed

route for public transportation. The red line is the recommended route, because it has Demand Potential. The thickness of the line shows the level of demand for public transportation

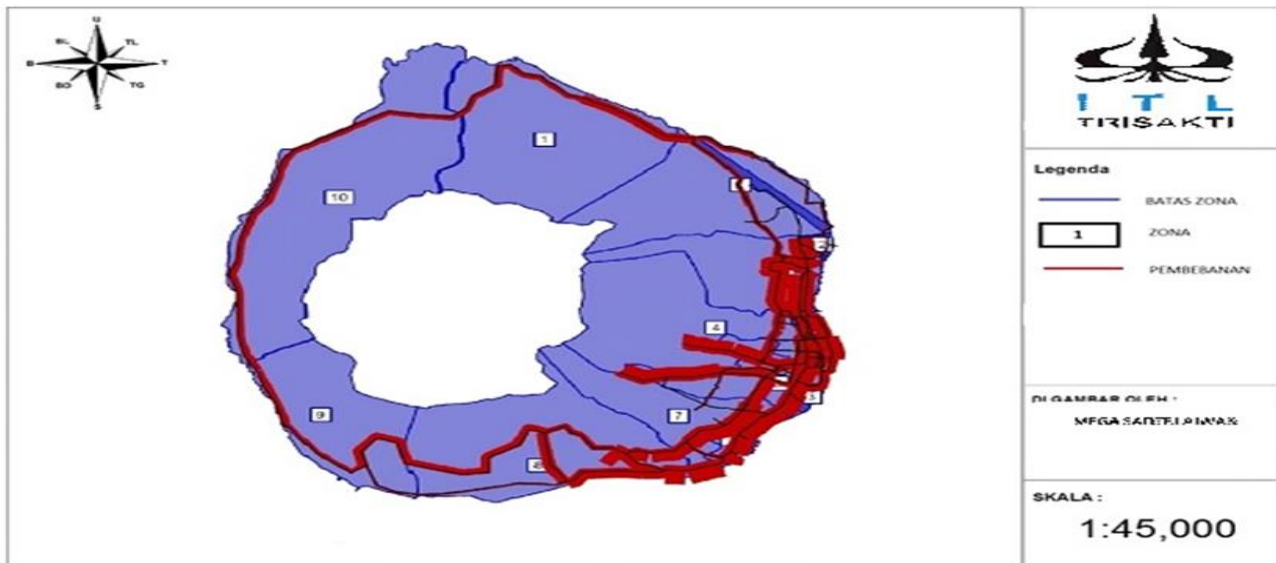


Fig. 2: Map of Ternate City's Potential Demand

Source: Processed data, Author 2021

**D. Proposed route network**

Based on the analysis of 14 existing route networks, 9 proposed public transport routes have linear routes. As follows:

No	Tray Number	Route	Route	Route network type	Route Length (Km)
1	01	JL. Kesatrian – Bandara Sultan Babullah	<b>Jl. Kesatriaan</b> – Jl. Sultan Khairun – Jl. Pemuda – Jl. Babullah – Akehuda (KampusUnkhair) – <b>Bandara Sultan Babullah</b>	Linear	5,5
2	02	JL. Sultan M.Djabir - Tarau	<b>Jl. Sultan M. Djabir</b> – Jl. A.M Kamaruddin - Jl. Pemuda – Jl. Cakalang – Jl. Batu Angus – Tarau	Linear	7
3	03	JL. Kesatrian - Sulamadaha	<b>Jl. Kesatriaan</b> – Jl Sultan Khairun – Jl. Pemuda – Jl. DarulKhairaat – Jl. NgidiKasturian – Jl. FaceiTarau – Jl. Batu Angus – <b>Sulamadaha</b>	Linear	13
4	04	JL. Kesatrian – Togafu	<b>Jl. Kesatriaan</b> – Jl. Sultan Khairun – Jl. Pemuda – Jl. Cakalang–Terminal Dhufa-Dfufa – Jl. Batu Angus - <b>Togafu</b>	Linear	22
5	05	Jl. PahlawanRevolusi - Moya	<b>Jl. PahlawanRevolusi</b> – Jl. Nukila – Jl. HasanBoesoeri – Jl. Arnold Mononutu – Jl. KapitenPattimura – Jl. NgidiKasturian - <b>Moya</b>	Linear	5,2
6	06	Jl. PahlawanRevolusi - Jerbus	<b>Jl. PahlawanRevolusi</b> – Jl. Nukila – Jl. Mononutu – Jl. KapitenPattimura – Jl. YosSudarso – Jl. KampungPisang - <b>Jerbus</b>	Linear	5,5
7	07	Jl. PahlawanRevolusi - Taduma	<b>Jl. PahlawanRevolusi</b> – Jl. Nukila – Jl. Mononutu – Jl. HasanEsa – Jl. Raya Bastiong – Jl. Kalumata – Jl. PorosNgade – Jl. Raya Fitu – Jl. Raya Jambula – Jl. Pertamina – Jl. Kastela - <b>Taduma</b>	Linear	6

Table 6: Table of Proposed Route Network

Source: Processed data, Author 2021

**E. Evaluation of Route Network Performance and Proposed Transport Operations**

From the results of the analysis that has been carried out, it is obtained the latest public transportation routes to

improve the performance of public transportation in Ternate City.

- a. Evaluation of the Performance of the Existing Transport Network Based on (Decree of the Director General of Land Transportation No. 687 of 2002)

ANALISIS KINERJA JARINGAN			
TRAYEK	CAKUPAN PELAYANAN	TUMPANG TINDIH	
0 1	1,68	50%	M
0 2	2	32%	M
0 3	5,92	45%	M
0 4	17,6	66%	TM
0 5	2,72	35%	M
0 6	2	39%	M
0 7	4,8	85%	TM
0 8	14,4	45%	M
0 9	12,8	64%	TM
<b>TOTAL</b>	<b>68,72</b>	<b>6 M</b>	<b>3 TM</b>
	<b>42%</b>		

Table 7: Table of Proposed Route Network Performance

Source: Processed data, Author 2021

## b. Evaluation of Existing Transport Operational Performance Based on (World Bank) – World Bank

ANALISIS KINERJA OPERASIONAL								
TRAYEK	FREKUENSI		LOAD FAKTOR		HEADWAY		WAKTU PERJALANAN	
0 1	29	M	70%	M	2,1	M	10	M
0 2	25	M	70%	M	2,4	M	12	M
0 3	14	M	70%	M	4,5	M	19,5	M
0 4	10	M	70%	M	6,2	M	26,4	M
0 5	30	M	70%	M	2,1	M	10,4	M
0 6	30	M	70%	M	2,1	M	11	M
0 7	22	M	70%	M	2,7	M	10,3	M
0 8	18	M	70%	M	3,3	M	19	M
0 9	12	M	70%	M	6	M	21,6	M
<b>TOTAL</b>	<b>9 M</b>	<b>0 TM</b>	<b>9 M</b>	<b>0 TM</b>	<b>9 M</b>	<b>0 TM</b>	<b>9 M</b>	<b>0 TM</b>

Table 8: Table of Proposed Public Transport Operational Performance

Source: Processed data, Author 2021

Operational performance of the proposed route network public transport can be compared with condition of the existing route network, where indicators that can be assessed include number of routes, number of fleets, average frequency, average headway, average travel time, service coverage, average load factor and average overlapping level.

From the results of the analysis, it can be seen that from a total of 14 existing routes, it can be reduced to 9 routes. This can increase the effectiveness in the operation of public transportation in Ternate City, so that people can use public transportation safely and comfortably.

No	Indikator	Satuan	Eksisting	Usulan
1	Jumlah Trayek	trayek	14	9
2	Jumlah Armada	armada	152	162
3	Frekuensi Rata-Rata	kendaraan/jam	7	21
4	Headway Rata-Rata	menit	23	3,5
5	Waktu Tempuh Rata-Rata	menit	43,2	15,5
6	Cakupan Pelayanan	%	32%	42%
7	Faktor Muat Rata-Rata	%	48%	70%
8	Tingkat Tumpang Tindih Rata-Rata	%	62%	24%

Table 9: Comparison Table of Proposed Public Transport Network and Operational Performance

Source: Processed data, Author 2021

By reducing the number of routes and rationalizing the number of fleets, Operational Performance can be improved. The frequency of existing public transportation is an average of 7 vehicles/hour, which can be improved to 21

vehicles/hour. The average time between vehicles can also be increased from the existing condition of 23 minutes to 3.5 minutes on the proposed route network. And the existing average travel time is 43.2 minutes to 15.5 minutes.

**F. Alternative Route Network Determination**

Based on the Decree of the Director General of Customs and Culture No.Sk.687/Aj.206/Drjd/2002 concerning Technical Guidelines for the Implementation of Public Passenger Transport in Urban Areas in Fixed and Regular Routes, it is explained that in determining public transportation routes there are several factors that must be considered. Among others are:

- a) Land use patterns;
- b) Movement patterns of public transport passengers;
- c) Population density;
- d) Service area;
- e) Network characteristics.

From the analysis of potential demand loading, 2 alternative routes for service areas were determined, which were then proposed as BRT transport routes. The routes in the route are:

- **Alternative Route 1 (Jl. Pahlawan Revolution – Jl. Mononutu – Jl. HasanEsa – Terminal Bastiong – Jl. Raya Bastiong – Jl. Kalumata – Kalumata)**  
This route has a length of 6 km, with land use as a very dense activity center, this route passes through the city center which consists of shops, offices, markets, ports and settlements, through collector road access with a road width (> 6 m) road status National and City, with service coverage of 6 km<sup>2</sup> covering 400 m to the right and 400 m to the left along the route. Based on the description above, this route is in accordance with the criteria for determining the route and was chosen as Alternative Route I in the BRT transport operation plan.
- **Alternative Route 2 (Jl. Pahlawan Revolution – Jl. Mononutu – Jl. HasanEsa – Jl. Raya Bastiong – Jl. Kalumata – Jl. Unkhair Campus – Unkhair Campus)**

This route has a length of 9.5 km, with land use as a busy center of activity, this route passes through the city center in the City of Ternate, shops, offices, markets, ports, settlements, and education centers, through collector road access with a width of (> 6 m) National and City road status, with a service coverage of 12.5 km<sup>2</sup> covering 400 m to the right and 400 m to the left along the route. Based on the description above, this route is in accordance with the criteria for determining the route and was chosen as Alternative Route 2 in the BRT transport operation plan.

- **Passengers per Corridor according to alternative**  
The results of plotting passengers on routes that have been determined with the help of VISSUM and the distribution matrix of origin and destination of community trips are used as the basis for determining passenger calculations so that the number of passengers per corridor for each alternative I and II is as follows:
  - **Alternative 1**  
From the loading results, the number of passengers per day for route 1 is 2762 and 230 passengers/hour;
  - **Alternative 2**  
From the loading results, the number of passengers per day for route 1 is 2266 and 189 passengers/hour.

To support the service coverage of the BRT transport route, it is proposed to integrate with the feeder route service as a successor to the BRT route service which allows the exchange of modes at the meeting point of the main route so as to expand the service coverage by passing the following roads:

No	Tray Number	Route	Route	Route network type	Route Length (Km)
1	01	JL. Kesatrian – Bandara Sultan Babullah	<b>Jl. Kesatriaan</b> – Jl. Sultan Khairun – Jl. Pemuda – Jl. Babullah – Akehuda (Kampus Unkhair) – <b>Bandara Sultan Babullah</b>	Linear	5,5
2	02	JL. Sultan M.Djabir - Tarau	<b>Jl. Sultan M. Djabir</b> – Jl. A.M Kamaruddin - Jl. Pemuda – Jl. Cakalang – Jl. Batu Angus – Tarau	Linear	7
3	03	JL. Kesatrian - Sulamadaha	<b>Jl. Kesatriaan</b> – Jl Sultan Khairun – Jl. Pemuda – Jl. DarulKhairaat – Jl. NgidiKasturian – Jl. FaceiTarau – Jl. Batu Angus – <b>Sulamadhaha</b>	Linear	13
4	04	JL. Kesatrian – Togafo	<b>Jl. Kesatriaan</b> – Jl. Sultan Khairun – Jl. Pemuda –Jl. Cakalang– Terminal Dhufa-Dfufa – Jl. Batu Angus - <b>Togafo</b>	Linear	22
5	05	Jl. PahlawanRevolusi - Moya	<b>Jl. PahlawanRevolusi</b> – Jl. Nukila – Jl. HasanBoesoeri – Jl. Arnold Mononutu – Jl. KapitenPattimura – Jl. NgidiKasturian - <b>Moya</b>	Linear	5,2
6	06	Jl. PahlawanRevolusi - Jerbus	<b>Jl. PahlawanRevolusi</b> – Jl. Nukila – Jl. Mononutu – Jl. KapitenPattimura – Jl. YosSudarso – Jl. KampungPisang - <b>Jerbus</b>	Linear	5,5
7	07	Jl. PahlawanRevolusi - Taduma	<b>Jl. PahlawanRevolusi</b> – Jl. Nukila – Jl. Mononutu – Jl. HasanEsa – Jl. Raya Bastiong – Jl. Kalumata – Jl. PorosNgade – Jl. Raya Fitu – Jl. Raya Jambula – Jl. Pertamina – Jl. Kastela - <b>Taduma</b>	Linear	6

Table 10: Feeder Routes for Selected Proposed Routes of BRT Transport

Source: Processed data, Author 2021

**G. Selection of Vehicle Type**

According to the Decree of the Director General of Land Transportation Number SK.687/AJ.206/DRJD/2002, the types of transportation based on the size of the city and routes can be divided based on four classifications, namely Kota Raya with a population of > 1,000,000 people, and Kota Besar with a population of 500,000-1,000. 000 inhabitants, Medium Towns with 500,000-100,000 inhabitants, and Small Towns with <100,000 inhabitants. So that the type of mode that will later be used to serve the needs of this mass public transportation, must be determined according to service needs.

The MSS concept for BRT is outlined in 4 substances, namely:

- Service Reliability
- Security and safety
- Convenience
- Convenience

The basis for determining the type of transportation based on the size of the city considers the type of vehicle based on the route classification and passenger capacity per day. The following is a table for determining the type of transportation based on vehicle capacity.

Type of Transportation	Vehicle Capacity			Passenger Capacity/Day/Vehicle
	Sit	Stand Up	Total	
General Passenger Car	8	-	8	250-300
Small Bus	19	-	19	300-400
Medium Bus	20	10	30	500-600
Single Floor Big Bus	49	30	79	1000-1200
Double Floor Big Bus	85	35	120	1500-1800

Table 11: Types of transportation based on passenger capacity per day

Source: Director General of Transportation Decree No Sk.687/Aj.206/Drjd/2002

Because Ternate is a small population city, the operation of BRT transportation in Ternate City will be carried out using a Medium Bus fleet with the current development potential. Based on the above provisions, the operation of BRT transportation in Ternate City will be

carried out using a Medium Bus fleet with the current potential for development, the following are the requests obtained from the results of loading potential demand as follows:

Route	Number of Requests (passenger/day)	Capacity (PNP/day/vehicle)	Fleet Needs	Fleet Determination
1	2762	230	Medium Bus	Medium Bus
2	2266	189	Medium Bus	Medium Bus

Table 12: Types of transportation based on the minimum number of passengers with optimistic demand

Source: Processed data, Author 2021

The design of the medium bus, which will be used as a Bus Rapid Transit (BRT) fleet, applies a model of 19 seated passengers facing each other and 1 driver seat + 10 standing passengers, and a special additional area for passengers with disabilities. The design of BRT vehicles also needs to pay attention to the Regulation of the Minister of Transportation No. PM 15 of 2019 concerning the Implementation of Transportation of People with Public Motorized Vehicles in the Route of Article 98 paragraph (2) Supervision of the fulfillment of technical requirements and roadworthiness of

Motorized Vehicles as referred to in Article 96 paragraph (1) letter b includes:

- proof of passing the periodic test of motorized vehicles;
- physical Motor Vehicle; and
- Minimum Service Standard

For more details can be seen in the following image



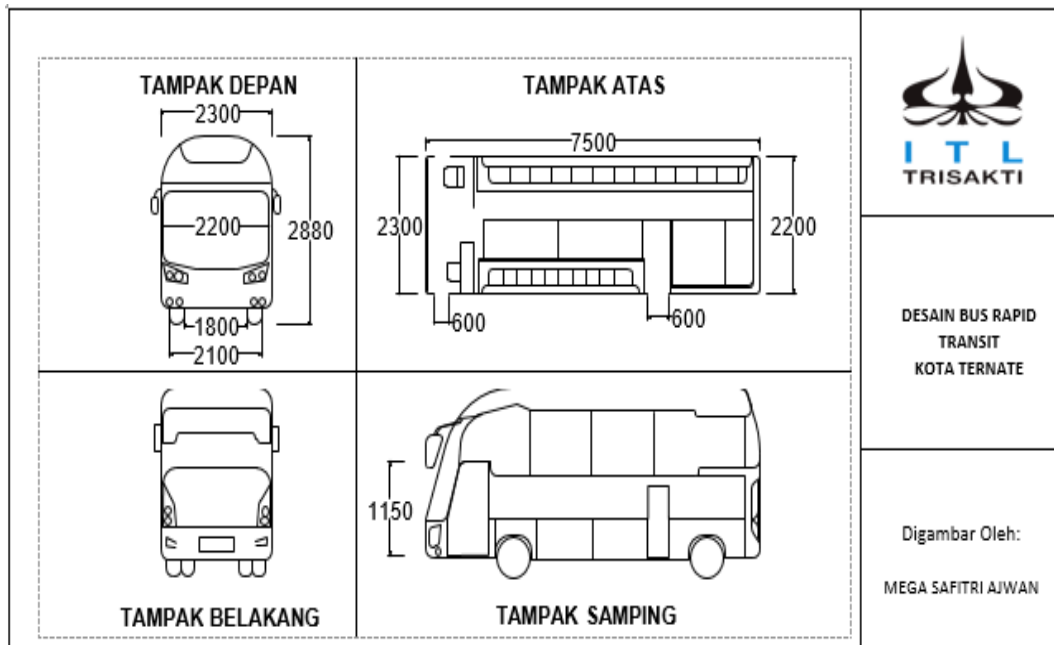


Fig. 2: Design of the Ternate City Bus Rapid Transit

Source: Processed data, Author 2021

H. Operational Performance Analysis of Each Alternative

a) Alternative Operational Performance 1

The operational performance of the BRT operation in Ternate City Alternative 1 is an operational performance

offered based on the demand for public transportation in current conditions (actual demand) added up with a balanced interest in moving cars and motorbikes.

No	Indicator	Operation Plan	Unit
1	Transportation type	General Passenger Car (MPU)	
2	Capacity	30	Passenger
3	Route Length	6	Km
4	Plan Operation Speed	20	km/hour
5	Travel Time (Travel Time)	10,3	Minute
6	Time Stop at the Knot	1,0	Minute
7	Round Trip Time	47	Minute
8	Public transport requests/day	2762	Trip/day
9	Passengers per hour	230	Passenger

Table 13: Operational Performance Recapitulation (Alternative 1)

Source: Processed data, Author 2021

In the operating pattern, the number of fleet requirements can be determined based on the planned load factor to be determined. There are 6 (six) load factors determined, namely 50%, 60%, 70%, 80%, 90%, and 100%. The following is a calculation of fleet needs in Alternative 1:

Indicator	Load Factor						Description
	50%	60%	70%	80%	90%	100%	
Fleet Need	61	51	16	38	34	31	Vehicle
Transport Time	1.2	1.5	2,7	2.0	2.2	2.5	Minute
Vehicle Frequency	49	41	22	31	27	25	Vehicle/hour

Table 14: Alternative Fleet Needs 1

Source: Processed data, Author 2021

To anticipate changes in load factors that occur when the route network is implemented, 6 choices of load factors are made. However, the plan for the operation of Alternative 1 of the Ternate City BRT Network is with a load factor of 70% so that the number of fleets needed is 17 fleets.

a) Alternative Operational Performance 2  
The operational performance of the BRT operation in Ternate Alternative 2 is an operational performance offered based on the current demand for public transport (actual demand).

No	Indikator	Rencana Operasi	Satuan
1	JenisKendaraan	General Passenger Car (MPU)	
2	Kapasitas	30	Passenger
3	PanjangRute	6	Km
4	KecepatanOperasirencana	20	Km/hour
5	WaktuPerjalanan( <i>Travel Time</i> )	10,3	Minute
6	WaktuBerhenti di Simpul	1,0	Minute
7	WaktuBolak-balik( <i>Round Trip Time</i> )	47	Minute
8	Permintaanangkutananumum/hari	2762	Trip/day
9	Penumpang per jam	230	Passenger

Table 15: Operational Performance Recapitulation (Alternative 2)

Source: Processed data, Author 2021

In the operating pattern, the number of fleet requirements can be determined based on the planned load factor to be determined. There are 6 (six) load factors

determined, namely 50%, 60%, 70%, 80%, 90%, and 100%. The following is a calculation of fleet needs in Alternative 2

Indicator	Load Factor						Description
	50%	60%	70%	80%	90%	100%	
Fleet Need	61	51	16	38	34	31	Vehicle
Transport Time	1.2	1.5	2,7	2.0	2.2	2.5	Minute
Vehicle Frequency	49	41	22	31	27	25	Vehicle/hour

Table 16: Alternative Fleet Needs 2

Source: Processed data, Author 2021

To anticipate changes in load factors that occur when the route network is implemented, 6 choices of load factors are made. However, the plan for the operation of Alternative 2 of the Ternate City BRT Network is with a load factor of 70% so that the number of fleets needed is 10 fleets.

I. Determination of the Best Alternative

Based on the speed, headway and frequency criteria in the Decree of the Director General of Transportation No Sk.687/Aj.206/Drjd/2002 and the calculations performed for the two alternatives, Alternative 1 was chosen as the best alternative condition with the following route and operating performance:

Ternate City BRT Operation Plan				
Criteria	Route 1	Route 2	Standard Operation (Director General Decree)	Description
Operating Speed (km/h)	20	20	20	<b>Fulfil</b>
Headway (Minute)	2.7	3.3	5-10	<b>Fulfil</b>
Frequency	22	18	12	<b>Fulfil</b>
Load Factor (LF)	70%	70%	70%	<b>Fulfil i</b>

Table 17: Criteria for Selected Alternatives

Source: Processed data, Author 2021

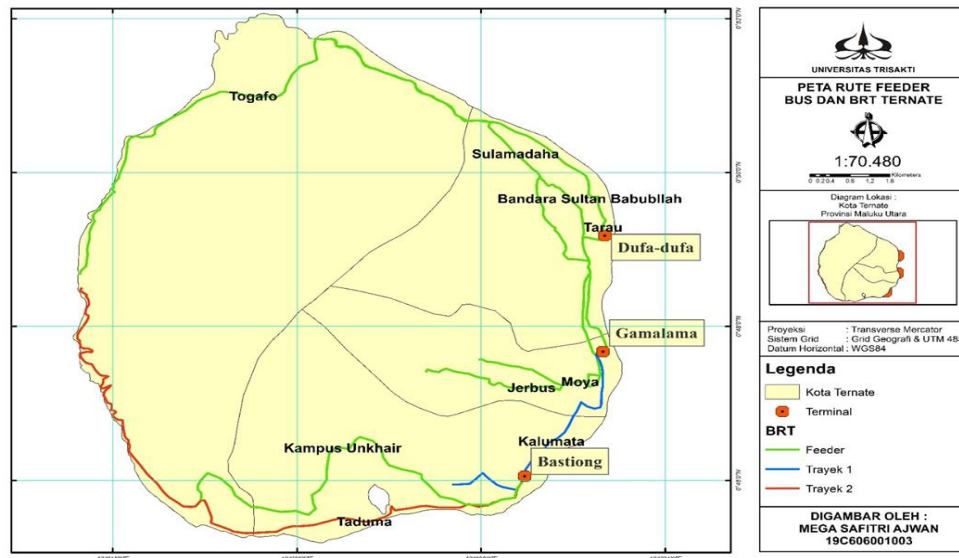


Fig. 3: Ternate City Bus Rapid Transit Route

Source: Processed data, Author 2021

#### IV. CONCLUSION

Based on the analysis of the aims and objectives and the results of research on the development of the Bus Rapid Transit (BRT) Route Network Analysis in Ternate City, the conclusions that can be conveyed include:

- Based on the analysis of the performance of the existing transportation and operational route network, which originally contained 14 existing routes, after the analysis, it was obtained 9 new routes for the performance of the transportation and operational route network in accordance with the LLAJ SPM and World Bank Standards.
- Based on the results of the Home Interview and Dynamic survey, it is known that as many as 10,134 passengers per day use public transportation. So that based on the travel pattern, it can be seen the travel line of public transportation service users in each zone and can make it easier to estimate which routes may be used in planning public transportation. In the total distribution of people's interest in moving from private vehicles to public transportation, the population from using private vehicles moves to public transportation in Ternate City as many as 35,403 people. Based on this data, it can be seen that the potential demand for public transportation in Ternate City by combining actual demand with interest in moving with a total interest in moving using public transportation is 45,536 people.
- Based on the existing analysis carried out, 9 new routes were obtained which were then based on these routes, further analysis was carried out based on 2 (two) determined alternatives. To choose the route that will be the best alternative, an analysis of the network and operational performance of each alternative is carried out based on the LLAJ SPM and World Bank Standards as well as the Decree of the Director General of Hubdat No.Sk.687/Aj.206/Drjd/2002, so that the best alternative is obtained, namely Alternative 1.

- For the type of transportation based on the four classifications of the Decree of the General Land Transportation Number SK.687/AJ.206/DRJD/2002, and look at the conditions and land use in the City of Ternate. Then the type of mode used can be in accordance with the services required. So that the use of BRT mode in Ternate City adjusts to the service, namely Medium Bus with a total capacity of 30 people, consisting of 20 people sitting and 10 standing.

#### REFERENCES

- [1.] Ahmad Munawar, 2006, Manajemen Lalulintas Perkotaan, Beta Off set, Yogyakarta
- [2.] Arikunto, Suharsimi, 2006. Metode Penelitian Kualitatif, Jakarta, Bumi Aksara
- [3.] Basrowidan Suwandi, (2008), Memahami Penelitian Kualitatif. Jakarta: Rineka Cipta
- [4.] Badan Pusat Statistik, 2021, Kota Ternate Dalam Angka 2021, BPS Kota Ternate, Provinsi Maluku Utara
- [5.] Creswell, Jhon W. 2016. Research Design Pendekatan Kualitatif, Kuantitatif, dan Mixed. Yogyakarta: Pustaka Pelajar.
- [6.] Dewi.S, 2015, Penentuan Jumlah Armada dan Rute Angkutan Kota yang Optimal di Kota Bandung Berdasarkan Load Factor: Studi Kasus Trayek Riung Bandung-Dago, Jurnal Teknik Industri, Bandung
- [7.] Sonya Sulistyono, Ludfi Djakfar, Achmad Wicaksono, 2017, Kebijakan Penataan Jaringan Trayek Angkutan Umum Perkotaan Jember, Jurnal Transportasi Vol. 17 No. 2.
- [8.] Nugroho, WulanSapto and Basuki, Imam, 2018 Penataan Trayek Angkutan Antar Kota Dalam Provinsi (AkdP) Berbasis Obyek Wisata. In: Simposium Forum Studi Transportasiantar Perguruan Tinggi ke-21, 19 - 120 Oktober 2018, Universitas Brawijaya, Malang.

- [9.] Weldy Anugra Riawan, 2018, Analisis Pelayanan Bus Rapid Transit Kapasitas Sedang Pada Sistem Transportasi Perkotaan, *Warta Penelitian Perhubungan* 30 (2018) 119-132
- [10.] Wulansari, St., Mt., Dwi Novi, 2016, Kompetensi Pemilihan Moda Angkutan Penumpang berdasarkan Model Logit Selisihan dan Model Binomial Nisbah, Universitas 17 Agustus 1945, Jakarta
- [11.] Giannopoulos. G A, 1989, *Bus Planning and Operation in Urban Area: A Practical Guide*, England.
- [12.] Iskandar, *Metodologi Penelitian Kualitatif* (Jakarta, Gedung Persada, 2009), cetakan 1 halaman 11
- [13.] Joko Subagyo, 2011, *Metode Penelitian dalam teori dan praktek* : Jakarta : Rhineka Cipta
- [14.] Kelompok PKL Kota Ternate, 2018, *Pola Umum Transportasi Darat Kota Ternate*, Tugas Akhir, Tidak di terbitkan, STTD, Bekasi.
- [15.] LPM ITB, 2003, *Modul Pelatihan Perencanaan Sistem Angkutan Umum*, Bandung.
- [16.] Marsudi, 2006, *Analisis Kinerja Jaringan Trayek Mobil Penumpang Umum di Kota Salatiga*, Politeknik Negeri Semarang, Semarang
- [17.] Moeleong, L.J. 2010, *Metodologi Penelitian Kualitatif*. Bandung: Remaja Rosdakarya
- [18.] Nasution, 1996. *Metode Penelitian Naturalistik Kualitatif*, Bandung: Tarsito
- [19.] Of yar Z.T, 2000, *Model Perencanaan Penentuan Rute Angkutan Umum: Studi Kasus Kota Bandung*, Institut Teknologi Bandung, Bandung
- [20.] Peraturan Pemerintah Nomor 74 Tahun 2014 tentang Angkutan Jalan, Kementerian Perhubungan RI, Jakarta
- [21.] Peraturan Menteri No 98 Tahun 2013 tentang Standart Pelayanan Minimum Angkutan
- [22.] Orang Dengan Kendaraan Bermotor Umum Dalam Trayek, Kementerian Perhubungan RI, Jakarta
- [23.] *Planing Transport Verkehr AG. (2007). Vissim 5.0 User Manual*, Rexi ,I. S., 2016 “Simulasi Aliran Lalu Lintas Pada Simpang Bersinyal Dengan Menggunakan Microscopic Simulator (Studi Kasus :Persimpangan Tiga Sawahan Padang)”
- [24.] Selviana.W, 2014, *Kajian Biaya Operasional Kendaraan Umum Jalur Terminal Mardika-Air Salobar di Kota Ambon*, *Jurnal Teknik Sipi IPoltek Negeri Ambon*, Ambon
- [25.] Surat Keputusan Direktorat Jendral Perhubungan Darat Nomor 687 Tahun 2002, Kementerian Perhubungan RI, Jakarta
- [26.] Tamin, Ofyar, 2008, *Perencanaan Permodelan Transportasi*. Bandung
- [27.] Thomas. E, 2001, *Bus Rapid Transit*, Presentation at the Institute of Transportation Engineers Annual Meeting, IL, Chicago.
- [28.] Tod Litman, 2001, *Generate Traffic: Implication For Transport Planning*, ITE Journal. Victoria Transport Policy Institute.
- [29.] Undang-Undang Nomor 22 Tahun 2009 tentang Lalu Lintas dan Angkutan Jalan, Kementerian Perhubungan RI, Jakarta
- [30.] Vukan R. Vuchie, *Urban Public Transport Systems*, *Transport Engineering and Planning*, Vol Urban Public Transport Systems, Vukan R. Vuchie
- [31.] VISSUM User Manual – version 2.1. PTV Planing Transport Verker AG, Karlsruhe, Germany, 2011.
- [32.] Weldy Anugra Riawan, 2018, Analisis Bus Rapid Transit (BRT) Kapasitas Sedang Pada Sistem Transportasi Perkotaan, *Warta Penelitian Perhubungan* 30 (2018) 119-132
- [33.] Warpani, S.1990. *Perencanaan Permodelan Transportasi Edisike Dua*. Bandung: Penerbit ITB
- [34.] Warpani.S, 2002, *Pengelolaan Lalu Lintas dan Angkutan Jalan*, Institut Teknologi Bandung, Bandung <http://ternatekota.bps.go.id>