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Bus Rapid Transit (BRT) Operations To Reduce Traffic Congestion On Kaligawe Road In Semarang

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Abstract - Traffic congestion in the city of Semarang is increasing. This is due to the unbalance between the development of road infrastructure and the increasing number of vehicles. Therefore, an orderly, smooth, safe, and convenient mass transportation is needed to reduce congestion. The purpose of this research is to analyze the performance of Bus Rapid Transit (BRT) operation in Semarang City through Kaligawe road. This route is expected to become a reliable public transport in breaking down congestion. The research methodology begins with conducting a Kaligawe road performance survey which is about 4 KM in length, including traffic volume of Semarang-Demak direction of 3.982 emp and the reverse direction of Demak-Semarang is 3.814 emp. While degree of saturation ranged from 0.59 to 0.83. The results of the analysis on BRT found an unbalanced comparison between the capacity of BRT and the volume of traffic passing through the road. The results of this analysis and survey is necessary to maximize the function and work of BRT in several ways ie the location around the shelter must be barrier-free so that BRT can stop at the shelter. there should be a shelter guard who serves as a janitor, security, and information provider about the schedule and about the BRT. The socialization needs to be improved to the public, preferably the holding of Smart Card and feeder transportation, and the holding of tariff reduction in order to increase public interest.

Keywords*: Performance Analysis, BRT, Kaligawe Road*

1. Introduction

The traffic congestion is a major problem that became the subject of problems often faced by a number of major cities in Indonesia, especially in Semarang City. This is due to uneven road infrastructure development with increasing number of vehicles. The increasing number of these vehicles is dominated by private vehicles. Therefore, a breakthrough is needed in overcoming the congation. Various ways have been done in overcoming traffic jam one of them is by using mass transportation.

Various efforts have been made by the government to meet the good mass transit such as TransJakarta or better known as Busway, TransSolo, TransJogja, TransLampung, and so on. Bus Rapid Transport (BRT) in Semarang has commenced operations on September 1, 2009 which was built with the intent to reduce traffic congestion and also can reduce the use of private vehicles to switch to public transport.

BRT corridor II passing through the City Region (BWK) I area covers Semarang Tengah, East Semarang and South Semarang Subdistricts, BWK II covers: Candisari and Gajahmungkur Subdistricts, and BWK III covers: West Semarang and North Semarang Subdistricts, and BWK VII including: Banyumanik Subdistrict, is expected to accommodate the mobility of the people who headed and left the area. BRT corridor II corridor is expected to reduce the congestion of Semarang city that more complained by the community, such as in Jatingaleh by way of policy set by Semarang City Government one BRT reduce three buses operating in the same line.

The development of BRT is planned to be developed into six corridors to serve mass transit in Semarang City with major road segment routes. The six corridors are: corridor 1 serving terminal of Mangkang - Penggaron terminal (realized), corridor 2 serves Terboyo - Ungaran terminal (realized), corridor 3 serves Tanjung Mas Port - Banyumanik housing, corridor 4 serves terminal Terboyo - UNDIP Tembalang, corridor 5 serves Penggaron terminal - Terboyo terminal, and corridor 6 serves Ahmad Yani Airport - Terboyo terminal. then this observation is done from terminal Terboyo - Ungaran/Sisemut which is approximately 30 km and has 54 stop stop.

2. Statement of Problems

In Semarang there are many public transportation routes that serve various routes. However, the high public interest in using private vehicles rather than mass transportation became one of the causes of congestion in the city of Semarang. Semarang city government continues to solve traffic jam one of them with the operation of BRT. For now BRT corridor I of six planned corridors, which have been operating for 3 years. While BRT corridor II has been operated from 1 October 2012 serving Terminal Terboyo - Ungaran route.

3. The Objectives

The objective of this research are:

- To analyze the performance of post road operation BRT Corridor II route Terboyo - Ungaran with existing parameters so that later can optimize the use of BRT as mass transportation facilities that can reduce of traffic congestion.
- To analyze the road segment on the BRT route Terboyo – Ungaran on Kaligawe highway.

4. Literature Review

A. Passenger Public Transport.

According to Law No.22 of article 1 year 2009 abaout traffic and road transport that transport is the movement of people and / or goods from one place to another by using vehicles in the Road Traffic Room. Whereas a public motor vehicle is any vehicle used for the transport of goods and / or persons charged. So the definition of public transportation is the movement of people and / or goods by using public motor vehicles charged in accordance with their needs in the Space Traffic Road. Public transport of passengers is mass transit conducted by rent system. Public transport of passengers includes city buses, mini buses, trains, water transport, and air freight (Warpani, 1990).

Passenger public transport aims to provide a good and decent transportation service for the community. The main purpose of public transportation is to provide transportation services that are fast, safe, cheap, and convenient. Due to its mass nature, it is necessary to have similarities among passengers with regard to origin and destination. The level of public transport services is usually expressed in several parameters, among others:

a. Availability of the mode promised by the operator, the number of available shuttles for the route to meet the need for community mobility.
b. Travel time, time required by a transport to reach the destination of the passenger.
c. Timeliness comes and goes shuttles.
d. Cost, is the total to be paid by passengers to arrive at the travel destination.
e. Carers' concern will be passengers.
f. Frequency, number of passing vehicles per unit time

g. Interval time between public transport (headway)
h. Load Factor
i. Giving the right information
j. Security / comfort, concerning the security and comfort of passengers inside and outside of transportation.
k. Cleanliness / neatness that is in the transport.

B. Bus Rapid Transit (BRT) System

Bus Rapid Transit System is a mass transit based on roads that utilize special and exclusive channels. While Busway is a high-quality mass transit facility based on fast, convenient, and low cost transit system with vehicles passing through special tracks on the fast lane side.

According to the Directorate General of Land Transportation 2006, Bus Special Lane (Busway) is a fast bus transportation based on bus operation with bus special lane system. The Special Bus Line is the physical separation of the bus lane from other traffic either with a permanent separator or a temporary separator. For special bus lane capacity is calculated with the assumption that every bus can not precede each other.

BRT Operating System

1. Closed system: Closed/separate system with other traffic flows. The existing BRT system has special facilities and operated by selected operators.
2. Open system: Open operating system operated without exclusive nature or in operation still mixed with other traffic flows.

C. Bus Stop Infrastructure

According to Idwan Santoso (1996), bus stopping infrastructure is a location where passengers can rise and fall from buses, and locations where buses can stop to raise and lower passengers according to operational arrangements or passenger demand. Physically, bus stops can be equipped with shelter infrastructure or just a sign.

According to the Directorate General of Land Transportation (1996) the place of public transport stops consists of bus stops and bus stops. The bus stop is a public passenger stop for down and / or raise passengers equipped with a building.

Source: APTA, 2010

Figure 1. Halte (*Shelter*)

D. The Distance between Halte (Shelter)

The distance between bus stops is very big impact on the commercial bus speed which can ultimately affect the service performance. The distance between bus stops on a particular route path is very important in terms of two points of interest, namely the point of view of passengers and the point of view of the operator. If the inter-stop corner of the bus is made long enough, then it is viewed from the point of view of passengers, means:

- Bus speed becomes more relatively high, because the bus does not stop too often, so the travel time becomes short.
- Bus becomes more comfortable, because acceleration and deceleration becomes rare

While viewed from the point of view of the operator:

- The number of fleets operated becomes less, due to the high average speed
- Fuel consumption will be more efficient.
- Maintenance costs are reduced.

From the other side's perspective means:

- The number of curbs that need to be supplied becomes less
- Road capacity lost due for bus stops is reduced
- The level of air and sound pollution is reduced.

Another criterion used to determine the distance between stops is a weather condition that affects comfort for passengers to travel to and from a stopover other than the condition of the land use condition of the route path corridor. For high density areas such as downtown areas, usually the stops between stops are smaller compared to areas where the density is relatively smaller, such as the suburbs.

Table 1. The Distance of Shalter (halte)

Zone	Land Used	Location	Distance of Halte (m)
1	The center of the activity is very crowded: markets, shops	CBD, City	200 - 300*)
2	Solid: offices, schools, services	City	300 – 400
3	Residential	City	300 – 400
4	Solid mix: housing, schools, services	Marginal	300 – 500
5	Sparse blends: housing, fields, rice fields, land un-used	Marginal	500 – 1000

Source: DirJen Perhubungan Darat (1996)

Note *) 200 m distance is used when it is necessary only, while the distance is generally 300 m.

5. The Data of BRT

A. Terboyo Terminal - Ungaran

Observation area, route Terboyo Terminal - Ungaran terminal has the following conditions:

- Track length: 26,78 meters
- Number of buses allowed: 21 units
- Environment around the track: Settlement, office area, church,Health facilities, trade areas,transport nodes, and conservation areas.
- Beginning trip: Terboyo Terminal
- Number of Shelters / Shelters: 32 stops

B. Terminal Ungaran - Terboyo

The observation area, the route of Ungaran Terminal - Terboyo Terminal has the following conditions:

- Track length: 26,95 meters
- Number of buses allowed: 21 units
- Environment around the track: Settlement, office area, church,health facilities, trading areas,transport nodes, and conservation areas.
- Beginning trip: Ungaran Terminal
- Number of Shelters / Shelters: 30 stops

6. Characteristics of BRT and Operation

Vehicle capacity and characteristics of BRT Corridor II route Terboyo Terminal - Ungaran Terminal can be seen in table 2:

Table 2. Characteristics of Trans Semarang BRT

No	Characteristics of Moda	BRT
1	Vehicle Merk	Hyno
2	Moda Type	Middle Bus
3	Class	Economic Class AC
4	Capacity	36 persons
5	Operation days	355 days
6	Manufacturing year	2012
7	Life services	5 years
8	Number of vehicles	21 unit

Source: BRT Operator. 2012

7. Data Analysis

A. Forcating to 10 Years

The production or attraction of the trip is the first stage of transport planning. To predict the vehicle at the age of years to come can use the formula:

$$P\,(t + n) = Pt\,(1 + r)^n$$

Where:

P(t + n) = value on the yaer - n
Pt = fisrt value
r = the vehicles increase (3,94%)
n = periode (years)

So from the above data it is known that the current at peak hour for Semarang-Demak and Demak-Semarang road segments is Q = 3982 emp/hour and Q = 3814 emp/hour. So for the production in 5 years to come are:

P (t + n) = 3982 $(1 + 3{,}94\%)^1$ = 3982 (1,0394) = 3964,27 emp/hour

The degree of saturation for Kaligawe road of Semarang-Demak segment at peak hour of afternoon of 2014 is: DS =Q/C = 3964,27/5594,316 = 0,59

The calculation of Semarang-Demak road performance for the next 10 years prediction can be seen in Table 3 and 4 the following Table:

Table 3. The production Traffic in 10 years Semarang – Demak Direction

Year	To Years	Traffic Flow (Pt)	Increase	Capacity	DS = Q/C
2014	1	3982	0,0394	6468	0,62
2015	2	4139	0,0394	6468	0,64
2016	3	4302	0,0394	6468	0,67
2017	4	4471	0,0394	6468	0,69
2018	5	4648	0,0394	6468	0,72
2019	6	4831	0,0394	6468	0,75
2020	7	5021	0,0394	6468	0,78
2021	8	5219	0,0394	6468	0,81
2022	9	5425	0,0394	6468	0,84
2023	10	5638	0,0394	6468	0,87

Source: Data analyzed

Table 4. The production Traffic in 10 years Demak – Semarang Direction

Year	To Years	Traffic Flow (Pt)	Increase	Capacity	DS =Q/C
2014	1	3814	0,0394	6468	0,59
2015	2	3964	0,0394	6468	0,61
2016	3	4120	0,0394	6468	0,64
2017	4	4283	0,0394	6468	0,66
2018	5	4452	0,0394	6468	0,69
2019	6	4627	0,0394	6468	0,72
2020	7	4809	0,0394	6468	0,74
2021	8	4999	0,0394	6468	0,77
2022	9	5196	0,0394	6468	0,80
2023	10	5400	0,0394	6468	0,83

Source: Data Analyzed

Based on the results of 10-year evaluation analysis, it is concluded when the year 2021 Semarang city will experience a uniform congestion, especially in Kaligawe area.

8. Conclusion

- In the research study of traffic congestion of Kaligawe road of Semarang City that has been done, it can be taken a conclusion, in the form of:
- Large traffic volume, with total traffic volume of Semarang-Demak direction, and Demak-Semarang direction amounted to 3982 smp / hour, and traffic volume of Demak-Semarang direction amounted to 3814 smp / hour. The road performance becomes quite saturated with its saturation degree of 0.61 and 0.58; with its LOS value is C because the volume of traffic passing through the road is not proportional to its capacity (6468 emp/hour).
- Transportation, existing public transportation equipment is not feasible, so people tend to use private vehicles, because public transport is expensive and uncomfortable.
- BRT operation is not maximal because not many want to ride BRT.

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