Bus Trans Semarang toward Sustainable Transportation in Semarang City

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Abstract Semarang is a metropolitan city with population of 1.6 million. Due to heavy use of private vehicle, Semarang also experiences traffic congestion problems like other metropolitan cities. To deal with this problem, Government of Semarang provides public transportation, one of which is Bus Trans Semarang. Passengers of Bus Trans Semarang increase every year. In 2017, on average there was 287,738 passengers per month, the number increases to 301,678 passengers per month in 2018. Bus Trans Semarang route was also developed into seven corridors. The service has reached almost entire city of Semarang. Purpose of this research is to find out effectiveness of Bus Trans Semarang as a sustainable public transportation service which supports mobility of the people and a solution to solve congestion problems in the next few years. Results of this study suggest that Bus Trans Semarang reduces congestion problems.

Keywords: bus trans semarang, sustainable transportation, traffic congestion problems

1. Introduction
Transportation is a derivative form of economic, social and cultural activities. These activities affect establishment of land use such as trade and service centers, industrial centers, tourism centers, government centers, and residential centers [1]. In meeting their needs, people constantly make movements toward these activity centers. People interaction requires adequate means of transportation to reach the activity center they are aiming for [2]. Nowadays problem is that availability of public transportation in big cities is inadequate to support people mobility, therefore some prefer using private transportation.

Increasing number of private transportation has resulted in traffic problems, namely congestion. Traffic congestion is mainly caused by massive movement of vehicle during particular time toward similar activity center [1]. This encourages decision makers to consider transit-based mass transportation system as solution to such problem. Yet policy makers and transportation planners face another
challenge to find modes of transportation which benefit the community under limited government budget. Bus Rapid Transit (BRT) is the answer to these challenges [3].

Bus Rapid Transit (BRT) is a transit-based mass transportation system that can support citizen mobility. BRT provides improved service better than conventional public transportation with low to medium costs. BRT offers safety, economic and environmental benefits. Some of these advantages have encouraged decision makers to implement BRT transportation system in their area [4].

Semarang is the capital of Central Java Province, center of various activities such as government, trade, education, and culture. The city has high level of economic growth and continues to increase based on its economic performance. Meanwhile urban traffic caused by rapid growth of private vehicles may hinder development of this city. Therefore, it needs concrete solutions to overcome this.

Capacity of the road decreases as the use of private vehicles increase in Semarang. Addition of roads is not proportional to constant increase of vehicle ownership. The result is less land for widening road and parking lots. On the other hand, public is reluctant to use public transportation due to lack of services, in terms of network, facilities, infrastructure, and so forth. People prefer private vehicle over mass transportation since it offers safety, comfort, feasibility, ease and efficiency. In order to overcome this, Government of Semarang City has developed Bus Rapid Transit (BRT) mode namely Bus Trans Semarang to improve existing urban transportation services. Bus Trans Semarang offers convenience, safety and on time schedule. Operation of Bus Trans Semarang involve public-private partnership. Local government cooperates with private sector to manage seven corridors covering Semarang city.

Sustainable transportation system contributes to environmental, social and economic sustainability of the community. Sustainable transportation has become a global issue and is used as reference by several countries in formulating urban transportation policies, include in Indonesia. Sustainable transportation is strategy of development concept in transportation sector. In addressing transportation problems, government plays important role by issuing appropriate policies to restructure and improve performance of public transport transportation services. Government has started renewing public transport facilities and infrastructure, setting service standards, travel time, number of passengers according to mode capacity, comfort level, network system, and accessibility for certain regions. Therefore, presence of Bus Trans Semarang is expected to be able to change people behavior of using private vehicles to public transportation, so as to reduce traffic congestion in Semarang.

Purpose of this study is to identify Bus Trans Semarang services in supporting sustainable transportation in the city. Results of this study can be taken into consideration so that stakeholders may improve quality of public transportation services such as Bus Trans Semarang. Bus Trans Semarang can bring Semarang achieve sustainable transportation goals, include in increased use of public transportation.

2. Literature Review

2.1 Concept of Sustainable Transportation

Various studies concluded that uncontrolled transportation contribute to decreasing quality of life of urban communities such as declining health levels, poor urban quality, increased traffic accidents, and increased psychiatric pressure due to traffic congestion. Various environmental impacts arising from these transportation activities have encouraged development of environmental-friendly transportation system known as sustainable transportation. Sustainable transportation in particular can be interpreted as an effort to meet mobility needs of current generation without decreasing quality of transportation.

2.2 Bus Rapid Transit

Bus Rapid Transit (BRT) is a bus-based mass transportation system with high capacity and speed, it delivers good service at a relatively low cost [5]. BRT system is able to increase community movements in urban areas [4]. BRT also has flexibility and speed with a more affordable rate compared to conventional train; as well as better quality compared to conventional bus [3]. In addition, Deng, Ma and Nelson (2016) believe that BRT is the aswer to heavy mobility in cities, more flexible than LRT or
other public transportation. There is also a new paradigm that BRT can contribute to urban development [6].

BRT has become a popular means transportation throughout the world because of advantages it offers. Some cities have successfully implemented BRT, include in Curitiba, Sao Paolo, Brazil, Bogota, Santiago, Chile, Seoul, and Lima [7]. Existence of Bus Rapid Transit and supporting facilities increase comfort for users, so that people are interested in switching from private mode of transportation to BRT [8]. In addition, BRT system has potential to solve transportation problems in urban areas. Alonso in [9] explains that land rent or land prices rise as accessibility increases. This can be achieved by implementation of new transportation which is able to provide good accessibility; and BRT is public transportation mode with high accessibility [10].

It can be concluded that Bus Rapid Transit (BRT) is a modern transit-based bus transportation that has advantages such as fast, reliable, safe, comfortable, inexpensive, easy to reach and friendly to the environment. Bus Rapid Transit (BRT) is able to increase land accessibility so that it can influence land prices.

2.3 Bus Services or Public Transportation
Performance of transportation services, include in public transportation, can be reviewed from several things, such as route service, time service, rates and service coverage. The following is explanation of BRT transportation service.

2.4 Route Service and Shelter
BRT route network is generally designed following pattern of a city. For example, as Bogota and Curitiba have radial city pattern, then the BRT network system also has radial pattern. However, some BRT route do not follow city pattern, such as cities in China. BRT network systems in China are scattered in all regions, aiming to minimize mode transfer [8].

BRT stops only at shelters. Rather than bus stop, BRT shelter has complete facilities, such as availability of clear information for passengers regarding departure and arrival schedules, route map, comfortable seating, access for pedestrians to the bus stops, safe and comfortable waiting room, good lighting and presence of officers or CCTV cameras to improve security [11].

2.5 Time Services
There are two terms of time in transportation service system, i.e. travel time and waiting (dwelling) time (Merlin, 2017). Travel time means cost of time spent on transport. While waiting time relates to the time a vehicle spends at a scheduled stop. Conventional public transportation usually takes longer time to board passengers. While waiting time on conventional transportation is unpredictable, customers can anticipate it by arrive early to minimize waiting time.

2.6 Tariff
According to Miro (2011), tariffs in transportation system refers to service value of provider’s moving process object from place of origin to place of destination. Whereas according to Sebayang (2007) tariff means term of service payment through three mechanism: bargaining, lease agreements, and provisions from the Government. Payment mechanism through lease agreement applies only to those who directly involved in the agreement. It is when user of determine duration and destination of transport service. Tariff is set by the Government to protect service providers interest, especially related to businesses sustainability as well as to ensure service quality.

BRT tariff generally benefits the users since it is affordable and cheaper than those set by private sector. For example, it costs only one dollar to explore Bogota on BRT ride throughout the day. Although ticket fare is quite affordable, BRT operating in Latin America still receive government subsidies to operate. In some countries BRT use regular ticket verification, while some use a voucher system [8].
2.7 Service Area
According to [15], public transportation coverage is related to variables of population and road network. Public transportation is service based on population variables and road links. Public transport bus service is divided into three:

a. Local bus service which covers 0.4 km area with population density greater than 1,500 people / km², not less than 90% of the population can be served,

b. Local bus services which covers 0.8 km area with population density of 800-1,500 people / km², 50-75% of the population can be served,

c. Express bus service which cover 0.8 km from arterial roads.

3. Research methods
This study applies random sampling method since each member of population had equal opportunity to become sample. Sample is taken randomly and coincidentally. Random sampling is included in Probability Sampling. This procedure enables any elementary unit of population to be taken as sample. Respondents are taken by chance (random).

Data collection technique used in this study is technique of collecting primary data and secondary data. Primary data is obtained by distributing questionnaires to Bus Trans Semarang users. As compiment, secondary data are gathered from several literature sources, such as relevant articles and data from Semarang City Transportation Agency. To achieve the research objectives, research targets are needed. This research is aimed to identify Bus Trans Semarang’s contribution to sustainable transportation planning in Semarang.

4. General Description of Semarang City and Bus Trans Semarang

4.1 Semarang City
The city of Semarang is located between 6°50’ – 7°10’ South Latitude line and 109°35’- 110°50’ East Longitude line. Semarang consists of 16 sub-districts and covers area of 373.8 km². The following is administrative boundary of Semarang City:

| Side      | Name                  |
|-----------|-----------------------|
| North side| Java Sea              |
| South Side| Semarang Regency      |
| West side | Kendal Regency        |
| East side | Demak Regency         |

Semarang is a metropolitan city with population of 1,729,428 [16]. The following figure illustrates population density in Semarang according to 2017 BPS data. Based on gender type, there are more female than male in Semarang, yet only slight different in number. Sub-district with the highest population is Pedurungan with total population of 199,153. Semarang is a dense city. Population in this city increases every year, but it is not balanced Gayamsari is sub-district with the highest density (12,853 people/km²).
Based BPS population data, Semarang residents is dominated by productive age group. This group has high mobility rate, for example regular movement to schools, campuses, workplaces, and markets. In order to support resident mobility, reliable mass transportation is needed. It should be cost-efficient, comfortable and safe. Semarang already has a variety of public transportation modes to serve movement of its people, include in BRT.

4.2 Bus Trans Semarang
Semarang as metropolitan city has various type of public transportation, one which is promoted by the Semarang City Government is Bus Trans Semarang. Bus Trans Semarang is a mass transit service based on BRT (Bus Rapid Transit) operating within Semarang City and Semarang Regency (Ungaran). Bus Trans Semarang service aims to reduce traffic congestion in Semarang which increases every year. In addition, Bus Trans Semarang is also dedicated to accommodate residents from sub-urban to the city center. Bus Trans Semarang is different from other public transportation services because users must hop on and off on fixed bus stops.

Bus rates is determined by Regulation of Semarang Mayor Number 16A Year 2017. Bus rate is applied based on two types of user. Students pay for Rp. 1,000.00 per one way ticket and adult pay for Rp. 3,500. Cash payment can be made on bus or at bus stop. While users can also use non-cash payments by converting rupiahs into e-money first via machines carried by bus officer. Bus Trans Semarang operates within fixed route as seen in Figure 2:

Figure 1. Map of Semarang City Administration

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Figure 2. Route and corridor of bus trans Semarang

Based on Figure 2, Bus Trans Semarang has seven operating corridors. Bus Trans Semarang operates early at 05.30 WIB on Monday-Saturday and at 05.45 am on Sunday. The following are corridors of Bus Trans Semarang:

1. Corridor I: Mangkang Terminal — Penggaron Terminal
2. Corridor II: Terboyo Terminal — Sisemut Terminal
3. Corridor III: Tanjung Emas Seaport — Taman Diponegoro
4. Corridor IV: Cangkiran Terminal — Ahmad Yani Airport — Tawang Railway Station
5. Corridor V: Dinar Mas Meteseh — PRPP
6. Corridor VI: UNDIP Tembalang — UNNES Sekaran
7. Corridor VII: Terboyo Terminal — Pemuda Balaikota

5. Results

5.1 Characteristics of Bus Trans Semarang Service Routes
Bus Trans Semarang already has seven routes spread throughout the city. Although not all is reachable, at least the bus passess along the main roads. Access coverage is priority to users. Scope of the service can be seen from range of bus stops. Existence of bus stops along the route influences accessibility of the service toward.
However, distribution of bus stops (shelters) is uneven and concentrated in Central - South Semarang. Shelters in outer sub-districts such as Tugu, Ngaliyan, Gunungpati, and Genuk are not yet adequate. The longer distance between bus stops, the less eager people to take the bus. Inadequate shelter can certainly demotivate people to use bus service. Moreover, roadsides are not safe and convenient enough for pedestrian to walk after bus stop. The following is a map that illustrates route and the distribution of its routes, Figure 3:

![Figure 3: Service route and bus stop of Bus Rapid Transit Semarang](image)

Figure 3 shows that Bus Trans Semarang service has reached all sub-district centers in Semarang City. However, distance between two nearest bus stops in four outer sub-districts are still too far. This has caused the use of private vehicles by people in the area to be quite high. Resident of those sub-districts must use feeder bus to reach main roads to access Bus Trans Semarang service. Due to quite high demand of outer sub-district users, Bus Trans Semarang can support realization of sustainable transportation in Semarang, which in turn can reduce traffic congestion.

5.2 Characteristics of Bus Trans Semarang Service Time
Bus Trans Semarang serves during two timetables. Monday to Saturday, bus regularly operates from 05.30 am to 18.00 pm. The service is valid for Corridor I to VII. Besides, night service is applied to bus Corridor IV which connect Ahmad Yani Airport to five intersection shelters. During night service, bus operates from 18.00 to 24.00 pm. Therefore, even though Bus Trans Semarang has not provided 24 hours service it has well accommodate need of urban transportation. Student and worker benefit more by long-hour bus operation, especially earlier before morning peak hours and later after evening peak hour.
5.3 Characteristics of Bus Trans Semarang Rates
Regulation of Semarang Mayor Number 16A Year 2017 control rate and payment method for Bus Trans Semarang Rapid Transit service. Bus rate is applied based on two types of user. Students pay for Rp. 1,000.00 per one way ticket and general public pay for Rp. 3,500. Payment can be made on the bus or at bus stop. Payment can be made in cash and non-cash. Bus operator provides non-cash payment machines to convert cash to electronic card and e-money. E-card payment has been implemented since 2013 and e-money (Go-Pay or OVO payment) since 2018.

There are still many who have not used non-cash payment method due to technological backward. Purpose of non-cash payment service is to make it easier for users to make transactions and accelerate their movements. This method of payment also includes service provided by Bus Trans Semarang to its users. Non-cash payments increase reliability of Bus Trans Semarang, as indicator of effective and efficient transportation service.

5.4 Characteristics of Bus Trans Semarang Service Area
Questionnaires filled by Bus Trans Semarang users show that 39% purpose of travelling by the bus is to working offices, 27% to campus or school, 10% to stores, 18% for social or recreational activities, and 5% to airport and station. From the data, it can concluded that Bus Trans Semarang corridors already serves various activity ranging from work, study, shopping, recreational social activities, and others.

Below picture shows land use traversed by Bus Trans Semarang route. The land use consists of various kinds of designations shown in different colors. The land use consists of airports, train stations, terminals, settlements, trade and services, worship, green space, industry, military special areas, health, education, offices, agriculture, ponds, reservoirs, landfill. It shows that all residential areas and public facilities such as trade and services offices in Semarang City have been served by Bus Trans Semarang. For example Corridor IV which serves a variety of land uses such as trade and service centre, offices, and settlements. So that it is expected to reduce the use of private vehicles and traffic congestion in Semarang. Route of other corridors can be seen in Figure. 4:

![Bus Trans Semarang map of service area](image-url)
5.5 Characteristics of Bus Trans Semarang Users

Characteristics of Bus Trans Semarang users can be seen through three aspects. They are: (1) occupation (type of work), (2) ownership of private vehicles, and (3) frequency of using Bus Trans Semarang a week. These aspects will be explained in the following sub-chapters:

1. Bus Trans Semarang User Movement Pattern

Movement pattern represents mobility of population from one land to another land use. Increasing movement requires reliable mode of transportation. Semarang City has recently added another Bus Trans Semarang corridor, namely Undip-Unnes Corridor. However, the addition has yet resolved transportation problem in Semarang City. Bus Trans Semarang only serves along main roads, namely arterial roads, primary collector roads, and secondary collectors. Meanwhile it has not reach residential areas outer sub-districts, therefore users must use feeder transportation service to reach final destination.

Residents are forced to use private vehicles for they are faster and more flexible compared to public transportation. Therefore, the use of private vehicles continues to increase every year. Based on above explanation, it is essential for the bus operator to broaden service coverage.

| Sub-District Name         | User Origin | User Destination |
|---------------------------|-------------|------------------|
| Banyumanik Sub-district   | 10%         | 9%               |
| Ngaliyan Sub-district     | 9%          | 5%               |
| Western Semarang Sub-district | 7%   | 9%               |
| Central Semarang Sub-district | 4%   | 20%              |
| Southern Semarang Sub-district | 4%   | 9%               |
| Northern Semarang Sub-district | 5%   | 3%               |
| Tembalang Sub-district    | 26%         | 10%              |
| Pedurungan Sub-district   | 1%          | 2%               |
| Eastern Semarang Sub-district | 4%   | 4%               |
| Gayamsari Sub-district    | 4%          | 3%               |
| Gunungpati Sub-district   | 3%          | 1%               |
| Mijen Sub-district        | 9%          | 14%              |
| Tugu Sub-district         | 1%          | 3%               |
| Gajahmungkur Sub-district | 5%          | 1%               |
| Candisari Sub-district    | 3%          | 5%               |
| Genuk Sub-district        | 4%          | 3%               |

Bus Trans Semarang support mobility of the residents, especially local movements from city center to suburbs and vice versa. All (100%) of movements served by Bus Trans Semarang is local movements, since the service only covers City of Semarang. The highest origin of movement are educational area, such as Tembalang (26%) and residential areas such as Banyumanik (10%).

Meanwhile related to destination area, majority of Bus Trans Semarang users travel to Central Semarang (20%), Mijen (14%), and Tembalang (10%). Central Semarang is center of the city where governmental and private offices situated, while Mijen is place of factories and industrial complexes. It indicates that locals travel to these districts to work. Tembalang, located in higher southern Semarang, is
education area where universities, colleges and schools exist; therefore people travel for educational purpose.

2. Based on Occupation
   Resident of Semarang is dominated by productive citizen. Due to high mobility, people often leave home for school, market or office. Questionnaires filled by Bus Trans Semarang users shows that 49% of 155 respondents work as employee or entrepreneur. Relatively cheap tariff (Rp. 3,500 for adult and Rp. 1,000 for student per one way ticket) is the main reason of why workers and students chose this mode of transportation. At the lowest percentage of 6%, housewife and frelancer also ride the bus to travel. The following is the percentage of Bus Trans Semarang users based on occupation (Figure 5):

![Figure 5. Characteristics of Bus Trans Semarang users by occupation](image)

3. Vehicle Ownership
   Based on vehicle ownership, 52% of respondents own private vehicles in the form of motorbikes, 8% of respondents have private vehicles in form of motorbikes and cars. A total of 39% of respondents do not own private vehicle, neither motorbike nor car. The percentage shows that Bus Trans Semarang is an alternative mode to support travel activities despite vehicle ownership. On the contrary, Bus Trans Semarang is not only used by groups without vehicle possession, but groups with private vehicle(s). The following is diagram of user characteristics based on private vehicle ownership (Figure 6.):

![Figure 6. Characteristics of Bus Trans Semarang users by vehicle ownership](image)

Figure 6 shows that majority of Bus Trans Semarang users have private vehicle and make the bus alternative mode of transportation. Thus, it is expected that Bus Trans Semarang can change pattern of transportation mode. Bus Trans Semarang is highly realized as a sustainable transportation in Semarang.
4. Frequency using Bus Trans Semarang Service

Travel frequency is intensity of one's movements in a certain period of time. Frequency of trips is strongly influenced by type of activities to be carried out. Figure 7 shows that 54% of Bus Trans Semarang users utilizes the modes 1-5 times a week. The use of bus with an intensity of 1-2 times means that the mode is used to complete sudden needs, such as to accidentally pick up children from school due to flat tire. While users with 1-5 times intensity ride Bus Trans Semarang for certain trips in a week such as to stations, recreational activities or even shopping at markets, malls and supermarkets. Around 21% of passenger ride the bus 6-10 times a week. They are usually ride the bus to complete routine trips, such as to go to work or to school. Then around 25% of passanger ride the bus 11-15 times a week. While the remaining 1% ride Bus Trans Semarang more than 7 times a week. Based on the survey results, passengers who ride the bus more than 10 times tend to use Bus Trans Semarang for round trips, i.e. leaving home then returning home due to occupational needs (Figure 7).

![Figure 7. Travel frequency using Bus Trans Semarang](image)

5. Conclusion

Results of the analysis shows that 49% of Bus Trans Semarang service users are employees or entrepreneurs, while 99% of Bus Trans Semarang passengers own private vehicles. It shows that Bus Trans Semarang is an alternative of transportation mode in the city. Although not yet chosen as the main public transportation, at least operator of Bus Trans Semarang continue to develop its service. When the service was launched in 2009, Bus Trans Semarang only serves one route or corridor, namely Corridor One (Terminal Mangkang-Terminal Penggaron). In 2012, Corridor II was launched, followed by Corridor IV in 2012, and Corridor III in 2014. In 2017 the Transportation Agency of Semarang City introduced new corridors, namely Corridor V and Corridor VI. Lately in 2018, Corridor VII was added. Continuous addition of corridor aims to increase range of service, thus Bus Trans Semarang can reach 16 sub-districts in Semarang.

Survey results show positive response of Bus Trans Semarang users. Since 54% of respondents go by the bus 1-5 times a week. It means that people ride Bus Trans Semarang at least one a day to travel. The number of passanger increases along with corridor addition. Therefore Bus Trans Semarang could become a sustainable transportation in Semarang. The service is proven to reduce traffic congestion and change people’s choice of transportation mode from private vehicles to public transportation.
Acknowledgment
Researchers would like to thank Urban and Regional Planning Department, Faculty of Engineering, Diponegoro University who have given permission to conduct research for International Scientific Publication (RPI) through the Letter of Assignment No. 329 - 96/UN7.P4.3/PP/2019. Thanks to informants who have provided data and information so as to enable preparation of this article, including Bus Trans Semarang users and Liaison Office Semarang (Dinas Perhubungan Kota Semarang).

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