

IMPLEMENTATION OF SUSTAINABLE TRANSPORTATION USING GAP ANALYSIS: CASE STUDY OF SEMARANG CITY

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Received: 24.02.2020

Revised: 05.03.2020

Accepted: 08.04.2020

Abstract

The Semarang City Government is currently getting more serious to provide more advanced and environmental-friendly transportation to reduce the traffic jams and to lessen the air pollution by implementing the sustainable transportation development. It is not easy. Public assessment as seen from their perceptions is needed to realize a sustainable transportation system. It is a quantitative descriptive study. Respondents were taken using incidental sampling techniques and consisting of pedestrian lane users, bicycle lanes users and mass public transportation users. Economic, social and environmental are the variables which analyzed by the gap analysis and scoring method to measuring the criteria on the implementation of sustainable transportation. The results show that the pedestrians' perception on the pedestrian lanes was 40%. Then, the bicyclists' perception on bicycle-lane was bad for only 29.83%. Next, the passengers' perception on mass-public transportation (Trans Semarang BRT) was 52%. In average, public perception on sustainable transportation in Semarang City was 40.61% (fair). According to the scoring process, the gap analysis was 45% (fair). It means that the sustainable transportation system at Semarang City was not optimal, so awareness and cooperation of all stakeholders is needed to create a sustainable transportation system.

Key words: sustainable, transportation, green, environment, economics, city

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DOI: <http://dx.doi.org/10.31838/jcr.07.07.09>

INTRODUCTION

The development of urban areas with all their attractiveness leads many more people interested to move to the cities or urbanization. It makes the urban population go up especially at the metropolitan city. As one of the metropolitan cities and the capital city of Central Java Province, the population at Semarang

City in the past five years has increased as the population density at Semarang City can be seen in figure 1. The population density at Semarang City creates more transportation needs. The greater the population in a region, the greater the need for transportation (Xie, Fanga, & Liub, 2016).

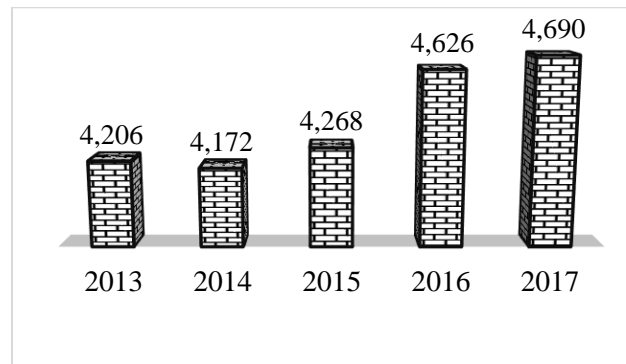


Figure 1. Semarang City Population Density for 2013-2017
Source: (BPS, 2018)

The transportation development at Semarang City is prioritized to optimize the spatial utilization and to increase the planned, harmonized, balanced and equitable regional infrastructure development then; taking into account on the concept of environmental and sustainable development (Bappeda Kota Semarang, 2017a). Sustainable transportation means a transportation system using fuel, vehicle emissions, security, traffic jam, social and economic access which does not give negative impacts and cannot be anticipated by the future generations (Brotodewo, 2010). Based on (Centre for Sustainable Transportation, 2002); there are several indicators to realize the

sustainable transportation: ease of access, non-motorized transportation (walking, cycling), and mass public transportation. Thus; the implementation of the sustainable transportation is carried out by providing mass transportation modes such as; buses, public cars, rickshaws, etc. supported by facilities and infrastructure such as shelters, roads, street lightings, pedestrian lanes or pavement walks etc. The Semarang City Government has provided a mass transportation mode called *Trans Semarang Bus Rapid Transit (BRT)* or *Trans Semarang City Bus*. However; the numbers of private vehicles are going up each year; it makes the traffic jams, hinders the

economic activity, and creates the environmental pollution. Traffic jams at Semarang City happen because the increase of private vehicles is not in line with the growth of roads. So a large investment is needed to make efficient the using of alternative energy and technologies to minimize these negative externalities (Saidi, Shahbaz, & Akhtar, 2018). It needs citizen's awareness in order to change the use of transportation modes. The research (Xia, Zhang, Braunack-Mayer, & Crabb, 2017) stated generally that the 'push' measurement (such as the more expensive petrol price) is not effective in terms of the utilization of mass public transportation, compared to the 'pull' measurement (such as the rise of mass public transportation fares). 'Cycling Safety factor and car use comfort' and 'public transportation negative emotion' related positively on the respondents' distance. The other two factors of 'sustainable transport benefits awareness' and 'traffic problems awareness' associated positively with the revenue of measurement from sustainable transportation promotion, respondents who use car more often scored higher on 'cycling safety concerns and car use comfort' and have degree from university and less likely to reduce the use of cars.

Nowadays, the Semarang City Government is currently getting more serious to provide more advanced and environmental-friendly transportation to reduce the traffic jams and to lessen the air pollution by implementing the sustainable transportation development. It is not easy as (Shankar, Divya, & Jharkharia, 2018) states that the obstacles to realize and to implement the sustainable transportation are financial resources, public awareness and public behavior in using environmentally friendly transportation. Thus it needs good cooperation between the community as the users (demand) and the government as the provider (supply). Therefore the study is needed to find out the public assessment on the effort created by the government to realize the sustainable transportation system. Public assessments are carried out by looking at their perceptions of sustainable transportation.

LITERATURE REVIEW

The research that has been done by (Deb & Ahmed, 2018) stated that perception and expectation from the passengers was one of the most important thing to estimate the service quality of city bus transportation. The research is called *Determining the Service Quality of the City Bus Service Based on User's Perceptions and Expectations* was aimed to look for the service quality from city bus service based on the passengers' perception and the expectation of the service. The research by (Deb & Ahmed, 2018) tried to compile data perception and user expectation by using questionnaire survey that had been done dan answered by the respondents who was asked with some questions about service attribute of city bus by using factor analysis, liner regression analysis, and structural equation model to find the latency factor that influenced the users perception and expectation.

The research by (Eefthymiou & Antoniou, 2017) conducted a study called *Understanding the Effects of Economic Crisis on Public Transport Users' Satisfaction and Demand*. This research focused on quantitative factors such as service quality, provision of information and convenience, influencing transportation demand can be valuable in the planning and evaluation of public transportation. The aim was to measure the impact of the crisis on the satisfaction and demand of users of public transportation which are included as latent variables on discrete hybrids and latent variable models. The study area was conducted in Athens, the capital of Greece with a population of around 4 million with 5 public transportation service providers before the merger in 2011 and 2014. Data were collected using a questionnaire. Questionnaire questions consist of demographic questions, travel patterns, and qualitative characteristics of the system. By conducting a face-to-face questionnaire system, researchers also conducted a customer satisfaction survey. Characteristics used as the evaluation material are: 1. General characteristics of the public transportation transit system; 2. Terminals and stops; 3.

vehicles; 4. Transfer point. The results of this study are divided into two parts, the first part is investigating the differences between users perceptions of the characteristics of public transportation in 2013 and 2008, aims to identify the positive and negative impacts of the crisis, and the second part to measure the shift from private modes to public transportation.

This research is also supported by (Nesheli, Ceder, & Estines, 2016) was stating that in various situations (such as waiting more than 10 minutes), more than 60% of users will change their choices and adapt to travel behavior based on decision-support tools. This provides policy makers with an understanding of behavioral aspects of real-time operational tactics. The main objective of this study was to collect and analyze information from public transport passenger behavior and their perceptions related to the use of potential choice driving devices in the existing public transportation system. The second objective was to determine the potential benefits of a control strategy using operational tactics to reduce uncertainty of passenger travel schedules by increasing the reliability of public transportation services.

Based on previous research, then the originality of this research is to conduct research on the impact of transportation on the economic environment in Semarang, Indonesia. This is rarely done but it needs to be done because Semarang as one of the big cities in Indonesia needs to clean up to welcome changes in the environment and IT in the era of the Industrial Revolution 4.0. Semarang with its Javanese specialties deserves to be considered by the culture including transportation culture to support the future. This is in accordance with what was done by (Steg & Gifford, 2005) which states that although there is still no official term to declare a public transportation has a nature of sustainability, but it can be agreed that sustainable transportation is one that is balancing the current economy and future, social quality, and environmental quality.

THE RESEARCH METHODS

It was a quantitative research. It used primary and secondary data. The primary data are taken from distributing the questionnaires and observations. Then the secondary data was taken from literature, journals, the Office of Planning and Development (Bappeda) at Semarang City, the Office of Transportation at Semarang City, and the Office of Environment at Semarang City.

It used the incidental sampling; the samples were the pedestrians, bicyclists, and the users of mass public transport at Semarang City; they were 90 people. The variables of the study were economic, social and environmental variables. The indicators of sustainable transportation are easy access, non-motorized transportation (walking, cycling) and the provision of mass public transportation.

The data are then analyzed by gap analysis. The assessment carried out by using a scoring method on the sustainable transportation indicators which was modified from (Centre for Sustainable Transportation, 2002), (Desdyanza & Nurul, 2014), and (Bappeda Kota Semarang, 2017b). The indicators of the sustainable transportation are focus on access, non-motorized transportation, motorized transportation by current means, motorized transportation by potential means, and less need for movement of people.

The formula for calculating the percentage of implementing the sustainable transportation is below:

$$X_{max} = \sum ixS \dots\dots\dots (i)$$

$$P_s = \left(\frac{x_t}{x_{max}} \right) \times 100\% \dots\dots\dots (ii)$$

Notes:

X_{max} = The maximum score

$\sum i$ = The number of indicators

S = The maximum scoring points

P_s = The percentage of implementing the sustainable transportation

X_t = Total score of the implementation

Then, here they are the criteria for implementing sustainable transportation:

0- 20% : Very Bad;

21%-40% : Bad;

41% -60% : Fair;

61% -80% : Good;

81% -20% : Very good.

THE RESULTS AND DISCUSSION

The Perception of Pedestrians on the Pavement Walks at Semarang City.

The lowest indicator of pedestrians perception on the lane pedestrians performance at Semarang City is the availability of supporting facilities for 34.17%; and the highest indicator is the integration of pedestrian lanes with other transportation modes, especially mass-public transportation for 50.83% (Figure 2). The availability of pedestrian facilities includes the availability of benches along the lanes, trash bins, and others. On average, the five indicators of pedestrian lanes' performance are 40%. It

indicates that the overall development of the pedestrian lane is not maximized and below 50%.

The low level of pedestrian lanes performance at Semarang City happens because; first, the vegetation intensity to create the green lane is not enough. It is mostly used as the aesthetic and the barrier between the roads and pedestrian lanes; it is not considered for the pedestrians protector from the sunlight and rain, and pollution and noise. It is in line with (Kim, Lee, & Kim, 2018), they state that the green vegetation along the pedestrian lane is important to improve the pedestrians comfort. It is also found by the research of (Zhang, Liu, & Li, 2014) that pedestrian lanes should connect each other and connect to the shelters and the green vegetation along the pedestrian lanes will improve people's interest to walk through.

Second, there is less street furniture which can support the pedestrian activities. It is not only due to the absence of these facilities but also due to community behavior which actually damaged the facility. The lack of lightings in some pedestrian lanes makes the low security level at night. There are several pedestrian lanes like around the Pandanaran Street. which are used for parking lots of motorbikes and street vendors. It creates the traffic jam because there are not any large parking lots at the areas. It will be different if the parking lots are available for the riders and sellers as (Nag, Paul, & Saha, 2018) state that the availability of parking lots in urban areas can reduce vehicle mobility, avoid traffic jam and attract tourists tripping in urban areas.

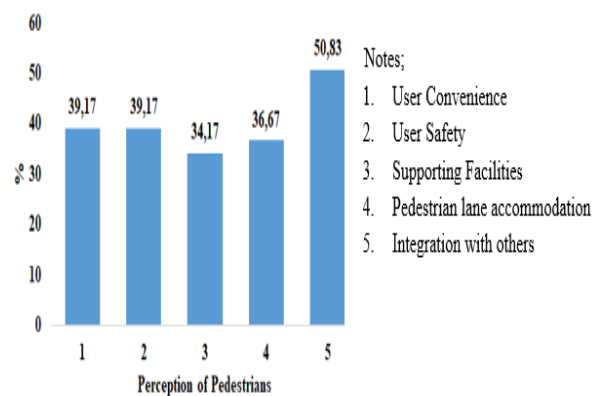


Figure 2. The Perception of Pedestrian Lanes' Users at Semarang City
Source: The Processed Primary Data, 2018

Third, the design of pedestrian lanes is considered unfriendly with persons with disabilities. There are various obstacles on the lanes; such as trees and electricity poles in the middle of the lane and the intersection of roads with pedestrian lanes (forcing people to go up and down). Furthermore; the planned pedestrian lanes are not fully built; such as on Pamularsih Street., Sriwijaya Street., S. Parman Street., HM. Agus Salim Street., Dr. Cipto Street., Kaligarang Street., MT. Haryono Street. and Veteran Street. They are not well built yet because it needs a lot of allocation of funds needed for all planned lanes. There are also limited lands along the road and many buildings coinciding with the pathways. On the other hand, (Qian, Zhou, & Chen, 2018) state that ideally, the requirements of pedestrian route to attract people to walk are easy access from various places and the quality of pedestrian lanes which makes users comfortable using it.

The Perception of Bicycle Lane Users on Bicycle Lane at Semarang City

The lowest indicator of bicycle lanes users perception at Semarang City is the availability of supporting facilities for 23.33% and the highest indicator of the bicycle lanes users perception at Semarang City is the integration of bicycle lanes with other modes of transportation, especially mass public transportation for 41.67% (Figure 3). The availability of bicycle lane facilities includes the availability of shelter, trash bins, bicycle parking lots and others. The average performance of bicycle lanes at Semarang City is 29.83% or very bad. It means the lanes have poor performance.

It indicates that the overall development of the bicycle lane is not maximized. The low level of bicycle lanes performance at Semarang City is due to; first, the lack of supporting facilities on bicycle lanes. The bicycle lanes, such as at Pahlawan Street.and Pemuda Street.are in bad condition; the boundary lines or the roadblocks between the bicycle lane and the road are not clear which can endanger the safety of bicycle users. Then according to

(Gerike & Koszowski, 2017), they state that the pedestrian and bicycle lanes provided in urban areas should pay attention to the

safety and comfort for its users by providing roadblocks and adequate facilities.

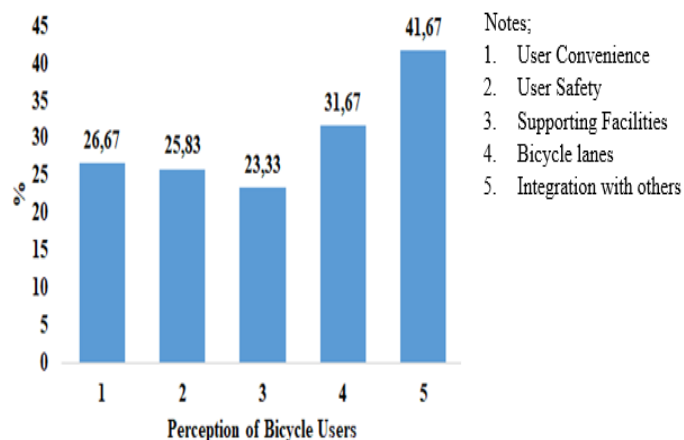


Figure 3. The Perception of Bicycle Lanes' Users at Semarang City
Source: The Processed Primary Data, 2018

Secondly, there are a lot of cars parking on the bicycle lane which clearly disturb the bicyclists. There are many roads at Semarang City which are planned to be built the bicycle lanes but they have not been built yet. It assumes that there are few bicyclists at Semarang City. There are only 2 of 14 roads equipped with bicycle lanes. The government should continue developing the bicycle lanes because riding bicycles is healthy and efficient because it does not use fuel. It is as stated by (Beland, 2014) that bicycling is considered effective to support the realization of sustainable transportation at urban areas

Semarang BRT is 52% or fair. It is better than the average performances of pedestrian and bicycle lanes. The perception of passengers on the time is low because they have to wait for a long time at the shelter for Trans Semarang BRT arrivals.

The Perception of Public Mass Transportation Users at Semarang City

The lowest indicator of Trans Semarang BRT' users perception is the time efficiency for 31.67% and the highest indicator of Trans Semarang BRT user perception is the Trans Semarang BRT tariff for 74.17% (Figure 4). Then, the average performance of Trans

The research conducted by (Rithoma, Ricky, & Rahmatullah, 2013) states that several shelters at Banyumanik area of Semarang City are not good and many conditions were damaged so its disturb the comfort of users. Moreover; the *Trans Semarang BRT* lane which is still integrated with other vehicles can be a barrier to *Trans Semarang BRT* trips, especially when traffic jams happen. Consequently; the *Trans Semarang BRT* needs longer time to arrive at a certain spot/ shelter. Thus; it needs the planning to attract the public's interest in using *Trans Semarang BRT*. The planning should fulfill the people's expectation and it should involve the community to create the better planning and implementation (Silitonga & Desi, 2017)

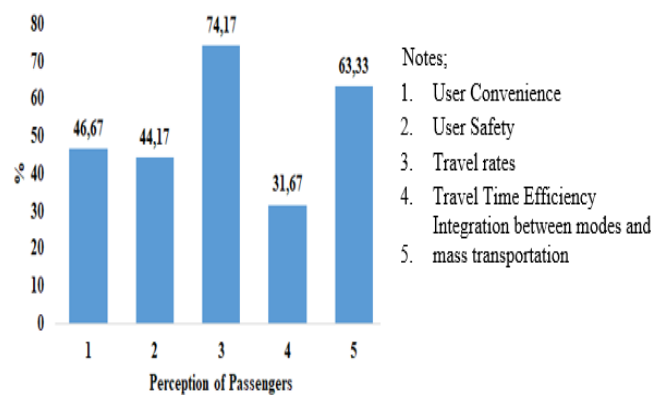


Figure 4. The Perception of Public Mass Transportation Users at Semarang City.
Source: The Processed Primary Data, 2018.

The Implementation Scoring for Sustainable Transportation The Economic Aspect

The first indicator on economic aspect is the focus on access; it is related to the affordable tariffs of mass public transportation. The second indicator is the time efficiency to move people with

the mass public transportation. It can move faster than private vehicles so the time needed is more efficient.

The scoring results of public perceptions on the effort made by the government to create the sustainable transportation system at Semarang City can be seen below on table 1.

Table 1. The Implementation Scoring of Economic Aspect on Sustainable Transportation

No	Indicator	Actual Condition	Ideal Condition	Score
1.	Focus on access	<p>The pedestrian lanes for disabilities are only available on several roads; e.g. at Ahmad Yani Street, Imam Bonjol Street, Mgr. Soegijapranata Street, Pahlawan Street, Pandanaran Street, Pemuda Street. and partially Veteran Street.</p> <p>Then, the supporting facilities on pedestrian lanes are very minimal.</p> <p>The design of mass public transport for disabilities already exists but there are few too sharp slopes which can endanger them.</p> <p>The tariffs of <i>Trans Semarang BRT</i> mass transit are affordable for everyone (The passengers' perception is 74.17%.)</p>	<p>All facilities; such as pedestrian lane, bicycle lane, crossing/ JPO) and public transportation facilities are designed by considering all aspects of comfort and safety for all users including users with special needs.</p> <p>The tariffs for mass public transportation are affordable for most people (the percentage of public perception is > 75%).</p>	2
2	Less need for movement of people	<p>Spatial planning at Semarang City is not based on TOD because urban spatial planning does not focus on the use of mass public transportation.</p> <p>The perception of mass public transportations' users at Semarang City is only 31.67 %. They assume that using private vehicles is faster than <i>Trans Semarang BRT</i> Semarang City.</p>	<p>TOD-based urban spatial planning and urban land use in mixed-use.</p> <p>Trip time by using mass public transportation mode is much faster than by using private vehicle (the percentage of public opinion is > 80%)</p>	1
Total Scores of Implementation				3

Source: The Processed Primary Data, 2018

The Environmental Aspect

The first environmental indicator is non-motorized transportation. The indicator is related to the provision of non-motorized transportation facilities and infrastructure; i.e. the pedestrian and bicycle lanes which should emphasize on the users' safety and comfort aspects.

The second environmental indicator is motorized transportation by current means. It is related to the provision of mass public transport which should pay attention to the users' safety and comfort. The mass public transportation lanes should be separated from other vehicle and should be non-fossil fuel to reduce air pollution.

Table 2. The Implementation Scoring of Environmental Aspect on Sustainable Transportation

No	Indicator	Actual Condition	Ideal Condition	Score
1.	Non-motorized transportation	<p>Pedestrian facilities are in fair performance with a user perception for 40%.</p> <p>The existing bicycle lane performance is relatively poor with an average performance is only 29.83%. There were only 2 bicycle lanes which already built; i.e. at Pahlawan Street. and Pemuda Street. The bicycle lane and pedestrian lane are separated from vehicle lanes but the separating lanes are only lines and they are not clear now.</p> <p>The crossing facilities such as zebra crossing available on several roads but there are not any bridges or JPOs.</p>	<p>The existing pedestrian facilities (facilities and infrastructure) should accommodate all users safety and comfort well, with the performance value is > 75%.</p> <p>The existing bicycle lane facilities are everywhere and connected to all city roads, especially to the main roads. Furthermore; both bicycle facilities and infrastructure can accommodate bicycle users well, with the bicycle lane performance is > 66%. Each lane (pedestrian lane, bicycle lane, or vehicle lane) has been completely separated using the hard barriers.</p> <p>Zebra crossing and JPO (skywalk) are at each the road sections, especially in the crowded centers.</p>	2
2.	Motorized transportation by current means	<p>The available mass public transportation is, is <i>Trans Semarang BRT</i> but the lanes are not separated (integrated) with other vehicle lanes.</p> <p>The perception of <i>Trans Semarang BRT</i> users is fair with the comfort level is 46.67% and the security level is 44.17%.</p> <p>Furthermore; the rail-based mass public transportation at Semarang City is still in the planning and is not realized yet.</p>	<p>There are modes of road and rail-based mass public transportation which serve lanes within the city and have special stops.</p> <p>For modes of road-based mass public transportation, it has a special lane which is separated from other vehicle lanes with hard barriers.</p> <p>The performance of the existing mass public transportation modes is very good for the users with the percentage of comfort and safety is > 75%</p>	2
Total Scores of Implementation				4

Source: The Processed Primary Data, 2018

The use of sustainable transportation will provide environmental aspects. This was observed by (Susniene, 2012) who stated that the benefits of public transportation are (1) increasing community mobility, reducing dependence on cars and having a negative impact on health while reducing the consequences of road widening. (2). Service performance has an impact on customer satisfaction, which then impacts market share and profits that produce retention. (3).The purpose of using

SERQUAL is as a diagnostic tool to find specific areas in the strengths and weaknesses of a company.

The Social Aspect

From the social aspect, the indicator observed is motorized transportation by potential means. Indicators are used to ensure that the available mass public transportation integrated with other transportation modes to make it easier for users to switch the transportation mode.

Table 3 . The Implementation Scoring of Social Aspect on Sustainable Transportation

No	Indicator	Actual Condition	Ideal Condition	Score
1	Motorized transportation by potential means	Private vehicles and mass public transportation at Semarang City are using fossil fuels. The use of alternative fuels at Semarang City is not applied yet. The alternative fuels are not widely available. The integration among modes of public transportation inside and outside the city is relatively good with the public perception is 63.33%.	All private vehicles and public transportation modes have used alternative fuels as the main fuel for vehicles. The availability of alternative fuels is easy to be found. The integration among modes of mass public transportation is very well integrated with the public perception is > 80%.	2
Total Value of Implementation				2

Source: The Processed Primary Data, 2018

The scores for implementing the sustainable transportation at Semarang City are based on five indicators using the analysis gap. The scoring results are then calculated using the formula in equation 2 and the result is 45%. It means that the implementation of sustainable transportation at Semarang City is fair and not maximal.

The research (Dell'Olio, Ibeas, & Cecin, 2010) states that the social aspects of people who use effective and efficient transportation will have a good impact. They found that if the calculations were carried out using Survey carried out before traveling by Bus as the dependent variable, the variable with the most weight was Reliability of Service (27.6 percent), Waiting time (23.8 percent) and Comfort (17, 1 percent). The results will change if the dependent variable is changed to Survey conducted after boarding the bus, the variable with the highest contribution to Reliability of Service becomes 27.2 percent, Waiting Time becomes 18.6 percent and driver kindness becomes 17.9 percent. Surveys conducted after the trip make bus users reduce the important power of waiting time and give it to the driver kindness. Another variable that changes after traveling is the quality of the vehicle. Other relevant variables are Driver kindness, waiting time, journey time, comfort during journey, in-vehicle safety, quality of vehicle and service reliability.

Therefore, the results of this study need to be considered. Community perceptions need to be known so that they can follow up the necessary follow-up, namely building perceptions for the community, government, policy makers, and stakeholders. The need to secure an understanding that public transportation is not just transportation for those who are 'unable' because in fact politicians and policy makers do not ride public transportation. This increases the negative perception of public transportation to policy makers and able people (Quodomine, 2015). As stated by (Vilakazi & Govender, 2014) that in any society, people are entitled to mobility in the same way as their rights to the sewage system. This means that passenger transportation is public utility; and the benefits derived from public utilities can only be realized if the system is planned and regulated so that all members of the community benefit the poor and the rich. To alleviate problems due to increased use of cars.

Transportation policy measures, including, in some places, increased costs for car use, prohibition or rationing of car use, and increased physical infrastructure, have been introduced. These steps may, however, show low acceptance and worthiness, and they will not be effective alone. Therefore, when designing and implementing sustainable transportation policies, policy

makers must consider a range of approaches other than the above, including education in schools, communities, workplaces and in the media to increase awareness of the impact of using private cars as well as providing detailed information on alternative benefits (Xia, Zhang, Braunack-Mayer, & Crabb, 2017).

To improve performance indicator, it is recommended to improve service quality attributes associated with specific performance indicators. For example, to increase the perception of safety, it is recommended to increase safety measures at bus stops and vehicle entrances. Bus service drivers must be instructed to drive carefully to avoid any kind of accident. To improve the timely performance of bus services, it is recommended to instruct bus operators to follow strict arrival and departure times and avoid unnecessary delays during trips. The bus service operator also suggests publishing travel times for different routes and recognizing that passengers are almost the same. In the same way, all performance factors can be improved. Improving the quality of bus service will make services more attractive to passengers and will reduce the excessive use of private vehicles and paratransit modes. Therefore, this research is very important in assessing passengers' viewpoints about services and making services more attractive according to their expectations of service. This research provides insight into current city bus services and it will assist bus service operators in determining areas that need to be improved (Deb & Ahmed, 2018).

It is, indeed, needed support from various parties to be able to implement good public transportation. This was revealed by (McLeod, Scheurer, & Curtis, 2017), who stated that the application of transformative public transportation in the future requires close regional orientation, collaboration between institutions, and must exploit the symbiotic benefits of public transportation and urban development to achieve good results. The findings of this systematic review support the mobility-oriented paradigm of public transportation.

Comprehensive research on community perception needs to be done. This is in line with that of research conducted by (Vilakazi & Govender, 2014) which states that service providers, transport planners and relevant government authorities, etc., need to know the perceptions of commuters and implement strategies to improve the situation

CONCLUSION

Based on the results of the study and the discussion; it can be concluded that the conditions and development of sustainable

transportation at Semarang City are not maximal because the performance value of the three sustainable transportation variables; i.e. pedestrian lane, bicycle lane and mass public transportation is below 100%. The performance value of pedestrian lanes at Semarang City is fair with the average performance is 40%. Then, the performance value of bicycle lane according to the perception of bicycle users is only 29.83% or it relatively bad because the poor performance. Then, the performance value of mass public transport or *Trans Semarang*

BRT is fair for 52%. The average performance of those three sustainable transportation variables is only 40.61%. Based on scoring with a percentage analysis gap; the scoring results are 45%. The overall results show that transportation development at Semarang City does not fully refer to the sustainable transportation system. Awareness and cooperation of all stakeholders is needed to create a sustainable transportation system.

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