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# Implementation of Passenger Information and Monitoring Systems in Trans Semarang Bus and Assessment of the Community Perception

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***Abstract:*** ***One of the methods to raise public interest in Trans Semarang buses is by providing real-time departure and arrival information. Therefore, it is necessary to improve public transportation services using the Monitoring System installed in the Semarang City Transportation Office as well as the Passenger Information System at 5 bus stops of Kesatrian, Elizabeth, UNDIP, UNIKA, and UNNES. This system, however, requires the Automatic Vehicle Location, GPS, and transmission bus's geographical location are determined and sent to the server via the satellite while the tracking info is sent using a wireless system via GSM. The system was designed to display bus location and speed information to estimate arrival time to passengers in real-time to ensure an accurate time of travel is shown on their android mobile phones and monitors at bus stops as well as the Transportation Office. The results obtained from the survey conducted showed 99.2% of 130 respondents were pleased with the implementation of the system.***

***Keywords : Systems; Monitoring; Passenger; Information; Semarang.***

## I. INTRODUCTION

Transportation is efficient when the system is easy, inexpensive, reliable, safe, comfortable, and environmentally friendly according to smart transportation with modern management arrangements. Smart mobility is one of the parameters used to achieve the concept of the smart city involving the management and planning of urban centers using digital data and technology systems (Dameri, 2013). It is generally defined as a system initiated to fulfill human needs with minimal movement and as quickly as possible (Boyd, 2013). According to Supriyanto et al (2010), the qualified urban transportation for cities with high population is through the use of mass public transportation and according to the data from the metropolitan city of Semarang, public transportation currently serves only 7% of the total population (Mudjiastuti. 2013; Mudjiastuti. 2016; Sukarto, 2006).

Meanwhile, in developed countries like Singapore, 85% of the population are being served using this system (Mudjiastuti. 2013).

It has also been reported that the Trans Semarang buses operate on one public road with mixed traffic thereby making it difficult to predict arrival time with certainty. Therefore, both Monitoring and Passenger Information Systems are needed to determine the departure schedule information which consequently helps public transport users plan a trip effectively, and ultimately change the community behavior concerning the use of the private vehicle (Trans Semarang Bus). This is expected to reduce congestion on roads, the volume of vehicles/traffic in the Semarang, and the consumption of fuel oil (BBM) made from non-renewable fossils (Mudjiastuti, 2013 and Tejja, 2016).

One of the efforts to increase the interests of the public in mass transportation is by providing information on departure and arrival in real-time [Swati, 2013]. However, it has been reported that predicting bus arrival is a major challenge to build a smart transportation system (Fanani et al. 2015). This has led to the desire to improve public transportation services by using the Monitoring and the Passenger Information Systems to ensure transit services are reliable for passengers. Moreover, transportation services also need to be equipped with one bus away tourist information to reduce the bus arrival waiting time for prospective passengers and improve their tolerance limits (Watkins et al. 2011). This is in line with the findings of Fanani et al, (2015) and Watkins et al, (2011) that the bus arrival prediction system is very important due to its ability to reduce the waiting time of prospective passengers.

The purpose of this research therefore was to analyze the implementation of the Monitoring System and Passenger Information System in Corridor VI of Trans Semarang to provide the information required by passengers to plan departure and arrival at their destination in real-time and also to determine public perceptions of these concepts. The benefits include being able to change people's behavior from using private vehicles to mass transportation in the form of buses as well as how people travel (Andre et al. 2007). It also has the ability to reduce road congestion, vehicle volume, and fuel/capita consumption (Handajani, 2012).

Tokyo and Japan have been reported to have implemented this system.

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This research made use of ringtone and vibrator to notify passengers of the close to their destination and avoid moving past the location. However, the weaknesses observed in the system include the inability of the bus to display its speed and the arrival time as well as the difficulties in monitoring the position of the bus in real-time (Yutaka, 2010 and Kenneth et al., 2002).

In order to resolve these challenges, integrated technology concerning information systems to monitor movement and number of passengers has been developed in Korea to provide information on arrival, departure, and position at each bus stop while in Indonesia only the new Monitoring System has been implemented in Jakarta.

The system has also been equipped with a bus tracking device to make prospective passengers observe bus trips at each bus stop. This was implemented through the installation of transmitting devices, GPS for buses and chip cards for passengers, with the receiving units located at bus stops and monitoring centers established to monitor bus trips in real-time. The transmitter has variable speed, bus number, and the number of passengers generated from the RF-ID installed on the chip card to count incoming and outgoing passengers.

## II. RESEARCH METHOD

The research was compiled based on the 2016-2020 University of Semarang Strategic Plan road map with reference to (1) Population and HR, (2) Food Security, (3) New and renewable energy, (4) Transportation, (5) Technology and Communication, (6) Law, and (7) Social and Economics. The transportation road map was the basis for the implementation of the smart city through smart transportation.

This research was funded by the Ministry of Research, Technology and Higher Education (Ristekdikti) and divided into 3 stages including (1) preparation involving obtaining permits and collaborating with the Semarang City Transportation Department and Industrial Partners (PT. INOVASI CYBER INVESTAMA), field survey to obtain primary data on Trans Semarang Bus's route, speed, boarding alighting, headway, distance between bus stop and its conditions, and questionnaire and secondary data on number of vehicles and bus stops, schedule, coordinates, route, bus type, and bus stop conditions, (2) implementation and testing of monitoring and passenger information systems, and (3) installation or implementation of a monitoring system to track the position of the Trans Semarang Bus at the control center and the Passenger Information System.

The Monitoring System was installed in the Head Office/Department of Transportation of the Semarang city. The Passenger Information System was implemented at Kesatrian, Elizabeth, UNDIP, UNIKA, and UNNES bus stops in the Corridor VI Route from Diponegoro University to Semarang State University while 9 GPSs were installed on the buses for proper monitoring.

The online questionnaire was filled by 130 respondents including students, workers, housewives, and transportation experts, aged 17 to 60 years, men and women riding buses, motorbikes, cars, as well as those without vehicles.

## III. REVIEW CRITERIA

### A. *Trans Semarang Bus Route Corridor VI*

The Trans Semarang Bus Route Corridor VI selected for this research is a new educational route requiring adjustments either from the local community or from the surrounding environment

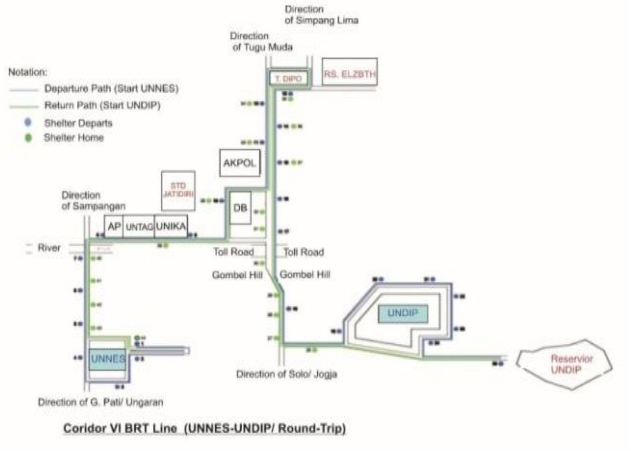
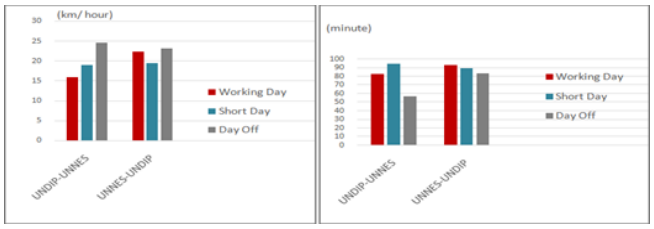



**Table 1. Travel Time and Average Speed of Trans Semarang Bus Corridor VI**

| Days | Traveling Times | | Average Speeds | |
|---|---|---|---|---|
| | UNDIP - UNNES (minutes) | UNNES - UNDIP (minutes) | UNDIP - UNNES (km/hour) | UNNES - UNDIP (km/hour) |
| Working Days | 83 | 93 | 15,95 | 22,37 |
| Short Days | 95 | 90 | 18,97 | 19,45 |
| Holidays | 57 | 84 | 24,53 | 23,15 |

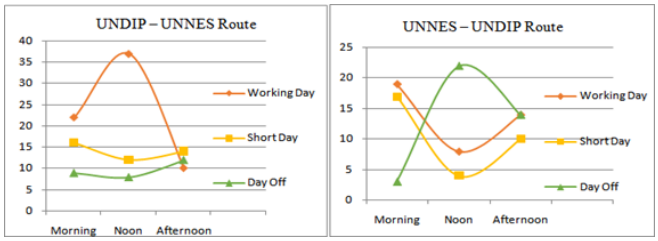
Source: 2018 Analysis Results

A graph to compare the travel time and average speed is shown in Figure 3 while the number of bus passengers is presented in Figure 4.




Source: 2018 Analysis Results

**Figure 3. Comparison Graph of Travel Time and Average Speed of Trans Semarang Bus Corridor VI**



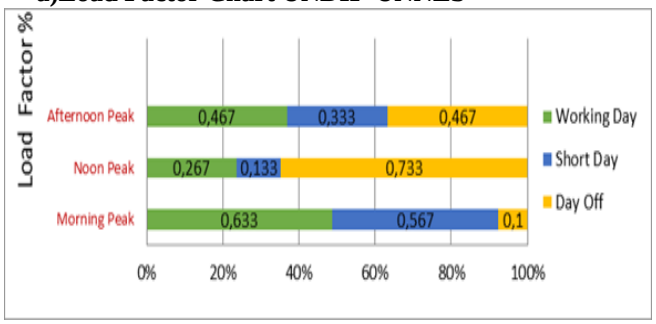

Source: 2018 Analysis Results

**Figure 4. Number of Trans Semarang Bus Corridor IV Passengers**

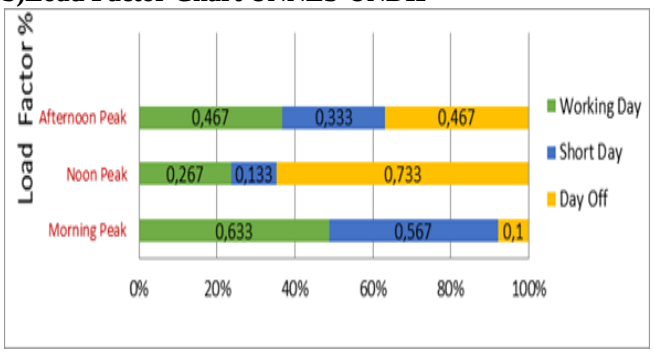
The Director-General of Land Transportation has set the public transport load factor parameters to be 60% - 80% or 0.6-0.8 with reserves of ± 30%/± 0.3 to accommodate the surge in passengers.

However, Corridor VI has a load factor of 37% -47%, and this is below the optimal load factor as shown in Figure 5.

**a)Load Factor Chart UNDIP-UNNES**




**b)Load Factor Chart UNNES-UNDIP**




**Source: 2018 Analysis Result**

**Figure 5. Graph of Load Factor**

## B. *Demand Distribution*

Land use around the stop point affects demand, for example, routes around educational institutions, offices, shopping centers, and housing usually have high demand rates due to their attraction there by causing traffic congestion. Locations of bus stops with high demand in Corridor VI are presented in Figure 6.


**Figure 6. Bus Stop Location with High Demand on Corridor VI**

The conditions of the bus stops are presented in Figure 7

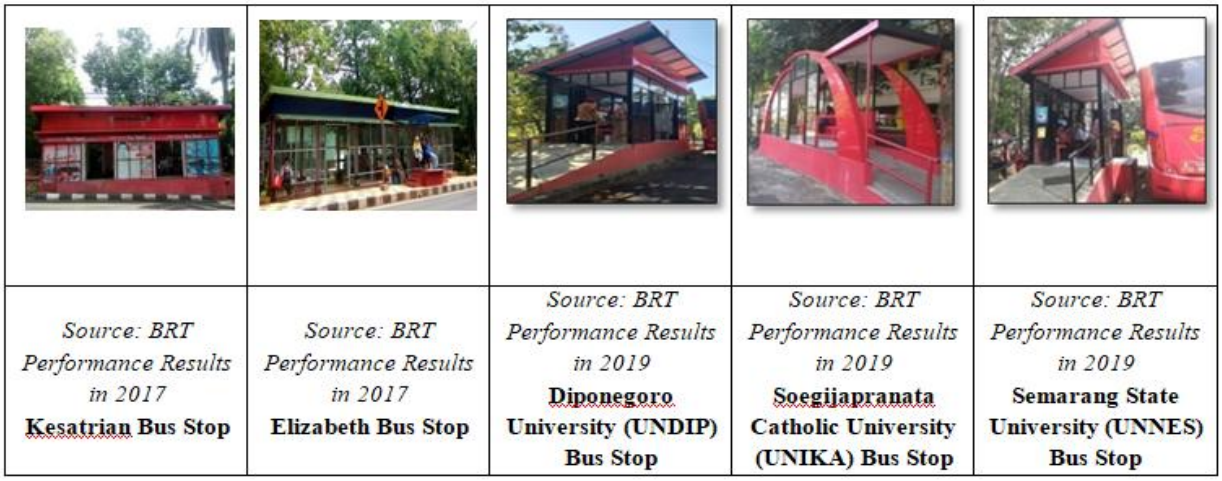



**Figure 7. Condition of bus stops in Kesatrian, Elizabeth, UNDIP, UNIKA, UNNES**

## C. Implementation of Monitoring System and Passenger Information System

The real-time implementation of this system was conducted by installing GPS on each bus to display coordinate data on the Passenger Information System as shown in Figure 8.


**Figure 8. Monitoring System Configuration to display coordinate data on the Passenger Information System**

The system was designed to stand alone in displaying the location of the bus to the central control unit through the use of a web server to monitor buses in real-time and mobile applications for the bus users.

### D. Monitoring System and Passenger Information System device

The devices used in this system include GPS, server, and monitor display as well as the use of GSM to transmit the information as shown in the system configuration presented in Figure 9.

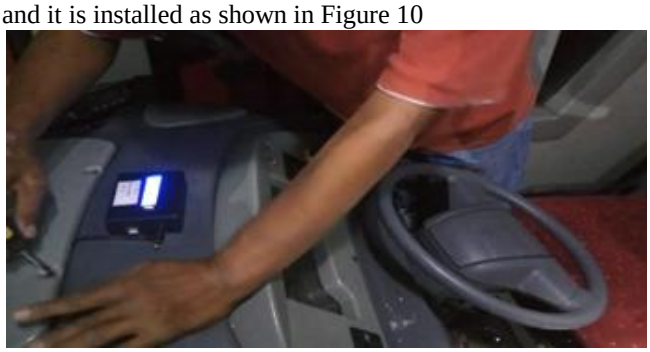

**Figure 9. Configuring the Monitoring System and Passenger Information System**

The configuration process shown in Figure 9 explained the improvement started from the feasibility of the bus stop facility, collection of data, connection to server via satellite using GPRS internet network, installation of GPS on the bus driver, operating the Monitoring System application at the Semarang Office of Transportation, and installation of the Passenger Information System monitor display at the bus stop.

The device consisted of three main components including 1) Bus Unit encompassing the Bus equipped with a GPS tracker, microcontroller module, and GSM to determine the speed, position, number, and destination of the bus station as well as the installed emergency signal, 2) Client-Side Application displayed at each stop in the form of a receiver unit and real-time monitoring to make prospective passengers see arrival time and load capacity of the bus firsthand, and 3) Central Control Center (CCU) to monitor the bus in real-time using receiver, emergency receiver, and micro control for the prospective passengers. The server is an intermediary between the bus module and the users or prospective passengers while the database consists of real-time information such as bus routes, actual arrival/departure times, number of passengers, and the real-time location of buses. The GPS module on the bus sends the latitude and longitude data stored in a computer system to the monitoring system while the prospective bus passengers can also make inquiry by entering the source, destination, and bus number and all buses traveling the route selected will be displayed as result and if the bus is within range, the loading capacity will be included. Moreover, if there is proximity between the location of the bus and the prospective passengers, the system would calculate the time to reach the location. Besides, there is a regular update of the latitude and longitude by the GUI/Monitoring System to display the bus location and arrival time. An iterative cycle process is followed for each search starting from the user or prospective passenger.

***Support Servers in Monitoring System Devices and Passenger Information System***

As previously stated, the server is an intermediary between the bus and passenger modules with the database consisting of the real-time information such as bus routes, estimated and actual arrival or departure times, number of passengers, and bus location. The GPS module on the bus sends data in the form of latitude and longitude stored in a computer system and it is installed as shown in Figure 10



Source: BRT Performance Results in 2017

**Figure 10. GPS has been installed in the Trans Semarang bus**

The GPS installed sendsthe fixed data of coordinates at each time interval to the main server and to calculate the position, signals are captured from at least three satellites depending on the type of GPS transceiver application including Loggers, Pullers, Or Pushers. The device receives GPS information and sends data periodically to the server for analysis. To receive appropriate signal, the GPS antenna is connected to the right jack and one slot is allocated to the SIM card to receive signals from the GSM tower. Moreover, positive and negative cables were connected to the bus power supply system to ensure the tracking device is powered on to receive signals from satellites. At each time point, the GPS receiver assigns a location value and the bus unit has coordinates with a timestamp which are compared to the previous coordinates to make sure updates are sent to the server via the GPRS network Simultaneously, it is possible for the passengers to search for any destination and bus number to generate all routes currently in operation and the nearest bus range to the passenger's current location. In addition, the bus's latitude and longitude and the arrival time will be updated to the prospective passengers by the system. An example of the Passenger Information System installed is shown in Figure 11.


Source: BRT Performance Result in 2017

**Figure 11. Installed Passenger Information System**

The user/passenger module is an interactive web-based application used to serve several functions for remote users. For example, when the user sends a request, the device accesses the data stored in the server and provides a list of available buses according to the number and destination inputted. The user is tasked with the responsibilities of viewing or choosing an explicit bus range to understand the real-time location or any other information needed after which the results are reflected on the user's screen.

This cycle is repeated for every search conducted by passengers. Moreover, the schematic diagrams of the system are presented in Figures 12 and 13.

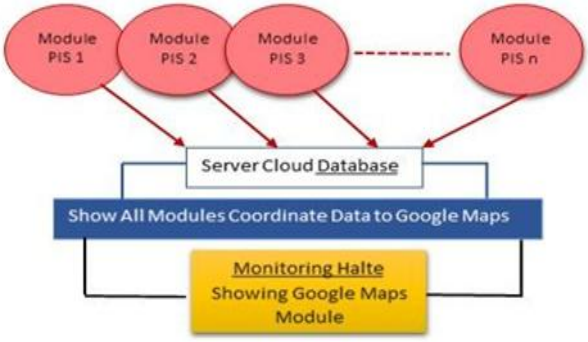



**Figure 12. Block diagram of the Monitoring System and Passenger Information System**

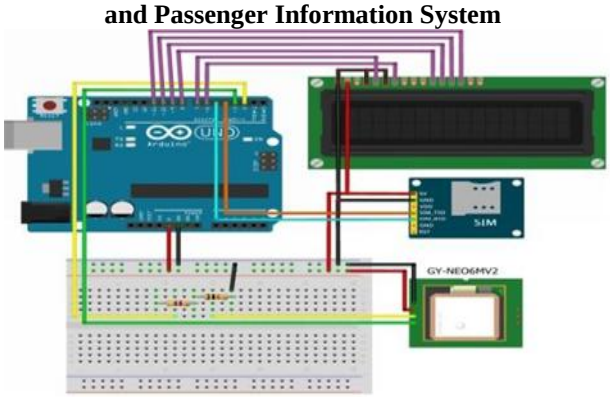


**Figure 13. Block Diagram of Monitoring System and Passenger Information System (Hardware)**

This system provides actual bus arrival and departure information and also serves as an effort to provide reliable and modern transportation infrastructure and as a result of this, it can be used to plan a better urban transportation system (Advait et al. 2009). It is also possible to use it in achieving the implementation of smart transportation towards actualizing smart cities in Indonesia, especially the Semarang city.

It is possible for prospective passengers to access data based on their destination and availability of buses due to the use of Automatic Vehicle Location (AVL) which provides the exact location of the bus. It is also important to state that GPS which is the tracking technology is advantageous to monitor the bus position.

Flowchart Monitoring System and Passenger Information System

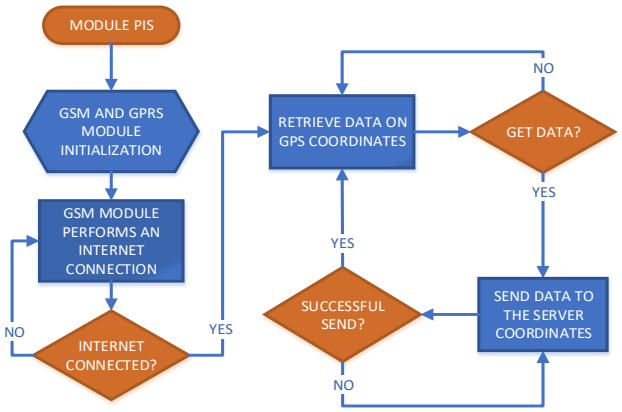



**Figure 14. Flowchart of the Passenger Information System**

Figure 14 shows the description of the steps in implementing the systems and these are further elaborated as follows:

1) Ensure the module is connected to the DC power source through the 9V/2A Adapter provided or directly through the use of battery.
2) The device will automatically turn on and initialize the configuration of the GSM and GPS modules.
   a. Network initialization (type) SIM CARD.
   b. SIM CARD connection.
3) The GSM module will switch the internet (data) connection to the detected SIM Card.
4) After the connection, the LCD on the device will show "Internet connection".
5) GPS module installed, will retrieve location data or coordinates.
   a) If the display shows "G0 (GPS = 0) · GPS position has not been detected", it means there is no GPS location coordinate data.
   b) If the display shows "G1 (GPS = 1)· GPS position is detected", it means a GPS location coordinate data has been obtained and such data will be displayed on the LCD.
6) This is followed by the transfer of the GPS location coordinate data in Latitude, Longitude, and Speed to the cloud database or website server registered on the Passenger Information System tool.
7) Steps 5 and 6 transmit data repeatedly.

**Real-Time**

The use of the Passenger Information System in public bus transportation attracts public transport users due to its ability to minimize the waiting time at bus stops thereby leading to effective prediction and management of time. It is also helpful in obtaining information on the route to be passed by a bus in Corridor VI as well as the time to arrive at the destination.

**Analysis of Community Perceptions on the Implementation of Trans Semarang Bus Information System and Passenger Information System**

The Monitoring System was installed at the Semarang City Transportation Office while the Passenger Information System was at 5 bus stops.

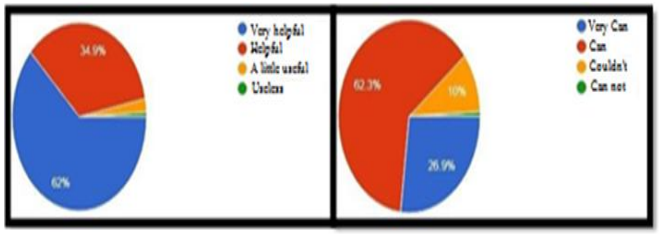
Questionnaires were filled online by 130 respondents which were students, workers, housewives, and transportation experts between the ages of 17 and 60 years, men and women riding motorbikes, cars, or buses.

The results showed 85.3% of respondents rarely use Trans Semarang Bus due to lack of services as shown in Figure 15 (a) while 72.5% use it because it is affordable as presented in Figure 15 (b).


Source:Questionnaire Results in 2019

**15 (a). Trans Semarang Bus Users 15 (b). Reasons to Use Trans Semarang Bus**

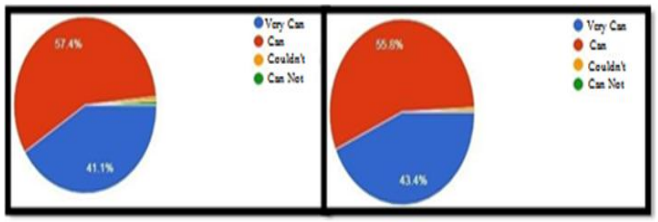
The Passenger Information System was reported to provide several benefits to the community as observed in the response of 62% that it is very useful as shown in Figure 16 (a)and 62.3% found it easy to switch to the Trans Semarang Bus as presented in Figure 16 (b).




Source: Questionnaire Results in 2019

**16 (a). The utilization of the Passenger Information System 16 (b). Community's interest to switch using Trans Semarang Bus**

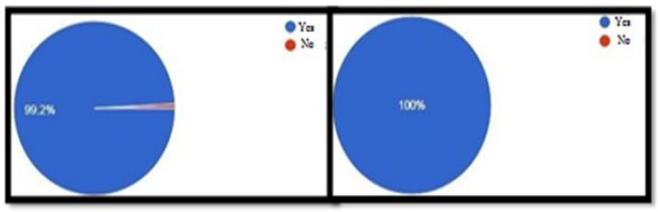
After the installation of the Passenger Information System, 98.5% found it extremely easy to estimate the arrival time of the Trans Semarang Bus in Real-time as shown in Figure 17 (a) and 99.2% revealed it is easy to track the buses using the technology as shown in Figure 17 (b).




Source: Questionnaire Results in 2019

**17 (a). Passenger Information System can estimate the arrival time of Trans Semarang Bus in Real-time 17 (b). Passenger Information System can track the Trans Semarang Bus**

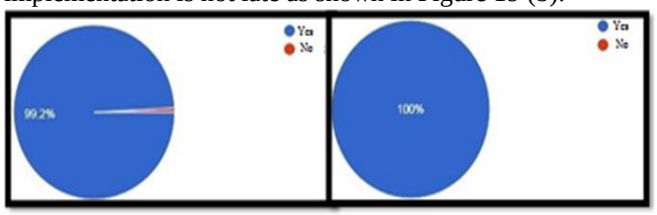
Regarding the implementation of the Monitoring and Passenger Information Systems in 5 bus stops (Kesatrian, Elizabeth, UNDIP, UNIKA, and UNNES), 99.2% were happy as presented in Figure 18 (a) and 100% expected the expansion of the system to other areas as seen in Figure 18 (b).




Source: Questionnaire Results in 2019

**18 (a). The community feels happy with the implementation of the Passenger Information System 18 (b). Community expectations for expanding the Monitoring System and Passenger Information System.**

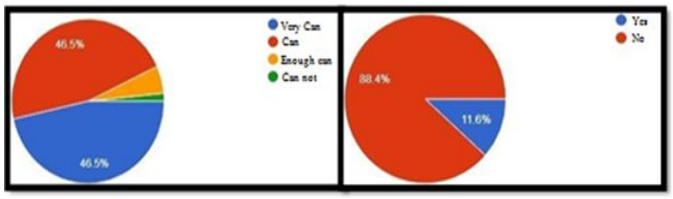
Based on the application of the system, 46.5% of the community found it very easy to plan departure time as presented in Figure 19 (a) and 88.4% believed the implementation is not late as shown in Figure 19 (b).




Source: Questionnaire Results in 2019

**19 (a). Passenger Information Systemcan plan for departure time easier 19 (b). After the implementation of the Passenger Information System, the community feels it is not late.**

Furthermore, 89.1% of the respondents believed the Passenger Information System has the ability to predict in real-time according to the results o in Figure 20 (a).




Source: Questionnaire Results in 2019

**20 (a). Passenger Information System can predict in real-time 20 (b). The distance that people need to travel from home to the destination place.**

It was also discovered that 85.3% of the respondents rarely use buses due to lack of reliable, safe, comfortable, time-efficient and modern public transportation service facilities. The Monitoring and Passenger Information Systems were, however, implemented to remedy this situation by providing a sense of security, time efficiency, comfortability for passengers by integrating information and communication technology into the transportation system and make it accessible to the public through the use of a smartphone device.

The system has already been installed in 5 bus stops including Kesatrian, Elizabeth, UNDIP, UNIKA, and UNNES as well as 9 GPS devices on the bus for the use of the passengers, bus operators, and the Department of Transportation.

This has increased the level of happiness in the community regarding the use of public buses and several private vehicle passengers have been attracted to make use of mass public transportation thereby reducing the number of private vehicles, congestions and city traffic, fuel consumption, and air pollution to establish smart transportation.

## IV. CONCLUSION

The Monitoring System has been installed at the Semarang City Transportation Office while the Passenger Information System has been implemented in 5 bus stopsincluding Kesatrian, Elizabeth, UNDIP,

UNIKA, and UNNES and this has led to the happiness of 99.2% of the respondents. Moreover, 9 GPS devices were installed in Trans Semarang Corridor VI buses for the use of passengers, bus operators, and the Department of Transportation. It is important to note that this system has attracted private vehicle users to usemass public transportation there by reducing congestion and city traffic.

## ACKNOWLEDGMENT

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## AUTHORS PROFILE

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Writing several books, proceedings, national and international journals that are useful for teaching, research and as a reference in the field of transportation. Has conducted research and community service. Experience in International Conference exposes in various cities in Indonesia such as Jakarta, Bandung, Surabaya, Yogyakarta, Palembang, Makassar, Kendari, Semarang and abroad such as France, Singapore, Japan, Malaysia. One of the scientific journal writing is International Journal of Civil Engineering & Technology (IJCIET) 2017 by title "A study on the relationship between land use and urban transport with fuel consumption in Java" and as Keynote Speaker Semarang International Conference Series 2019 by title "Smart transportation that integrated with information and communication technology will accelerate formation of smart city".

Awarded in 2011 and 2012 as the Best Speaker (Complete Research) at the ITB Bandung Postgraduate Civil Engineering National Conference. The Best Presenter of the First International Conference 2018 in Palembang and 2019 Key Transportation Experts on the Provisions of the Indonesian Transportation Society (MTI) in Jakarta.

**A.K. Nugroho, A**ndi Kurniawan Nugroho was born in Batang, Indonesia, April, 3, 1976. He is a lecturer in Electrical Engineering Department, Universitas Semarang (USM). He has been ahead Microprocessor and Microcontroller Laboratory in Electrical Engineering, Universitas Semarang since 2017- now. He received ST and MT degrees in Electrical Engineering from Universitas Semarang (USM), Semarang and Universitas Gajah Mada (UGM), Yogyakarta in 1999, and 2007, respectively. He has written in international journals and international proceedings according to his field of competence. He has written in international journals and international proceedings according to his field of competence. In 2015, he was an international referee at the Asia-Pacific Robot Contest The ABU Asia-Pacific Robot Contest (ABU Robocon) at Universitas Muhamadiyah Yogyakarta (UMY) and often became a robotic expert and medical control expert. To improve the area of additional competence, he was also heavily involved in electrical development experts and became a member of the Indonesian Engineers Association (PII).Since September 2017 until now, he is still studying doctoral studies at Institut Teknologi Sepuluh Nopember (ITS), Surabaya specializing in the Medical Image Analysis with scholarships that have been received from the Indonesian government. In September 2019 - December 2019, he was awarded a scholarship to continue research at Nara Institute of Science and Technology (NAIST) Ikoma,Japan with a sandwich-like scholarship program. His current research interests interactive analysis of medical images and robotics based on deep learning and machine learning.

**Harmini**, Harmini was born in Madiun, Indonesia, November,8, 1982. She is a lecturer in Electrical Engineering Department, Universitas Semarang (USM) since 2012. Teaching course Basic of Energy Conversion, Power Electronic and Signal System.Completed Bachelor Degree of Electrical Engineering Study Program at Institute Teknologi Sepuluh Nopember (ITS), Surabaya, Indonesia (2006) specially in Telecommunication System. Graduated Master Degree of Machine Engineering specially Renewable Energy at Gajah Mada University, Yogyakarta, Indonesia (2011). She has been a secretary of electrical engineering Department, Universitas Semarang since 2017 – Now. Instructor on Training in Energy Management for Farming Grobogan Regency, Central Java (2017). Join Community Biogas at Livestock Group in Purworejo Regency (2019). Partnership Coordinator for Renewable energy Research Project, 2014 – Present, Faculty of Engineering, Universitas Semarang. Society Membership in Persatuan Insinyur Indonesia (2017- present). Current research interests in Renewable Energy, Solar Photovoltaic System Off Grid and on grid connected, MPPT (Maximum Power Point Tracker) on Solar Photovoltaic System, Wind Power System, Hybrid System Solar and Wind Energy, Monitoring System at Renewable Energy, Renewable energy system and planning, Remote area power system, Power Electronic such as Inverter, Rectifier and Converter, Artificial Intelligence that is applied to renewable energy, sustainable development. Writing several books, proceeding, national journal that are used to teaching, research and reference in Renewable Energy System.