Analysis and Modelling of Salatiga City's Public Transportation Service Performance

Handajani, Mudjiastuti
Civil Engineering
Semarang university
Semarang, Indonesia
mudjiastutihandajani@usm.ac.id

Firmawan, Ferry
Civil Engineering
Semarang University
Semarang, Indonesia
drferryfirm@usm.ac.id

Harmini
Electrical Engineering
Semarang University
Semarang, Indonesia
harmini@usm.ac.id

***Abstract*—Salatiga City is one of the development cities in Central Java Province with the population more than 190,000 people. With this amount, the movement of commodities or persons from one location to another will cause the roads to be quite congested, especially when using private vehicles. The Salatiga City has good quality level for public transportation but it still faces many problems such as no provision for fare per kilometer, no bus stops to facilitate and increase the comfortable of the users and no rules regarding the time for drivers to pick up passengers. With the long-term goal of aiding Salatiga City's government implement smart transportation, an examination of the city's passenger public transportation will be conducted using a case study on the Tamansari-Blotongan Route. From the results of the analysis will be followed by modelling real time information. With the long-term goal of assisting Salatiga City's government in implementing smart transportation, A case study on the Tamansari-Blotongan Route will be used to analyze the city of Salatiga's public transportation system. transportation pertaining to the minimum service requirements for mass transit on roads. The findings revealed that the majority of 90 of the transportations on the Tamansari - Blotongan route had good physical condition and were appropriate to use. Based on a number of factors, The level of the route complied with the standards specified by the Directorate General of Land Transportation. The load factor research revealed a value of 0.73, which is included in category A, and most indications show it has satisfied passenger satisfaction, although waiting times still need to be improved.**

Keywords— public transportation; performance; modelling; passenger; Salatiga

I. INTRODUCTION

Transportation is a basic need of society that requires constant attention to fulfill production, consumption, and distribution needs. This is a result of its tactical role in fostering economic stability, ensuring continuity in community activities, and advancing government policies. Public transit is required given the contemporary more reasonable, more accessible, and more dependable, fiercely competitive economic environment and rising standards of living. When running public transportation, it is also important to pay attention to the balance between the amount of supply and the current demand[1]. This is the reason urban transportation was introduced to move people and goods from a location to another through different routes in an urban area (Transportation Minister of Republik Indonesia 2019). This was further divided into three categories which include those operating at low-speed and reducing the speed of other vehicles, those without specific stops, and those that usually violate traffic laws [2].

Salatiga City has topographical conditions as well as a natural layout and its geographical distribution is mostly a bumpy area[3]. The Salatiga City administration wants to create a system of economical city transit, dependable, safe, comfortable, regularly scheduled, and with a cutting-edge management system[4]. This is indicated by the efforts made to provide real-time information on public transport to allow passengers to plan the time to leave and arrive at their destinations[5]. The system is expected to change the shift in community attitudes toward using public transportation instead than private cars to reduce traffic jams, traffic volume, and the consumption of fuel oil (BBM) produced from non-renewable fossil fuels[6] and [7]. This study was carried out to evaluate the effectiveness of Salatiga City's public transportation system, and its findings are anticipated to be used as the foundation for further research and as a guide for the city government's plans to develop an information technology-based public transportation system (IT).

II. METHODE

A. Methode

This study was planned for 1 year and initiated by requesting permission and collaboration from the Salatiga City Transportation Development, preparation phase of this study was begun with permission and cooperation with. Study conducting field surveys to obtain primary data on boarding alighting or passenger circulation and headway or distance between two transportations as well as secondary data on the number of transportations, number of passengers, routes, schedules, and speed. Public transportation for passengers that is appropriate for passengers is a service that is safe, fast, cheap, and comfortable [8][9]. Furthermore, data were also obtained from relevant agencies as indicated in the study. Figure 1 shows a research flowchart.

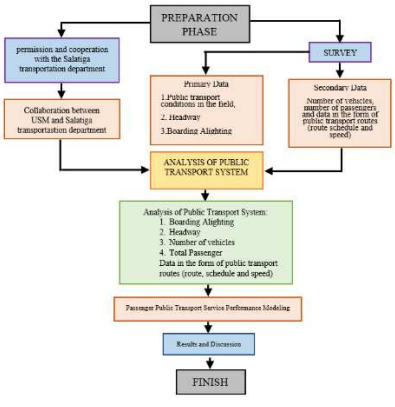

Figure 1. Study Flowchart

III. Result and Discussion

A. *Passenger Overview*

(1) Passenger by Gender

The survey results showed the passengers grouping based on gender that there were 74 women and 56 men. Comparison of the data that has been obtained can be seen in Figure 2

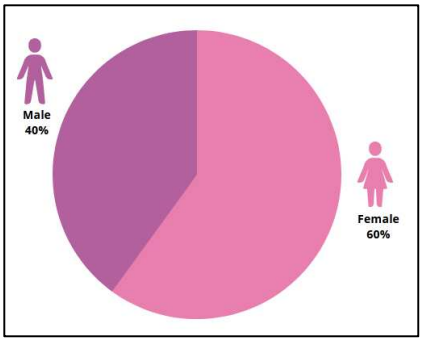

Figure 2 Respondents' Percentage

Source: Data Analysis, 2020

(2) Passenger by Age

It was discovered that most of the passengers represented by 55% were > 40 years followed by 25-40 with 25% and 15-25 years with 20% as indicated in the following Figure 3.

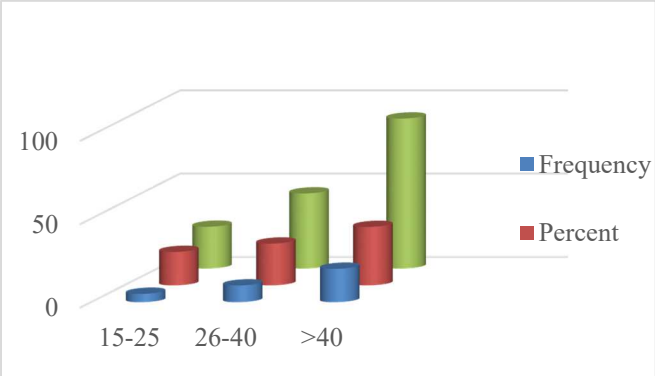

Figure 3 Passengers by Age

Source: Data Analysis, 2020

(3) Reasons to choose Public Transportation

Because of public transportation utilization in the community there are no other easy-to-get and cheap modes of transport. This was indicated by many respondents represented by 70% that use public transport due to its low costs followed by the 22.5% because it can be reached easily, and 7.5% due to the absence of other vehicles.

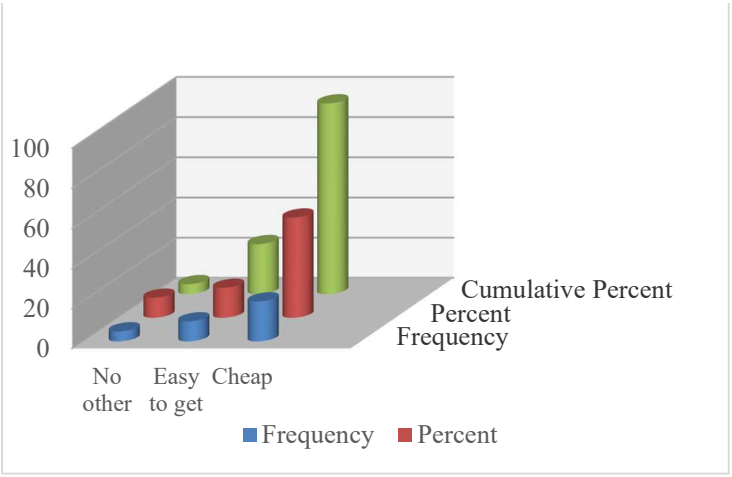

Figure 4 Reasons to Use Public Transportations

Source: Data Analysis, 2020

(4) Passengers' Destination

The findings showed that 35% of respondents use public transport to reach the market, 35% to go to school, and 30% to working place.

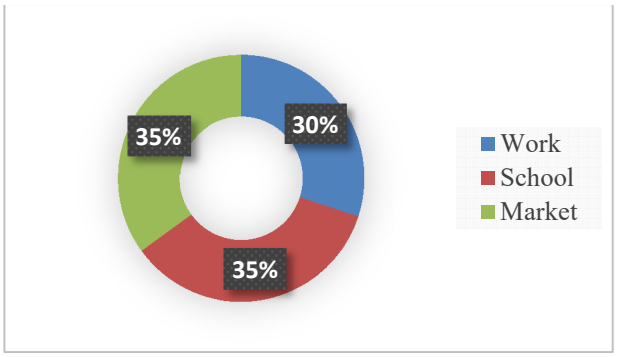

Figure 5 Passengers' Destination

Source: Data Analysis, 2020.

B. *Passenger Satisfaction and Performance level*

The effectiveness and importance of Salatiga City's public transportation services were evaluated using the following criteria:

(1) Satisfaction Level

The Likert scale showed that the performance level has a value of 3.781, indicating it is in the "**Quite Good**" category. Figure 6 shows the responses' outcomes as well as how many Salatiga City people commute via public transportation.

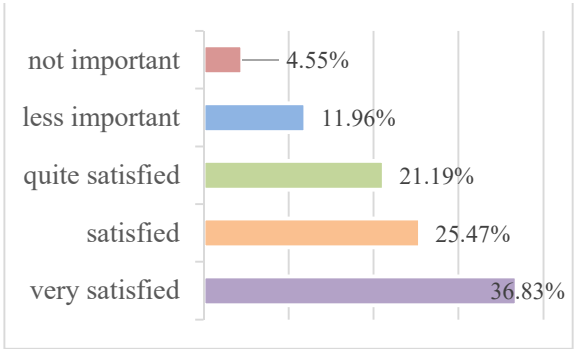

Figure 6 Comparison of the results of satisfaction levels

(2) Performance Level

The Likert scale showed the performance level has a value of 4.060 which indicates a **"Good"** category. Figure 7 displays the responses, together with the percentage of Salatiga City residents who use public transit.

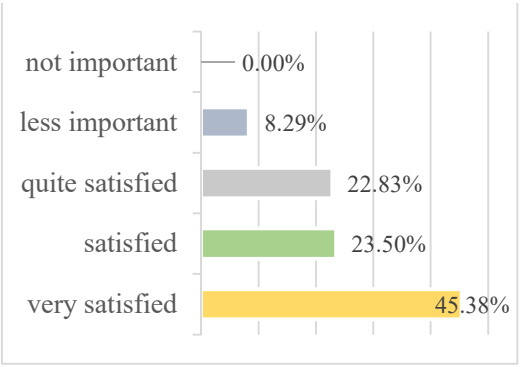

Figure 7 Comparison of performance level results

(3) Conformity between Performance and Satisfaction

- Conformity is based on comparing performance and importance level to establish the elements impacting Salatiga City's public transportation's quality in descending order of importance. The following calculation shows that the physical state and accessibility to public transportation were both observed to have the maximum value of 141.395%:
- The average satisfaction level had a value of 3.781 and this means the satisfaction in each dimension is in the **Good Enough** category.
- The average performance was found to be 4.060 and this indicates the performance level for each dimension is in a **Good** category.
- Following the calculation of the average performance and satisfaction level, a Cartesian diagram labeled "Importance Performance Analysis" was used to describe the elements impacting the quality of service. The average satisfaction and performance level values were used in the Cartesian diagram as a divisor.

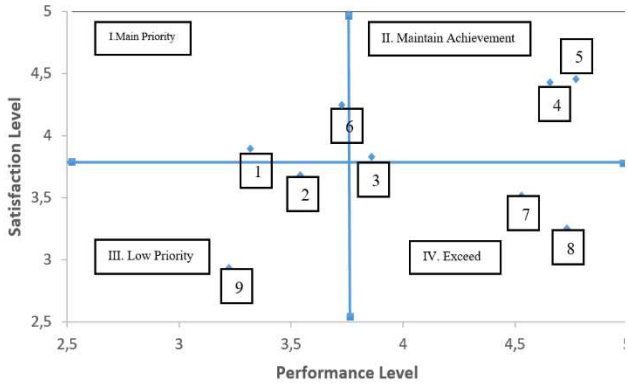

Figure 1 Cartesian Diagram

Source: Analysis, 2021

Notes :

1 : Speed
2 : Rates
3 : Comfort
4 : Security
5 : Safety
6 : Service
7 : Headway
8 : Pysical conditions and facilities
9 : Easy access to information

Figure 8 shows the four quadrants in the Cartesian diagram. Quadrant I contain the factors considered to be important by the respondents but not present as expected, thereby, causing very low satisfaction and this means there is a need to improve these attributes. Quadrant II contains factors considered important and enjoyed by respondents which led to a relatively higher satisfaction level, and this means they need to be maintained. Quadrant III comprises of factors considered by the respondents to be lacking but do not have any practical usefulness while Quadrant IV contains factors considered less important but perceived by the respondents to be excessive in the system.

It is urgent to remember that an analysis of importance and performance is a strategy generally used to rank distinct aspects and collections of services to discover and plan necessary activities [10][11][12]. This method was applied to these indicators as indicated by the Cartesian diagram and the deductions are stated as follows:

Table 1 Application of cartesian diagram indicators

Quadrant		Indicator Point	Performance level	Satisfaction level	Category
I	Main Priority	(6)	3.7	4.1	Good Enough and Important
II	Maintain Achievement	(4) (5)	4.6 4.7	4.3 4.4	Good Good Enough
III	Low Priority	(1) (2) (3) (9)	3.4 3.6 3.8 4.7	3.8 3.7 3.8 4.4	Good Enough Good Enough Good Enough Good
IV	Exceed	(7) (8)	4.5 3.3	3.5 2.8	Good and Quite Important Good Enough and Less Important

Source: Data Analysis, 2020

C. Load Factor

Sunday morning journeys had an average load factor of 75.21% and were typically full when they passed by Ex. Soka Bus With 11 passengers, the terminal on board. Meanwhile, the value for the Blotongan Kesongo market section was discovered to be the smallest with 0%. The Sunda road between Tamansari and Blotongan with the highest load factory afternoons was found to be 90.91% Having a total of 10 passengers on the Poltas portion, while the part with the fewest passengers is Tamansari Bus Station. with 0% due to the reduction to 8 passengers. The average load factor for this period was recorded to be 70.13%. The average for the route's load factor on Tuesday mornings was recorded to be 71.90% with the most passenger destination being the KFC Salatiga while the remaining 28% is for those going to offices and shopping centers. It's also crucial to remember that, the Blotongan Kesongo market segment has a 0% minimum daily load factor. The average load factor on Tuesday afternoon was recorded to be 70% while the lowest was at the Tamansari terminal segment and the highest, 100%, was discovered while traveling along a route in the Kemiri region. Moreover, the degree of occupancy and the number of seats were used to calculate the daily average load factor as indicated in the following equation[13]:

$$load\ factor = \frac{\text{The number of passengers in MPU}}{\text{The number of seats in MPU}} \times 100\% \quad (1)$$

$$load\ factor = \frac{8}{11} \times\ 100\% = 72.73\%$$

The average value of the factor daily load indicates it is in the category according to Government of Republik Indonesia Constitution in 2009 because it is < 0.8

Every year, it has been shown that the general population is becoming more and more interested in using public transit, albeit not to the extent that was anticipated. This is indicated by the load factor, headway, and speed presented in the following Figure 9.

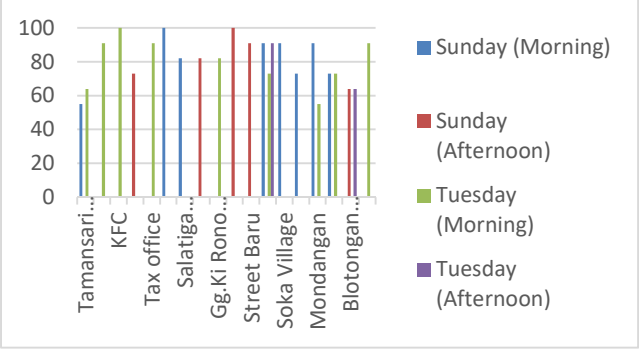

Figure 9 Speed, Headway, and Load Factor

Source: Analysis 2020

D. Economic Overview

Passenger information system in real-time model is used to determine the certainty of travel time savings. The model provides data on the general public transport routes in the City, taking into account that existing facilities will provide assistance to passengers. This is necessary for the accuracy of the trip time so as to reduce waiting time at each specified stop and this makes it easier to predict departure and arrival times. The advantages are stated as follows:

Time becomes more efficient and effective

It shows by the fact that students do not always want to wait for long time for the public transportation arrival because they do not want to be late for school. Therefore the method for determining the time value is as follows:

The value of time determined by considering per capita income (GDP) is as follows:

Time Taking per capita income into account Score= (PDBR / JP)/WKT

Explanation :

PDRB = Gross Regional Domestic Income (per capita/Rp),

JP = Number of Population (individuals),

WKT = Annual Working Time (hours).

Fuel Usage

Real-time information will reduce passenger wait times, which is anticipated to reduce the use of private vehicles in Salatiga City in favor of public transportation. Additionally, it considerably lowers the amount of vehicles on the road from Monday through Friday. It is also an ability to reduce fuel consumption. When 1,000 private vehicles are used, the average fuel usage can reach 10L per day. This can be reduced by using public transportation, thereby saving 10,000L per day.

Environmental Review

One of the cities in the Central Java Province is Salatiga City. with a population of more than 190,000 people. When employing private vehicles, these circumstances will result in a busy flow of persons or products from one location to another. Therefore, the Salatiga City government must pay more attention to the level of public transport services in order to divert private vehicle users to use public transportation. It was observed that the Salatiga City itself had reduced passenger capacity on public transportation due to the pandemic. The capacity of public transport, which previously could accommodate 8 passengers, was limited to only 5 passengers. This will add to the decline in public interest in using public transportation. Switching to the use of public transportation will reduce traffic density and consumption of fuel oil (BBM) and will make the Salatiga City as the smart and environmentally friendly transportation system city

E. Real-Time Passenger Information System Architecture and Modeling for Public Transportation in Salatiga City

The execution of By informing passengers of the status of their transportation, including location and time, the passenger information system aims to improve public transportation services, particularly in Salatiga City..

A simulator and processing server are the two primary components of Salatiga City's public transportation information system which are explained as follows:

1. Simulator

   In this simulator application consists of 3 applications, namely:

   a. Display, it is placed where public transport waits for passengers.

   b. Mobile Application, web and android based

   c. Control room application, web and android based

2. Public transport simulator

The main functions of this public transport simulator are:

a. To obtain the name or code of the public transportation system and the GPS coordinates of its stop points.

b. To determine the length of the journey and the direction of travel by public transportation.

c. using the GPRS network to transfer data to the server.

3. Processing server

The processing server's responsibility is to gather data, such as the location and transit system's speed. This processing server can also determine the estimated time of arrival in real time for all public transportation units. Public transportation data can be stored on the server, which can cut down on database requests. Static and dynamic data are separated into separate database tables.

Included in static data or temporary data in database tables is information about public transportation location points that will always be updated. As for dynamic data, namely information data on the route number, code/id, and the name of the passenger public transport. Public transport drivers are also given control to activate public transport status and vice versa. If the driver alerts the server that there is a problem with public transportation, the status of that mode of transportation may change to inactive. The location log database table will contain information on the location of the public transportation. If this situation really occurs, it will be easier for public transportation companies to immediately send assistance.

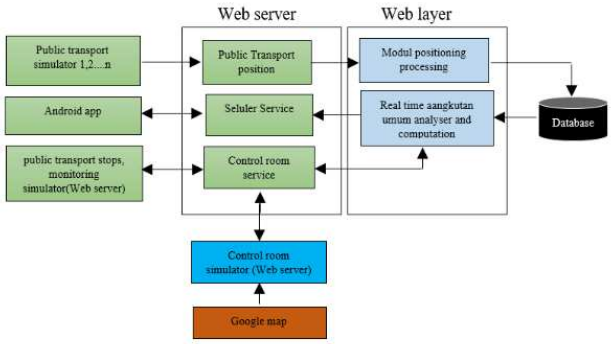

Figure 10 Real-Time Passenger Information System for Public Transportation in Salatiga City: Architecture and Model

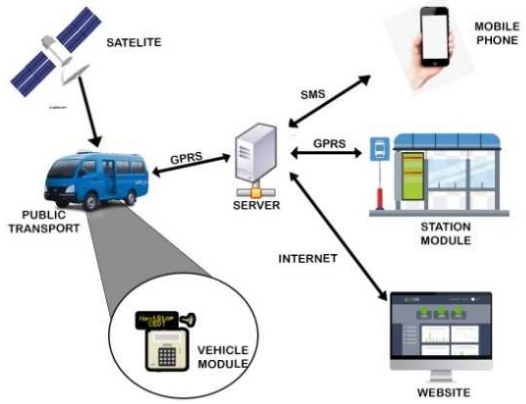

Figure 11 Salatiga City's public transportation information system diagram

Figure 11 shows how GPRS and satellite connectivity were used to construct a public transportation information system in Salatiga City. An explanation of Salatiga City's public transportation information system:

a. Satellite communications are designed using Google Maps to capture the movements on public transport.

b. Through GPRS, the database server will receive and store data that has been captured by satellite communications.

c. Vehicle module is a module that will be placed on every public transportation to accommodate and provide a signal to the server or web so that users can easily access it via Android/SMS.

d. Control screens will be installed at every public transport stop to display information about public transport movements.

e. The system also applies RFID which can detect the number of passengers on public transport.

IV. Conclusion

The analyses, calculations, and observations showed that the public transports on the Tamansari - Blotongan route in Salatiga City is feasible to use based on their physical condition. This is because the total of 90 fleets offered is adequate for meeting the needs of passengers.. Moreover, the performance analysis conducted using different indicators showed that the quality of services being provided meets the standards set by the Direktorat Jendral Perhubungan Darat, but the waiting time needs to be improved. To assure a shift from the use of private vehicles to public transportation, these indications can be used to develop a passenger information system model that provides information about the location and certainty of trip time. Additionally, it is anticipated that the Information System's current features would help users find the right route-related information.

Acknowledgment

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