

Evaluation of Stop Infrastructure in Surakarta using Importance Performance Analysis and Customer Satisfaction Index Methods

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Abstract. The comfort and reliability of public transportation are greatly influenced by the availability of adequate supporting infrastructure, especially bus stops that function optimally. Well-maintained bus stop facilities not only support operational efficiency but also significantly influence passenger satisfaction and overall user experience. This study aims to evaluate the condition of bus stop infrastructure supporting Batik Solo Trans (BST) in Surakarta, Central Java, with a focus on assessing the availability and quality of facilities as well as measuring user satisfaction. Primary data were obtained through field observations and a survey involving 100 randomly selected BST passengers. Two analytical methods were applied: Importance-Performance Analysis (IPA) to identify discrepancies between user expectations and perceived service performance, and the Customer Satisfaction Index (CSI) to quantify the overall level of satisfaction. The findings indicate that most facilities are available and in generally good condition; however, improvements are needed in route information boards and cleanliness. The CSI score of 68.08% suggests that users are moderately satisfied with the current level of service provision.

Introduction

Based on Law No. 22 of 2009 [1], public transportation includes the movement of people and goods within the road traffic area, which is organized to meet public safety and comfort aspects. Transportation is organized to meet the community's needs for safety, comfort, and affordability. The population in urban areas continues to grow each year due to high rates of urbanization [2]. This growth can lead to various issues, particularly traffic congestion [3] which is partly caused by the increasing use of private [4].

Traffic congestion has become a source of problems experienced by the community where the increase also occurs in the use of private vehicles in urban areas [5]. So that the sustainability of the city must be supported by adequate infrastructure for as long as possible [6]. The mobility of road users has increased while facilities and infrastructure are very limited resulting in traffic congestion is expected to increase every year [7].

The road network as a basic infrastructure that is very important in the development of the region, especially the city of Surakarta [8]. Surakarta is an autonomous region with the status of a city under the Central Java Province in Indonesia [9]. The role of transportation in development is very important in supporting economic activities, where mass public transportation is a transportation service that has a fixed route and schedule, such as Bus [10]. Bus stops are the main infrastructure supporting public transportation buses and not all bus stops function properly [11]. Bus stops are for picking up and dropping off passengers and predetermined travel routes (Minister of Transportation of the Republic of Indonesia, 2018).

Since its launch on September 1st, 2010, Batik Solo Trans (BST) has helped the community as a mode of public transportation. Buses operating in this city have provided direct routes to Kartasura, Palur to Adi Sumarmo Airport [6]. A passenger transportation infrastructure that is not managed properly can cause problems, namely causing the demands of community mobility to not be met [12]. Over time, BST has become a necessity for the community in their daily activities, therefore supporting infrastructure for public transportation is highly expected to be able to optimize public transportation facilities, especially bus stops for BST [13]. BST in providing public transportation in the city of Surakarta, namely at the Department of Transportation, Communication and Informatics (Dishubkominfo) of Surakarta City, PT. Bengawan Solo Trans (PT. BST), Perum Damri Cab. Surakarta City, and the Batik Solo Trans route area. Dishubkominfo acts as a regulator for the implementation of the BST program, Perum Damri as the operator of BST corridor 1 and PT Bengawan Solo Trans as the operator of BST corridor 2 [14].

Based on the background above, this study needs to be conducted to identify the condition of BST and Halte infrastructure, then assess and analyze the condition of infrastructure based on the community as users of public transportation in Surakarta. This study uses primary data in the form of questionnaire results and observations of BST and Bus Stop conditions in the field and uses secondary data from the Surakarta City Transportation Agency. Although research on BST and Halte infrastructure has been conducted by other researchers, this research in Surakarta is based on primary data according to the reality at the location. Based on the background described, this study is conducted to identify the condition of BST and bus stop infrastructure, and to evaluate and analyze their condition from the perspective of the community as users of public transportation in Surakarta. This research utilizes primary data obtained from questionnaires and field observations of BST and bus stop conditions, as well as secondary data from the Surakarta City Transportation Agency. Although studies on BST and bus stop infrastructure have been conducted by previous researchers, this study is distinguished by its use of primary data that reflects the actual conditions at the research location in Surakarta.

Literature Review

This research is in Surakarta City sustainability BST (Batik Solo Trans) in providing transportation modes. Primary data used in this evaluation includes data from observations of existing facilities in BST modes with their stops and questionnaires assessing respondents regarding existing facilities. In addition, this evaluation also uses data on the availability of supporting facilities for BST and stops sourced from the Surakarta City Transportation Agency.

The primary investigation survey was conducted on September 7th, 2023, taken from the Kartasura Terminal to the Palur Terminal against the existing BST and Halte facilities while distributing questionnaires to respondents. The distribution of questionnaires was carried out not only directly but also through social media with Google Forms to reach target respondents in other corridors. The traffic violation investigation survey was conducted to observe violations that occurred in the field during the survey along with their types and by conducting interviews. Interviews were conducted by providing questions arranged in a questionnaire form.

A study that uses observational data needs to validate the data or validity to prove whether the observed results are in accordance with reality or not. Validity can be done using triangulation techniques, namely validity checking techniques by using something other than the data itself as a comparison [15]. This process can be done by comparing the results of observations with questionnaires, or literature, or with other related documents.

Identification of facilities already available at bus stops and buses is arranged according to the Government Regulation No. 10 of 2012. The condition of each facility is investigated in the field and then compared with the standard.

Table 1. Bus Stop Facilities by Government Regulation No. 10 of 2012 [16]

Symbol	Facilities
FU1	Bus stop identity (bus stop nameplate) that is functional and clearly visible
FU2	Direction signs at bus stops
FU3	Optimal lighting for bus stops/TPB
FU4	Clearly visible route information board
FU5	Seating at the bus stop is functioning properly and is sufficient to accommodate passengers/potential passengers.
FT6	Public telephone at the bus stop is working properly
FT7	Cleaning facilities in the form of trash bins placed in strategic locations
FT8	Fences at bus stops as protection for passengers/potential passengers
FT9	Billboards/notices that are clearly visible

Table 2. Solo Trans Bus Facilities (BST) by Government Regulation No. 10 of 2012 [16]

Symbol	Facilities
F1	Vehicle identity (number and route name) on the front and rear of the vehicle which can be clearly seen.
F2	Vehicle crew identity (uniforms with crew name and company identification).
F3	Lighting lights that function well
F4	Window film on vehicles to reduce direct exposure to sunlight.
F5	Hazard warning lights in vehicles.
F6	Safety facilities (glass breakers, fire extinguishers, lighting equipment) are installed in easily accessible places and equipped with instructions for use.
F7	Health facilities (first aid kits) are in good condition.
F8	Emergency response information (in the form of stickers containing emergency telephone numbers) placed in a place that is easily visible.

Method

Identification of facilities that are already available at bus stops and buses is arranged according to the Government Regulation No. 10 of 2012. Each facility is investigated for its condition in the field and then compared with the standard. The questionnaire data were analysed using the Importance Performance Analysis (IPA) and Customer Satisfaction Index (CSI) methods.

Importance Performance Analysis (IPA). The IPA method is used to evaluate the suitability between the performance of services perceived by users and the level of importance they expect from certain facilities. Based on these results, it can be seen the factors that influence user assessment of service facilities at the terminal. The suitability between performance and interests is analysed using Formula 1 [16]. From this value, it can be said that there is a match if the Tki is in the range of 80-100% [17].

$$Tki = \frac{Xi}{Yi} \times 100\% \quad (1)$$

Where Tki is the level of suitability, Xi is the performance assessment score (satisfaction) and Yi is the importance assessment score (expectation).

The satisfaction level score is plotted on the X and the expectation level score is plotted on the Y of the Cartesian diagram. The average value of the satisfaction and expectation levels for each attribute can be calculated using Formula 2 and Formula 3 [17].

$$\overline{Xi} = \frac{\sum Xi}{n} \quad (2)$$

$$\overline{Yi} = \frac{\sum Yi}{n} \quad (3)$$

Where $\overline{Xi}$ is the average level of performance (satisfaction), $\overline{Yi}$ is the average level of importance (expectation), and n is the number of respondents.

The importance-performance position map in the Cartesian diagram can be found using Formula 4 and Formula 5 [18].

$$X\bar{i} = \frac{\sum_{i=n}^k \overline{Xi}}{k} \quad (4)$$

$$Y\bar{i} = \frac{\sum_{l=n}^k \overline{Yi}}{k} \quad (5)$$

The value of k indicates the number of attributes that can affect satisfaction. The elements obtained are then mapped in a Cartesian diagram as shown in **Fig. 1**.

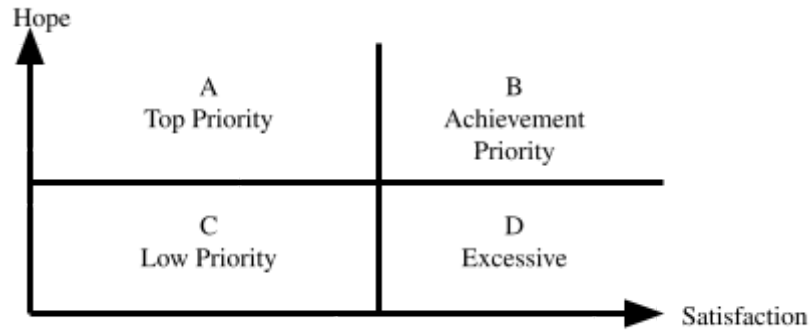


Fig. 1. Science Cartesian Diagram [19]

Factors that influence user assessment are spread across Quadrant A (Top Priority). This quadrant contains factors that are considered important by users, but their performance is not yet in accordance with user expectations, so they must be improved [19]. Performance improvement can be done by diverting resources to factors spread across Quadrant D which are considered less important but have excessive performance so they can be reduced.

Customer Satisfaction Index (CSI). The general degree of customer satisfaction with the services offered at bus stops and buses is ascertained using the CSI approach. The steps needed to calculate the CSI value are as follows:

Determining the Mean Importance Score (MIS). Determining the Mean Importance Score (MIS), which is the average score of the importance assessment of each indicator. It can be symbolized by $\overline{Xi}$.

Determining the Mean Satisfaction Score (MSS). Determining the Mean Satisfaction Score (MSS), which is the average score of the satisfaction performance assessment of each indicator. It can be symbolized by $\overline{Yi}$.

Find the Weight Factor (WF) for each indicator using Formula 6.

$$WF = \frac{MIS}{\sum MIS} \times 100\% \quad (6)$$

Find the Weight Score (WS) for each indicator using Formula 7.

$$WS = WF. \sum MSS \quad (7)$$

Determine the CSI value using Formula 8.

$$CSI = \frac{WS}{HS} \times 100\% \quad (8)$$

HS (High Scale) value indicates the largest scale used. Satisfaction criteria based on CSI value can be seen in **Table 2**.

Table 3. Satisfaction Level Criteria (20)

No.	CSI Value (%)	Information
1.	81% - 100%	Very satisfied
2.	66% - 80.99%	Satisfied
3.	51% - 65.99%	Quite Satisfied
4.	35% - 50.99%	Less satisfied
5.	0% - 34.99%	Not satisfied

Results and Discussion

Existing Condition of Bs Stops. As mentioned earlier, Surakarta City Bus Stop refers to Government Regulation No. 10 of 2012 **Table 1** Bus Stop Facilities, the availability of facilities at this bus stop is sufficient with overall good conditions although there are still some facilities that are not yet available. The results of the identification of service facilities at the bus stops are presented in **Table 3**.

Table 4. Identification of Bus Stop Facilities

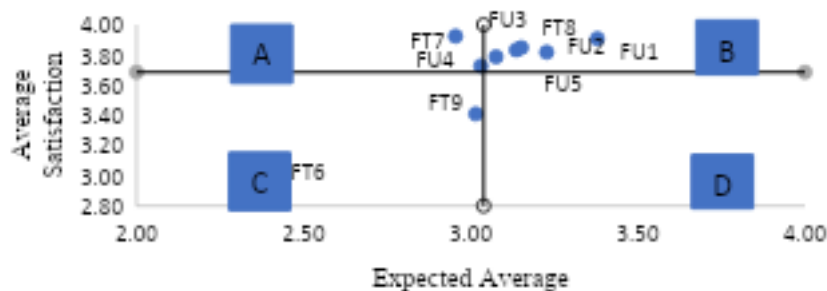
Symbol	Yes (V) / No (-)	Condition
FU1	V	Availability of bus stop identity (bus stop nameplate) that is functional and clearly visible
FU2	V	Availability of signs at bus stops
FU3	-	Availability of optimal lighting at bus stops/TPB
FU4	-	Availability of clearly visible route information boards
FU5	V	Availability of seats at bus stops that function well and accommodate enough passengers/potential passengers
FT6	V	Availability of public telephones at bus stops that are functioning properly
FT7	-	Availability of cleaning facilities in the form of trash bins placed in strategic locations
FT8	V	Availability of fences at bus stops as protection for passengers/potential passengers
FT9	-	Availability of clearly visible billboards/announcements
FU1	V	Availability of bus stop identity (bus stop nameplate) that is functional and clearly visible

Service and Level of Satisfaction at Bus Stops. Referring to Formula 1 to Formula 5, the level of conformity between satisfaction and expectations of bus stops users can be analysed. Based on Formula 6 to Formula 8, the level of user satisfaction is then analysed. The results of the analysis of both for each facility can be seen in **Table 4**.

Table 5. Results of Science and CSI Analysis

Facilities Available	Science Analysis			CSI Analysis				
	$\bar{X}_i$	$\bar{Y}_i$	Tki (%)	MSS ($\bar{X}_i$)	MIS ($\bar{Y}_i$)	WF	W.S.	CSI
FU1	3.28	3.80	86.32	3.28	3.80	11,585	38,000	76.00
FU2	3.17	3.70	85.68	3.17	3.70	11,280	35,759	71.52
FU3	3.10	3.71	83.56	3.10	3.71	11,311	35,064	70.13
FU4	3.04	3.71	81.94	3.04	3.71	11,311	34,385	68.77
FU5	3.11	3.78	82.28	3.11	3.78	11,524	35,841	71.68
FT6	2.47	3.01	82.06	2.47	3.01	9,177	22,667	45.33
FT7	3.03	3.90	77.69	3.03	3.90	11,890	36,027	72.05
FT8	3.14	3.81	82.41	3.14	3.81	11,616	36,474	72.95
FT9	3.12	3.38	92.31	3.12	3.38	10,305	32,151	64.30
Amount	27.46	32.8	754.24	27.46	32.80	1,000	103,930	612.74
Average	3.05	3.64	83.80	CSI Results□				68.08

Then, to find out the factors that influence user satisfaction and expectations regarding the service facilities available at the bus stops, the average value of the satisfaction level ($\bar{X}_i$) and the average level of expectations ($\bar{Y}_i$) are analysed and described using a Cartesian diagram as shown in Figure 2.

**Fig. 2.** Cartesian Diagram of Natural Science Bus Stops in Surakarta

Quadrant A is a quadrant that has a very low level of satisfaction so that it is the main priority for improvement. The indicators included in quadrant A are FU4 and FT7. Quadrant B is the quadrant expected by passengers and has been in accordance with what is felt by passengers. Attributes in quadrant B can also be sorted according to priority level to be maintained. There are 5 indicators included in quadrant B, namely FU1, FU2, FU3, FU5, and FT8.

Due to the presence of extra amenities that passengers deem less significant and the fact that the service is actually not particularly noteworthy, Quadrant C is a low-priority quadrant. There are 2 indicators that fall into quadrant C, namely FT6 and FT9. While the facilities in quadrant D have a low level of importance but have a very low level of satisfaction with the service facilities, it is described that there are no indicators that fall into quadrant D.

Conclusion

The facilities at the bus stops are adequate and in good condition, according to Government Regulation No. 10 of 2012; however, additional facilities that are not currently available must be added. Based on the IPA method, it is known that there are 2 bus stop facilities that affect user assessments spread across Quadrant A, including route information boards (FU4) and cleanliness

facilities (trash cans) (FT7). These facilities are considered important but their performance has not been as expected so they need to be improved. The average CSI value obtained was 68.08%, which means that users as a whole are quite satisfied with the service at the Surakarta city bus stops.

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