Analysis of Transjakarta Bus Stop user Services by IoT at Dukuh Atas Dua

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ABSTRACT

Transportation is an essential means to support the success of national development, especially to support the economic sector. Transjakarta Bus is a bus rapid transit (BRT) transportation system. Transjakarta passengers continue to increase over time, the highest point in the number of Transjakarta passengers occurred in April 2023, which was 33,500 people. During the transition period, the existing facilities provided at the Dukuh Atas Dua Bus Stop for Transjakarta Bus passengers had a positive impact, passengers felt comfortable with the bus stop facilities that were much more complete than before. Transjakarta Bus user service level at the Dukuh Atas Dua Bus Stop obtained several characteristics. Starting from the characteristics of male gender, it is more dominant at 56% or as many as 224 respondents. While based on user characteristics based on age, namely 30 years and under, it is more dominant at 45% or as many as 179 respondents. Furthermore, based on undergraduate education, it is more dominant at 38% or as many as 150 respondents. Analysis of user responses to the Transjakarta Bus Stop service at Dukuh Atas Dua obtained Reliability indicators of 52.3% or with a score of 4, Responsiveness 52.5% or with a score of 4 and Tangibility 54.0% or with a score of 4 with all respondents stating that users strongly agree. This study discusses IoT implementation at Dukuh Atas 2 TransJakarta Bus Stop to improve transportation efficiency, safety, passenger comfort, and smart city integration.

Keywords: service, satisfaction, facilities, bus stops, Dukuh Atas Dua.

INTRODUCTION

The development of bus stops as supporting facilities for public transportation has undergone significant changes since it was first introduced until now. Bus stops, or public transportation stops, play an important role in increasing the comfort, efficiency, and accessibility of public transportation services such as buses, trams, or other public transportation. In the 19th century, when public transportation began to develop in large cities, such as horse-drawn carriages and trams, the need for a place to stop to pick up and drop off passengers became increasingly apparent. However, bus stops at this time were often simple and only in the form of points or signs indicating that the vehicle would stop. There were no adequate seats or shelters. As urbanization and the number of public transportation users increased, especially in countries with large cities, the design of bus stops began to develop. In this era, bus stops began to be equipped with simple benches and roofs as shelter from bad weather. Bus stops were also often given clearer signs to make it easier for passengers to know where they were stopping [1]. During this period, the role of bus stops was not only as a place to stop, but also part of orderly transportation management. Simple information boards began to be placed at bus stops to inform passengers about vehicle routes and schedules. In the late 20th century, information technology began to influence the development of bus stops. The design of bus stops not only considered physical comfort, but also provided more information to passengers. Modern bus stops began to be equipped with route maps, more detailed bus schedules, and better lighting, especially in urban areas. In addition, during this period, bus stops were also designed with the

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aesthetics and function of the city in mind. In large cities, bus stops became part of the modern urban landscape design, which used stronger and more durable materials, such as metal and glass. Innovation was also seen in systems that were more friendly to disabled users, with better accessibility. Entering the digital era, bus stops have become more sophisticated with the use of integrated digital technology. Many bus stops in large cities are now equipped with digital screens that display real-time information about the arrival of buses or other public transportation. Passengers can see estimated arrival times, route information, and even updates regarding travel disruptions [2].

In addition, many modern bus stops have facilities such as chargers for electronic devices, free Wi-Fi, and more environmentally friendly designs with the addition of solar panels or recycled materials. Some cities have also begun to integrate the smart city concept into the bus stop design with sensors that can collect traffic data and passenger interactions to improve the efficiency of public transportation. In the future, bus stops are expected to continue to evolve along with technological advances and the increasing need for urban mobility. Trends such as autonomous vehicles, the Internet of Things (IoT), and the concept of environmentally friendly transportation are expected to influence the design and function of bus stops. Bus stops will not only be a place to stop, but also a center for information and connectivity between various modes of transportation, including car sharing schemes such as bicycles or electric scooters [3-5].

Among the public problems that arise along with the development of urban society, one of them is the management of mass transportation. Because almost all big cities in Indonesia, including Jakarta, have complex traffic problems. Even the city of Jakarta, the capital of the Republic of Indonesia, is expected to experience severe stagnation due to prolonged traffic congestion. Transportation is a very important means to support the success of national development, especially to support the economic activities of the community [6]. The diversity and characteristics of society make transportation a central problem for public officials. Proper and mature planning in policy making is the first step needed to overcome transportation problems [7]. Based on this reality, the strategic role of transportation has two important tasks, namely as a development engine and as a service provider in real operations [7]. Urban traffic problems usually include congestion, parking, public transportation, pollution and traffic management. The main cause of the picture of Jakarta's congestion is uncontrolled vehicle growth, insufficient availability and use of public transportation and low traffic discipline. Then in the end this congestion causes negative impacts such as loss of time and economic value due to low driving speeds and long driving times, wasted energy, vehicle wear which causes high vehicle maintenance costs, air pollution and increased stress for road users [7]. According to the Central Statistics Agency (BPS) projected an increase in the population of DKI Jakarta in 2022 to reach 10.67 million people. The increase in this number increased slightly by 0.66% compared to the previous year of 10.6 million in 2021. Given this, adequate public transportation is also needed to support the mobilization of the daily needs of the population [8].

Based on the survey results, the urban community of DKI Jakarta and its surroundings has a very high travel intensity in this metropolitan area. The benefits of transportation are used to distribute primary, secondary, tourism, work and other needs [9]. The efforts of the DKI Jakarta provincial government to limit the use of private vehicles from neighboring areas/cities to Jakarta are summarized in the 2010-2030 Regional Medium-Term Development Plan (RPJMD) which has a strategy for developing a mass transportation-based transportation system. One real effort to reduce the density and use of private vehicles in the DKI Jakarta area is to implement a mass transportation system on the Commuter Line Electric Train, Bus Rapid Transit (TransJakarta), LRT (Light Rail Transit) and the construction of MRT (Mass Rapid Transit) so that people can take advantage of quality, efficient, fast, safe and comfortable transportation modes. Transjakarta is the first Bus Rapid Transit (BRT) transportation system in Southeast and South Asia, which has been operating since 2004 in Jakarta, Indonesia. TransJakarta is designed as public transportation to support the very busy activities of the capital city. The Transjakarta route is the longest route in the world, which is 251.2 km and has 287 stops in 13 corridors, Transjakarta which originally operated from 05:00 - 22:00 WIB, now operates up to 24 hours [5]. The number of Transjakarta passengers continues to increase over time, the highest point in the number of Transjakarta passengers occurred on June 6, 2023 reaching 958,756 passengers, an increase of 4.8% compared to May 22, 2023 [10]. The purpose of

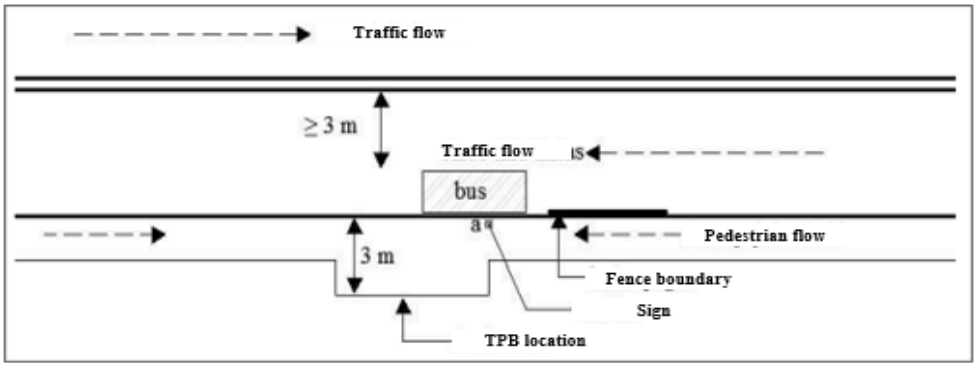
this study is: 1) To find out the existing condition of the Dukuh Atas two Transjakarta bus stop service in the previous two years, 2) To find out the level of service of Transjakarta bus stop users in Dukuh Atas Dua, 3) To find out the level of satisfaction of Transjakarta bus stop users in Dukuh Atas Dua, 4) To find out the characteristics of Dukuh Atas Dua Transjakarta bus stop users in serving prospective passengers.

Definition of Bus Stop

A bus stop is a place where public vehicles stop for the purpose of picking up and dropping off passengers. A bus stop is a place specifically designed as a place for prospective passengers to wait for the arrival of the bus. The forms vary, but are relatively monotonous. In fact, the shape of bus stops around the world does not have standardization, depending on the specific needs of the place where the bus stop will be built [5].

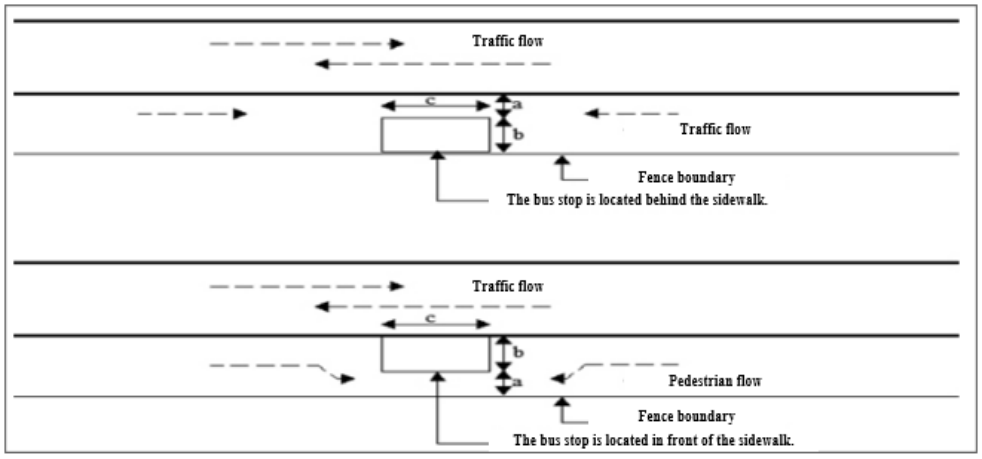
Another opinion [11] bus stops are places where transportation buses stop. Bus stops are grouped into two, namely:

1. Protected bus stops, stopping places in the form of buildings used by passengers to wait for buses or other public transportation that can protect passengers from hot weather and rain
2. Unprotected bus stops, namely a stopping place that functions as a temporary stop for buses or other public vehicles when they are going to pick up and drop off passengers.



Values: a ≥ 1.5 m (sidewalk), b ≥ 2 m (bus stop width), c ≥ 4 m (bus stop length)

Figure 1. Layout of bus stops on the road section



Value a = min 0.60 m from the outermost edge of the road shoulder

Figure 2. Layout of Bus TPB on Road Sections [12-13]

Over time, science and architecture have also developed, this has influenced the shape and design of bus stops around the world, various ideas are presented to realize attractive and comfortable bus

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stop designs, also inseparable from the desire to provide the best service to bus stop passengers while waiting for the bus they are using. Types of bus stops include:

Old bus stops without walls

Advantages:

a. Economical because of its simple shape, very easy and cheap to make.
b. Very easy to use and maintain, although on average old bus stops do not get good maintenance.

Disadvantages:

a. The comfort of prospective passengers is not guaranteed, because the facilities are very minimal
b. Security is not guaranteed, because people can freely enter and exit the bus stop

Modern bus stops without walls

Figure 3. An old bus stop without walls [14]

Advantages:
Economical, because of its simple shape, it is very easy and cheap to make, especially if supported by sponsors like the advertisement image above

Disadvantages:

a. The facilities are still inadequate because there are only benches for waiting
b. The safety of prospective passengers is not guaranteed

Figure 4. Modern bus stop without walls

Advantages:

a. The comfort and safety of prospective bus passengers are guaranteed.
b. The shape of the bus stop is more modern.

Disadvantages:

a. The cost of building a bus stop is more expensive
b. Its operation is more complicated and expensive because it uses the help of several machines that already have technology

Figure 5. Closed box-shaped bus stop

Purpose of building a bus stop

The purpose of building a bus stop is for a public passenger vehicle stopping place (TPKPU) is:
1. Ensure smooth and orderly traffic flow
2. Ensure the safety of public transportation users
3. Ensure passenger safety when getting on and off
4. Facilitate the transfer of passengers to public transportation or buses

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General requirements for bus stops

According to the Decree of the Director General of Land Transportation concerning Technical Guidelines for Engineering Public Passenger Vehicle Stopping Places, based on the general requirements for bus stops, namely [12], [15]:
1. Located along the public transportation/bus route
2. Located on a pedestrian (foot) path and close to pedestrian (foot) facilities
3. Directed close to the center of activity or settlements
4. Equipped with guide signs
5. Does not interfere with the smooth flow of traffic traffic

Shutter facilities

According to the Decree of the Director General of Land Transportation, it is stated that in general, bus stop facilities consist of [12], [16]:
1. Bus stop identity in the form of name and/or number
2. Direction signs
3. Route information board
4. Lighting
5. Seats

The basic purpose of bus stop improvements is to provide excellent service to the user community. The size of good service includes good and safe service, reliable, orderly, fast, cheap, comfortable, easy to reach, pleasant, modern and dignified [17]. Existing Dukuh Atas Transjakarta bus stop facilities, in front of the bus stop door, passengers can currently enter the bus stop area with transactions that do not serve manual or cash ticket purchases, but all passengers transact using electronic money.

In the passenger queue area, there is a door barrier that uses an automatic door so that passengers do not need to worry about falling while queuing, because it has been designed safely

Figure 6. Automatic Tapping Door and Vending Machine (Source: Personal photo, 2023)

Figure 7. Automatic busway door (Source: Personal photo, 2023)

Other bus stop facilities are also equipped with a place of worship or prayer room equipped with a water tap for ablution, there are toilets specifically for men and women as well as disabled toilets so that users will be comfortable at the bus stop, as shown in the picture below.

The existence of this disabled lane and lift is to make it easier for Dukuh Atas Bus Stop users with special needs to feel comfortable when at the bus stop.

Figure 8. Priority lanes and lifts for the disabled (Source: Personal Photo, 2023)

Transjakarta bus stop users can cross the pedestrian bridge (JPO) to transit to the next bus stop or transfer between other modes of transportation safely and comfortably as illustrated in the image below.

Figure 9. Dukuh Atas Dua JPO (Source: Personal Photo, 2023)

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Figure 10. Entrance to the Dukuh Atas Dua Bus Stop (Source: Youtube aksanaofficial, 2023)

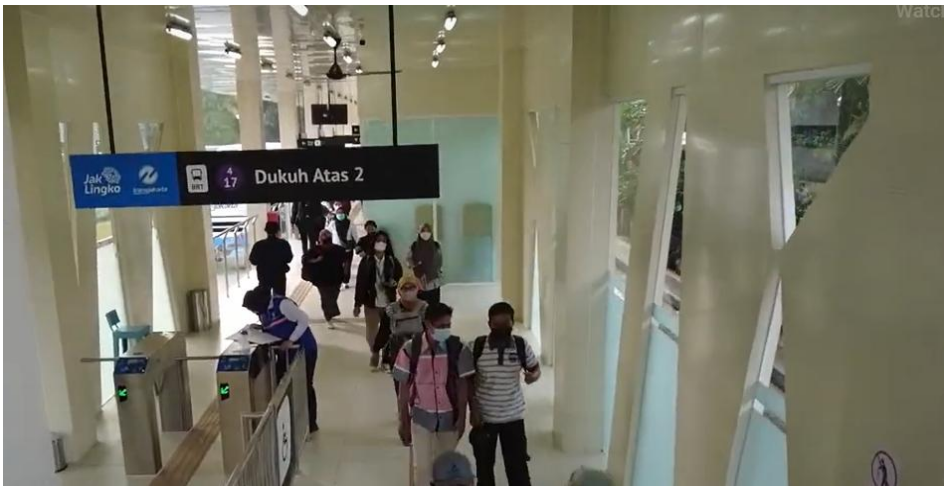

Figure 11. Dukuh Atas Dua Bus Stop Activities (Source: Youtube arkana official, 2023)

Understanding Service

The quality of service provided to customers is in accordance with service standards, which are standardized guidelines for service delivery. Also argues that service quality can be achieved through meeting customer needs and desires, as well as the service provider's commitment to meeting customer expectations [18], [[25].

Service quality is a customer's long-term cognitive evaluation of a company's service delivery. Essentially, the better the service a company provides, the higher the level of satisfaction and repeat purchases [19], [26].

Based on the definitions of these experts, the authors conclude that service is a standard provided to customers that fulfills customer needs and desires in accordance with customer expectations.

Service Indicators

Service indicators consist of:

1. Tangibles, namely the company's ability to demonstrate its existence to external parties.
2. Reliability, the company's ability to provide services as promised accurately and reliably.

3. Responsiveness, the desire to help and provide fast and accurate service to customers with clear information.
4. Assurance, the ability of employees to provide and increase customer trust in the company by providing courteous service.
5. Individual Attention (Empathy), namely providing sincere and individual or personal attention to customers, striving to understand their desires [20], [27].

Customer Satisfaction

Customer satisfaction is a person's feeling of happiness or disappointment resulting from comparing a product or service and its performance (or results) with expectations. If performance or results do not meet expectations, the person will feel dissatisfied [21], [28]. Therefore, the dimensions of customer satisfaction are perceived performance and expectations. Metrics derived from a perceived performance perspective include product/service performance, service performance, product/service expectations, and service expectations.

Based on expert opinion, the author concludes that customer satisfaction is a level of need or desire that becomes an expectation, which elicits both sad and happy reactions from customers who use a product or service.

Factors Influencing Customer Satisfaction

Factors influencing customer satisfaction include:

1. Product quality: Customers will feel satisfied if their results indicate that the product they use is of high quality.
2. Service quality: Customers will feel satisfied if they receive good service or service that meets their expectations.
3. Emotion: Customers will feel proud and confident that others will admire them when using a product from a particular brand, which tends to result in higher levels of satisfaction. This satisfaction is not due to product quality but rather to social or self-esteem, which makes customers feel satisfied with a particular brand.
4. Price: Products with the same quality but priced relatively low will provide higher value to customers.
5. Cost, namely customers who do not need to incur additional costs or do not need to waste time to get a product or service tend to be satisfied with the product or service.

Customer satisfaction is achieved by improving bus stop infrastructure, which is currently very important. Bus stops are a key component of fixed-route city bus services, so achieving good quality is crucial for improving public transportation services. Public transportation services are highly dependent on the quality of the infrastructure that supports them, one of which is bus stops. As one of the main facilities for public transportation users, complete bus stops play a crucial role in increasing comfort and ease of travel. A good bus stop should provide sufficient seating, especially in large cities with high passenger volumes. These seats should be protected by a roof to protect passengers from the heat or rain, so they can wait comfortably. In addition, clear information boards regarding bus schedules, routes, and arrival times are essential elements of a complete bus stop. Accurate information helps passengers better plan their trips, avoid confusion, and minimize uncertainty while waiting for transportation. In today's digital era, some modern bus stops are even equipped with digital screens that provide real-time information regarding bus departures, giving passengers certainty about when their bus will arrive. Accessibility is also a primary concern. A good bus stop should be designed to be accessible to people with disabilities, including providing wheelchair ramps and designated areas for easy boarding and disembarkation. Strategically located bus stops, close to public facilities or commercial areas, will also make it easier for passengers to reach their destinations. Adequate lighting is another important aspect, especially at night. A well-lit bus stop provides a sense of security for waiting passengers and helps bus drivers see passengers more clearly. Cleanliness of the bus stop is also crucial. A clean bus stop reflects attention to user comfort and fosters a sense of responsibility for maintaining public facilities.

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Sampling Technique

A questionnaire survey can be conducted to assess the characteristics of Transjakarta users at the Dukuh Atas Dua bus stop, comparing the level of service before and after the revitalization. The number of respondents or sample users can be calculated using the Slovin equation as follows:

$$N = \frac{N}{N.d^2 + 1}$$

Description:

N: Number of Samples

N: Average Number of Users

D: Percentage allowance for inaccuracy due to sampling error (5%).

The author distributed this questionnaire to collect data by distributing or providing several questions or statements to respondents, with the number of respondents calculated using the formula above.

Likert Scale with SPSS version 26

The Likert scale is a tool for measuring questionnaires based on their research instruments. Table 1 shows the Likert scale as follows:

Table 1. Scale based on the Likert scale

Statement	Score
Strongly agree	5
Agree	4
Neutral	3
Disagree	2
Strongly disagree	1

After the questionnaire was assessed, it was tabulated in SPSS version 26, with validity and reliability tests performed.

Validity Test

Researchers conduct pilot tests on questions to determine whether respondents understand the questions being asked. If a respondent's answer is invalid, it indicates that the respondent does not understand the question. Validity testing is performed by comparing the calculated r value with the table r value for degrees of freedom (df) = n-2 with an alpha value of 0.05. If the calculated r value is greater than the table r value and the t-value is positive, the question item is valid. The following indicators are used to determine validity in research:

a. If the calculated r value is greater than the table r value, the questionnaire is considered valid.

b. If the calculated r ≤ table r, the instrument is declared invalid [22].

Reliability Test

A reliability test is a set of similar measuring instruments that are carried out repeatedly. A reliability test is the consistency of research results using different research methods under different conditions. Therefore, a reliability test is a series of measuring instruments that test the consistency of answers generated by researchers to respondents to obtain correct answers [23].

To obtain the same respondent answers, a reliable instrument must be used. Measurements are conducted once, and reliability is determined using statistical tests using Cronbach's Alpha analysis with the following value clarifications: A Cronbach's Alpha value between 0.41 and 0.60 is considered sufficiently reliable, which is the reference in this study.

RESEARCH METHODOLOGY

Place and Time

This research was conducted at the Dukuh Atas Dua Transjakarta bus stop on Jalan MH Thamrin, Setia Budi Village, South Jakarta. The research period was one week, from September 11, 2023, to September 17, 2023, from 1:00 PM to 4:00 PM WIB.

Tools

The tools used in this research were:

1. Smartphone to document research results.
2. Laptop to process data using SPSS version 26 software.
3. Books or journals to find reference sources for the literature review.

Materials

The materials used in this study are:

1. Primary data, which is data obtained directly in the field, for example, respondents' answers to distributed questionnaires.
2. Secondary data, which is data already available from the research site, for example, data on Transjakarta bus users.

Research Method

This research uses a quantitative method. Compiling this research requires complete data, both technically and in the field, to ensure the research runs smoothly. The research method consists of the following steps:

1. The initial stage begins with selecting a research topic and title. In this study, the research title is "Analysis of Service for Transjakarta Bus Stop Users in Dukuh Atas Dua."
2. The second stage is determining the research location. The research location is the Transjakarta Bus Stop in Dukuh Atas Dua, South Jakarta. The research object is integrated intermodal bus service based on the perceptions of Transjakarta bus users after the revitalization.
3. The third stage is determining the data collection and analysis methods. Data collection was conducted through a field survey of Transjakarta bus users at the Dukuh Atas Dua bus stop. Data analysis was then conducted using SPSS version 26 [24] and Microsoft Excel software.
4. The fourth stage involved collecting questionnaire data. This questionnaire data collection took place over a one-week period, from 1:00 PM to 4:00 PM. A total of 400 respondents were recruited.
5. The fifth stage involved data processing using SPSS version 26. After the data was processed, the questionnaire results were selected by testing for validity and reliability. Once the data was declared valid, the data processing and discussion of the results were carried out to ensure that the results and discussion align with the objectives stated above.
6. The final stage is drawing conclusions. These conclusions address the objectives stated in Chapter 1 (Introduction). Conclusions should be aligned with the objectives so that the research aligns with the predicted results. Furthermore, any suggestions are presented in this section as an improvement effort for the bus stop controllers, in this case the BPTJ and the DKI Jakarta Provincial Government as the land owner and operator of the Transjakarta Bus, and the operation of all bus stops in all corridors in this region.

The research flowchart is shown below.

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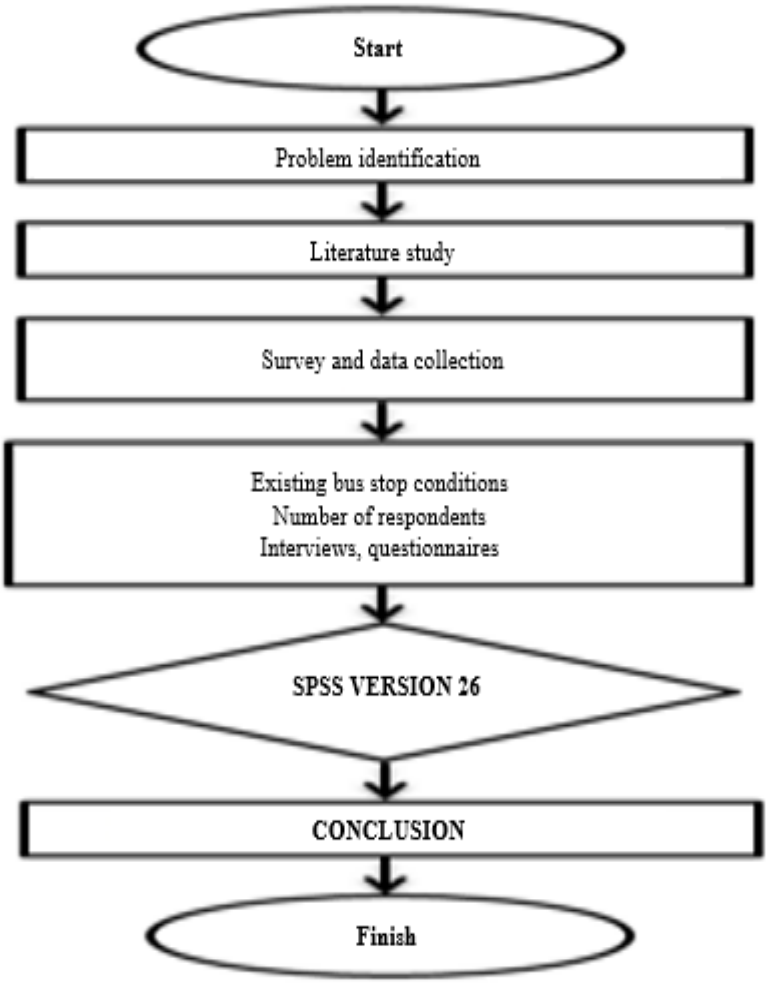

Figure 12. Research Flowchart

RESULTS AND DISCUSSION

Research Results

The results of the research from the designated locations indicate that the research, using both secondary and primary data, demonstrates the following:

The secondary data on the volume of Transjakarta bus stop users at Dukuh Atas Dua can be illustrated as follows.

Secondary data results

Data on the number of Transjakarta bus stop users at Dukuh Atas Dua in January and February 2022 and March and April 2023 are shown in Table 13 below.

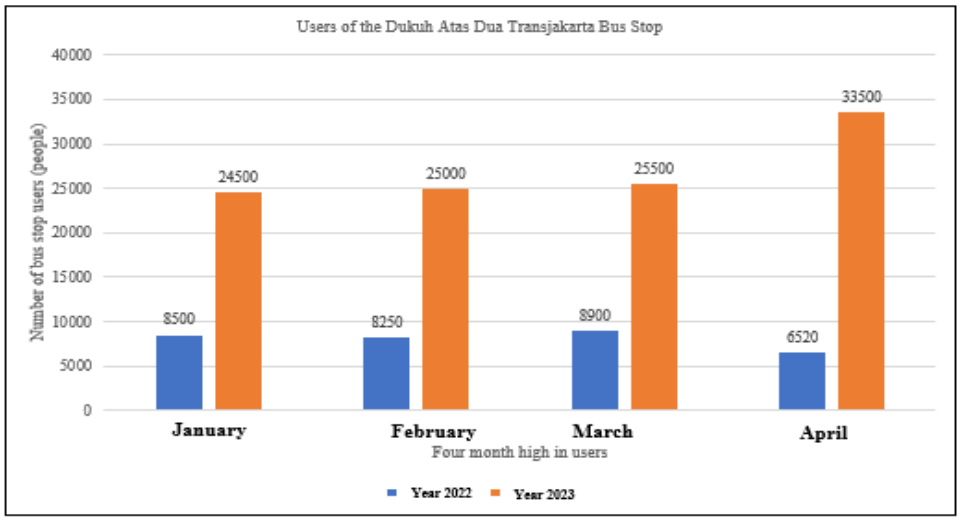

Figure 13. Bus Stop User Volume 2022-2023 Source: DLAJ 2023

The data above shows that the number of Transjakarta bus stop users in Dukuh Atas Dua in April 2023 was 33,500, significantly higher than the 6,250 in the same month in 2022. This was due to bus stop improvements, which reduced the number of users and allowed for more efficient user congestion to be achieved as planned.

Discussion of Service Level Based on User Perceptions of the Dukuh Atas Dua Transjakarta Bus Stop

The results of this analysis were generated from a questionnaire distributed by the author to users of the Dukuh Atas Dua Transjakarta bus stop after the revitalization in 2023. The results examined several aspects, including operational aspects, comfort, and facilities for Transjakarta bus stop users. To determine the number of respondents needed as a sample in this study, the population data for the city of South Jakarta is 2,406,082 people, so the number of respondents or samples is using the Slovin formula as follows.

$$\boldsymbol{n} = \frac{2.406.082}{(2.406.082)\,.\,(0.005)^2 + 1} = 400 \text{ Sample}$$

Based on the calculations above, the required number of respondents was 400, which served as the sample for the study.

Analysis of the characteristics of Dukuh Atas Dua Transjakarta bus stop users based on gender, education, and age is as follows:

Characteristics of Dukuh Atas Dua Transjakarta bus stop users by gender

The characteristics of post-revitalization Transjakarta bus stop users by gender are shown in Table 2 below.

Table 2. Dukuh Atas Dua Transjakarta bus stop users by gender

		Gender			
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	Male	224	56.0	56.0	56.0
	Female	176	44.0	44.0	100.0
	Total	400	100.0	100.0	

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Source: Data processed using SPSS version 26, 2024.

The diagram showing the characteristics of Dukuh Atas Dua Transjakarta Bus Stop users based on gender can be seen in Figure 14 below.

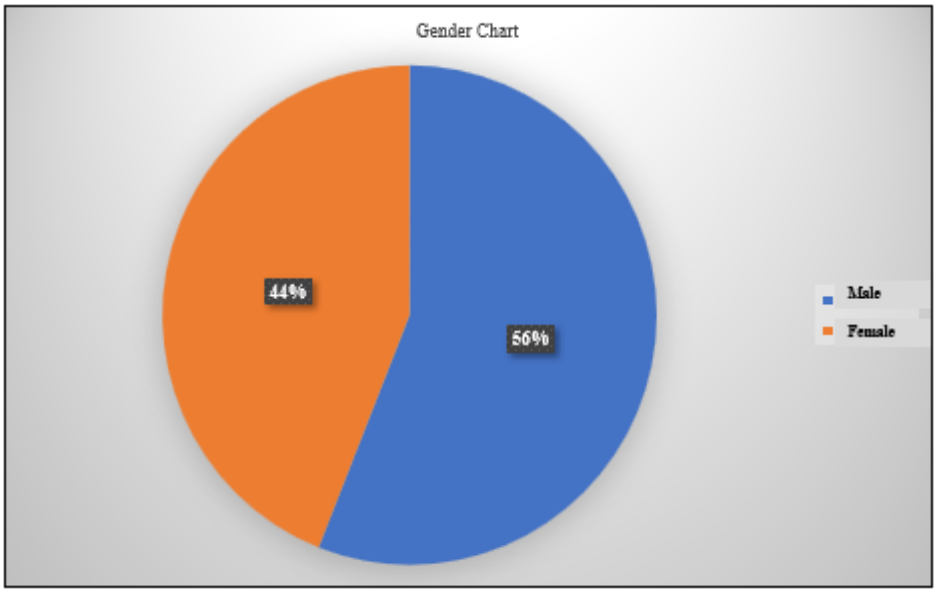

Figure 14. Gender Graph

Based on the analysis of characteristics by gender in the figure, it can be seen that males predominate over females, representing 56% of the 224 respondents, while females represent 44% of the 176 respondents.

Characteristics of Dukuh Atas Dua Transjakarta Bus Stop Users by Age

The characteristics of Dukuh Atas Dua Transjakarta Bus Stop users by age can be seen in Table 3 below.

Table 3. Dukuh Atas Dua Transjakarta Bus Stop Users by Age

	Age	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	21-30	179	44.8	44.8	44.8
	31-40	133	33.3	33.3	78.0
	41-50	67	16.8	16.8	94.8
	51 and above	21	5.3	5.3	100.0
	Total	400	100.0	100.0	

Source: Data processed using SPSS version 26, 2024.

The diagram showing the characteristics of Dukuh Atas Dua Transjakarta bus stop users based on age can be seen in the image below.

Based on the analysis of characteristics by age in the figure, it can be seen that the 21-30 year old age group is more dominant, with a value of 45%, or 179 respondents, because this age group is more productive for traveling.

Characteristics of Dukuh Atas Transjakarta Bus Stop Users by Education Level

The characteristics of Transjakarta Bus Stop users by education level can be seen in Table 5 below.

Table 5. Dukuh Atas Dua Transjakarta Bus Stop Users by Education Level

Education		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	High School	64	16.0	16.0	16.0
	Diploma	126	31.5	31.5	47.5
	Bachelor's Degree	150	37.5	37.5	85.0
	Postgraduate Degree	60	15.0	15.0	100.0
	Total	400	100.0	100.0	

Source: Data processed using SPSS version 26, 2024.

The diagram of the characteristics of Dukuh Atas Dua Transjakarta bus stop users based on education can be seen in the image below.

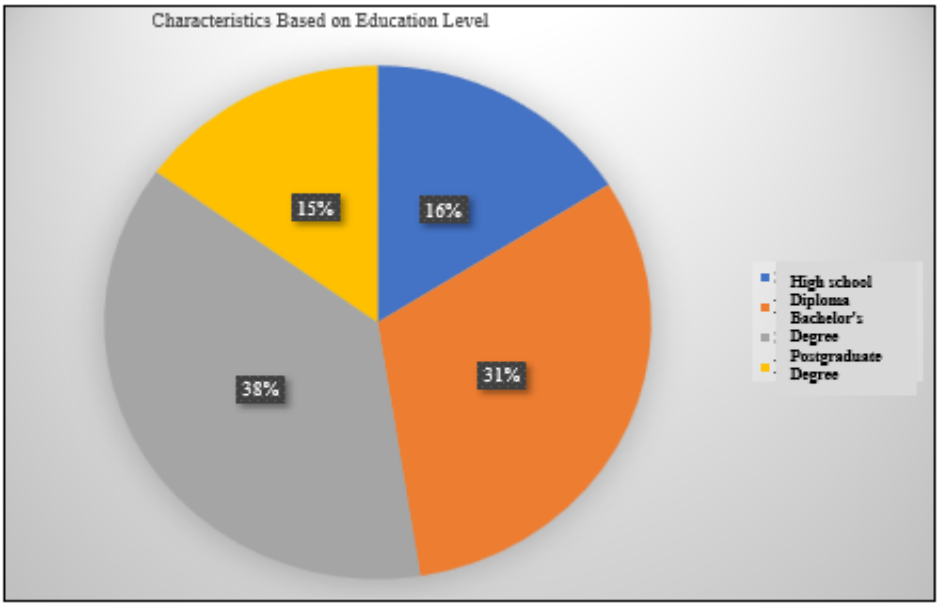

Figure 15. Education Level Graph

Based on the analysis, the characteristics of Dukuh Atas Dua Transjakarta Bus Stop users based on education are that bachelor's degrees are the most dominant, with 156 people, or 38%, compared to other educational levels.

Next, we analyze the responses of Dukuh Atas Dua Transjakarta Bus Stop users regarding service and after revitalization.

Discussion of user responses to Dukuh Atas Dua Transjakarta Bus Stop service.

User responses to Dukuh Atas Dua Transjakarta Bus Stop service levels can be seen in Table 6 below.

Table 6. User responses to Dukuh Atas Dua Transjakarta bus stop service levels

Indicators		Score				Percentage (%)			
		1	2	3	4	1	2	3	4
Reliability	P1	0	14	183	203	0	3,5	45,8	50,7
	P2	0	18	173	209	0	4,5	43,3	**52,3**
Responsiveness	P3	0	12	178	210	0	3,0	44,5	**52,5**
	P4	0	16	175	209	0	4,0	43,8	52,3

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Indicators		Score				Percentage (%)			
		1	2	3	4	1	2	3	4
Tangibility	P5	0	10	180	210	0	2,5	45,0	52,5
	P6	0	18	166	216	0	4,5	41,5	**54,0**

Source: Data processed using SPSS version 26, 2024.

The service diagram for the Dukuh Atas Dua bus stop can be seen in Figure 16 below.

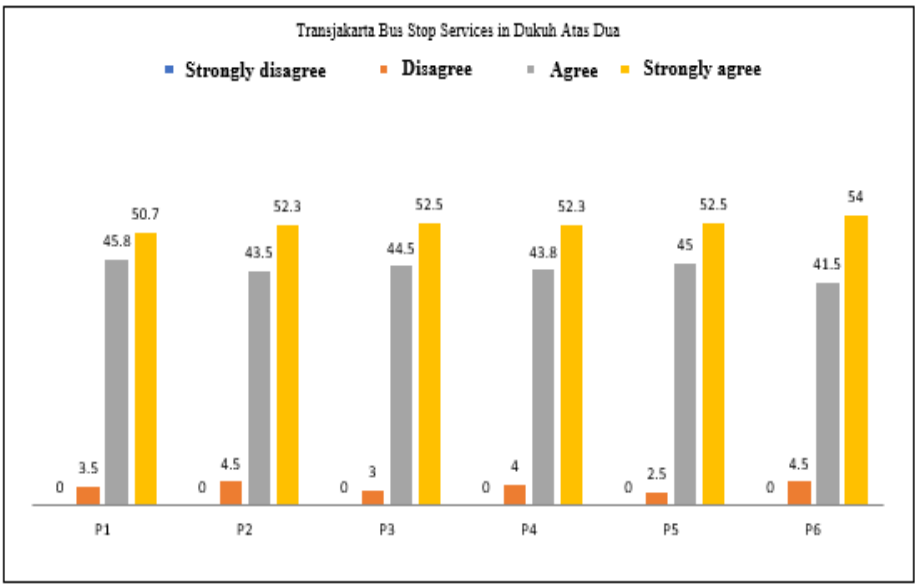

Figure 16. Dukuh Atas Dua Transjakarta Bus Stop Service

Based on the analysis of user responses to the service at the Dukuh Atas Dua Transjakarta Bus Stop, reliability was 52.3%, representing 209 respondents, responsiveness was 52.5%, representing 210 respondents, and tangibility was 54.0%, representing 216 respondents, who expressed very high satisfaction with the level of service at the Dukuh Atas Dua Transjakarta Bus Stop.

The following table also presents information regarding the level of service provided to users at the Dukuh Atas Dua Transjakarta Bus Stop.

Table 7. Questionnaire for the 400 respondents at the Dukuh Atas Dua Bus Stop

No	Questions
1	Is there sufficient information regarding Transjakarta bus departure schedules available at the Dukuh Atas Dua bus stop?
2	Is the Dukuh Atas Dua Transjakarta Bus Stop easily accessible for passengers?
3	Is there a connection between the commuter line (KRL) and Transjakarta buses at the Dukuh Atas Dua bus stop?
4	Is the Dukuh Atas Dua Transjakarta Bus Stop easily accessible from Sudirman Station?
5	Do staff respond to user complaints and issues at the Dukuh Atas Dua bus stop?
6	Are there adequate facilities for people with disabilities?

Discussion of User Satisfaction Responses at the Dukuh Atas Dua Transjakarta Bus Stop

User satisfaction responses at the Dukuh Atas Dukuh Dua Transjakarta bus stop after the revitalization can be seen in Table 8 below.

Table 8. User Satisfaction Responses at the Dukuh Atas Dua Transjakarta Bus Stop

Indicators	Score				Percentage (%)			
	1	2	3	4	1	2	3	4

Physical Improvements	P1	0	17	176	207	0	4.3	44.0	51.7
	P2	0	15	161	224	0	3.8	40.3	**56.0**
Organizer	P3	2	19	177	202	5	4.8	44.3	50.5
	P4	0	22	174	204	0	5.5	43.5	**51.0**

Source: Data processed using SPSS version 26, 2024.

The diagram of Transjakarta bus stop users' satisfaction with Dukuh Atas Dua can be seen in Figure 17 below.

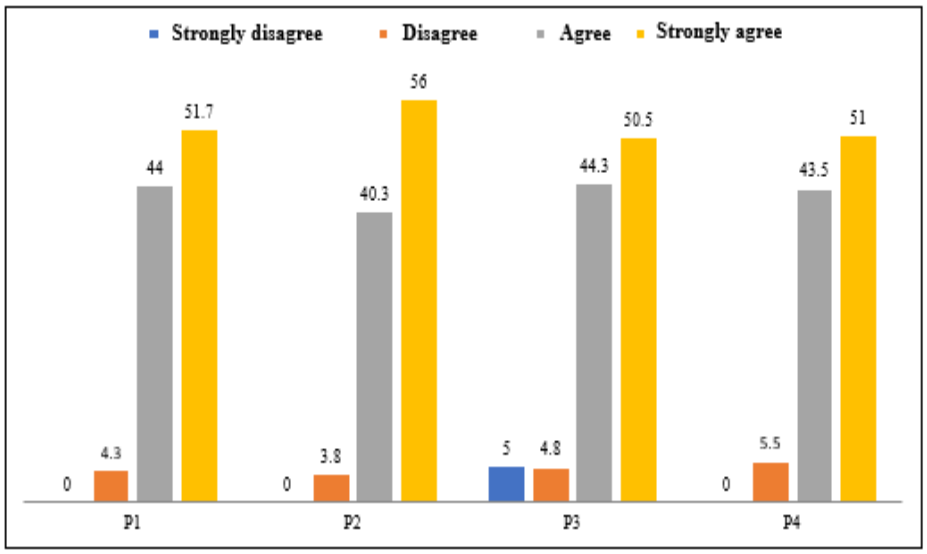

Figure 17. User Satisfaction Responses at the Dukuh Atas Dua Transjakarta Bus Stop

Based on the analysis of user satisfaction responses at the Dukuh Atas Dua Transjakarta bus stop, 56%, or 224 respondents, strongly agreed with the physical improvements indicator, and 51%, or 204 respondents, agreed with the governance indicator. This is because physical improvements can provide user satisfaction.

The questionnaire was tested for validity by calculating the r value in SPSS version 26, as shown in Table 9 below:

Table 9. Validity Test Results

No	Indicators	P	rcount	rtable	Description
Service	Reliability	P1	0.639	**0,098**	valid
		P2	0.620	0,098	valid
	Responsiveness	P3	0.560	0,098	valid
		P4	0.552	0,098	valid
	Direct Evidence	P5	0.614	0,098	valid
		P6	0.608	0,098	valid
Service Satisfaction	Evidence of Physical Condition	P1	0.609	0,098	valid
		P2	0.568	0,098	valid
	Governance	P3	0.432	0,098	valid

No	Indicators	P	rcount	rtable	Description
	Indicators	P4	0.508	0,098	valid

Source: Data processed using SPSS version 26, 2024

Reliability Test

The results of the reliability test on the questionnaire can be seen in Table 10 below:

Table 10. Reliability Test for Dukuh Atas Dua Transjakarta Bus Stop Services

Cronbach alfa	Provisions	Description
0.622	0,06	Reliabel

Source: Data processed using SPSS version 26, 2024

Table 11. Reliability test of user satisfaction at the Dukuh Atas Dua Transjakarta Bus Stop

Cronbach alfa	Provisions	Description
0.135	0,06	Reliabel

Source: Data processed using SPSS version 26, 2024

Table 12. Questionnaire questions regarding user satisfaction and comfort at the Dukuh Atas Dua Transjakarta bus stop

No	Questions
1	Do users feel safe and comfortable at the Dukuh Atas Dua Transjakarta Bus Stop?
2	Are the facilities at the Dukuh Atas Dua Transjakarta Bus Stop comprehensive?
3	Is the Dukuh Atas Dua Transjakarta Bus Stop easily accessible?
4	Are information and directions at the Dukuh Atas Dua Transjakarta Bus Stop easily visible?

Based on the analysis of the satisfaction responses of the Dukuh Atas Dua Transjakarta bus stop users, the physical evidence indicators that support the smoothness of waiting for the Transjakarta bus are 56% or as many as 224 respondents said they strongly agree and with the improvement in the quality of governance, 51% or as many as 204 respondents said they agree with the satisfaction at the Dukuh Atas Bus Stop due to the satisfaction of the Dukuh Atas Dua Bus Stop users with the service and governance that is very responsive to the bus stop environment.

The implementation of the Internet of Things (IoT) at the Dukuh Atas 2 TransJakarta Bus Stop has significantly improved the quality of public transportation services in Jakarta. IoT refers to a network of interconnected digital devices that collect, transmit, and process data automatically through the internet. At Dukuh Atas 2, IoT technology supports operational efficiency, passenger convenience, and smart urban mobility integration.

One of the most visible IoT applications is the real-time passenger information system. Digital displays installed at the bus stop provide live updates on bus arrival times, route information, and traffic conditions. This system uses GPS sensors embedded in TransJakarta buses to transmit location data continuously to the control center and passenger information screens. As a result, passengers can estimate waiting times more accurately and plan their trips efficiently. IoT is also applied through smart ticketing systems using electronic cards and QR-code payments. These systems automatically record passenger transactions and travel patterns, helping operators analyze passenger demand and optimize service schedules. In addition, CCTV cameras connected through IoT networks enhance security monitoring and enable faster response to incidents or overcrowding conditions. Environmental monitoring is another important feature. Sensors installed around the bus stop can measure temperature, lighting, air quality, and energy consumption. These data help improve passenger comfort and support sustainable transportation management. Furthermore, integration with nearby transit systems such as MRT Jakarta, KRL Commuter Line, and pedestrian facilities creates a smart mobility ecosystem in the Dukuh Atas transit-oriented development area.

CONCLUSIONS

Based on the analysis conducted on users of the Dukuh Atas Dua Transjakarta Bus Stop, the following conclusions are drawn: 1) The existing service conditions at the Dukuh Atas Dua Transjakarta bus stop were 33,500 users in April 2023, the highest level ever achieved by this Transjakarta bus stop. 2) The level of service for Transjakarta users at the Dukuh Atas Dua bus stop, based on the analysis and user responses to the Dukuh Atas Dua Transjakarta bus stop service, has three indicators: Reliability (52.3%) or 209 respondents, Responsiveness (52.5%) or 210 respondents, and Tangibility (direct evidence) of 54.0% or 216 respondents, who stated that they were very satisfied with the Transjakarta bus stop service at the Dukuh Atas Dua bus stop. 3) From the results of the study above, it can be explained that the level of satisfaction responses from Transjakarta users at the Dukuh Atas Dua bus stop is very high. Users of the Dukuh Atas Dua Transjakarta Bus Stop with physical environmental evidence indicators obtained satisfaction of 56% or as many as 224 respondents said they were very satisfied with the physical environment and 51% or as many as 204 respondents said they strongly agreed with the completion of the revitalization of the Dukuh Atas Transjakarta Bus Stop so that the conditions are increasingly comfortable and safe, 4) In serving users of the Dukuh Atas Transjakarta Bus Stop, the characteristics of users were obtained based on gender, age, and education level. For the male gender, it was more dominant, namely 56% or as many as 224 respondents, while based on age, it was more dominant in the age range between 21 years and 30 years, namely 45% or and based on undergraduate education, it was more dominant, namely 156 respondents or 38%. IoT implementation at Dukuh Atas 2 TransJakarta Bus Stop improves transportation efficiency, passenger comfort, safety, accessibility, and supports Jakarta's smart city development.

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