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Suroboyo Bus Vehicle Operating Cost Analysis

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Keywords
vehicle operating costs, public transport subsidies.

Abstract
Public transportation plays a vital role in supporting urban mobility and promoting sustainable economic development. One of the key challenges in public transportation is ensuring that services remain affordable to the public while operating efficiently and sustainably. Based on this background and these challenges, analyzing the Suroboyo Bus fare subsidy on operational costs is a relevant and strategic topic for research. This research aims to identify optimal subsidy policy strategies and provide recommendations for improving operational efficiency. The research uses a quantitative analysis method to calculate the operating costs of the Suroboyo Bus vehicles and the subsidy provided by the Surabaya City Government. The calculation results show that the vehicle operating cost of the Suroboyo Bus is Rp. 17,643 per kilometer, while the fare subsidy provided by the Surabaya City Government is Rp. 18,201,326,602 per year. These results indicate that the current Suroboyo Bus fare, in accordance with the Surabaya Mayor Regulation, is still more affordable than the community's ability and desire to use the Suroboyo Bus. The implications of this research suggest that the Surabaya City Government should adjust the Suroboyo Bus fare to improve services and add routes according to public demand. In addition, the use of technology in operational management will positively impact service sustainability and more effective subsidy management.

Introduction

Suroboyo Bus is one of the innovative forms of public transportation in Surabaya City that uses a subsidy-based fare system to ensure affordability and attract people to switch from using private vehicles. The service has contributed to reducing congestion and pollution, in line with the government's efforts to create a more environmentally friendly transportation system (Hassan et al., 2021). In addition, Suroboyo Bus emphasizes the concept of sustainability by encouraging users to pay fares using plastic waste, a unique innovation to raise environmental awareness (Suryawan & Lee, 2024)

It is important for operators to find operational cost optimization strategies (Rota et al., 2023). Efficiency can be achieved through proper fleet size and trip scheduling. This evaluation will ensure that subsidies are used effectively and that there is no wastage of funds. In some countries, the use of technologies such as big data and Internet of Things (IoT) has been proven to help in efficient route planning and adjustment of operational time based on passenger demand (Ushakov et al., 2022). These technologies enable operators to reduce costs and improve services (Javaid et al., 2022a).

To improve the existence and competitiveness of public transport, the Surabaya government needs to consider several aspects, including operational costs, infrastructure investment, and fair pricing (Peters, 2022). Through this policy, the government not only covers part of the operational costs but also ensures that operators can maintain good service standards (Challoumis & Eriotis, 2024). Such a subsidy program aims to increase ridership, reduce carbon emissions, and reduce traffic congestion (Bleviss, 2021)

An analysis of operational costs and fares is important to maintain the financial sustainability of the program (Gleißner et al., 2022). Operating cost components include fuel, maintenance, staff salaries, and fleet depreciation, all of which must be managed efficiently to ensure that subsidies are well-targeted (Krill et al., 2023). Without proper analysis, the government risks facing an unmanageable budget burden, threatening the sustainability of the public transport program (Marandi & Main, 2021)

Meanwhile, technology and data can be key in improving operational efficiency (Javaid et al., 2022b). The use of e-ticketing and GPS-based monitoring applications allows operators to monitor routes, trip frequency, and fleet performance in real-time (Vanderschuren & Jobanputra, n.d.). These technologies can also assist the government in measuring the effectiveness of subsidies and making data-driven decisions for policy adjustments (Yang et al., 2023). Thus, the integration of technology in bus operations not only improves service quality but also ensures that subsidies can be better allocated (Wang et al., 2023)

In addition, to improve efficiency and sustainability, the government may consider involving the private sector in the management of services (Rashed & Shah, 2021). Through public-private partnership (PPP) schemes, operators can share operational burdens and risks, thereby reducing dependence on government budgets (Liu et al., 2024). This kind of cooperation model can also open up opportunities for service innovation and improved user satisfaction (Peng & Li, 2021).

Suroboyo Bus operating costs are relatively large, but with the tariff subsidy provided by the Surabaya City Government, it can reduce the value of the tariff charged to Suroboyo Bus users (Anityasari et al., 2023). Therefore, this research will analyze the Suroboyo Bus fare subsidy on vehicle operating costs and the prevailing tariff (Darmoyono, 2024).

Based on the background and existing challenges, the analysis of Surabaya bus operating costs is a relevant and strategic topic to be researched (Ratnawati et al., n.d.). Through this research, it is expected to find an optimal subsidy policy strategy and recommendations for improving operational efficiency (Sun et al., 2022). With the right analysis, the Surabaya City government can improve the quality of public transport services, reduce congestion, and encourage people to switch to public transportation. In addition, the utilization of technology in operational management will have a positive impact on service sustainability and more effective subsidy management (Ma et al., 2021).

This research aims to analyze the impact of fare subsidies on the operational costs of the Suroboyo Bus in Surabaya by emphasizing the role of technologies such as e-ticketing, GPS, and big data in improving efficiency, reducing congestion, and lowering carbon emissions, so that the results can be used as a basis for the Surabaya City government to formulate more optimal subsidy policies, help operators manage operational costs effectively, and improve the quality of affordable and environmentally friendly public transportation services, as well as being a reference for further research in the transportation sector.

Materials and Method

1. Preparation Stage

   In the preparation stage, the activities to be carried out are as follows.

   a. Preparation

      In this preparation stage, researchers will prepare correspondence including data request letters and permission letters to conduct field surveys if needed to the relevant agencies in the context of conducting this research.

   b. Literature Research

      At this literature research stage, researchers will research several references related to this research as a basis for moving to the next stage, namely data collection and analysis.

   c. Tariff Policy

      Surabaya Mayor Regulation Number 22 of 2023 concerning Tariffs and Waste Contributions in the Use of Regional Public Service Agency Services of the Technical Implementation Unit of the Public Transportation Management Service at the Surabaya City Transportation Agency.

2. Preliminary Survey

   In this preliminary survey, the author will make initial observations to determine the location of the survey, determine the survey time, determine the number of surveyors and check the survey form.

   a. Determination of Survey Location

      The location of the survey was carried out to make it easier to determine the questionnaire data. The survey locations in this research consisted of 1 starting location, namely Purabaya Terminal (North-South Corridor).

   b. Survey Timing

      Survey time is determined on weekdays and weekends. There is no time limit in conducting the survey. Surveys can be conducted during Suroboyo Bus operational hours, from 05.00-21.00.

   c. Determination of Number of Surveyors

      In this research, it is estimated that 1 surveyor is needed for the corridor/route with the following division of tasks:

      1) Vehicle Survey

         This survey requires 1 surveyor (the researcher himself) who is in charge of observing the vehicle in the form of travel time, route length, and documentation.

      2) Survey Form Checking

         Checking the survey form is done so that there are no difficulties when researchers make observations by providing survey forms.

3. Data Collection Stage

   a. Primary Data

      Primary data collection in this research consists of passenger surveys and operator surveys. Operator Survey, this survey was conducted in relation to the driver to obtain Vehicle Operating

Cost data. This survey was conducted by conducting interviews related to several parameters, including: KM traveled per day, vehicle crew income, fuel, bus washing.

b. Secondary Data

In this research, secondary data was obtained from relevant agencies of Surabaya City Government and other data sources related to Travel Routes, Operating Hours, and Vehicle Operating Costs, both direct and indirect costs.

4. Data Compilation Stage

This stage is the stage of data recapitulation, both primary data and secondary data. Data recapitulation related to the survey results includes a description of the survey results to the operator (can be in the form of tables and graphs), data on the number of passengers, and data on the components of Vehicle Operating Costs.

Results and Discussion

Descriptive Analysis of Respondent Interview Results

The following is a descriptive analysis of the results of an interview survey of respondents who are passengers of the Suroboyo Bus fleet.

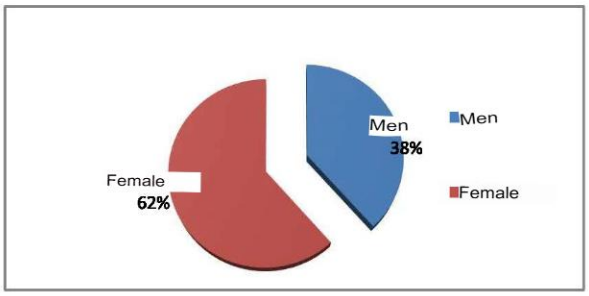


Figure 1. Diagram of the Percentage of Respondents Based on Gender
Source: Processed by Researchers 2024

Based on the interview data, of the 99 respondents interviewed, 38.38% were male and 61.62% were female. Then based on the age group, the majority of respondents are aged 22-26 years with a percentage of 27.27%.

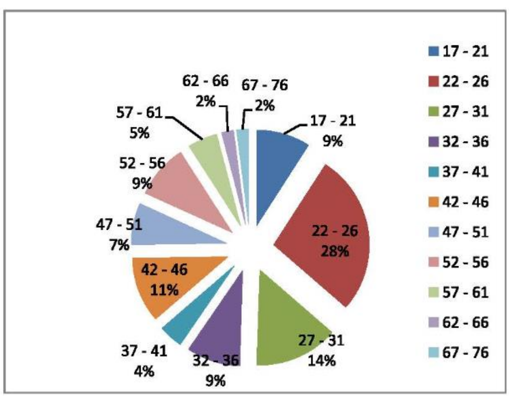


Figure 1 . Diagram of Percentage of Respondents by Age
Source: Processed by Researchers 2024

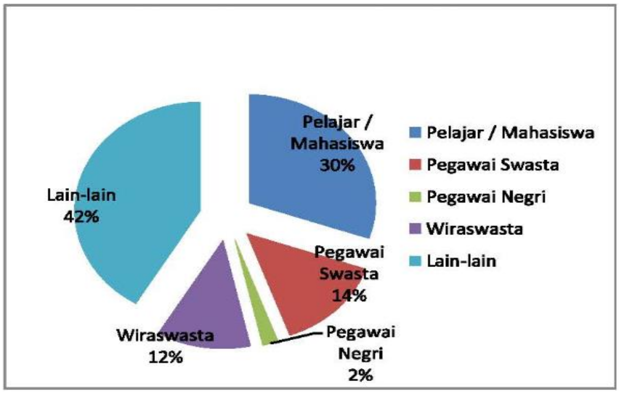


Figure 2 . Diagram of Percentage of Respondents by Type of Work
Source: Processed by Researchers 2024

Based on the interview data, the most respondents are students with a percentage of 30%. Meanwhile, various other types of work have a percentage of 42%. Furthermore, based on the purpose of the trip, the highest percentage of respondents with the intention of tourism, which is 40%, then followed by the purpose of work (21%) and shopping (18%).

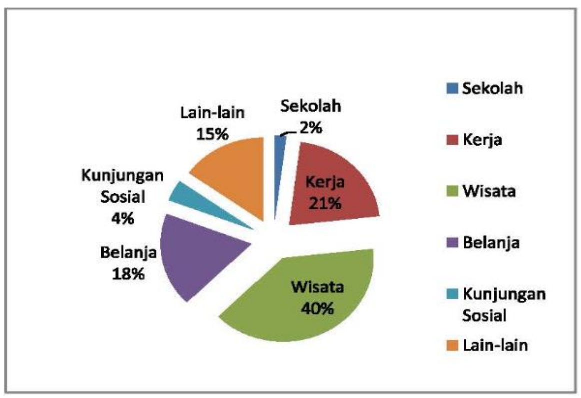


Figure 3 . Diagram of Percentage of Respondents by Trip Purpose
Source: Processed by Researchers 2024

Next, based on how to get to the bus stop, the highest percentage of respondents went to the bus stop by walking (44%), then to the bus stop by being dropped off (30%) and to the bus stop using a private vehicle (13%). Meanwhile, the highest percentage of respondents based on how passengers from the bus stop get to their destination is by walking (45%), then by using online transportation (22%), and by using city transportation or being picked up (11%).

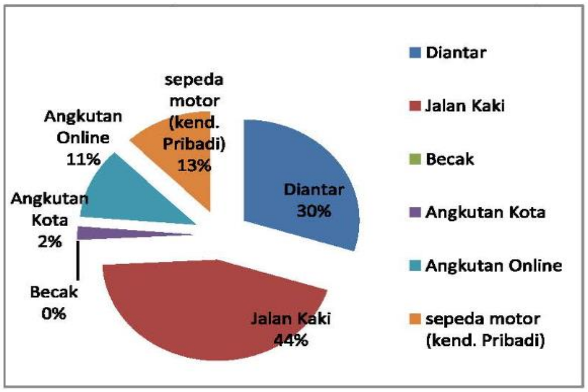


Figure 4 . Diagram of Percentage of Respondents Based on How to Get to the Bus Stop
Source: Processed by Researchers 2024

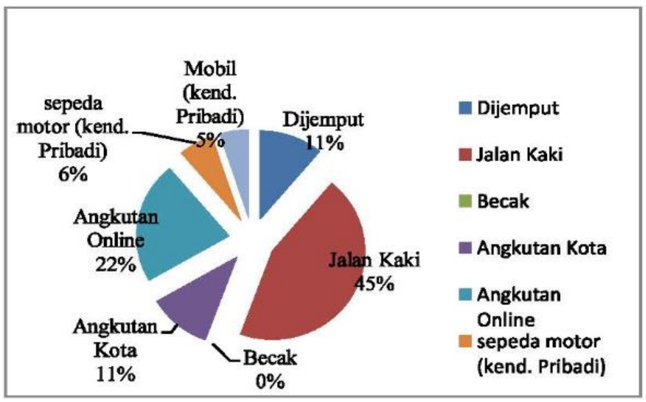


Figure 5 . Diagram of Percentage of Respondents Based on Method From Bus Stop to Destination
Source: Processed by Researchers 2024

Then the highest percentage of respondents based on the mode of transportation used before the Suroboyo Bus was using 2-wheeled vehicles (43.43%) and online transportation (30.30%).

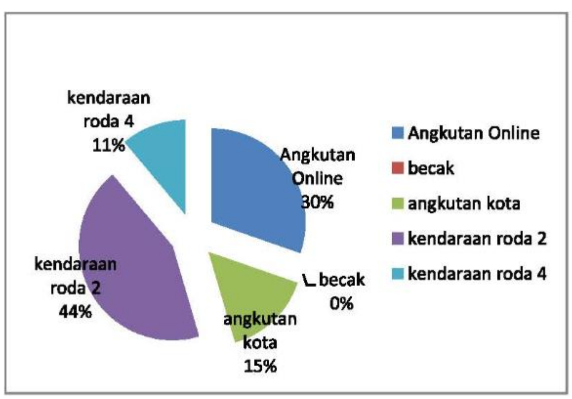


Figure 6 . Diagram of the Percentage of Respondents Based on the Mode of Transportation Used Before the Suroboyo Bus
Source: Processed by Researchers 2024

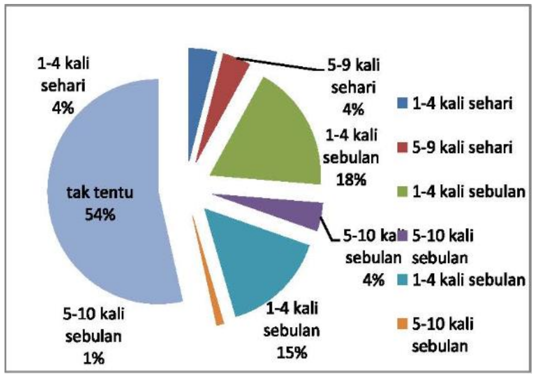


Figure 7 . Diagram of Percentage of Respondents Based on Intensity of Using the Bus
Source: Processed by Researchers 2024

Based on the intensity of using the bus, the largest percentage of respondents used the bus with an indeterminate intensity (54%), then 1-4 times a week (18%), and 1-4 times a month (15%). Then based on the level of service when using Suroboyo Bus, the highest percentage of respondents stated that it was very satisfying (53.54%) and stated that it was satisfying (33.33%).

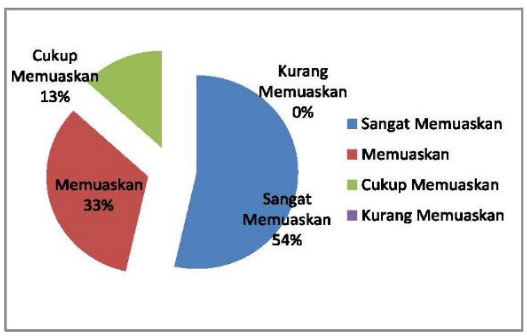
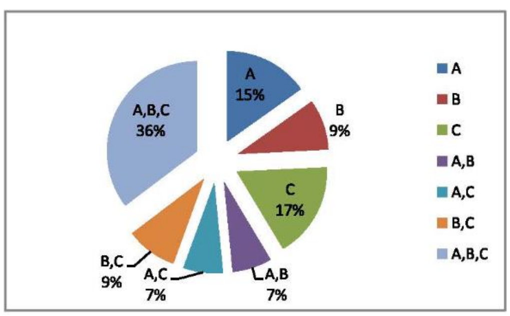


Figure 8 . Diagram of Percentage of Respondents Based on Level Using Suroboyo Bus
Source: Processed by Researchers 2024



Keterangan :

A = Penambahan Jumlah Armada Suroboyo Bus
B = Penambahan Rute Baru oleh Suroboyo Bus
C = Peningkatan Kecepatan

Figure9 . Diagram of Percentage of Respondents Based on Factors that Need to be From Suroboyo Bus
Source: Processed by Researchers 2024

Based on the factors that need to be improved from Suroboyo Bus, 36% of respondents stated that the factors of increasing the number of fleets, adding new routes, and increasing speed need to be improved. Then 17% of respondents stated that the speed improvement factor needed to be improved, and 15% of respondents stated that the factor of increasing the number of fleets needed to be improved.

Travel Cost Requirement Analysis

Operating Cost Calculation

The following are preliminary data related to the specifications of the Suroboyo Bus fleet.

Table 1. Suroboyo Bus Fleet Specification Data

Specifications	Description
Engine & Transmission	
Machine	Mercedes-Benz OM 906 LA Euro 3 Diesel, 6 Cylinder Inline, Direct Injection with Turbo charger and Intercooler
Diameter/Step	102/130 mm
Total Cylinder Content	6374 cc
Max Power	191 KW (260 hp) @ 2200 rpm
Max Torque	950 Nm @ 1200-1600 rpm
Transmission	ZF Ecolife 6 AP 1000 B / 3.36 - 0.62 Full Automatic
Gear Comparison	Forward = 3.36/1.91/1.42/1.00/0.72/0.62 Backward = 4.24
Max Speed	60 km/h
Axle	
Front (1st Axle)	MB VO 4/39 CL 7.5
Capacity (1st Axle)	6,500 kg
Behind	MB RO 390 - 11.5/C22.5
Gear Comparison	5,875 (47:8)
Capacity (2nd Axle)	10,500 kg
GVW	-
Suspension	
Home	Suspension with 2 air balloon 2 telescopic, Double Acting Shock Absorbers, Stabilizer
Behind	Suspension with 4 air balloon 4 telescopic, double acting shock absrbers
Brake & Steering	
Main Brake	Disc Brake, Full Air Brake System
Parking Brake	Spring, Compressed Air Control of Rear Axle
Additional Brakes	Exhaust Brake, Constant Throttle, Retarder
Retarder	-
Safety Supplement	ABS (Anti-Lock Braking System)
Steering	Power Steering ZF 8097
Tires & Rims	295/80 R22.5 / 8.25 x 22.5 PR 16
Electrical and Tank	
System	24 Volts
Alternator	28 V/100 A x 2
Battery	2x135Ah, 12V
Tank Capacity	210 Liters
Main Size	
Wheel Axis Distance	5,950
Front Path	2,486

Specifications	Description
Back Lane	3,350
Total Length	11,786
Total Width	2,472
Front wheel clearance	2,101
Rear wheel base distance	1,821
Turning Radius	10,350
Chassis Weight (kg)	5.880
Gross Vehicle Weight (kg)	17.000

Source: Processed by Researchers 2024

The following are the results of the calculation of vehicle operating costs for the Suroboyo Bus fleet based on the results of interviews and secondary data collection.

Table 2. Table of Fleet Requirements and Kilometer Production

Details	Value	Unit	Description
Operating Hours	16	Hours	Morning, Afternoon, Evening
Total number of corridors	1	Corridor	
Total number of buses	14	Bus	SO + Reserve
SGO Big Bus	14	Bus	Operationally Ready
SO Large Bus	13	Bus	Operation Ready
Maximum Miles Traveled	304,00	km	Includes 3% KM Empty

Source: Processed by Researchers 2024

From the data table above, it is known that the total kilometers traveled per day is 304 km/unit.

Table 3. Table of Fleet Requirements and Kilometer Production

Item	Value	Source	Description
Operation Time	16	Hours	
Distance	42,2	Km	
Kec. Average	25	Km/hour	
Calculated travel time (Hour)	1,69	Hours	
Calculated travel time (Minutes)	101,28	Minutes	
Number of bus stops	53	Point	
Dwell Time at bus stop + acceleration and deceleration	16,83	Minutes	Dwell time per stop 20 seconds
Waiting time at End Stop (Rest)	15	Minutes	
Total Time for 1 Trip (CT)	133,11	Minutes	
PP Frequency	7,0		
KM Traveled per day	304,26	Km	
ARMADA PLAN			
Headway	10	Minutes	
Fleet Availability	13	Fleet	
Reserve	1	Fleet	

Details	Value	Unit	Description
Total Fleet Requirement	14	Fleet	
Total KM	3.955	Km	Km Traveled per 1 day

Source: Processed by Researchers 2024

From the data table above, it is known that the Suroboyo Bus fleet needs 13 (thirteen) operationally ready buses and the total kilometers traveled per day is 3,955 km.

Based on the results of the Suroboyo Bus fleet operating cost calculation, it is known that the total vehicle operating cost per kilometer consists of two main components, namely direct costs and indirect costs. Direct costs include expenses directly related to bus operations, such as fuel, vehicle maintenance, and driver salaries, with a total of Rp 15,340.00 per kilometer. Meanwhile, indirect costs include operational support elements, such as management, administration, and other supporting facilities, totaling IDR 2,303.00 per kilometer.

From the combination of these two components, a total vehicle operating cost per bus of Rp 17,643.00 per kilometer was obtained. This figure provides a comprehensive overview of the cost requirements for each kilometer traveled by the Suroboyo Bus fleet. This information is very important as a basis for decision-making related to cost management, fare determination, and evaluation of operational efficiency.

To support the sustainability of efficient operations, Suroboyo Bus is advised to conduct regular evaluations of direct and indirect cost components. In addition, investments in supporting technologies such as fleet management systems and the use of more fuel-efficient vehicles can help reduce costs. With these measures, Suroboyo Bus is expected to continue providing reliable and affordable transportation services to the public, without compromising on service quality.

Applicable Suroboyo Bus Fares Based on Surabaya Mayor Regulation

Based on the Mayor's Regulation Number 22 of 2023 concerning Tariffs and Waste Contributions in the Use of Regional Public Service Agency Services of the Technical Implementation Unit of the Public Transportation Management Service at the Surabaya City Transportation Agency, the general tariff is Rp. 5000, - for students Rp. 2,500, - while for the elderly over 60 years old and toddlers under 5 years old are given a special tariff of Rp. 0, - or free.

Calculation of Government Subsidies to Vehicle Operating Costs and Prevailing Tariffs

Based on the respondent's WTP value, the average WTP value is Rp.7,520 which if rounded is equal to Rp. 7600, -. So that the recommended tariff for Suroboyo Bus based on the desire to pay the public is Rp. 8,000, - while the respondent's ability to pay (ATP) condition is Rp. 15,000, - where the value (ATP) is above the value of the desire to pay (WTP). It is hoped that the services provided can reach all levels of society and increase public interest in using safe, comfortable and cheap public transportation. From the calculation of vehicle operating costs, the cost of subsidies provided by the government can be calculated as follows:

Table 4. Suroboyo Bus Subsidy Value Based on Vehicle Operating Costs

No.	Vehicle Operating Cost/Km	Vehicle Operating Costs/Year	Income Per Year	Surabaya City Government Subsidy Per Year
1	Rp 17.643,-	IDR 25,538,771,790,-	Rp 7.337.445.188,-	Rp 18.201.326.602,-

Source: Processed by Researchers 2024

Conclusion

The conclusion of this study shows that the operational cost of the Suroboyo Bus reaches IDR 17,643 per kilometer, consisting of direct costs of IDR 15,340 and indirect costs of IDR 2,303 per kilometer. To ensure safe, comfortable, orderly, smooth, timely, reliable public transportation and affordable fares, strong intervention from the Surabaya City Government is needed through sustainable subsidies. The subsidy not only reduces the burden on the community but also increases the attractiveness of public services. Therefore, it is recommended that the government continue to provide subsidies, evaluate operating costs and tariffs periodically, implement technological solutions for efficiency, and consider dynamic pricing models and increasing the frequency and routes of on-demand buses. The findings of this study highlight the critical role of government subsidies in maintaining affordable public transportation services, particularly in urban areas like Surabaya. By continuing to provide subsidies, the government can ensure that public transport remains accessible to a broader range of people, thus promoting its use and reducing traffic congestion. The results also suggest that periodic evaluations of operating costs and fare structures are essential to ensure financial sustainability while maintaining service quality. Implementing technological solutions could enhance operational efficiency, contributing to a more sustainable transportation system. Future research could explore the long-term impact of these subsidies on both the sustainability of the public transportation system and the local economy. Additionally, further studies could investigate the effects of dynamic pricing models on demand and revenue generation, as well as how technology can be leveraged to reduce operational costs. It is also suggested that the Surabaya City Government consider expanding the on-demand bus service, potentially based on real-time demand data, to further improve service coverage and convenience for passengers.

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