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Analysis of Operational Performance and Investment Costs of AKDP Bus Services (Madiun-Ponorogo Route) Using Net Present Value (NPV), Internal Rate of Return (IRR), Payback Period (PP), and Break Event Point (BEP) Methods

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A B S T R A C T

The decrease in public enthusiasm for public transport, driven by a rise in private vehicle usage and other transport options, has led to a review of the effectiveness and quality of public transit services. This study aimed to evaluate the operational efficiency and significance of the Madiun-Ponorogo intercity bus (AKDP) line, as well as to assess the potential for making investments to enhance service quality. The research employed a descriptive quantitative approach. The examination utilized operational performance metrics, while the assessment of investment was carried out using methods such as Net Present Value (NPV), Internal Rate of Return (IRR), Payback Period (PP), and Break Even Point (BEP). Findings indicated that the operational performance of the Madiun-Ponorogo intercity bus route remains inadequate, illustrated by lengthy intervals between buses that lead to extended waiting periods. The investment assessment was deemed financially viable, denoted by a positive NPV, an IRR that exceeds the 6% interest, a Payback Period occurring by the fifth year with a net gain of Rp 578,131,790, and a BEP that surpasses the established minimum in both unit and monetary values

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INTRODUCTION

Madiun City boasts excellent transportation access, located close to the Trans-Java toll road. This position makes Madiun a transit hub for various regions in East Java and beyond. Located on the main southern route across Java, Madiun serves as a crucial transportation hub supporting human mobility and the distribution of goods. This role is further enhanced by the presence of the Purboyo Type A Terminal, which serves various types of public transportation, particularly intercity and interprovincial buses (AKAP) and intercity buses within the province (AKDP). These buses operate regularly, connecting various cities both within and outside the province. A robust transportation network not only facilitates mobility and connectivity between regions but also significantly contributes to economic growth, social development, and improved public welfare (Tjendani et al., 2025).

Over time, the economic growth of regencies/cities in East Java has experienced increasingly rapid growth. Based on data from the East Java Central Statistics Agency (BPS), economic growth in East Java in the fourth quarter of 2025 was projected at 5.33%, higher than the 4.93% recorded in the fourth quarter of 2024. This also impacts people's purchasing power to meet their living needs. This is directly proportional to the increase in community mobility, particularly movement between regions in East Java. Annual economic growth naturally leads to increased population mobility, particularly among individuals who choose to work outside the region and between cities in search of better job opportunities in different locations. This indicates that areas experiencing increased mobility reflect more intensive economic activity and increased community purchasing power (Asha Sabitha, 2022).

This study specifically examines the performance of Intercity and Intraprovincial Transportation (AKDP) on the Madiun-Ponorogo route. This route was chosen because it plays an important role as a means of mobility for people between regions, especially for students, workers, and people who do not have private vehicles. There are several problems related to the quality of service to users, such as less-than-optimal comfort, limited travel support facilities, and relatively long waiting times for departures. These conditions cause the level of user comfort to not fully comply with the Minimum Service Standards (SPM) for Transportation of People on Routes set by the government. Research conducted by (Ubudina & Nugroho, 2018) regarding the supervision of SPM AKDP buses in East Java stated that there are still vehicles that do not meet the minimum service standards set by the government, both in terms of comfort, safety, and regularity of service. Therefore, an alternative that can be done is to add a fleet on the Madiun-Ponorogo route to improve operational performance and provide a better journey for the community. Based on (Purboyo Type A Terminal Production Data, 2026), AKDP transportation services on the Madiun-Ponorogo route have a load factor of 24% for each departure, this condition indicates that the passenger occupancy rate is below the set standard of 70%. This indicates that the number of operating fleets is not fully proportional to passenger demand and reflects the low level of transportation capacity utilization and has the potential to cause operational inefficiencies for operators. This has led to an increase in the

use of private vehicles in various regions. The use of private vehicles can reduce demand for public transportation, resulting in a decrease in the number of passengers (Yudhanto et al., 2022). In addition to private vehicles, technological advances also play a role in the shift in transportation modes, which of course also causes a decrease in demand. Online transportation is considered a more practical, fast, and flexible alternative for people to switch from public transportation to online transportation (Diajeng Anugrah Cantika Sari et al., 2023).

In terms of safety and comfort for service users, the Directorate General of Land Transportation, Ministry of Transportation continues to improve safety aspects in passenger transportation, by conducting safety inspections (rampchecks) on bus fleets at Type A Terminals throughout Indonesia (PublikasiDirjen Hubdat, 2026b). Based on Rampcheck data from BPTD Class II East Java in roadworthiness tests at all Type A Terminals in East Java, it was found that 529 buses were declared unroadworthy as stated by the Head of BPTD Class II East Java (Detikjatim, 2025). A total of 290 buses has been roadworthiness tested at Purboyo Type A Terminal, there were 15 buses that were given warnings that were considered unfit for operation and the buses were returned to the Pool (Radar Madiun, 2024). The Directorate General of Land Transportation has requested that transportation operators ensure that all vehicles or fleets they use are roadworthy and in prime condition (PublikasiDirjen Hubdat, 2026a). This aligns with previous research showing that the primary factor in choosing a mode of public transportation is comfort (Mardikawati et al., 2023).

According to Law Number 22 of 2009, Article 48, every motorized vehicle operated on the road must meet technical and roadworthiness requirements. This provision serves as the basis for the implementation of public transportation, as emphasized in the Minister of Transportation Regulation Number 98 of 2013 (Minister of Transportation, 2013) concerning Minimum Service Standards for Public Motorized Vehicle Transportation within Routes, Article 2 paragraphs (1 and 2) states that public transportation companies that organize passenger transportation within routes are required to meet the Minimum Service Standards for Public Motorized Vehicle Transportation within Routes, which must pay attention to various aspects, namely Security, Safety, Comfort, Affordability, Equality, and Regularity, which have been updated regarding several aspects of the Minimum Service Standards for Public Motorized Vehicle Transportation within Routes, namely the Minister of Transportation Regulation Number 29 of 2015 (Minister of Transportation PM 29, 2015).

Service quality and user satisfaction remain the main themes in various contexts. Research conducted by (Margiandistira G, 2023), an analysis method that can facilitate the proposal for improvements and the stages of Importance Performance Analysis (IPA) begins with weighting using the Likert Scale after respondents assess each aspect of service, as well as calculating the level of passenger satisfaction.

This study aims to conduct a quantitative descriptive analysis of the operational performance of public transportation based on the Decree of the

Director General of Land Transportation No. SK. 687 of 2002 through the main indicators as a basis for evaluation by the relevant Bus Companies (PO) in order to increase the effectiveness of public transportation services.

THEORETICAL REVIEW

Research conducted by Putri Ulina Panjaitan (2025) aimed to identify the factors that most significantly influence passenger satisfaction levels, thus providing recommendations for improvement for terminal management. Based on the results of processing the Cartesian diagram using the Importance Performance Analysis method, three attributes were identified as priority for improvement, and ten attributes were successfully implemented by the Purabaya Type A Terminal.

Research conducted by Handiansyah et al. (2021) aimed to develop operational performance guidelines and guidelines for improving the performance of public transportation services on the AL and HA routes. The analytical methods used in this study were operational performance analysis and Important Performance Analysis (IPA) to identify facts and expectations regarding Malang city transportation services. Six aspect indicators fell into quadrant 1 for the AL route and 10 aspect indicators fell into quadrant 1 for the HA route.

Research conducted by (Pramesti et al., 2024) examined the implementation of the Minister of Transportation Regulation Number 29 of 2015, and analyzed the service performance of the Gunung Harta Executive Class Bus. Performance was analyzed based on Passenger perceptions with reference to Minimum Service Standards and evaluated using the IPA (Importance Performance Analysis) method. Research conducted by (Ayu Retnoningtyas D & Dewi Martha Ketut, 2020) used the Importance Performance Analysis method which uses User preferences to assess the performance of public transportation services. The results of the study showed that the factors included in the priority quadrant for improvement were waiting time, regularity and availability of modes. In addition, there are service factors whose performance needs to be maintained, including security, safety, comfort, convenience, punctuality, information and fare affordability.

METHODOLOGY

Research data can be obtained through data collection. The data required for this study are primary and secondary data focused on the research location.

1. Secondary Data

The initial stage was coordination with the Purboyo Type A Terminal to obtain data related to the operational performance of the Madiun-Ponorogo intercity bus (AKDP) route, such as fleet size, trip frequency, departure schedules, load factors, and passenger production data.

2. Primary Data

Primary data is data obtained directly from the field through surveys. Primary data collection included:

a. Passenger Interviews, conducted to obtain primary data regarding user perceptions, experiences, and assessments.

b. Inventory of Facilities and Infrastructure, conducted to record and assess facilities and infrastructure to determine the extent to which existing facilities and infrastructure support optimal operational performance and service delivery.
c. Static Surveys, conducted to obtain data directly related to bus operational characteristics and conditions at the terminal at specific times deemed representative of actual bus operational conditions.
d. Dynamic Survey, conducted by following the bus journey from the starting point to the end point to obtain an overview of the operational performance of the bus during operation and evaluate time efficiency and travel comfort from the service user's perspective.

Data Analysis Techniques

Data analysis was conducted after collecting primary and secondary data to analyze the operational performance and service levels of AKDP buses at the Purboyo Madiun Type A Terminal. Data analysis methods included descriptive analysis and Importance Performance Analysis (IPA) based on user satisfaction.

Descriptive Analysis

The initial stage of the analysis was descriptive to provide an overview of the current situation. This descriptive analysis included an explanation of the results of passenger interview surveys, an inventory of facilities and infrastructure in the field, and secondary data obtained from relevant agencies. The results of this descriptive analysis served as the basis for assessing public transportation service standards based on regulations.

Public Transportation Operational Performance Analysis

After the required data is collected, it will be analyzed to calculate the following:

1. Frequency is calculated using formula (2.1).
2. Load Factor is calculated using formula (2.2) expressed as a percentage (%).
3. Headway is calculated in units of time using formula (2.3).
4. Waiting Time is calculated using formula (2.4).

Sampling Analysis

The sampling in this study used Simple Random Sampling. The subjects measured were passengers on the Madiun-Ponorogo route. The sample size was determined using the Slovin formula, systematically written in formula (2.5). Based on production data from the Purboyo Type A Terminal in 2026, the number of passengers used in the population for one week was 650. Therefore, the calculation for determining the sample size is as follows:

$$n = \frac{650}{1+650\,(0,1)^2}$$

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$$= \frac{650}{7,5}$$

$$n = 86,67$$

The sample size calculation yielded a value of 86.67. Therefore, the sample size required for this study was 87 respondents to collect the primary data questionnaire. This sample was randomly selected from a total population of 650 people (bus users on the Madiun-Ponorogo route).

Cost Feasibility Analysis Method

The cost feasibility analysis method is a process for assessing the feasibility of a business, which serves as a benchmark for determining whether it is feasible to operate. This analysis aims to determine the ability to meet financial obligations and evaluate the extent to which investments will generate profits. This analysis uses market prices to value goods and services, focusing on costs, revenues, and interest rates (Almakky et al., 2022). The following methods are used to assess cost feasibility:

Net Present Value (NPV)

Net Present Value (NPV) is a method used to calculate the difference between benefits or revenues and costs or expenditures. NPV is often applied in capital budgeting to analyze the profitability of a project or investment. NPV is calculated using the following formula: (Milasari, 2025).

NPV = PV Benefit – PV Cost (2.19)
Note:
PV Benefit = Present value of profit/gain
PV Cost = Present value of cost/capital

The feasibility indicator is that if the NPV is positive (NPV > 0), the business is feasible. Conversely, if the NPV is negative (NPV < 0), the business is not feasible.

Internal Rate of Return (IRR)

The Internal Rate of Return (IRR) is the interest rate that makes the net present value (NPV) equal to the total investment cost of the project, or the maximum interest rate that can recover the invested capital. The IRR is calculated using the formula:

IRR = i’ + NPV'/(NPV^'-NPV'') (i’-i”) (2.20)
Where:
i” = Lowest discount rate that results in a negative NPV
i’ = Highest discount rate that results in a positive NPV
NPV’ = Positive NPV
NPV” = Negative NPV

Payback Period (PP)

The Payback Period (PP) is the time period over which a project's cash inflows and initial capital outlay are equal. The Payback Period approach is typically used as a first-line screening procedure and can help determine how long it will take to recoup a project's costs. In other words, the payback period is the amount of time required for an investment to reach the break-even point. The formula for the Payback Period is as follows:

PP = Investment / (Net Cash Inflow) x 1 Year (2.21)

An investment proposal will be accepted if the Payback Period is shorter than the maximum limit and will be rejected otherwise.

Break Even Point (BEP)

BEP is the point at which production or sales must be achieved to recover costs, or the point at which profit is zero. This is formulated as follows:

$$\text{BEP Unit} = FC / (P - VC) \quad (2.22)$$

Where:
FC = Fixed Costs
P = Selling Price
VC = Variable Costs

A feasibility indicator: If the actual number of passengers is greater than the BEP unit, the business is profitable and viable. Conversely, if it is lower, the business is losing money or not viable.

$$\text{BEP Rupiah} = FC/(1-VC/S) \text{ or } FC/(CMR) \quad (2.23)$$

Were

$$CMR = (P-VC)/P \quad (2.24)$$

Where:
CMR = Contribution Margin Ratio
FC = Fixed Costs
P = Selling Price
VC = Variable Costs

A feasibility indicator: If actual revenue is higher than the BEP rupiah, the business is financially viable and profitable. If it is lower, then the business is not able to cover all costs or is not viable.

RESULTS AND DISCUSSION

Public Transportation Operational Performance

Frequency and Headway

The calculation of frequency and headway for intercity transportation on the Madiun-Ponorogo route is as follows:

$$\text{Frequency} = 60/\text{Headway}$$
$$= 60/60$$
$$= 1$$

Frequency is the number of vehicles passing within a specific time period.

$$\text{Headway} = 60/\text{Frequency}$$
$$= 60/1$$
$$= 60 \text{ minutes}$$

The waiting time between vehicles (headway) is 60 minutes. The calculation for subsequent hours is the same as above, as can be seen in the following table:

The highest frequency of arrivals is between 9:00 and 10:00 AM, with 4 vehicles per hour, with a 15-minute headway. Meanwhile, the highest frequency of departures is between 9:00 and 10:00 AM, with 5 vehicles per hour, with a 12-minute headway. This indicates that during certain hours, service is quite good due to the relatively short arrival and departure time intervals. However,

headways of up to 60 minutes are still common, indicating that some operations are still quite long, resulting in long passenger wait times.

Waiting Time and Load Factor

The calculation of Waiting Time and Load Factor for the Madiun-Ponorogo intercity transportation route is as follows:

Waiting Time = Departure Time - Arrival Time
= 2:51 AM – 2:43 AM
= 8 minutes
Load Factor = (Number of Passengers) / (Vehicle Capacity) x 100%
= (5)/25 x 100%
= 20%

The waiting time (layover time) is relatively the same, namely 8 minutes. Meanwhile, the highest load factor is at arrival, namely 20% and the highest load factor is at departure, namely 28%. This value indicates that the passenger occupancy rate on the Madiun-Ponorogo bus route is still relatively low and has not met the established standards. Based on the Decree of the Director General of Land Transportation Number SK.687/AJ.206/DRJD/2002 concerning Technical Guidelines for the Implementation of Public Passenger Transportation, the minimum load factor standard set is 70%. Thus, this condition indicates that the level of fleet utilization is still not optimal due to the low number of public transportation users on this route.

Cost Analysis

This cost feasibility analysis was conducted to determine whether the initial investment for fleet expansion was feasible. The feasibility assessment was conducted using the Net Present Value (NPV), Internal Rate of Return (IRR), and Break-Even Point (BEP) methods, which are common methods in public project investment analysis based on the concept of the time value of money.

Based on the Cartesian Diagram in the IPA method, several attributes in Quadrant I were identified as top priorities for improvement. Quadrant I represents the area containing factors considered important by users, but their level of satisfaction with the performance remains low. Quadrant I contains eight attributes:

10 (Safety Equipment (Extinguisher, Glass Breaker, and Flashlight));
12 (Main Facilities (Seats, Seat Numbers, Luggage Rack, Undercarriage));
14 (Travel Speed);
19 (Seat Belts);
22 (Air Conditioning);
25 (Service Information);
26 (Waiting Time);
27 (Accuracy and Certainty of Departure Schedules).

In this case, to support the fulfillment of the eight attributes in Quadrant I, an investment cost analysis is required as a basis for efforts to improve service quality. It is recommended to add a fleet, as follows:

To meet the need for improved service quality, the following calculation is used to increase the fleet size for the Madiun-Ponorogo route:

Fleet Requirement = (cycle time)/headway
= (196 minutes) / (20 minutes)

= 9.8 rounded to 10 fleets
Available fleet = 8 fleets
= 10 – 8 = 2 fleets

Therefore, to meet the need for improved service quality with a 20-minute headway, an additional 2 fleets are required.

Next, calculate the vehicle operating costs for one fleet unit to obtain the operating costs per vehicle. The following is the calculation of vehicle operating costs for the Madiun-Ponorogo route:

1. Direct Costs

a. Vehicle Depreciation

1) Vehicle Price = IDR 503,000,000
2) Depreciation Period = 5 Years
3) Residual Value = 20%
4) After residual = IDR 100,600,000
5) Mileage traveled per year = 34,944 km

Depreciation Cost = (IDR 503,000,000 – IDR 100,600,000): 5 years
= IDR 80,480,000 per year
= IDR 2,303.11 per bus/km
= IDR 92 per passenger/km

b. Capital Cost

1) Loan Repayment Period = 5 Years
2) Annual Interest Rate = 6%

Capital Interest Cost = (5 Years + 1): 2 x 6% x
Rp 503,000,000: 5 Years
= Rp 18,108,000 per year
= Rp 518.20 per bus.km
= Rp 20.73 per passenger.km

c. Fuel Cost

1) Mileage Traveled/day = 112 km
2) Fuel Type = Diesel
3) Fuel Consumption = 4.5 km/liter

Fuel Cost = 24.89 liters/day x Rp 6,800 x 26 days x 12 months
= Rp 52,806,642 per year
= Rp 1,511.11 per bus.km
= Rp 60.44 per passenger.km

d. Tire Usage Cost

1) 6 tire replacements
2) Maximum mileage per year = 34,944 km
3) Tire life = 20,000 km
4) Price per tire = Rp 1,250,000

Tire cost = 34,944 km/year: 20,000 km x 6
Tires x Rp 1,100,000
= Rp 11,531,520 per year
= Rp 330 per bus/km
= Rp 13.2 per passenger/km

e. Minor Service

1) Engine Oil (9 x Rp 29,000) = Rp 261,000
2) Differential Oil (4 x Rp 30,000) = Rp 120,000
3) Transmission Oil (4.5 x Rp 30,000) = Rp 135,000
4) Grease (1 x Rp 21,000) = Rp 21,000
5) Filter (1 x Rp 37,500) = Rp 37,500

Total = Rp 574,500
Minor Service Cost = 34,944 km/year: 4,000
km x Rp 574,500
= Rp 5,018,832 per year
= Rp 143.63 per bus.km
= Rp 5.75 per passenger.km

Vehicle operating costs based on the additional fleet on the Madiun-Ponorogo route total Rp 5,170.56 per bus/km, Rp 206.82 per passenger/km, and a total annual vehicle operating cost of Rp 180,680,142.

This fleet expansion includes buses with a capacity of 25 passengers. Based on current fares, the estimated revenue is as follows:
Revenue per trip: 17 x Rp 20,000 = Rp 340,000
Revenue per day: 13 x 4 x Rp 20,000 = Rp 1,360,000
Revenue per month: Rp 1,040,000 x 26 = Rp 35,360,000
Revenue per year: Rp 27,040,000 x 12 = Rp 424,320,000

CONCLUSION AND RECOMMENDATION

Under existing conditions, the operational performance of AKDP transportation (Madiun-Ponorogo route) in terms of frequency and layover time is quite good in certain periods. However, there are still headways that indicate service intervals are not optimal, resulting in quite long passenger waiting times. Furthermore, the low load factor indicates that the level of service utilization is still low. Therefore, efforts are needed to improve service quality and strategies to attract public interest in using public transportation on the Madiun-Ponorogo route.

The results of investment analysis with an interest rate of 6% with a payback period of 5 years, obtained a Net Present Value (NPV) of Rp 534,953,219,- (positive value), and an Internal Rate of Return (IRR) of 8.27% (more than an interest rate of 6%), Payback Period occurred in the 5th year, the accumulated net benefits reached Rp 578,131,790, and BEP showed that the BEP unit was 14,249 passengers and the BEP rupiah was Rp 284,974,836 which had exceeded the minimum limit both in terms of units and rupiah. So it can be concluded that the addition of the fleet to the AKDP transportation route Madiun-Ponorogo is feasible.

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