FUEL CONSUMPTION AND OPERATING COST ANALYSIS OF DENPASAR SCHOOL BUSES

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ABSTRACT
This study aims to analyze fuel consumption, vehicle maintenance costs, and vehicle operating cost requirements for school bus services in Denpasar City as a basis for improving the efficiency and sustainability of school transportation services. The study employed a descriptive quantitative approach through field observations, fuel consumption measurements using the full tank-to-full tank method, interviews, documentation, and analysis of fleet operational data. The collected data were analyzed to determine fuel consumption, vehicle maintenance costs, and vehicle operating costs for each route. The results indicate that annual vehicle maintenance costs ranged from IDR 14,693,976 to IDR 29,590,277 per vehicle, with an average of IDR 22,830,576. The average fuel consumption was 0.222 liters per kilometer, with an average fuel efficiency of approximately 4.767 kilometers per liter. The calculation of vehicle operating costs revealed considerable variations among routes, influenced by vehicle age, travel distance, and traffic conditions. These findings suggest that effective maintenance management, fuel consumption control, and operational adjustments based on route characteristics are essential for improving cost efficiency and supporting the long-term sustainability of school bus services.

Keywords: fuel consumption; school bus; transportation efficiency; vehicle maintenance; vehicle operating cost

INTRODUCTION
School transportation is an important component of public transportation services that supports students' mobility, enhances travel safety, and reduces reliance on private vehicles (Muley et al., 2023). The increasing number of students in urban areas has led to a growing demand for daily trips to and from schools. This condition has contributed to the increased use of private vehicles, particularly motorcycles and cars, which in turn exacerbates traffic congestion, fuel consumption, greenhouse gas emissions, and the risk of road traffic accidents. Previous studies have demonstrated that the provision of school bus services can reduce dependence on private vehicles, improve student safety, and promote a more sustainable urban transportation system (Farida & Maulana, 2023; Hariyani et al., 2023).

The Denpasar City Government has operated a Free School Bus Service since 2018 as part of its efforts to improve student safety while reducing urban traffic congestion. The program has demonstrated positive development, as reflected by the increasing number of users each year. Based on operational data, 13 school buses serve approximately 900–1,000 students daily, thereby reducing the number of private motor vehicles on the road. Furthermore, the load factor increased substantially from 15% in 2021 to 83% in 2024, indicating a high level of service utilization and confirming the program's effectiveness in encouraging students to shift from private vehicles to public transportation (Setiawan et al., 2025). These findings suggest that the school bus service has become an essential component of the urban transportation system in Denpasar City.

Despite its substantial benefits, the sustainability of school bus services largely depends on the government's ability to manage vehicle operating costs efficiently. Fuel consumption, vehicle maintenance costs, spare parts replacement, and other operating expenses constitute the primary

cost components that determine the overall expenditure required to provide the service. Rising fuel prices, increasing vehicle age, and intensive operational use can significantly increase the financial burden on local government budgets. Therefore, the analysis of vehicle operating costs is essential for budget planning, evaluating service efficiency, and supporting evidence-based decision-making to ensure the long-term sustainability of school transportation services (Harianto, 2024; Paparella et al., 2023; Widyaningrum & Wibisono, 2024).

Fuel consumption represents the largest cost component in vehicle operations and is influenced by various factors, including traffic conditions, route characteristics, vehicle speed, passenger load, and driver behavior (Anttila et al., 2022). On the other hand, preventive vehicle maintenance plays a crucial role in maintaining fleet reliability, reducing the risk of mechanical failures, extending vehicle service life, and lowering long-term operating costs (Karabağ et al., 2024; Taoufyq et al., 2025). Therefore, the integrated management of fuel consumption and vehicle maintenance is a key strategy for improving operational efficiency while supporting the long-term sustainability of public transportation services (Tan et al., 2022).

Previous studies have extensively examined vehicle operating costs in public transportation and urban transport systems (Katreddi et al., 2023; Kusuma & Dewantoro, 2024). However, most of these studies have focused on urban buses, intercity buses, and regular public transport services (Rocha et al., 2023; Thoengsal & Tumpu, 2025), while research specifically addressing fuel consumption, vehicle maintenance costs, and vehicle operating costs of school bus services managed by local governments remains very limited (Kusuma & Dewantoro, 2024). In addition, several studies have relied on standard cost approaches rather than actual vehicle operational data (Kurganov et al., 2024). This indicates a research gap that can be addressed through field-based studies using actual operational data, thereby providing more realistic and accurate estimates of vehicle operating costs that better reflect real-world operating conditions.

Based on these conditions, this study was conducted to analyze fuel consumption, vehicle maintenance costs, and vehicle operating cost requirements for the Denpasar City School Bus service using actual operational data. Fuel consumption was measured using the full tank-to-full tank method, while vehicle maintenance costs were calculated based on the fleet's actual maintenance expenditure records (Sitnik et al., 2026). The use of actual operational and maintenance data enables more reliable estimation of vehicle operating costs than approaches based solely on standard cost assumptions or generalized models (Katreddi et al., 2023). The findings are expected to provide an empirical basis for vehicle operating cost management, improve budget efficiency, support data-driven fleet management, and enhance the long-term sustainability of school bus services in Denpasar City (Mohamed, 2025).

METHOD

This study employed a quantitative approach with a descriptive research method to analyze fuel consumption, vehicle maintenance costs, and vehicle operating costs of the Denpasar City School Bus service. A quantitative approach was selected because it enables objective measurement of vehicle operating cost components based on actual operational data, thereby providing a reliable assessment of the operational efficiency of school transportation services (Manzolli et al., 2022; Nawaz et al., 2024).

The object of this study comprised the entire fleet of Denpasar City School Buses managed by the Denpasar City Transportation Agency. The research was conducted across all operational school bus routes and focused on analyzing fuel consumption, vehicle maintenance costs, and vehicle operating costs. The study variables included fuel consumption, measured as the ratio

of fuel consumed to the distance traveled using the full tank-to-full tank method; vehicle maintenance costs, calculated from actual expenditures for scheduled maintenance, spare parts replacement, and vehicle repairs; and vehicle operating costs, determined by combining fixed and variable cost components in accordance with the official guidelines for vehicle operating cost calculation (Gonera et al., 2024; Sitnik et al., 2026).

The study population consisted of the entire fleet of Denpasar City School Buses operating during the study period. A census sampling method was employed, in which all operational vehicles were included as research samples. The census approach was selected because it enables all elements of the population to be analyzed without sampling error, thereby providing a more comprehensive representation of the operational characteristics of each route and producing more accurate estimates of vehicle operating costs (Burakauskaitė & Čiginas, 2023).

The study utilized both primary and secondary data. Primary data were collected through direct observation of school bus operations, fuel consumption measurements using the full tank-to-full tank method, interviews with drivers and fleet managers, and documentation of vehicle operating conditions (Sitnik et al., 2026). Secondary data were obtained from the Denpasar City Transportation Agency and included vehicle inventory records, fleet operational data, travel distances, vehicle maintenance costs, fuel consumption records, and other supporting documents. The primary research instruments consisted of survey forms, observation sheets, vehicle odometers, fuel refueling records, a computer, and statistical data analysis software.

Data were analyzed using a descriptive quantitative approach. Fuel consumption was calculated based on the ratio of fuel volume consumed to the distance traveled (Sitnik et al., 2026). Vehicle maintenance costs were determined from the total actual maintenance expenditures incurred during the study period, while vehicle operating costs were calculated by aggregating all fixed and variable cost components for each route (Kurganov et al., 2024). Prior to further analysis, the data were tested for normality using the Kolmogorov–Smirnov test. Correlation and linear regression analyses were then performed to identify the relationships between operational variables and fuel consumption. The assumption of homoscedasticity was evaluated using the Glejser test to ensure that the regression model satisfied the classical assumptions. All statistical analyses were conducted using statistical software with a significance level of 5%, and the results were used as the basis for evaluating the operational cost efficiency of the Denpasar City School Bus service.

RESULT AND DISCUSSION

Overview of the Denpasar City School Bus Service

The Denpasar City School Bus Service is a public transportation program operated by the Denpasar City Government to provide safe, comfortable, and free transportation for students. The program was launched in 2018 under Denpasar Mayor Decree No. 188.45/HK/2018 concerning the Establishment of the Technical Planning Team, Implementation Team, Supervisory Team, and Socialization/Publicity Team for the 2018 School Transportation Service Program. The service was established to improve students' accessibility to schools, reduce the use of private vehicles, and enhance road traffic safety for students.

During the study period, the school bus service was operated using a fleet of 14 buses, with an additional three donated vehicles introduced in 2025 to enhance service capacity. The fleet serves 13 primary routes distributed throughout Denpasar City. Each route was designed to

connect residential areas with schools that have a high student population, thereby meeting students' mobility needs during morning departures and afternoon return trips.

The operational characteristics of each route vary in terms of route length, service coverage area, number of students served, and traffic conditions. For example, Route BS-1 serves the North and West Denpasar areas with a route length of approximately 71 km and accommodates 37 students, while Route BS-2 has a route length of 75 km serving 55 students, and Route BS-3 covers approximately 87 km and serves 47 students. These differences in operational characteristics result in varying levels of fuel consumption, vehicle maintenance requirements, and vehicle operating costs across routes, making route-specific analysis essential.

In addition to route characteristics, fleet utilization is an important indicator for evaluating the effectiveness of the school bus service. Therefore, this study presents vehicle utilization data, including the number of trips, operational mileage, and fleet utilization for each route, as the basis for analyzing fuel consumption, vehicle maintenance costs, and vehicle operating costs. The vehicle utilization data are presented in Table 1.

Table 1.
Vehicle Utilization of the Denpasar City School Bus Service

No	Route	Number of Students	Number of Passengers	Vehicle Utilization
1	BS-1	37	57	77.03%
2	BS-2	55	72	65.45%
3	BS-3	47	82	87.23%
4	BS-4	42	56	66.67%
5	BS-5	47	76	80.85%
6	BS-6	54	79	73.15%
7	BS-7	49	36	36.73%
8	BS-8	31	25	40.32%
9	BS-9	50	85	85.00%
10	BS-10	49	69	70.41%
11	BS-11	40	57	71.25%
12	BS-12	49	58	59.18%
13	BS-13	42	58	69.05%
Average				67.87%

Note: Utility represents the ratio of the number of passengers to the total student capacity (number of students × two trips: outbound and return).

Fuel Consumption Analysis

Fuel Consumption Summary

Fuel consumption analysis was conducted for the entire Denpasar City School Bus fleet using the full tank-to-full tank method. Measurements were carried out on each operational route by considering vehicle age, round-trip route length, average operating speed, travel duration, travel time, idle time, and the volume of fuel consumed. All vehicles used Dexlite diesel fuel, ensuring that fuel consumption measurements were comparable across all routes. The summary of fuel consumption is presented in Table 2.

Table 2.
Summary of Fuel Consumption of the Denpasar City School Bus Fleet

Route	Vehicle Age (years)	Round-Trip Distance (km)	Average Speed (km/h)	Travel Duration (min)	Travel Time (min)	Total Fuel Consumption per Route (L)	Idle Time (min)	Fuel Consumption Correction (L)	Total Fuel Consumption Excluding Idle (L)	Fuel Efficiency Excluding Idle (km/L)	Fuel Consumption Excluding Idle (L/km)
BS-1	8	71	26.19	232	186	16.83	46	0.690	16.140	4.399	0.227
BS-2	8	75	29.54	234	194	14.49	40	0.600	13.890	5.400	0.185
BS-3	8	87	29.70	327	231	17.48	96	1.440	16.040	5.424	0.184
BS-4	8	50	22.65	207	176	12.43	31	0.465	11.965	4.179	0.239
BS-5	8	65	25.62	225	192	18.11	33	0.495	17.615	3.690	0.271
BS-6	8	76	30.57	282	277	16.95	5	0.075	16.875	4.504	0.222
BS-7	7	34	26.92	139	121	12.72	18	0.270	12.450	2.731	0.366
BS-8	7	43	25.40	163	138	11.95	25	0.375	11.575	3.715	0.269
BS-9	6	58	28.99	169	162	11.06	7	0.105	10.955	5.294	0.189
BS-10	6	89	28.44	324	277	19.04	47	0.705	18.335	4.854	0.206
BS-11	6	80	22.90	245	231	16.38	14	0.210	16.170	4.947	0.202
BS-12	6	62	22.24	241	184	17.36	57	0.855	16.505	3.756	0.266
BS-13	12	53	23.71	161	148	13.12	13	0.195	12.925	4.101	0.244
BS-14	5	69	23.06	322	290	9.02	32	0.480	8.540	8.080	0.124
BS-15	0	73	23.27	306	261	12.67	45	0.675	11.995	6.086	0.164
BS-16	6	31	19.86	270	197	8.10	73	1.095	7.005	4.425	0.226
BS-17	6	37	21.88	216	205	6.94	11	0.165	6.775	5.461	0.183
Average	6.765	61.941	25.349	239.000	204.118	13.803	34.882	0.523	13.280	4.767	0.222

Based on Table 2, the operational characteristics vary across routes in terms of travel distance, operating speed, idle time, and total fuel consumption. These variations influence the fuel efficiency achieved on each route. Routes with longer travel distances do not necessarily exhibit higher fuel consumption, as fuel efficiency is also affected by traffic flow conditions, average vehicle speed, and the duration of vehicle idling during passenger pick-up and drop-off operations. The analysis results indicate that Route BS-14 achieved the highest fuel efficiency, reaching 8.080 km/L, equivalent to a fuel consumption rate of 0.124 L/km. This high level of efficiency can be attributed to the combination of a relatively long travel distance, lower fuel consumption, and well-controlled idle time. In contrast, Route BS-7 recorded the lowest fuel efficiency at 2.731 km/L, equivalent to 0.366 L/km, indicating substantially higher fuel consumption per kilometer traveled. These findings suggest that the operational characteristics of Route BS-7 are comparatively less efficient and require further evaluation to identify opportunities for improving fuel economy and overall operational performance.

Overall, the Denpasar City School Bus fleet recorded an average fuel consumption of 0.222 L/km, equivalent to an average fuel efficiency of approximately 4.767 km/L. Based on the Dexlite fuel price of IDR 13,850 per liter, the estimated fuel cost was approximately IDR 3,074.7 per kilometer. This average value can serve as a practical reference for estimating fuel requirements in operational planning and for developing the fuel cost component of vehicle operating costs for each school bus route. The variation in fuel consumption across routes indicates that operational efficiency is influenced not only by travel distance but also by idle time, average vehicle speed, traffic conditions, and route characteristics. Therefore, improvements in fuel efficiency can be achieved by reducing idle time, allocating vehicles according to the operational characteristics of each route, and optimizing service operations to achieve a more balanced level of fuel consumption across all routes.

Analysis of the Effect of Idle Time on Fuel Consumption

In addition to analyzing actual fuel consumption, this study evaluated the effect of idle time on fuel efficiency. The results indicate that the average fuel consumption before idle-time correction was 13.808 L, whereas the average fuel consumption after excluding the effect of idle time decreased to 13.280 L, with an average route length of 61.94 km. Based on these

values, the average fuel efficiency excluding idle time was 4.664 km/L, while the actual fuel efficiency was 4.486 km/L, resulting in a correction factor of 1.04. These findings indicate that idle time increased actual fuel consumption by approximately 4% compared with operating conditions without idling. These findings indicate that idle time contributes to increased fuel consumption, particularly on routes with frequent stops and heavy traffic congestion. Therefore, reducing idle time through optimized service scheduling, minimizing vehicle waiting time, and improving traffic flow has the potential to enhance fuel efficiency and reduce vehicle operating costs.

Based on the fuel consumption analysis, it can be concluded that fuel efficiency varies across the Denpasar City School Bus routes. The fleet recorded an average fuel consumption of 0.222 L/km, equivalent to an average fuel efficiency of approximately 4.767 km/L. Route BS-14 achieved the highest fuel efficiency, whereas Route BS-7 exhibited the highest fuel consumption. These differences are primarily attributable to variations in operational characteristics, including travel distance, idle time, operating speed, and traffic conditions. These findings provide the basis for the subsequent analysis of vehicle maintenance costs and the calculation of vehicle operating costs presented in the following section.

Analysis of Vehicle Operating Costs (VOC)

Vehicle operating cost analysis was conducted to determine the total costs required to operate the Denpasar City School Bus service over one year of operation. The calculation of vehicle operating costs included both fixed and variable cost components, comprising vehicle depreciation, capital interest, vehicle tax, fuel costs, maintenance costs, tire costs, lubricants, and other operating expenses. The calculated vehicle operating costs for each route are presented in table 3.

Table 3.
Comparison of Vehicle Operating Costs (VOC) Across Routes per Year

No.	Route	Vehicle Type	Vehicle Brand	Vehicle Age (years)	Travel Distance (km)	Fuel Cost (IDR/year)	Maintenance Cost (IDR/year)	Annual Vehicle Tax (IDR/year)	Total Vehicle Operating Cost (IDR/year)
1	BS-1	Minibus	Hino	8	71.0	52,446,488	25,784,249	1,075,300	79,306,037
2	BS-2	Minibus	Hino	8	75.0	45,154,463	26,735,756	1,075,300	72,965,519
3	BS-3	Minibus	Hino	8	87.0	54,472,050	29,590,277	1,075,300	85,137,627
4	BS-4	Minibus	Hino	8	50.0	38,734,988	20,788,838	1,075,300	60,599,125
5	BS-5	Minibus	Hino	8	65.0	56,435,288	24,356,989	1,075,300	81,867,576
6	BS-6	Minibus	Hino	8	76.0	52,820,438	26,973,633	1,343,400	81,137,471
7	BS-7	Medium Bus	Hino	7	34.0	39,638,700	21,066,054	1,623,200	62,327,954
8	BS-8	Medium Bus	Hino	7	43.0	37,239,188	23,626,038	1,623,200	62,488,426
9	BS-9	Minibus	Isuzu	6	58.0	34,465,725	19,825,407	1,091,600	55,382,732
10	BS-10	Minibus	Isuzu	6	89.0	59,333,400	25,717,050	1,091,600	86,142,050
11	BS-11	Minibus	Isuzu	6	80.0	51,044,175	24,006,573	1,091,600	76,142,348
12	BS-12	Minibus	Isuzu	6	62.0	54,098,100	20,585,619	1,091,600	75,775,319
13	BS-13	Medium Bus	Toyota	12	53.0	40,885,200	23,942,850	1,031,900	65,859,950
14	BS-14	Minibus	Isuzu	5	73.5	28,108,575	21,915,990	1,091,600	51,116,165
15	BS-15	Minibus	Isuzu	0	74.5	39,482,888	22,676,202	1,091,600	63,250,690
16	BS-16	Minibus	Isuzu	6	45.0	25,241,625	14,693,976	1,091,600	41,027,201
17	BS-17	Minibus	Isuzu	6	51.0	21,626,775	15,834,294	1,091,600	38,552,669
Average				7	62.0	43,013,415	22,830,576	1,160,647	67,004,639
Total						731,228,063	388,119,795	19,731,000	1,139,078,857

Based on the calculation results, vehicle operating costs varied across the different routes. These differences were primarily influenced by the operational characteristics of each route,

particularly travel distance, fuel consumption, vehicle age, and maintenance requirements. Routes with longer travel distances generally incurred higher operating costs because they required greater fuel consumption and more frequent maintenance than routes with shorter travel distances. The largest components of vehicle operating costs were fuel and vehicle maintenance expenses, whereas the contribution of the annual vehicle tax was relatively small, amounting to approximately IDR 19,731,000, or 1.7% of the total operating cost. These findings indicate that improving fuel efficiency and implementing an effective fleet maintenance program are the key factors in controlling the operating costs of the school bus service. When analyzed by individual route, Route BS-3 recorded the highest vehicle operating cost, amounting to IDR 85,137,627 per year, whereas Route BS-2 had the lowest operating cost at IDR 72,965,519 per year. These differences were primarily attributable to variations in annual travel distance, fuel costs, and maintenance expenses. Route BS-3 operated approximately 87,000 km per year, compared with approximately 75,000 km per year for Route BS-2. Consequently, the greater annual mileage of Route BS-3 resulted in higher fuel consumption and increased vehicle maintenance costs.

In addition to route characteristics, vehicle age also influenced the magnitude of vehicle operating costs. Older vehicles, particularly those assigned to Routes BS-1 to BS-6, with an average age of approximately 8 years, incurred higher maintenance costs than newer vehicles, such as those operating on Routes BS-11 and BS-12, which were approximately 6 years old. These findings indicate that as vehicles age, the need for component replacement and maintenance activities increases, leading to higher annual operating costs. Differences in vehicle operating costs were also influenced by the type of vehicle used. The medium buses operating on Routes BS-7 and BS-13 incurred relatively lower operating costs than several minibuses, despite having larger passenger capacities. These findings indicate that operational efficiency is determined not only by vehicle size but also by fleet utilization, vehicle technical condition, operating patterns, and the effectiveness of the maintenance program implemented. To facilitate comparison of vehicle operating costs across routes, the calculation results are presented graphically in Figure 1. The figure shows that the distribution of vehicle operating costs generally follows the patterns of travel distance and fuel consumption for each route. Routes with longer travel distances and higher fuel consumption tend to incur greater operating costs, whereas routes with more efficient operational characteristics exhibit lower total vehicle operating costs.

Figure 1. Comparison of Total Vehicle Operating Costs Across Routes

Based on the vehicle operating cost analysis, it can be concluded that operating costs vary across the Denpasar City School Bus routes as a result of differences in travel distance, fuel consumption, vehicle age, and maintenance expenses. Route BS-3 recorded the highest vehicle operating cost at IDR 85,137,627 per year, whereas Route BS-2 had the lowest operating cost at IDR 72,965,519 per year. These findings suggest that efforts to control vehicle operating costs should focus on improving fuel efficiency, optimizing operational schedules, and implementing preventive maintenance programs, particularly for vehicles with longer service lives.

DISCUSSION

The results show that the Denpasar City School Bus fleet achieved an average fuel consumption of 0.222 L/km (4.767 km/L), with considerable variation among routes. Route BS-14 recorded the highest fuel efficiency (8.080 km/L), whereas Route BS-7 exhibited the lowest (2.731 km/L). These findings indicate that fuel consumption is influenced not only by travel distance but also by average speed, idle time, traffic conditions, and route characteristics, consistent with previous studies (Anttila et al., 2022; Gonera et al., 2024). Idle time increased fuel consumption by approximately 4%, suggesting that reducing engine idling could improve fleet fuel efficiency. Furthermore, the results confirm that fuel efficiency is determined by the interaction of multiple operational factors, including vehicle condition, driving behavior, and traffic conditions (Kurganov et al., 2024; Manzolli et al., 2022). The novelty of this study lies in the use of a census approach covering the entire Denpasar City School Bus fleet and the application of the full tank-to-full tank method based on actual operational data, providing a more representative assessment of fuel consumption than studies relying on standard cost assumptions or simulation models.

The results indicate that annual maintenance costs for the Denpasar City School Bus fleet ranged from IDR 14.69 million to IDR 29.59 million per vehicle, with an average of IDR 22.83 million. Maintenance costs were higher for older vehicles and routes with greater operational intensity, indicating that vehicle age and mileage are the primary drivers of maintenance expenditure. These findings are consistent with the Reliability-Centered Maintenance (RCM) concept, which emphasizes maintenance planning based on component reliability and failure risk (Karabağ et al., 2024). Furthermore, implementing scheduled preventive maintenance can reduce unexpected failures, extend vehicle service life, and lower long-term operating costs compared with corrective maintenance (Harianto, 2024; Taoufyq et al., 2025). These results highlight the importance of proactive maintenance strategies to improve fleet reliability and operational efficiency.

The results show that vehicle operating costs varied across the Denpasar City School Bus routes, ranging from IDR 38.55 million to IDR 86.14 million per year, primarily due to differences in travel distance, fuel consumption, vehicle age, and maintenance requirements. Fuel and maintenance costs were the largest contributors to total operating costs, consistent with the Vehicle Operating Cost framework in Minister of Transportation Decree No. KM 251 of 2022. These findings agree with previous studies emphasizing that fuel efficiency and fleet maintenance are the main drivers of bus operating costs (Kurganov et al., 2024; Widyaningrum & Wibisono, 2024). Therefore, route-specific fleet management, improved fuel efficiency, and preventive maintenance are essential for optimizing the operational budget while maintaining the quality and sustainability of the Denpasar City School Bus service.

The novelty of this study lies in the use of actual operational data from the entire Denpasar City School Bus fleet through a census approach, providing a comprehensive representation

of fleet operations. Unlike previous studies that relied on standard cost assumptions, this research combines the full tank-to-full tank method for measuring fuel consumption with actual maintenance cost records, resulting in more accurate vehicle operating cost estimates (Kurganov et al., 2024; Sitnik et al., 2026). Moreover, the study identifies key operational factors, including vehicle age, travel distance, fuel consumption, and maintenance requirements, that explain cost variations across routes. These findings provide practical evidence to support operational budgeting, fleet management, and sustainable policy development for the Denpasar City Government.

CONCLUSION

This study demonstrates that fuel consumption, maintenance costs, and vehicle operating costs of the Denpasar City School Bus service are influenced by route-specific operational characteristics, particularly travel distance, traffic conditions, idle time, vehicle age, and fleet utilization. Estimating fuel consumption using the full tank-to-full tank method and maintenance costs based on actual operational records provided more representative vehicle operating cost estimates than conventional standard-cost approaches. The observed variation in operating costs indicates that fleet management should be tailored to the characteristics of individual routes through improved fuel efficiency, reduced idle time, and planned preventive maintenance. These findings provide an empirical basis for the Denpasar City Government to improve operational budgeting, enhance fleet management efficiency, and support the long-term sustainability of a safe, effective, and reliable school bus service.

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