Volume 4, No. 5 May 2025 - (xx-xx)
p-ISSN 2980-4868 | e-ISSN 2980-4841
https://ajesh.ph/index.php/gp

Analysis of Operational Costs of Road User Vehicles in Maliana District in Bobonaro Regency, Timor Leste

Domingos Godinho[1]*, Hanie Teki Tjendani[2], Esti Wulandari[3]
University of 17 Agustus 1945 Surabaya, Indonesia[1,2,3]
*Email: domingosgodinho511@gmail.com, hanie@untag-sby.ac.id, wulandariesti@untag-sby.ac.id

ABSTRACT
The rapid increase in vehicle ownership and insufficient road upgrades in Maliana District, Bobonaro Regency, have resulted in severe congestion and rising Vehicle Operating Costs (BOK). This study aims to calculate and compare BOK for light vehicles under existing and proposed road conditions on the Maliana–Bobonaro corridor. Data were collected through direct field observation and stakeholder interviews using a descriptive quantitative approach. The PCI (Pacific Consultants International) method was applied to analyze fixed and variable cost components, including fuel, maintenance, depreciation, and insurance. The results show a significant reduction in BOK from Rp30,611.83/km under current road conditions to Rp10,621.35/km in the proposed scenario. This substantial decrease reflects the potential cost efficiency from planned infrastructure improvements. The findings support the need for urgent road development to enhance regional mobility, reduce economic burden on road users, and optimize transportation infrastructure investment. Future studies are encouraged to include additional vehicle types, integrate environmental cost factors, and apply traffic simulation models for a broader policy impact evaluation.

Keywords: Road Section, BOK, and Economic Analysis.

INTRODUCTION

Roads are land transportation infrastructure that covers all parts of the road, including complementary facilities and equipment, which are used for traffic on the ground level, above the ground level, or under the ground or water, except for railways, truck roads, and cable roads. The existence of roads is very important for the community to establish connections between regions while smoothing economic activities and daily life (Dumbaugh & Rae, 2009). Economic growth and improved people's welfare often impact increasing travel volume. Traffic occurs because of the community's need for fast, safe, and smooth transportation (Helling, 1997; Litman, 2017).

Along with the increase in population and urbanization, especially in urban areas, mobility and traffic density are increasing, so the need for transportation is also increasing (Ceder, 2021; De Vos & Witlox, 2013). The congestion phenomenon is common in major cities, including in the developing Bobonaro. This can be seen on the Maliana District road, where traffic conditions are congested and less regular, especially during peak hours. Not

infrequently, congestion that occurs on this route has an impact on the safety of road users and causes travel delays (Albalate & Fageda, 2019; Wang et al., 2013; Zheng et al., 2020).

Transportation is important and cannot be separated from modern human life. Transportation plays a significant role in various aspects, such as socio-cultural, economic, technological, political, defense, and legal. Transportation development is very crucial to support development, as it serves as a catalyst that accelerates economic growth and regional development. In East Timor, history records that the country has gone through three colonial periods, namely colonization by the Portuguese for about 450 years, Japan for 2.5 years, and Indonesia for 24 years. During this period, road infrastructure development in Timor-Leste received less attention. However, the government currently strives to improve connectivity between regions, especially connecting cities on the border with Indonesia, such as Bobonaro Regency and Covalima Regency. This effort aims to strengthen accessibility and encourage the development of border areas.

After independence, rapid development has posed various challenges, including traffic congestion, a common problem in major cities, especially in developing countries such as Timor-Leste. In particular, Bobonaro Regency faces a similar problem. One of the main causes of congestion is the increasing number of vehicle ownership, while the available road width cannot accommodate the growing volume of vehicles that continues to increase every day. Bobonaro Regency, as one of the areas with a dense population and many crowded places, such as markets and tourist destinations, directly experienced a surge in the flow of vehicles to these locations (Putro et al., 2024; Tjendani & Wulandari, 2025). One of the main roads in this district is the Maliana-Bobonaro road section, which has a length of 3 km with a configuration of 4 two-way lanes and is equipped with a median. This road is an important arterial route connecting various directions, including the flow of vehicles to and from the market, from and to Bobonaro Regency, and from and to the City of Dili. The high volume of vehicles crossing this road often causes significant congestion. Regarding these conditions, the author took the initiative to research the performance of the Maliana-Bobonaro road section, especially in the intersection area of Balibo District to Bobonaro intersection, which is often a congestion point. This study also aims to calculate the Vehicle Operating Cost (BOK) caused by traffic delays. Based on this background, the author feels compelled to study the problem in depth and present it as a scientific paper as a final project entitled "Analysis of Operational Costs of Road User Vehicles in Maliana District in Bobonaro Regency, Timor Leste."

The increase in the number of vehicles in an area often gives rise to various traffic problems that require continuous handling (Buchanan & Gunn, 2015; Miglani & Kumar, 2019). This problem generally occurs due to road capacity that is not proportional to the growth in vehicle volume, thus leading to increased traffic generation and congestion at a given time and location. The road section in Maliana District, the main road in the middle of Maliana City and adjacent to the border with Atambua, Indonesia, has a strategic role. This path also provides access to various tourist destinations, such as hot springs in the Bobonaro District.

In this area, several facilities such as hotels, shops, and boarding houses cause high vehicle activity that passes, enters, and parks, and many human activities around the road. This study uses observation methods and direct recording in the field to collect data. The primary data captured includes road geometry, traffic volume, and speed. Meanwhile, secondary data was obtained through a literature study and the Indonesian Road Capacity Guidelines (PKJI 2023). Data analysis was carried out based on traffic volume, side obstacles, road capacity, degree of saturation, free flow speed, and speed and travel time, in accordance with the reference from PKJI 2023.

Traffic congestion occurs due to the increasing number of vehicles and transportation needs, while the provision of planned transportation facilities is no longer adequate. As a result, the function of the previously designed transportation infrastructure cannot operate optimally, so the transportation needs of the city community are disrupted. In addition to limited transportation facilities, various other factors also contribute to traffic congestion.

Some experts define traffic flow using basic measures such as flow concentration and velocity. Flow, which is often equated with volume, more appropriately refers to the number of vehicles in a given space over a period of time. Traffic flow is formed from the interaction of individual drivers and vehicles on a road, with characteristics that vary depending on location, time, driver behavior, and driving habits. According to Silvia Sukirman (1994), the dimensions and conditions of the road, including traffic jams and side disturbances, affect traffic flow. Speeds in urban areas tend to be lower than in rural areas because of more distractions. The surrounding land use pattern also influences traffic flow, and the increase in transportation modes often causes congestion. Congestion occurs due to the high concentration of people with similar needs at the same time and route, triggering complex traffic conflicts. Road conditions can reduce vehicle travel time and operating costs (BOK). On the contrary, poor road conditions slow travel time and increase BOK.

The road connecting Balibo and Bobonaro Districts is a parallel border line with a length of about 156,231 km, where effective handling in 2018/2019 covers 8.2 km. The condition of this road is still not optimal, so it impacts the travel time of vehicles crossing it. As a result of these conditions, vehicles take hours to cross the road, which ultimately affects the Vehicle Operating Cost (BOK) component.

The increasing number of vehicles in Maliana District, Bobonaro Regency, has led to severe traffic congestion due to road conditions that have not kept pace with urban growth. Poor infrastructure, high traffic volumes, and lack of consistent road upgrades have resulted in longer travel times and higher vehicle operating costs (VOC). This situation affects mobility and imposes financial burdens on road users, particularly in regions like Maliana, where roads are critical links to markets, public facilities, and neighboring countries like Indonesia.

Transportation infrastructure plays a vital role in socio-economic development, especially in newly independent countries like Timor Leste (de Sousa Guterres, 2024; Sacchetto et al., 2021). Maliana, a strategic area with a high volume of local and cross-border traffic, suffers from outdated road conditions that hinder economic activities and limit access to essential services. The inefficiencies in road performance—evidenced by frequent delays

and increased fuel consumption—amplify the urgency of reassessing road planning and operational cost impacts.

Furthermore, the Maliana–Bobonaro road is crucial for tourism, trade, and regional connectivity. However, the existing poor road quality contributes to vehicle damage, higher maintenance costs, and lost productivity, making it essential to quantify and analyze the Vehicle Operating Cost (VOK). Accurate estimation of these costs under existing versus planned road conditions is critical to justify infrastructure investments and guide sustainable transportation development policies (Yigitcanlar & Dur, 2010).

Several studies have explored the impact of road conditions on vehicle operational costs. Sukirman (1994) emphasized the influence of geometric design and side friction on traffic flow efficiency and operating costs, noting that urban roads with frequent obstructions tend to generate higher BOK due to lower average speeds. Similarly, N. Dwi (2013) examined highway network capacities and concluded that inadequate road planning in high-density areas leads to inefficient travel times and fuel consumption.

Zurroyyan (2024) analyzed comparative vehicle operating costs using the Moving Car Observer (MCO) method, finding substantial VOC differences between existing and improved road conditions on the Jarit-Puger corridor. These findings highlight the importance of accurate modeling and data-driven planning. Additionally, Rafiansyah (2023) evaluated the performance of ring road networks in Medan, revealing that maintenance and geometric upgrades significantly reduce BOK and congestion.

Pramu (2024) and Jihad (2023) contributed to this field by studying U-turn and intersection performance in urban networks, demonstrating that delays at bottlenecks inflate travel time and VOC. Despite the robust literature on VOC and road performance, few studies focus specifically on Timor-Leste's border regions or apply the PCI (Pacific Consultants International) method in operational cost analysis, which is the focus of this study.

While existing literature provides insights into the relationship between road conditions and VOC, most research has concentrated on Indonesian or other urban contexts, leaving border regions like Maliana in Timor Leste understudied. There is a lack of localized studies that quantify BOK using standardized international methods such as PCI under current and proposed road scenarios. This research fills that gap by applying detailed BOK calculations specific to the Maliana–Bobonaro corridor.

This study uniquely applies the PCI method to calculate and compare Vehicle Operating Costs (BOK) in both existing and planned conditions on a strategic international-border road segment in Timor-Leste. This research offers a comprehensive and contextualized evaluation not previously explored in the region by providing detailed cost components for fuel, maintenance, depreciation, and insurance.

The objective of this study is to determine and compare the Vehicle Operating Costs (BOK) for light vehicles under current and planned road conditions on the Maliana–Bobonaro route in Bobonaro Regency, Timor Leste, using the PCI method to support policy development in transportation infrastructure.

This research provides practical data for government agencies, policymakers, and infrastructure planners to assess cost-efficiency in road investments. It supports informed decision-making on road maintenance and upgrades while offering academic benefits in methodological application and empirical analysis for future transport-related research in developing regions.

METHOD

The methodology of this study involves both primary and secondary data collection. Primary data were gathered through direct field observations conducted at the research site to assess road geometry, environmental aspects, and land use characteristics. These observations were essential to capture real-time traffic conditions and road performance. Additionally, interviews were conducted with key stakeholders, including road users, contractors, consultants, and transportation authorities, to obtain contextual insights into the operational challenges faced on the Maliana–Bobonaro road section.

Secondary data were sourced from government documents, scientific literature, previous studies, and statistical reports relevant to road infrastructure and vehicle operating cost (VOC) analysis. These data validated and complemented the findings from field observations, ensuring a comprehensive understanding of the study area's transportation dynamics. Literature studies also helped align the research framework with existing theoretical models and best practices in transportation economics.

For data analysis, the study employed the Pacific Consultants International (PCI) method to calculate Vehicle Operating Costs (BOK). This method provides a standardized framework that considers fixed costs (e.g., depreciation, insurance, interest) and variable costs (e.g., fuel, oil, tires, maintenance). These cost components are adjusted based on key factors such as pavement quality, road conditions, vehicle type, and average speed, enabling accurate estimation of BOK under current and planned road scenarios.

RESULTS AND DISCUSSION

Vehicle Operating Cost Calculation (BOK)

Calculation of Vehicle Operating Costs (BOK) for light vehicles using PCI with the following price components:

Table 1. Pricing Components

Pricing Components			
V1	:	3,45	Km/M
V2	:	3,45	Km/M
Gasoline Price	:	15.000	liter
Oil Price	:	20.000	liter
Tire Price	:	500.000	bh
Routine Maintenance Pricing	:	600.000	per 1000 km
1. Dil	:	500.000	
2. Mechanical	:	150.000	
Vehicle Prices	:	200.000.000	Unit

Source: Field Survey

1. Calculation of Operating Costs of Existing Vehicles

The calculation of Existing Vehicle Operating Costs using the PCI formula for Light Vehicles is as follows:

Table 2. Calculation of BOK Exiting Conditions

	Non-Toll BOK Formula According to PCI For Light Vehicles:		**:**		**Per 1000 Km**
1.	Fuel consumption equation				
	Y = 0.05693*V2 - 6.42593*V + 269.18576				
	So	Y1 =	250,30	=	3754480,137
		Y2 =	250,30	=	3754480,137
2.	Engine oil consumption equation				
	So	Y1	2,084490548	=	41689,81096
		Y2	2,084490548	=	41689,81096
3	Similarities of Tire Usage				
	Y = 0.0008848*V-0.0045333				
	So	Y1 =	-0,0018612	=	-930,602
		Y2 =	-0,0018612	=	-930,602
4	Equation of maintenance costs				
4.1	Parts cost				
	Y = 0.0000064*V+0.0005567				
	So	Y1 =	0,000576028	=	288,014
		Y2 =	0,000576028	=	288,014
4.2	Mechanical Costs				
	Y = 0.00362*V+0.36267				
	So	Y1 =	0,3736024	=	56040,36
		Y2 =	0,3736024	=	56040,36
5	Equation of depreciation				
	Y = 1 / (2.5*V+100)				
	So	Y1 =	0,009298001	=	1859600,186
		Y2 =	0,009298001	=	1859600,186
6	Equation of interest rates				
	Y = 150 / (500*V)				
	So	Y1 =	0,099337748	=	19867549,67
		Y2 =	0,099337748	=	19867549,67
7	Similarities of insurance				
	Y = 38 / (500*V)				
	So	Y1 =	0,025165563	=	5033112,583
		Y2 =	0,025165563	=	5033112,583
	BOOK 1	=	30611830,16	/1000 Km	
	BOOK 2	=	30611830,16	/1000 Km	

Non-Toll BOK Formula According to PCI For Light Vehicles:			:	**Per 1000 Km**
Price per Km :				
BOOK 1	=	30611,83016	/ Km	
BOOK 2	=	30611,83016	/ Km	

Source: Calculation Results

The calculation of Vehicle Operational Costs using the PCI Formula equation shows that the value of the existing Vehicle Operating Costs, both in the direction of Maliana—Bobonaro and in the direction of Bobonaro—Maliana, is **Rp. 30,611.83** Per Kilometer.

2. Calculation of Operational Costs of Planned Vehicles

Calculation of Vehicle Operating Costs The plan for the Maliana – Bobonaro and Bobonaro – Maliana directions using the PCI equation for Light vehicles is as follows:

Table 3. BOK Calculation of Maliana – Bobonaro Section Plan

Non-Toll BOK formula according to PCI:					**Per 1000 Km**
For light vehicles in the direction of Maliana-Bobonaro					
1	Fuel consumption equation				
	Y = 0.05693*V2 - 6.42593*V + 269.18576				
	So	Y1 =	10513	=	157688166
		Y2 =	11263	=	168951606
2	Engine oil consumption equation				
	Y = 0.003*V2 - 0.04070*V + 2.20403				
	So	Y1 =	88	=	1750972,1
		Y2 =	94	=	1876041,5
3	Equations of tire usage				
	Y = 0.0008848*V - 0.0045333				
	So	Y1 =	-0,07817	=	-39085,28
		Y2 =	-0,08375	=	-41877,09
4	Equation of maintenance costs				
4.1	Spare Parts Cost				
	Y = 0.00000*V + 0.0005567				
	So	Y1 =	0,024193	=	12096,588
		Y2 =	0,025921	=	12960,630
4.2	Mechanical Costs				
	Y = 0.00362*V + 0.36267				
	So	Y1 =	15,6913	=	2353695,1
		Y2 =	16,8121	=	2521816,2
5	Equation of depreciation				
	Y = 1 / (2.5*V + 100)				
	So	Y1 =	0,390516	=	78103207,81
		Y2 =	0,418410	=	83682008,37

	Non-Toll BOK formula according to PCI:				Per 1000 Km
6	Equation of interest rates				
	Y = 150 / (500*V)				
	so	Y1 =	4,172185	=	834437086,1
		Y2 =	4,470199	=	894039735,1
7	Similarities of insurance				
	Y = 38 / (500*V)				
	So	Y1 =	1,056954	=	211390728,5
		Y2 =	1,132450	=	226490066,2
	Book 1	=	10621,349964	/1000 Km	
	Book 2	=	11380,017819	/1000 Km	
	Price Per Km :				
	Book 1	=	10,62134996	/ Km	
	Book 2	=	11,38001782	/ Km	

Source: Calculation Results

From the results of the calculation of the Vehicle Operating Cost (BOK) of the Maliana – Bobonaro and Bobonaro – Maliana Road Sections, the following BOK values were produced:

1. BOK Plan Maliana Bobonaro = 10.62134996/km
2. BOK Plan Bobonaro Maliana = 11.38001782/km

The difference between BOK Existing and Plan is as follows:

Table 4. Existing BOK Dispute and Plan

No	Description	BOK existing/km (Rp)	BOK Plan/Km (Rp)	Chelsea BOK/Km (Rp)
1	Arah Maliana-Bobonaro	30.611,83016	10,62134996	30.601,20881
2	Arah Bobonaro-Maliana	30.611,83016	11,38001782	30.600,45014

Source: Calculation Results

From the data on the difference in BOK values between Existing and BOK, the BOK value is then searched for daily and annually by multiplying the length of the road by the difference in the BOK value. For the annual BOK, the value of the daily BOK is multiplied by 365 days. The results of the calculation are as follows:

Table 5. Annual BOK Calculation

Yes	Description	Difference in BOK Km (Rp)	Road Length (km)	BOK/Day (Rp)	BOK/Year (Rp)
1	Arah Maliana - Bobonaro	30.601,21	6,90	211.148,34	77.069.144,1
2	Arah Bobonaro - Maliana	30.600,45	6,90	211.143,11	77.067.2335,2

Source: Calculation Results

From the results of the calculation, the Daily BOK Value for the length of the handling road of 6.9 Km is as follows:

1. Annual BOK of Maliana-Bobonaro Plan = 77,069,144.1/Year
2. Annual BOK Plan Bobonaro – Maliana = 77,067,235.2/Year

CONCLUSION

The analysis and calculation results indicate a substantial reduction in Vehicle Operating Cost (BOK) from existing to planned road conditions, with BOK decreasing from Rp30,611.83/km to Rp10,621.35/km. Both directions—Maliana to Bobonaro and vice versa—currently incur identical operating costs of Rp30,611.83/km. However, the proposed road improvements are projected to reduce this cost to Rp10,621.35/km in both directions, demonstrating significant operational cost efficiency. These findings highlight the economic benefits of infrastructure enhancement along this corridor. Future research should expand the analysis to include other vehicle types such as motorcycles and heavy trucks, integrate traffic flow simulations, and assess the environmental impact of reduced fuel consumption to provide a more holistic evaluation of road improvements.

REFERENCES

Albalate, D., & Fageda, X. (2019). Congestion, road safety, and the effectiveness of public policies in urban areas. *Sustainability*, *11*(18), 5092.

Buchanan, C., & Gunn, S. (2015). *Traffic in Towns: A study of the long-term traffic problems in urban areas*. Routledge.

Ceder, A. (2021). Urban mobility and public transport: future perspectives and review. *International Journal of Urban Sciences*, *25*(4), 455–479.

de Sousa Guterres, A. (2024). Analysis of The Pillars of Rural Development: A Concept For Timor-Leste. *International Scientific Journal of UNPAZ Timor-Leste*, *1*(02), 78–84.

De Vos, J., & Witlox, F. (2013). Transportation policy as spatial planning tool; reducing urban sprawl by increasing travel costs and clustering infrastructure and public transportation. *Journal of transport geography*, *33*, 117–125.

Dumbaugh, E., & Rae, R. (2009). Safe urban form: Revisiting the relationship between community design and traffic safety. *Journal of the American Planning Association*, *75*(3), 309–329.

Helling, A. (1997). Transportation and economic development: A review. *Public Works Management & Policy*, *2*(1), 79–93.

Jihad, A. (2023). Performance Analysis of the Median Opening U-Turn of the North Veteran Road Section. *JOURNAL OF FLYOVER (JFO)*, 1–9.

Litman, T. (2017). *Generated traffic and induced travel*. Victoria Transport Policy Institute Victoria, BC, Canada.

Miglani, A., & Kumar, N. (2019). Deep learning models for traffic flow prediction in autonomous vehicles: A review, solutions, and challenges. *Vehicular Communications*, *20*, 100184.

Pramu, Y. F. (2024). Signal junction performance analysis (case study jl. Manyar kertoarjo - jl.

Kertajaya – jl. Raya menur, surabaya city). *Journal of Scientech Research and Development*, *6*(1), 1–8.

Putro, H. P. H., Kumalasari, A. S., & Dirgahayani, P. (2024). Smart rest area development to support tourist trip in limited access transport area. Study in the Dieng area, Central Java. *IOP Conference Series: Earth and Environmental Science*, *1318*(1), 12014.

Rafiansyah, M. G. (2023). Performance Analysis of the Medan City Ring Road Network. *Scientific Journal of Civil and Architectural Engineering (JITAS)*, 1–12.

Sacchetto, C., Logan, S., Asare, J., & Saab, M. (2021). *Timor-Leste's drivers of growth and sectoral transformation*.

Silvia, S. (1994). *The Basics of Geometric Road Planning*. Nova Publishers.

Tjendani, H. T., & Wulandari, E. (2025). Road Performance Analysis in Maliana District, Bobonaro Regency, Timor Leste. *Enrichment: Journal of Multidisciplinary Research and Development*, *2*(11).

Wang, C., Quddus, M. A., & Ison, S. G. (2013). The effect of traffic and road characteristics on road safety: A review and future research direction. *Safety science*, *57*, 264–275.

Yigitcanlar, T., & Dur, F. (2010). Developing a sustainability assessment model: The sustainable infrastructure, land-use, environment and transport model. *Sustainability*, *2*(1), 321–340.

Zheng, Z., Wang, Z., Zhu, L., & Jiang, H. (2020). Determinants of the congestion caused by a traffic accident in urban road networks. *Accident Analysis & Prevention*, *136*, 105327.

Zurroyyan, M. F. (2024). Analysis Of The Comparative Operational Cost Of Vehicles On The 8 Jarit-Puger Lintasselatan Lot With Existing Roads Using The Moving Car Observer (Mco) Method. *Construction Engineering Management*, 1–6.