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4 Comparison analysis of Vehicle Operating Cost (VOC) between new toll road plan with existing road

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Abstract. Transportation planning, as the design of infrastructure needs and transportation service for the existence of an area, is an important factor for growth and sustainability of a region. Nowadays, the increase of vehicle number is not followed by the extending of infrastructure road, resulting in traffic jam in certain roads. The congestion occurring causes the increase of travel time so it will interfere the productivity of various sectors. The purpose of this study was to determine the vehicle operating costs (VOC) by using the Pacific Consultant International (PCI) method. This PCI method consisted of fixed costs and variable costs, in which the results were added to find out the total vehicle operating costs (VOC) per vehicle and vehicle operating costs (VOC) per day. The results showed that the vehicle operating costs (VOC) via the toll road were smaller than the costs of the existing road. Operational costs of vehicles (VOC) of passenger cars, buses, and trucks that passed the existing road in the morning peak hours were IDR 10.120,88, IDR 23.803,97, and IDR 25366.62 sequentially, whereas if those groups of vehicles passing via the toll road, showed the price respectively IDR 7.107,93, IDR 19.434,12 and IDR 22.180,15.

1. Introduction

Current developments the increase of vehicles number is not followed by the extending of infrastructure road, resulting in traffic jam in certain roads. The congestion occurring will trigger the improvement of traveling-time quality so that it detracts the productivity of various sectors. The extending of infrastructure road is tended to improve the quality of traveling time so it will be able to reduce the operational costs of vehicles passing the road. Therefore, it is necessary to be studied the changes of the performance of the sections along the road by calculating the changes or differences in vehicle operating costs (VOC) construction of roads or road networks. The correlation between the performance of roads on average daily traffic can be described as the bigger the daily traffic passing through the road, the bigger the value of vehicle operating costs on that road section. Calculation related to travel time variability will then add far different costs for different routes, affecting the choice of travel routes, and travel destination orientation [1]. These travel obstacles will cause various negative impacts, such as loss of time due to long trips and increasing vehicle operating costs (VOC) for existing roads, so the government develops a national road network specifically in Java in which it is known as Trans Java Toll Road project. The location of this research was at the Kertosono - Kediri road with an existing road length of 26 km and a planned toll road with a length of 24 km. The purpose of this study is to determine determine the space speed (space mean speeds) on several vehicle classification observations on existing roads, Comparing the average speed of space between existing roads and toll roads, Knowing the



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comparison of the results of Vehicle Operating Costs (VOC) against existing roads with new toll road pla

Vehicle operating costs are the total costs required to operate a vehicle in a traffic and road condition for one type of vehicle per kilometer traveled. Vehicle operating costs consist of two main components is running costs and fixed costs. Private car transportation consists of depreciation cost and taxes. Depreciation can be determined by purchase costs, salvage value, interest rates and age of vehicle usage. While taxes and insurance can be determined by the respective calculation methods. The results of all these fixed cost elements are added up to achieve the total fixed costs in unit of IDR /year [2]. To get total costs, the units of total fixed costs and total variable costs must be equalized. By fixing the vehicle mileage within one year, the total fixed costs can be made into unit of IDR / km and then added to the total variable costs for the total vehicle operating costs [3]. Depreciation calculation requires data such as the purchase price of the vehicle, the salvage value, the interest rate, and the age of vehicle usage [4]. Price vehicles can be obtained from vehicle factories plus administrative costs from related agencies.

Separated vehicle operating costs into running (e.g. fuel consumption, engine oil consumption, tire costs, maintenance costs, etc.) and standing costs (e.g. license, insurance, interest charges, etc.). Speed was indicated as the most important factor in fuel consumption while by increasing speed, maintenance costs were also found to increase. Vehicle size was identified also as another factor influencing fuel consumption and could be included in the model by using average axle numbers for each firm [5]. Calculate the operating costs of vehicles, namely passenger cars and medium trucks by including the influence of roughness using HDM IV which is commonly used in Indonesia. This approach can be used to publish recommended values of VOC for various road conditions to be used in economic evaluation of feasibility studies [6]. Estimated operating cost for commercial trucks based on fuel, repair, maintenance, tires and depreciation costs. He also considered adjustment factors for cost, based on pavement roughness, driving conditions and fuel price changes [7]. Transport Cost Analysis of City Bus and Private Car Usage in Johor Bahru, Malaysia [8], for the use of private transport, the value of vehicle operating costs is RM 2.05 / person-km and bus use, VOC is RM 0.7 /person-km. Its effects have also been examined on its environmental impact, showing that pollution caused by the use of private transport is 15 times greater than the environmental impact due to bus use.

Vehicle Operating Cost in Sri Lanka with a Special Reference on Short Haul Prime Mover Transportation [9] conducted a study of 50 truck drivers and produced a linear regression model between fuel costs and mileage of $4018 + 55.6 \text{ km}$, oil and mileage $0.7258 + 0.9401 \text{ km}$, prices for tire replacement, repairs and maintenance have contributed 10% of the total operational variable costs, and due to depreciation of the tire price is $0.39 + 0.9137 \text{ km}$.

2. Methods

In analyzing Vehicle Operating Costs (VOC) with Pacific Consultant International (PCI) methods to achieve goals, this research was conducted by following these steps: survey design, collecting data, analysis, and conclusions.

2.1. Primary data

- Traffic count survey was conducted at each determined survey post. Each vehicle crossing the survey post was recorded according to the type of vehicle and the hour traffic volume of each type of calculated vehicle. The survey method applied was to calculate the volume of vehicle traffic (cross-sectional vehicle traffic count) according to the type of vehicle passing the observation point by using a manual counting tool. The survey was prepared for 7 days (representing work days and holidays) for both routes; each for 24 hours.
- Travel Speed Survey (Travel Time Survey); Observation of vehicle speed on 3 travel routes.

Vehicle Operating Costs (VOC) Method of PCI (Pacific Consultants International Inc. Tokyo, costs, as follows:

- Operational Cost, Vehicle Operating Costs (VOC) components were included **fuel consumption, engine oil consumption, tire** usage, maintenance **costs** for vehicle parts **and** work, employee salary for commercial vehicles, and vehicle depreciation.
- Fixed costs, Fixed costs for vehicle Operating Costs (VOC) components were costs that were expended for a certain period and were not affected by the operational of the vehicle. These fixed costs were included interest cost, insurance cost, and overhead cost.

2.2. Secunder data

- Vehicle speed on the toll road is based on the applicable regulations, in which the minimum speed permitted on the Indonesian toll road is 60 km/hour and the maximum speed limit is 80 km / hour for in-town toll roads and 100 km/hour out of town toll roads.
- Geometry road was consisted of the existing Kertosono - Kediri 2 lanes 2 directions undivided the width of the lane width 3.5 m and geometric plan of the Kertosono – Kediri toll road 4 lanes 2 directions divided the width of the lane width 3.5 m.

3. Results and discussion

The results and discussion of the analysis stages consist of traffic fluctuations, travel time speeds and vehicle operating cost (VOC) exiting road and toll road analysis as follows :

3.1. Fluctuations in traffic flow

Fluctuations in the movement of traffic volumes in passenger car units per hour (pcu/hour) on working days on the Kertosono - Kediri and Kediri - Kertosono Roads while the Kertosono - Kediri and Kediri Roads are on the road segment that can represent **12** traffic volume during hours the peak on the Kertosono - Kediri road that is divided per direction can be seen in Figure 1 and Figure 2.

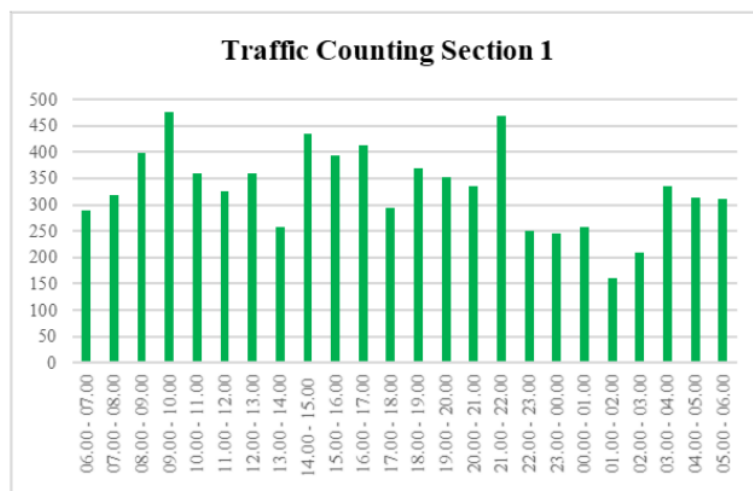


Figure 1. Fluctuations in traffic on the road section of Kediri – Kertosono.

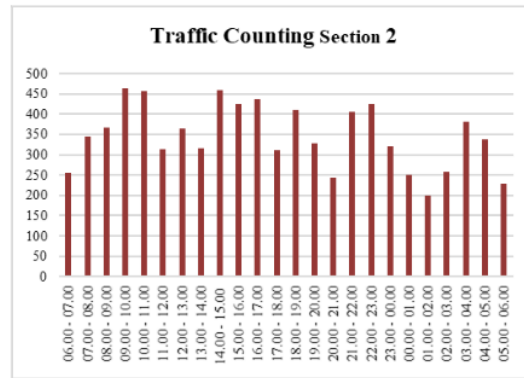


Figure 2. Fluctuations in traffic on the road section of Kertosono – Kediri.

Based on Figure 3. Shows that the fluctuations in traffic on the road section of Kediri - Kertosono on weekdays for 24 hours the total volume at peak hours occurs in the morning which is around 09.00 - 10.00 at 475 pcu / hour. Based on Figure 4. Shows that the fluctuations in traffic on the Kertosono - Kediri road on weekdays for 24 hours the total volume at peak hours occurs in the morning which is around 09.00 - 10.00 at 463 pcu / hour.

3.2. Analysis of travel time

At this stage, it will record the travel time and delays that occur on the road that aims to determine the travel time of traffic on a highway, the location of obstacles or congestion and the duration of the congestion. This survey data will be used for time delay analysis. Travel Time and Delay Surveys are conducted using the MCO (Moving Car Observer) method on a specified road section, with normal travel speeds following the flow of traffic. The things recorded in this survey are the length of the road, the time and speed of the trip, the delays that occur and the location that causes the delays. The results of a survey of travel time survey, divided into 3 segments of the road section.

The location of the survey was carried out on the roads around the Kertosono – Kediri toll road plan:

- Section Kertosono - Kediri
- Section Nganjuk - Kertosono
- Section Nganjuk – Kediri

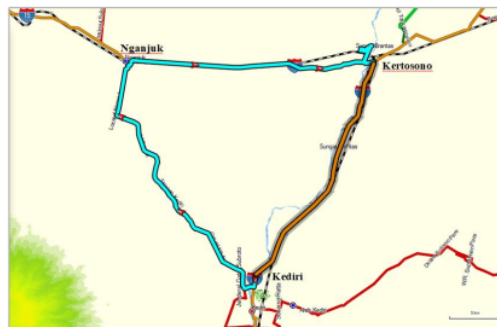


Figure 3. Travel Time Existing Road.

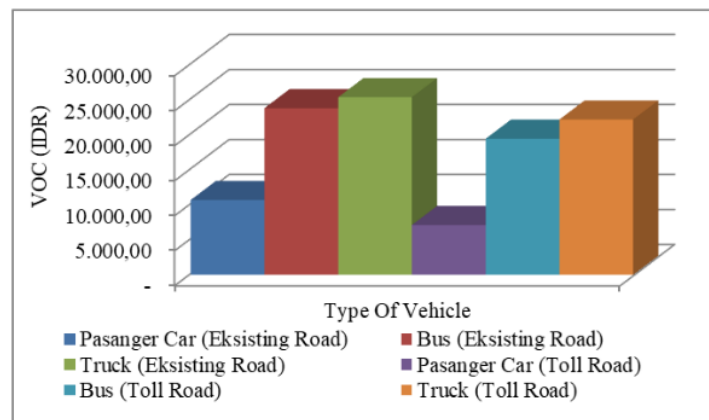
Table 1. Travel time existing road (morning and afternoon peak hours).

Section Road	Morning Peak Hours	Afternoon Peak Hours
Kertosono – Kediri	35.0 km/hours	40.2 km/hours
Nganjuk – Kertosono	23.0 km/hours	28.4 km/hours
Kediri – Nganjuk	31.4 km/hours	36.7 km/hours

Based on Table 1 and Figure 3. shows that the travel time of the three road sections in the morning peak hour and the peak hour in the afternoon is more significant in the Kertosono - Kediri road segment at 35.0 km/hours and 40.2 km/hours.

Table 2. Comparison Vehicle Operating Costs (VOC) between existing road with toll road.

Component	Variable	Existing Road			Toll Road		
		Pass. Car	Bus	Truck	Pass. Car	Bus	Truck
Running Cost	Fuel Costs	2.389,68	7.861,55	3.414,51	1.925,08	5.738,12	3.466,43
	Lubricant Costs	253,32	1.502,09	1.362,56	214,71	922	1.823,99
	Tyre changes	101,39	302,3	982,41	254,11	759,3	2.264,32
	Maintenance Costs	534,73	4.132,27	4.235,48	731,99	6.110,13	5.883,84
	Crew Costs	67,04	381,67	238,47	89,35	524,13	331,62
	Depreciation Costs	3.652,97	2.043,92	4.566,21	2.283,11	1.244,13	2.779,43
	Interest Rate Fee	2.935,42	1.073,06	2.397,26	1.284,25	469,46	1.048,80
Standing Cost	Insurance costs	743,64	429,22	1.949,77	325,34	187,79	853,03
	Travel Costs	-	3.913,89	3.913,89	-	1.712,33	1.712,33
	overhead costs	-	2.164,00	2.306,06	-	1.766,74	2.016,38
Total		10.678,2	23.804,0	25.366,6	7.107,93	19.434,1	22.180,1

**Figure 4.** Type Of Vehicle Existing Road and Toll Road Morning Peak Hours.

The results of the comparison of Table 2 and Figure 4 can be concluded that the calculation of vehicle operating costs by the PCI Method in this study a traffic survey was conducted on vehicle drivers to see the effect of VOC variables on considerations in choosing a route. The survey results show that more than 75% of the costs incurred only consider fuel but many other costs that have not been revealed. Other costs that may occur are; time-related costs, vehicle depreciation costs, lubricant costs, spare part costs, capital costs, congestion costs, convenience costs and others that to date all of these cost components cannot be explained in detail.

4. Conclusion

Results of the analysis of the average daily travel time travel time on the Kertosono - Kediri road in the morning peak hour of 35 km/hour and for the average speed at the peak hour of the afternoon that is equal to 40.2 km/hour.

Comparison of the operational costs of the Kertosono - Kediri arterial road vehicle with the planned Kertosono - Kediri toll road at the peak hour of the morning peak hours Operational Costs existing road passenger car, the cost is IDR 10.678,18 while toll road plans are IDR 7.107,93, Bus IDR 23.803,97 while toll road plans are IDR 19.434,12 and truck IDR 23.183,18 while toll road plans are IDR 22.180,15.

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