Comparison Analysis Operational Cost of Vehicle (VOC) Between Kayu Agung-Palembang-Betung Toll Road Plan with Existing Road

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Abstract. South Sumatra is one of the provinces whose development is very rapid in Indonesia. With the increasing development of centers of economic activity, politics, socio-culture and education make it an attraction for residents outside the city to travel to Palembang City. However, the condition of the existing highway which has become the driver's mainstay for travelling are not free of congestion. This causes travel time and Vehicle operational costs increase for every vehicle that passes the road. To overcome this problem, the government brought investors to build a toll road. The results of preliminary research show that people are still confused about the benefits through toll roads which are built beside travel time faster because they have to spend money to pay tolls. The main objective of this study was to determine the vehicle operating costs (VOC) using both roads with the Pacific Consultant International Method (PCI) and Industrial and Affiliate Research, Bandung Institute of Technology (LAPI ITB). Variable of the equation to determine the cost components is travel speed determined the Floating Car Method. The results show that the operational costs of vehicles (VOC) through toll roads are smaller when compared with existing roads. VOC of passenger cars that pass through the existing road in the morning Rp. 3395.45, trucks 2 axles loaded Rp. 5570.55 and trucks 2 axles with no payload of Rp. 3815.00, while if through toll road, passenger cars Rp. 2618.82 and trucks 2 axles Rp. 2918.71. In addition, information is obtained, more than 90% of drivers only consider fuel costs, they do not consider the cost of other variable variables in choosing a route.

Keyword: vehicle operating cost, toll road, existing road

1. Introduction

Toll road is one alternative to overcome the increasing congestion in the Province of South Sumatra. Stable pavement of toll roads, free of side barriers, free of u-turn cause the travel time and vehicle operating costs will be lower [1]. However, every vehicle through the toll road has to pay according to the class of the vehicle and the distance from the trip. For most people in South Sumatra, the toll roads are a new transportation infrastructure. Before the existence of the toll road, the drivers were free through the existing road. The results of the preliminary research show that the public still confuses about other advantageous the toll roads besides lower travel time because they have to spend money to pay tolls.
The purpose of this study was to determine the space speed (space mean speeds) for several vehicle types (passenger cars and trucks) and operational costs of vehicles (VOC) through existing roads with planned toll roads built.

2. Literature Review

2.1. Toll Road

According to the Law of the Republic of Indonesia No. 38 of 2004 concerning roads, toll roads are public roads that are part of the road network system and as national roads whose use is permitted to pay tolls. While the toll itself is a certain amount of money paid for toll road use. Toll road concessions are carried out by the government and / or business entities that meet the requirements [2]. Toll roads as part of the public road network system are cross-alternative, although in certain circumstances it is not an alternative crossing, has higher specifications and services than existing public roads, and has certain toll rates that must be paid by users if they want to use the toll road [3].

2.2. Vehicle Operating Costs (VOC)

Vehicle operating costs are the total costs incurred by road users using vehicles from the origin zone to the destination zone. Vehicle operating costs consist of two components, namely fixed costs and variable costs. Fixed costs are costs that do not change (do not change according to the volume of production volume of services to a certain extent) including depreciation, salary of drivers, overhead, insurance and permits [4,5]. Medium variable costs (costs) are costs that change based on the volume generated from fuel services, lubricant, tires, vehicle maintenance costs. Some of the most common methods in Indonesia are PCI 1988, LAPI ITB 1996 and Road User Cost Model (RUCM 1992).

2.3. Previous Researches

- **Saputro D S C et al (2014)**
  Saputro et al conducted a comparative analysis of vehicle operational costs (VOC) on primary arterial roads with planned toll road sections: Ungaran - Salatiga using the Pacific Consultant International (PCI) method. The vehicle speed in this study is the average velocity along the road which is the object of research [6].

- **Caesariawan I et al (2015)**
  Caesariawan et al. Conducted a study of the effect of time value on vehicle operational costs (VOC) for passenger cars on the existing road and Ambarawa ring road. Calculation of travel time values uses the Income Approach Method, while the calculation of vehicle operating costs (VOC) uses the Pacific Consultant International (PCI) Method [7].

- **Transport Canada Economic Analysis Directorate (2016)**
  Develop a model for estimating the operating costs of heavy vehicle per kilometers. The costs of recorded vehicle operating components are related to vehicle speed and road conditions. This study only calculates vehicle operating costs (VOC) and the value of travel time regardless of road pavement conditions. In this study, the calculation of vehicle operating costs (VOC) uses the Pacific Consultant International Method (PCI) and LAPI ITB. Both of these methods are used with consideration of data availability. The Road User Cost Model (RUCM) method is not used because the latest data roughness is not available. Vehicle speed which is the variable in equations to determine the cost components of the VOC using the floating car method considering the resulting data is quite accurate and easy to implement [8].

- **Kresnanto N C (2016)**
  Kresnanto conducts research on the analysis of VOC and the time value of several vehicle types of urban. The method for calculating vehicle operating costs uses pacific consultant International (PCI) and development of income approach for time value. The measurement of travel time and travel speed using the floating car method is by following each vehicle surveyed on the road. The road segment is divided into several segments, then the speed and travel time of each segment is averaged [9].

- **Ranawaka S et al. (2017)**
Ranawaka attempts to 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 [10].

3. Research Method
Structured and systematic stages are needed in conducting research. This will affect the effectiveness of time and work and avoid the occurrence of repetitive work and not needed. The flow chart of the research is presented in Figure 1

3.1 Primary Data
- Average Space Speed and Vehicle Travel Time
  The following will be explained the vehicle speed survey using the vehicle test method (Floating car method). This method is carried out with a test vehicle driven on a traffic flow following the following operating conditions:
  1. The driver tries to make a floating test vehicle in the traffic flow, which is to make sure that the number of vehicles that follow and are followed by the test vehicle are the same.
  2. Drivers regulate the speed of the test vehicle as expected speed of traffic flow.
  3. The test vehicle accelerates in accordance with the speed limit unless obstructed by traffic conditions.

  With this method can be obtained the total travel speed and location and the length of obstacles along the route. The study was conducted several times for each type of vehicle (passenger car, loaded and empty truck) for each direction of movement at the time of crowded and medium traffic flow. Based on the survey manual speed from the Ministry of Public Works, for each type of vehicle, a test vehicle survey is conducted 6 times for each direction.

- VOC Component Cost
  VOC component costs include fuel, engine oil, tires, costs maintenance, depreciation, interest rates and insurance. Fuel, engine oil, tires and maintenance costs were obtained through interviews with fueling stations, oil change shops, tire shops and workshops around the research site. Depreciation, interest and insurance costs are obtained from car dealers in the Palembang City Center.

3.2 Secondary Data
Secondary data is obtained from the competent authority in the determination transportation policies such as the Transportation Agency and the Regional Government. Following secondary data needed:
- Minimum and average speed on toll roads
  The minimum speed set on the toll road depends on the location of the road located, both in the city and outside the city. Minimum toll road speed limit is 60 km / h or 80 km / hr. While the maximum limit is usually shown on toll road signs, which can be different on each road section.

- Road Geometry
  The road geometry includes the length and width of the road and the radius of the bend is obtained from authorized institutions, namely the Ministry of Public Works and Toll Road Managers. If the required data is difficult to obtain or not available, geometric measurements of the road are carried out directly in the field.
4. Results and Discussion

The following will discuss tables and histogram curves as a result of data processing

4.1. Travel time and Travel Speed
Figure 2. Travel Time Comparison for Passenger Cars and Trucks

Figure 3. Comparison of Space Speed Curves
Figures 2 and 3 show the average speed of passenger car space 1 higher or travel time shorter compared to loaded or empty trucks on the existing road. This is due to the car passengers are more efficient when going through existing roads. From the curve above, it can be seen that the average speed of the empty truck space is higher than the loaded truck and the speed of the empty truck is almost the same as the passenger car (Figure 4). This shows that when it is empty the truck can drive almost as efficiently as a passenger car. In the afternoon the space mean speeds of various vehicles are lower than in the morning. This is because in the afternoon the vehicle is denser than in the morning.

4.2. Vehicle Operating Costs

| Table 1. Comparison of Vehicle Operating Costs Between Existing Roads With Toll Road Using the PCI Method |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Variabel | Passenger Car | Existing Road | Loaded Truck | Empty Truck | Toll Road | Passenger Car | Medium Truck |
| Fuel Costs | 786,8 | 835,66 | 2572,64 | 2767,77 | 1591,45 | 1677,05 | 545,1 | 878,55 |
| Lubricant Costs | 59,16 | 61,03 | 316,87 | 331,17 | 242,11 | 249,07 | 44,71 | 251,47 |
| Tire Charges | 33,37 | 30,27 | 31,8 | 27,61 | 62,87 | 58,64 | 48,52 | 91,06 |
| Maintenance Costs | 247,13 | 241,17 | 593,64 | 578,73 | 701,07 | 686,15 | 279,85 | 802,47 |
| Depreciation Costs | 713,03 | 744,03 | 419,49 | 438,62 | 316,46 | 294,38 | 590,5 | 257,58 |
| Interest Rate Fee | 1033,38 | 1124,9 | 549,01 | 618,19 | 301,74 | 322,34 | 738,13 | 214,9 |
| Insurance Fee | 522,59 | 569,83 | 447,45 | 503,39 | 247,28 | 262 | 372,34 | 173,68 |
| Travel Time | 0 | 0 | 639,63 | 719,42 | 352,03 | 375 | 0 | 249 |
| Total | 3395,45 | 3606,9 | 5570,55 | 5984,91 | 3815 | 3924,64 | 2618,82 | 2918,71 |
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Figure 5. Comparison curve of Vehicle Operating Costs Between Existing Roads and Toll Roads

From the results of calculations in Table 1 and Figure 5 it can be concluded that operational costs of toll road vehicles are smaller than existing roads. This matter due to the condition of toll road pavement better than road existing, there are no intersections and motorbikes. In addition, there are no side barriers such as markets or vehicle parking on the road so that the driver can drive the vehicle faster.

Table 2. Comparison of Vehicle Operating Costs Between Existing Roads With Toll Road Using the LAPI Method

| Variabel          | Existing Road | Toll Road |
|-------------------|---------------|-----------|
|                   | Passenger Car | Loaded Truck | Empty Truck | Passenger Car | Medium truck |
|                   | Morning       | Morning     | Afternoon   | Morning       | Afternoon     |
| Fuel Costs        | 786,8         | 835,66      | 2572,64     | 2767,77      | 1591,45       | 1677,05      | 480,45       | 899,41       |
| Lubricant Costs   | 59,25         | 61,12       | 316,87      | 331,17       | 242,11        | 249,07       | 4,78         | 7,61         |
| Tire Charges      | 33,37         | 30,27       | 31,8        | 27,61        | 62,87         | 58,64        | 48,53        | 91,05        |
| Maintenance Costs | 247,43        | 240,76      | 587,97      | 573,4        | 697,2         | 682,33       | 280,06       | 796,29       |
| Depreciation Costs| 635,9         | 660,81      | 334,03      | 346,25       | 264,89        | 272,57       | 536,82       | 265,06       |
| Interest Rate Fee | 0             | 0           | 0           | 0            | 0             | 0            | 0            | 0            |
| Insurance costs   | 523,54        | 570,1       | 446,88      | 502,4        | 245,83        | 261,87       | 373,98       | 174,58       |
| Travel time       | 0             | 0           | 639,93      | 719,42       | 352,03        | 375          | 0            | 250          |
| Total             | 2286,28       | 2398,72     | 4930,13     | 5268,02      | 3456,38       | 3576,54      | 1724,62      | 2484,01      |
The results of the comparison of Tables 1 and 2 or Figures 5 and 6 can be concluded that the calculation of vehicle operating costs with the LAPI and PCI Method is not much different.

4.3. Vehicle Driver Perception of VOC Variables

In this study an interview survey was conducted on vehicle drivers to see the effect of the VOC variable on consideration in choosing a route. The survey results show that more than 70% of motorists only consider fuel, while other VOC variable variables are not considered. Based on the interview, information was obtained that fuel was a consideration because it was directly purchased when the trip took place, while other variable variables were not. Thus this research can be input for motorized motorists that there are other costs to be incurred when traveling other than fuel.

5. Conclusion

Based on the discussion and the results on the calculation can be concluded as follows:

1) Space mean speed for direction of Palembang - Betung on the existing road for each vehicle and the departure times both morning and evening are as follows: Passenger car speed in the morning = 42.86 km / hr and afternoon = 39.36 km / hr, truck 2 axles loaded in the morning = 23.44 km / hr and afternoon = 20.85 km / hr, trucks 2 axles empty in the morning = 42.62 km / hr and afternoon = 40 km / hour. This shows that the traffic flow is more crowded in the afternoon than in the afternoon so that the vehicle speed in the afternoon is lower than the morning.

2) From the results of the comparison of vehicle operating costs (VOC), it is found that the cost of passing the toll road is smaller if compared with the existing road. Where is the vehicle in the morning for passenger cars, the cost is Rp 3395.45; loaded truck 2 axles Rp. 5570.55; and empty truck 2 axles Rp. 3815.00. Whereas if passing a toll road for passenger cars, that is Rp. 2618.82; for truck 2 axles Rp 2918.71.

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