Effect of Mobile Phone Use of Driver to Vehicle Operating Costs

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Abstract. Using a cell phone while driving does not only impact traffic safety but also vehicle operational cost. According to the background, it required to research the effect of mobile phone use of drivers to vehicle operational cost. Purpose of this research is to determine the characteristics of motorists who use a cell phone while driving on street Perintis Kemerdekaan, Makassar and to determine the effect of mobile phone use of drivers to vehicle operating costs on street Perintis Kemerdekaan, Makassar. This research will be conducted at street Perintis Kemerdekaan, Makassar, in front of The Regional Military, with a segment length of 100 m. Methods for vehicle operational cost are Pacific Consultant Indonesia and Department of Public Works, with vehicle components that affect vehicle operating costs, namely fuel consumption, engine oil consumption, mechanical costs, vehicle depreciation, tire usage, spare parts, capital interest, insurance, and unexpected costs. Both of these methods include the speed value as the main parameter for analysis. Male combinations use mobile phones more when driving than women. Where the influence of the use of mobile phones while driving on driving speed is also influenced by factors of age and gender. The effect of the use of mobile phones while driving on vehicle operating costs using the PT.PCI method is IDR 3261,9088 / km to IDR 4257,822 / km. The effect of using a mobile phone while driving on vehicle operating costs using the 2005 Public Works method varies from IDR 942 / km to IDR 1,147 / km.

1. Introduction

Cell phones cannot be separated from every individual. Almost every individual's needs can be met through mobile phones in every activity which is not limited by time and place, including when driving. Driving a vehicle requires a high level of concentration because each driver shares space in a road system with other drivers, thus other activities are undertaken while driving can trigger a decrease in concentration level, thus affecting the driver himself and other drivers. Article 106 Paragraph 1 [5] clearly states that motorized motorists who carry out other activities while driving and driving a vehicle that is affected by an activity that results in impaired concentration in driving are fined with a maximum fine of IDR 750,000. In fact, although there are laws that regulate and there have been many socializations about the adverse effects of using a mobile phone while driving, it does not discourage motorists from continuing to carry out these activities. The use of mobile phones while driving not only impacts the level of traffic safety, but also the vehicle operating costs. Based on the background above, the need to do a study of the effect of the use of mobile phones when driving on vehicle operating costs. Component Cost of Fuel Oil of Waste Transportation Cost [6] produces a percentage of fuel costs to the vehicle operating variable costs per km is 28.90% and 27.45% of the total cost.
Transport Cost Analysis of City Bus and Private Car Usage in Johor Bahru, Malaysia [7], 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 [8] conducted a study of 50 truck drivers and produced a linear regression model between fuel costs and mileage of \( 4018 + 55.6 \) km, oil and mileage \( 0.7258 + 0.9401 \) 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 \( 0.39 + 0.9137 \) km. Analyzing the Influence of Mobile Phone Use of Drivers on Traffic Flow Based on an Improved Cellular Automaton Model [9], simulating drivers' characteristics of cell phone use and analyzing using CA models. The results of the simulation show that the level of traffic flow decreases by 5% and the speed of the vehicle decreases if the driver uses a mobile phone. Estimating The Vehicle Operating Costs Through Railway Over Bridge [10] compared the value of vehicle operating costs from the IRC and HDM-VOC program with vehicle speeds of 100 km / h and 120 km / h. The total VOC for the speed of 100 km/hour IRC program is 8823,175 Rs / 1000 km and 12380,55 Rs with HDM-VOC program. The total VOC for the speed of 120 km/hour IRC program is 9138,564 Rs / 1000 km and 12891.45 Rs with HDM-VOC program.

Perceptions pf Cellphone Use While Driving [11]: Results from a Delphi Survey conducted a study of motorists, with the result that younger motorists preferred to play music through their cellphones while driving, this different from respondents from more mature riders. While the use of mobile phones when it is the second-factor causing accidents and deaths in traffic. The purpose of this study, namely: Knowing the characteristics of motorists who use a cell phone when driving on street Perintis Kemerdekaan, Makassar, determine the effect of the use of mobile phones when driving to vehicle speed on street Perintis Kemerdekaan, Makassar, and determine the effect of the use of mobile phones while driving to vehicle operating costs on street Perintis Kemerdekaan, Makassar.

2. Methodology

**Method of Calculation of Vehicle Operating Costs Pacific Consultant Indonesia**

Some equations to calculate the effect of vehicle components on vehicle operating costs for non-toll roads [1], namely:

a. Fuel Consumption Equation
   
   Vehicle Group I: \( Y = 0.05693 V^2 - 6,42593 V + 269,18567 \)  

b. Engine Oil Consumption Equation
   
   Vehicle Category I: \( Y = 0,00037 V^2 - 0,04070 V + 2,20405 \)  

c. Tire Consumption
   
   Vehicle Category I: \( Y = 0,00088848 V + 0.0045333 \)  

d. Spare Parts
   
   Vehicle Group I: \( Y = 0.0000064 V + 0.0005567 \)  

e. Mechanical Costs
   
   Vehicle Group I: \( Y = 0.00362 V + 0.36267 \)  

f. Depreciation
   
   Vehicle Group I: \( Y = 1 / (2.5 V + 125) \)  

g. Capital Interest
   
   Vehicle Group I: \( Y = (0.15 x 1000) / (500 V) \)  

h. Insurance
   
   Vehicle Group I: \( Y = 38 / (500 V) \)  

i. Overhead
   
   10% of sub total
Methods of the Department of Public Works 2005

VOC analysis based on this method is based on the vertical alignment conditions of the road terrain, fuel consumption, oil consumption, spare parts consumption, tire consumption.

a. Vertical alignment on the road terrain

Coefficient values based on vertical alignment of terrain, hill and mountain conditions can be seen in the Table 1:

| Terrain     | Average Up Hill (m/km) | Average Down Hill (m/km) |
|-------------|------------------------|--------------------------|
| Flat        | 2.5                    | -2.5                     |
| Hill        | 12.5                   | -12.5                    |
| Mountain    | 22.5                   | -22.5                    |

b. Fuel consumption

Fuel consumption is analyzed based on the rate of speed by predetermined use of fuel based on mileage per year. The mathematical equation for fuel consumption is:

\[ B_{iBBMj} = K_{BBMi} \times H_{BBMj} \]  (10)

Where:

- \( B_{iBBMj} \) for fuel consumption costs for vehicle type \( i \) in rupiah / km
- \( K_{BBMi} \) fuel consumption for this type of vehicle \( i \) in liters / km
- \( H_{BBMj} \) price of fuel for the type of BBMj in rupiah / liter
- \( i \) type of sedan vehicle
- \( A \) type of premium fuel oil

\[ K_{BBMi} = \left( \alpha \frac{1}{V_r} + \beta_1 V_r^2 + \beta_2 V_r + \beta_3 R_r + \beta_4 F_r + \beta_5 F_r^2 + \beta_6 D_T r + \beta_7 A_r + \beta_8 S_A + \beta_9 B_k + \beta_{10} B_k A_r + \beta_{11} B_k S_A \right) / 1000 \]  (13)

Where

- \( \alpha \): constanta
- \( \beta_1 \): parameter coefficient
- \( V_r \): speed
- \( R_r \): average up hill
- \( F_r \): average down hill

Constant values and parameter coefficients of the fuel consumption model, as well as typical values can be seen in Table 2, Table 3, Table 4, and Table 5.

| Type of Vehicle | \( \alpha \) | \( 1/V_r \) | \( V_r^2 \) | \( R_r \) | \( F_r \) | \( F_r^2 \) | \( D_T r \) | \( A_r \) | \( S_A \) |
|-----------------|-------------|-------------|-------------|---------|---------|---------|---------|-------|-------|
| Sedan           | 23.78       | 1181.2      | 0.0037      | 1.265   | 0.634   | -       | -       | -0.638| 36.21 |
| Utility         | 29.61       | 1251.8      | 0.0059      | 1.765   | 1.197   | -       | -       | 132.2 | 42.84 |
| Small Bus       | 94.35       | 1058.9      | 0.0094      | 1.607   | 1.488   | -       | -       | 166.1 | 49.58 |
| Large Bus       | 129.60      | 1912.2      | 0.0092      | 7.231   | 2.790   | -       | -       | 266.4 | 13.86 |

Table 2. Fuel Consumption model

Table 3. Typical Value of JPOi, KPOi, and OHOi Recommended
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Large Bus
2000
12
2,1 x 10^6

Table 4. Typical Values $\Phi, \gamma_1, \gamma_2$

| Type of Vehicle | $\Phi$   | $\gamma_1$ | $\gamma_2$ |
|-----------------|---------|------------|------------|
| Sedan           | -0,69   | 0,42       | 0,1        |
| Utiliti         | -0,69   | 0,42       | 0,1        |
| Small Bus       | -0,73   | 0,43       | 0,1        |
| Large Bus       | -0,15   | 0,13       | 0,1        |

Table 5. Typical Values $\chi, \delta_1, \delta_2, \delta_3$

| Type of Vehicle | $\chi$   | $\delta_1$ | $\delta_2$ | $\delta_3$ |
|-----------------|---------|------------|------------|------------|
| Sedan           | -0,01471| 0,01489    | -          | -          |
| Utiliti         | 0,01905 | 0,01489    | -          | -          |
| Small Bus       | 0,02400 | 0,02500    | 0,003500   | 0,000670   |
| Large Bus       | 0,10153 | -          | 0,000963   | 0,000244   |

c. Oil Consumption
Stages of oil consumption calculation are calculating losing oil due to contamination, then calculating oil consumption, and calculating oil consumption costs.

Losing oil due to contamination

\[ OHK_i = KPO_i \times JPO_i \]  

Where

$OHK_i$: losing oil due to contamination
$KPO_i$: oil capacity in liters
$JPO_i$: distance of oil change

\[ KO_i = OHK_i + OHO_i \times KBBM_i \]  

Where

$KO_i$: oil consumption for this type of vehicle $i$ in liters / km
$OHK_i$: losing oil due to contamination in liters / km
$OHO_i$: losing oil due to operation in liters / km
$KBBM_i$: fuel consumption in liters / km

\[ BO_i = KO_i \times HO_j \]  

Where

$BO_i$: oil consumption costs for vehicle type $i$ (rupiah / km)
$KO_i$: oil consumption for vehicle type $i$ (liter / km)
$HO_j$: oil price for $j$ type (rupiah / liter)
i: transportation type
j: oil type

d. Consumption of Spare Parts

Spare parts consumption consists of the calculation of the consumption of vehicle parts per million km and the cost of consumable parts.

\[ Pi = (\Phi + \gamma_1 IRI) \times \left(\frac{KFI_i}{1000000}\right)^{\gamma_2} \]  

Where

$Pi$: oil consumption costs for vehicle type $i$ (rupiah / km)
$\Phi$: oil capacity in liters
$\gamma_1$: oil consumption factor
$IRI$: distance of oil change
$KFI_i$: fuel consumption in liters / km
$\gamma_2$: oil consumption factor

Where

\[ Pi \]: consumption of type \( i \) vehicle parts per million kilometers

\( \phi \): constant

\( y_{1,2} \): parameter coefficient

\( IRI \): road roughness (m/km)

\( KJT_i \): cumulative trip length of type \( i \) vehicles (km)

\( i \): type of vehicle

\[ BPi = Pi \times HKBi / 1000000 \] \( (15) \)

Where

\( BPi \): vehicle maintenance costs for vehicle type \( i \) (rupiah / km)

\( HKBi \): average new vehicle prices for vehicle type \( i \) (rupiah)

\( Pi \): the relative value of the cost of parts against the price of a new vehicle

\( i \): type of vehicle

e. Tire Consumption

Tire consumption costs are calculated by calculating tire consumption for vehicles, then calculating tire consumption costs.

\[ KBi = \chi + \delta_1 IRI + \delta_2 TTR + \delta_3 DTr \] \( (16) \)

Where

\( KBi \): tire consumption for vehicle types \( i \)

\( \chi \): Constanta

\( \delta \): coefficient

\( IRI \): road roughness

\( TTR \): average up hill

\( DTr \): average curve degree

\[ BBi = KBi \times HBj / 1000 \] \( (17) \)

Where

\( BBi \): tire consumption costs for vehicle types \( i \)

\( HBj \): price of new tire types \( i \) (rupiah)

\( I \): type of vehicle

\( J \): type of tire

Beginning steps of a preliminary study, followed by data collection, both primary data in the form of road inventory data, determination of location and length of segments, vehicle speed measurements using Speed Gun, and secondary data, namely the cost of light vehicle components (private transport). The next step is to analyze the characteristics of the driver using the statistical method and the effect of the use of mobile phones when driving to the value of the VOC with the method of PT. Pacific Consultant Indonesia and the Department of Public Works. Research location on street Perintis Kemerdekaan with 100 m segment length. As for the attention in the selection of locations namely access and entry that affect the movement of traffic on the main road is limited, good pavement conditions, the type of terrain is flat, and side friction is very small.
3. Results and Discussion

3.1 Characteristics of Mobile Phone Users When Driving

During observations, the number of male motorists who use a cell phone while driving is higher than the female group. Age 20-30 years, the group of men more use mobile phones when driving, with a total of 58 people, while for the group of women do not use cell phones while driving. From the age factor, the older the driver, the more he will be aware of the discipline of driving, not using a cell phone. The characteristics of motorists who use mobile phones while driving can be seen in Table 6 and Figure 2.

| Table 6. Characteristics of Motorists Using a Mobile Phone While Driving |
|--------------------------|--------------------------|--------------------------|
| Age (years)              | Male                     | Female                   |
|                         | 20 - 30                  | 31 - 40                  | 41 - 50                  | > 50                     | 20 - 30                  | 31 - 40                  | 41 - 50                  | > 50                     |
| Number                   | 58                       | 17                       | 14                       | 4                        | 13                       | 11                       | 2                        |
3.2 Effects of the Use of a Mobile Phone While Driving To Average Vehicle Speed

The usage of mobile phones when driving considerably affects the driver in making determinations for vehicle speed. The speed of the vehicle when using a cell phone for the category of groups of men with ages 20-30 years is the highest compared to other ages, which is 33.84 km/hour, for ages 31-40 years which is 29.68 km/hour, ages 41 - 50 years is 26.88 km/hour, and the age of more than 50 years is 17.93 km/hour. Whereas the speed of the vehicle when driving for the category of women with the age group of 20-30 years is 28.34 km/hour, 31 - 40 years which is 24.07 km/hour, and 41-50 years which is 17.55 km/hour. The driving speed of the female group is smaller than the male group, due to female drivers being more careful in driving. The age factor also greatly influences the driver in making decisions to make decisions in driving speed. The older the driver, will more careful in driving. More details, the characteristics of drivers who use a cell phone when driving are presented in Table 7 and Figure 3.

| Age (years) | 20 - 30 | 31 - 40 | 41 - 50 | > 50 | 20 - 30 | 31 - 40 | 41 - 50 | > 50 |
|-------------|---------|---------|---------|------|---------|---------|---------|------|
| Speed (km/hour) | 33,83745 | 29,68348 | 26,88271 | 17,93132 | 28,33888 | 24,06811 | 17,54805 |

**Figure 2.** Characteristics of Motorists Using a Mobile Phone While Driving

**Table 7.** Effects of the Use of a Mobile Phone While Driving To Average Vehicle Speed
3.3 Effects of the Use of Mobile Phones When Driving To Vehicle Operating Costs

Investigation of vehicle operating cost calculations [1] obtained variations in fuel consumption of IDR 818,593 to 1217747 (lt per1000 km), engine oil consumption per 1000 km of IDR 254651 to IDR 326591. The use of tires per 1000 km of IDR 3385,457 to Rp. 19427,16. The total vehicle operating costs based on speed obtained IDR 3261,9088 per km to Rp. 4257,822 per km. For more details, vehicle operating costs can be seen in Table 8.

Table 8. Effects of Mobile Phone Usage While Driving To Vehicle Operating Costs Using the PT.PCI Method

| Age (years) | Male | Female |
|-------------|------|--------|
| Speed (km/hour) | 20 - 30 | 31 - 40 | 41 - 50 | > 50 | 20 - 30 | 31 - 40 | 41 - 50 | > 50 |
| Fuel Consumption | 818593,38 | 900292,76 | 963140,1 | 1205926 | 929684,2 | 1032596 | 1217747 |
| Oil Consumption | 254651 | 269198 | 280474 | 324439 | 274464 | 292997 | 326591 |
| Tire Consumption | 33385,457 | 29825,942 | 27425,98 | 19755,58 | 28673,77 | 25014,16 | 19427,16 |
| Depreciation | 1858741,7 | 1955639,5 | 2026882 | 2293966 | 1989206 | 2103904 | 2306982 |
| Overhead | 296537,16 | 315495,66 | 329792,2 | 384408,7 | 322202,8 | 345451,1 | 387074,8 |
| Total (Rp/1000 km) | 3261908,8 | 3470452,3 | 3627714 | 4228495 | 3544231 | 3799962 | 4257822 |
| Total (Rp/km) | 3261,9088 | 3470,4523 | 3627,714 | 4228,495 | 3544,231 | 3799,962 | 4257,822 |

The result of the usage of mobile phones while driving to vehicle operating costs [4], obtained the higher the driving speed the lower the vehicle operating costs. Fuel consumption of vehicles uses premium fuel types for IDR 7,000 per litre, for the consumption of oil, tires and spare parts independent of speed, so the value of oil consumption is the same for each level of vehicle speed. The value of vehicle operating costs using the 2005 Public works method varies from IDR 942 per km to IDR 1,147 per km. For more details, the effect of using a mobile phone when driving to vehicle operating costs using the 2005 Public Works method in Table 9.
Table 9. Effects of Mobile Phone Use While Driving To Vehicle Operating Costs Using the 2005 Public Works Method

| VOC Components       | Speed (km/hour) |
|----------------------|-----------------|
|                      | 33,83745        |
|                      | 29,68348        |
|                      | 26,88271        |
|                      | 17,93132        |
|                      | 28,33888        |
|                      | 24,06811        |
|                      | 17,54805        |
| Fuel Consumption     | Rp705           |
|                      | Rp732           |
|                      | Rp757           |
|                      | Rp900           |
|                      | Rp744           |
|                      | Rp790           |
|                      | Rp910           |
| Oil Consumption      | Rp71            |
|                      | Rp71            |
|                      | Rp71            |
|                      | Rp71            |
|                      | Rp71            |
|                      | Rp71            |
|                      | Rp71            |
| Sparepart Consumption| Rp146           |
|                      | Rp146           |
|                      | Rp146           |
|                      | Rp146           |
|                      | Rp146           |
|                      | Rp146           |
|                      | Rp146           |
| Tire Consumption     | Rp20            |
|                      | Rp20            |
|                      | Rp20            |
|                      | Rp20            |
|                      | Rp20            |
|                      | Rp20            |
|                      | Rp20            |
| Total (Rp/km)        | Rp942           |
|                      | Rp969           |
|                      | Rp994           |
|                      | Rp1.137         |
|                      | Rp980           |
|                      | Rp1.026         |
|                      | Rp1.147         |

4. Conclusion

Male groups use mobile phones more when driving than women. Where the influence of the use of mobile phones while driving on driving speed is also influenced by factors of age and gender. The effect of the use of mobile phones while driving on vehicle operating costs using the PT.PCI method is IDR 3261,9088 per km to IDR 4257,822 per km. The effect of using a mobile phone while driving on vehicle operating costs using the 2005 Public Works method varies from IDR 942 / km to IDR 1,147 per km.

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