# TOLL ROAD CHARGING IN INDONESIA

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abstract : This paper is focused on vehicle operating cost model developed for the toll rate determination. The model is implemented in several stretch of toll road, and the savings gained from traveling on the toll road are indicated. It is argued that rate may vary in time and or distance travel, as potential savings vary depending on the traffic and road environment. Average percentage of toll rate relative to the total savings currently applied were found in the range 30-80% for road financed by Jasa Marga, and more than 100% for BOT financed scheme, depending on the trip length. Assuming that the state and private partnership in toll road investment is smoothly progressing in Indonesia, the establishment of a clear procedure in the determination of toll rates is urgently required in the future. This include how to adjust the toll rate periodically to reflect changes in the national economy.

## 1. BACKGROUND

The Government of Indonesia (GOI), through the state toll road corporation (Jasa Marga), has actively promoted the private sector investment for the development of toll road network. Between 1978 and 1990 about 200 km of toll roads and 3 toll bridges were opened to traffic. By now some other 140 km of toll roads had been completed with private sector participation, most of which are within the urban vicinity. Over period of 1990/1994 the total financing involving private sector is estimated about US $ 555 million, which is 5% of the total public roads spending over the same period. Within the on-going Five Year Development Plan (PELITA VI), the GOI is inviting some US$ 3.1 billion contributions from the private sector for toll road network enhancement.

There are four key principles underlying the Government's toll road policy :

1. a free of charge alternative road connecting the same origin-destination has to be available to road users.

2. toll charges plus the vehicle operating cost using the toll road shall not be higher than the total vehicle operating cost using the alternative (non-toll) road[1].
3. the objective of toll roads provision is to achieve the balance in economic and regional development, through contributions from road users, and
4. to improve efficiency on transport and distribution services especially in more developed region.

The legal authority for setting and revising toll rates rests in the hand of the President of Indonesia. Initiation for rates revision may come from Jasa Marga and/or partners on toll road investment, but it must be endorsed by the Minister of Public Works and the State Secretary.

The privatization of Indonesian Toll Road Corporation (PT Jasa Marga) is now being prepared. One important aspect in such an establishment is how to determine the level of toll rate. Until now the determination of vehicle operating cost (VOC) as a prime input in toll rate determination is still based on a procedure developed by Pacific Consultant International in 1979 while carrying out a feasibility study for the Jakarta intra-urban toll road, and no standard procedure for the determination of value of time savings available up to now. Indeed both costs, VOC and time, are the primary source of savings, although no reasons not to include accident and or environment in the cost accounting.

As the savings (from vehicle operating cost) determine the level of charges, however the financial performance of the toll road operation may have an equally strong reason in revising the toll rate[2]. For example, since early 90's there has been at least 3 times toll rates revision for Jakarta intra-urban toll road. For future reference in toll road investment, it is absolutely necessary to establish a standard procedure on how toll road charges are set.

Up to now there is no standard practice on how to set the level of toll charges. Two approaches may well be sought. First, toll rates are determined as a proportion of savings users may gain from traveling on the toll roads. Secondly, the financial performance of the toll road operation governs the charge levels. This paper will concentrate on the first approach, which is called *technical approach* here after[3]. Therefore, it is necessary to first elaborate the aspect of savings, hence the vehicle operating cost (VOC) models on which authors are currently involved in a VOC study commissioned by Jasa Marga. The model developed will be compared with previous models developed by Pacific Consultant International (PCI, 1979). Some indications on the level of toll charges currently apply in the country will be mentioned, and these are compared with toll rates apply in some other places of the world. Finally suggestions for further research on the topics are outlined.

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[1] Sometimes it was stated that the toll rates shall not be higher than 70% of the savings road users gain from traveling on the toll road. This benchmark has no legal basis. It is just to refer the common expectation, so that road users still enjoy at least 30% of the savings.

[2] On toll roads located close to urban area, users sometimes may experience losses from traveling on the toll road. This occurs particularly at peak hour period or when special incidents happen on the toll roads.

[3] A study of toll rate setting from financial view point is now under way, funded by technical assistance of ADB (TA no. 2762-INO).

## 2. RECENT TOLL ROAD CHARGING PRACTICE

### 2.1 Legal Framework

The four key principles on toll road policy previously mentioned are stated in Law number 13, 1980 on Road and Government's Regulation number 8, 1990 on Toll Roads. The latter also provides the legal basis for private participation in toll roads investment. By this all private investment in toll roads is to be in the form of cooperation with Jasa Marga The legal authority for setting and revising toll rates rests in the hand of the President of Indonesia. Initiation for rate revision may come from Jasa Marga and/or partners on toll road investment, however this must be endorsed by the Minister of Public Works and the State Secretary.

### 2.2 Charging System

The level of charge applied is subject to type of the vehicle. Currently there are three levels of charge with vehicle characteristics given below:

Group I : Passenger car, Jeep, Pick up, Mini Bus, Small Truck (3/4), Medium Bus.
Group IIA : Large Truck, Large Bus with two axles
Group IIB : Large Bus, Large Truck with three axles or more.

The toll collecting system adopted in Indonesia consist of open and closed system. Most of urban toll roads adopt the open system.

The toll rates currently charged to the road user vary from one place to the other. Average rate for passenger is about US$ 0.036 – 0.04 per vehicle-km, and it can be US$ 0.08 – 0.24 per vehicle-km for joint venture or built-operate- transfer financed scheme.

As comparison, Table 1 shows several data of toll rates in the several cities around the world. In general it can be said that toll charge is quite expensive in Indonesia.

**Table 1 Toll Rate in Several Cities around the world**

| No. | Nation | Year | Charges |
|---|---|---|---|
| 1. | Dallas & Houston (USA) | 1987 | US$ 0.0129 – 0.0576 /km |
| 2. | Texas (USA) | 1987 | US$ 0.0319, US$ 0.0576, US$ 0.0478 /km |
| 3. | Arizona, California, Texas, Virginia (USA) | 1997 | US$ 0.0313 – 0.063 /km |
| 4. | Toronto, Ontario (Canada) | 1997 | US$ 0.0469 /km |
| 5. | Bangkok (Thailand) | 1997 | US$ 1.2 /trip *) |
| 6. | Portugal | 1996 | US$ 0.067 /km **) |
| 7. | Turkey | 1997 | US$ 0.02 /km |

Note :

*) One extended route will have US$ 0.4 more and another privately-owned elevated tollway charges drivers by distance ranging from 15-20 baht.

*) 45% government share for construction cost
55% drivers pay

## 3. THE DEVELOPMENT OF VEHICLE OPERATING COST MODEL

The vehicle operating cost components consist of:

- Fuel Consumption[#]
- Lubricant Consumption[#]
- Tyre Wear[#]
- Maintenance and Parts[#]
- Depreciation
- Insurance
- Time Value[#]

The basic equation for vehicle operating cost (VOC) model is developed based on data collected from some toll roads and their alternative (non-toll) roads. These comprise toll roads located spread over Java island. Not every component can be observed because of limitation and quality of the data. The study is focused on the empirical modeling of fuel consumption. The others are developed on desk from review made on past vehicle operating cost model.

Some important information found during the course of the study is outlined below.

### 3.1 The Base for Charging

Amongst the very important factor to be decided in the beginning is what condition should the toll rate be determined. Suppose if we make a reference to savings that users may gain from traveling on a toll road, in fact savings may vary according to the conditions found on the toll road and on the alternative road when users travel on it. These conditions may include traffic condition within the corridor, geometry of the road and the physical characteristics of the road pavement. These three factors will determine the level of savings users may gain from traveling on the toll road.

The amount of savings can be hypothesized in two extreme situations. One being that the savings is very small and/or none. This is referred to the condition if users travel at midnight when traffic is very low, assumed other factors such as geometry and pavement surface conditions are being equal. Another condition is when users experience a large amount of savings. This may happen if the alternative road is really bad such as it is significantly longer than the toll road, is in a bad maintenance and has many successive intersections along the corridor. The choice of time period will determine the level of savings, vice versa the conditions of the other factors.

One alternative is that the determination of toll charge could be based on an average condition between peak traffic period and off peak period, such that the condition represent a generally fair traffic. This would result in a fair toll rate viewed from the user point of view.

Other conditions would give either to low or high rate of toll, which will affect the revenue collected.

[#] Only this items are explicitly mentioned on the explanation of Law number 10, 1980.

In the study we decided to choose the fair condition, hence the effect of the determinant factors are assumed as fair as possible.

### 3.2 Vehicles Representative

The selection of vehicles representative is one of important issue on the determination of toll charge.

Currently Jasa Marga has classified vehicles into three group:

Group I : Passenger car, Jeep, Pick up, Mini Bus, Small Truck (3/4), Medium Bus.
Group IIA : Large Truck, Large Bus with two axles
Group IIB : Large Bus, Large Truck with three axles or more.

Determination of toll charge for each group could be based on representative vehicle in each group. This information ideally can be obtained from a specific survey on every stretch of toll road where a profile of vehicle type distribution is identified It is not impossible that every stretch of toll road has its own vehicle representative. However, this may not be practical. In the study we has used data of purchased vehicles from GAIKINDO (Association of Automotive Industry of Indonesia) to select representative vehicles. The highest number of purchased vehicle of each group will be selected to be a representative vehicle.

GAIKINDO has classified five category of vehicles:

- category I. Vehicle with 5 Ton weight
- category II Vehicle with 5 - 10 Ton weight
- category III Vehicle with 10 - 24 Ton weight
- category IV General Purpose Vehicle
- category V Vehicle with 24 Ton weight or more.

The study has used secondary data of purchased vehicles and some justification has been done to match the vehicle groups of Jasa Marga and vehicle classification of GAIKINDO. The results are as follow:

Group I is equal to category I and IV
Group IIA is equal to category II and III
Group IIB is equal to category V.

Example of vehicle representative from the study based on purchased vehicle data year 1994 and 1995 are as follow:

**Table 2 The Representative Vehicle Characteristic**

| Characteristic Vehicle | Representative Vehicle | | |
|---|---|---|---|
| | Category I Toyota Kijang | Category II A Hino H07C Bus | Category II B Hino H06CT Truck |
| Fuel | Gasoline | Diesel | Diesel |
| Engine Capacity | 1.500 cc | 6.728 cc | 6.485 cc |
| Load Capacity | 8 Person ≈ 240 Kg | 60 Person ≈ 3.000 Kg | 10.930 Kg |
| Dead Load | 1.040 Kg | 10.650 Kg | 10.930 Kg |

## 4. VEHICLE OPERATING COST MODEL

### 4.1 Data Requirement

The development of vehicle operating cost model requires various data listed below:

a. Basic price data for each vehicle representative

For each of the representative vehicle, basic data needed are as follows:

- Basic price of gasoline (Rp/liter)
- Basic price of diesel oil (Rp/liter)
- Basic price of lubricant for gasoline engine (Rp/liter)
- Basic price of lubricant for diesel engine (Rp/liter)
- Price of new tyre (Rp)
- Price of new vehicle (Rp)
- Price of depreciated vehicle (Rp)
- Annual vehicle usage (km)
- Insurance (Rp)
- Interest rate (%)
- Age of vehicle (year)

b. Road Geometry

The road geometry data collected consist of road length data and gradient data. For non-toll road, the length of road is determined based on the length of the most frequently used path that has the same origin destination and is used as an alternative for the toll road. For toll road, the road length is defined as the closest intersections to the toll gates, not the length in between toll gates.

Typology of toll and non-toll road network depends on the design of toll road alignment relative to the existing road. Different city may have a different typology which may significantly affect the difference in length between toll and non-toll road, hence the vehicle operating cost.

c. Traffic

The traffic data consist of traffic volume data and running speed. The data is used to get the picture of traffic condition on some of road section in the survey station.

## 4.2 Modeling

### 4.2.1 Fuel Consumption

There is a basic relationship between fuel consumption and speed out of road geometry, roughness and traffic condition. The kind of consumption is the basic fuel consumption, which is defined as fuel consumption on free flow condition, flat gradient (0%) and road roughness relatively not affect the fuel consumption. The basic fuel consumption model can be explained as follows.

$$\text{Fuel consumption} = \text{basic fuel } \{1+( kk + kl + kr )\} \quad \ldots\ldots\ldots\ldots\ldots (1)$$

where :

basic fuel in liter/1000km
kk = correction due to gradient
kl = correction due to traffic conditions
kr = correction due to road roughness

From our empirical modeling it has been found that the relationship between basic fuel and speed, v (kph), can be expressed as :

$$\text{Basic fuel for Category I} = 0{,}0284\, v^2 - 3{,}0644\, v + 141{,}68 \quad \ldots\ldots\ldots\ldots\ldots (2)$$

Figure 1 shows the relationship between the basic fuel consumption and speed.

For other vehicle categories, their basic fuel consumption are found from separate experiments. Their basic relationships relative to the basic fuel consumption of vehicle category I are given below.

$$\text{Basic fuel Category IIA} = 2.26533 * \text{Basic fuel Category I} \quad \ldots\ldots\ldots\ldots\ldots (3)$$
$$\text{Basic fuel Category IIB} = 2.90805 * \text{Basic fuel Category I} \quad \ldots\ldots\ldots\ldots\ldots (4)$$

Table 3 summarized the correction value for each of the category

**Table 3 Correction Value for Fuel Consumption Category I, IIA and IIB**

| | | |
|---|---|---|
| Correction due to (-) gradient (kk) | $g < -5\%$ | - 0,337 |
| | $-5\% \leq g < 0\%$ | - 0,158 |
| Correction due to (+) gradient (kk) | $0\% \leq g < 5\%$ | 0,400 |
| | $\geq 5\%$ | 0,820 |
| Correction due to traffic (kl) | $0 \leq v/c < 0{,}6$ | 0,050 |
| | $0{,}6 \leq v/c < 0{,}8$ | 0,185 |
| | $v/c \geq 0{,}8$ | 0,253 |
| Correction due to road roughness (kr) | < 3 m/km | 0,035 |
| | ≥ 3 m/km | 0,085 |

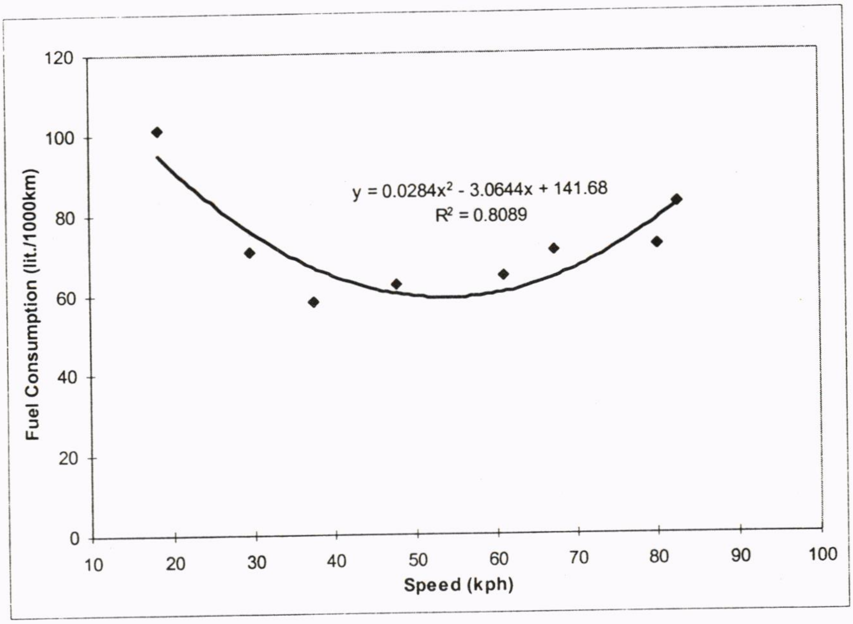


**Figure 1 Basic Fuel Curve for Vehicle Category I**

### 4.2.2 Lubricant (Toll and Non-Toll)

The model has been adapted from GENMERRI, a VOC model developed for road maintenance and programming. Table 4 shows the basic lubricant consumption in liter/km against speed (kph). The values are subject to corrections due to road roughness conditions, given in Table 5.

**Table 4 Basic Lubricant Consumption (liter/km)**

| Speed (km/jam) | Vehicle Category | | |
|---|---|---|---|
| | Category I | Category II a | Category II b |
| 10 - 20 | 0.0032 | 0.0060 | 0.0049 |
| 20 - 30 | 0.0030 | 0.0057 | 0.0046 |
| 30 - 40 | 0.0028 | 0.0055 | 0.0044 |
| 40 - 50 | 0.0027 | 0.0054 | 0.0043 |
| 50 - 60 | 0.0027 | 0.0054 | 0.0043 |
| 60 - 70 | 0.0029 | 0.0055 | 0.0044 |
| 70 - 80 | 0.0031 | 0.0057 | 0.0046 |
| 80 - 90 | 0.0033 | 0.0060 | 0.0049 |
| 90 - 100 | 0.0035 | 0.0064 | 0.0053 |
| 100 - 110 | 0.0038 | 0.0070 | 0.0059 |

**Table 5 Correction Factors for Lubricant Consumption for All Vehicle Category**

| Roughness | Correction Factor |
|---|---|
| < 3 m/km | 1.00 |
| ≥ 3 m/km | 1.50 |

### 4.2.3 Tyre

The economic life of tyre are influenced by three factors. First, rolling friction between tyre and the surface of the pavement. Second, the longitudinal and transversal forces along the tyre surface. Finally is the driving force friction due to air pressure when vehicles climb and or reduce the speed.

The model has been adopted from PCI model, as summarized below:
- Vehicle Category I : $Y = 0.0008848\ S - 0.0045333$
- Vehicle Category IIA : $Y = 0.0012356\ S - 0.0064667$
- Vehicle Category IIB : $Y = 0.0015553\ S - 0.0059333$

where Y is tyre consumption per 1000 km and S is the running speed (kph).

### 4.2.4 Vehicle Maintenance Cost

Maintenance cost comprises spare parts and wages for the maintenance labor. This is also adopted from the PCI model as given below :

1. Spare Parts
   - Vehicle Category I : $Y = 0.0000064\ S + 0.0005567$
   - Vehicle Category IIA : $Y = 0.0000332\ S + 0.0020891$
   - Vehicle Category IIB : $Y = 0.0000191\ S + 0.0015400$

   Y = spare parts cost per 1000 km
   S = running speed (kph)

2. Labor
   - Vehicle Category I : $Y = 0.00362\ S + 0.36267$
   - Vehicle Category IIA : $Y = 0.02311\ S + 1.97733$
   - Vehicle Category IIB : $Y = 0.01511\ S + 1.21200$

   Y = labor-hour per 1000 km
   S = running speed (kph).

### 4.2.5 Depreciation

Depreciation is expressed given by the PCI model.
- Vehicle Category I : $Y = 1/(2{,}5\ S + 125)$
- Vehicle Category IIA : $Y = 1/(9{,}0\ S + 450)$
- Vehicle Category IIB : $Y = 1/(6{,}0\ S + 300)$

Y = depreciation per 1.000 km, equated 1/2 depreciable value of the vehicle
S = running speed (kph)

#### 4.2.6 Interest

The model for interest is adopted from the HDM III model, where interest in veh-km, INT, is expressed as a fraction of the price of brand new vehicle:

$$INT = AINT/AKM$$

where :

AINT = 0.01 (AINV/2)
AINV = annual interest of vehicle (%)
AKM = average annual mileage expressed in km.

In our study it was assumed that interest would have no affect on choice between toll or non-toll road. Whether or not traveling via a toll road the interest would be the same, therefor no saving obtained from interest component.

#### 4.2.7 Insurance

According to the PCI model, insurance is expressed as :

- Vehicle Category I : $Y = 38/(500\ S)$
- Vehicle Category IIA : $Y = 6/(2571{,}42857\ S)$
- Vehicle Category IIB : $Y = 61/(1714{,}28571\ S)$

Y = insurance per 1000 km
S = running speed (kph)

#### 4.2.8 Value of Time

There is no hard evidence on value of time for Indonesia. PCI study assumed that vehicle utilization time savings is the basis for valuation, which is perhaps not that common.

In the study we choose to value user time saving as a source of value of time determination. Values of time used in previous feasibility studies in Java island were adjusted to reflect inflation. Few examples of value of time were listed in Appendix, for the sake of illustration, including the PCI's.

In the future it is vital to conduct the value of time study in any transportation choice case in Indonesia.

## 5. IMPLEMENTATION OF THE VOC MODEL

### 5.1 Savings Calculation

Savings may be obtained from each VOC component. Figures 2 to 5 depict the comparison of contribution from each component between PCI and the proposed model, based on several stretch of toll road in Java. The speed of 80 kph was assumed for the toll road, while two speed levels on the non-toll road were assumed i.e. 30 kph and 40 kph, to reflect bad and good traffic condition encountered on the non-toll road.

The difference between PCI and the proposed model basically lies on the assumption of interest. In the PCI model, interest gives a dominant contribution in the savings, while in the proposed model, it was assumed that interest does not have contributions to the total savings. In order words there is no difference in interest whether or not users travel via the toll road.

Observing from the contribution of each component in PCI model the greatest saving percentage is given by the interest and the smallest is given by the maintenance cost. In the proposed model the greatest saving percentage is given by insurance and the smallest is given by the lubricant. It is worth to note the negative values showing in the figures represent that the cost component for the toll road is more expensive than that of the non-toll road.

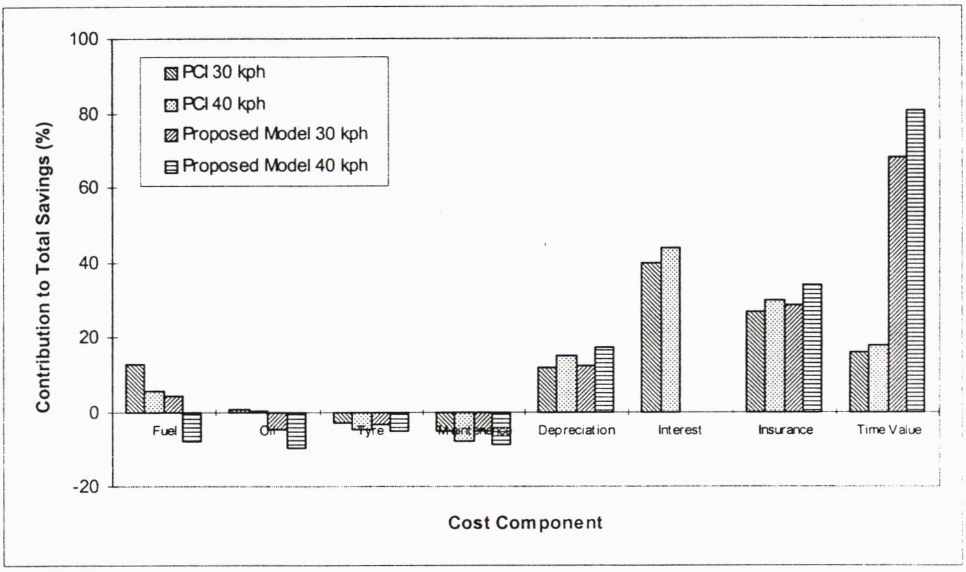


**Figure 2 Saving Contribution from Each Component (Padalarang-Cileunyi)**

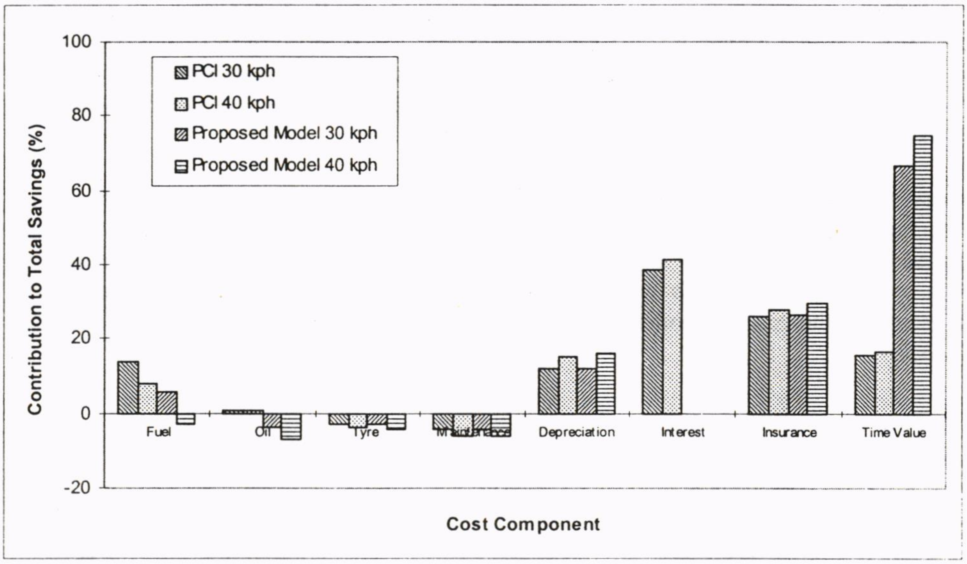


**Figure 3 Saving Contribution from Each Component (Cawang-Tomang, Jakarta)**

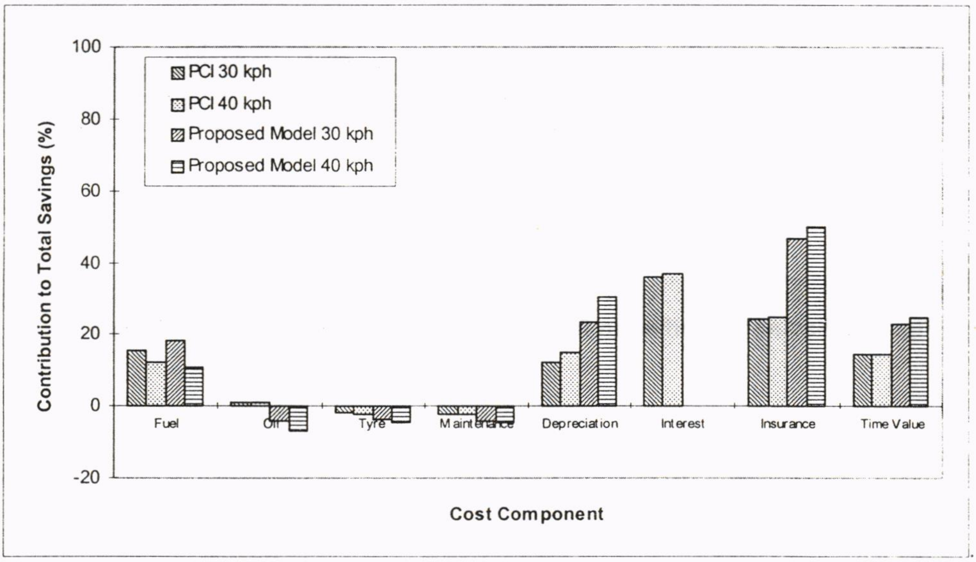


**Figure 4 Saving Contribution from Each Component (Jakarta-Cikampek)**

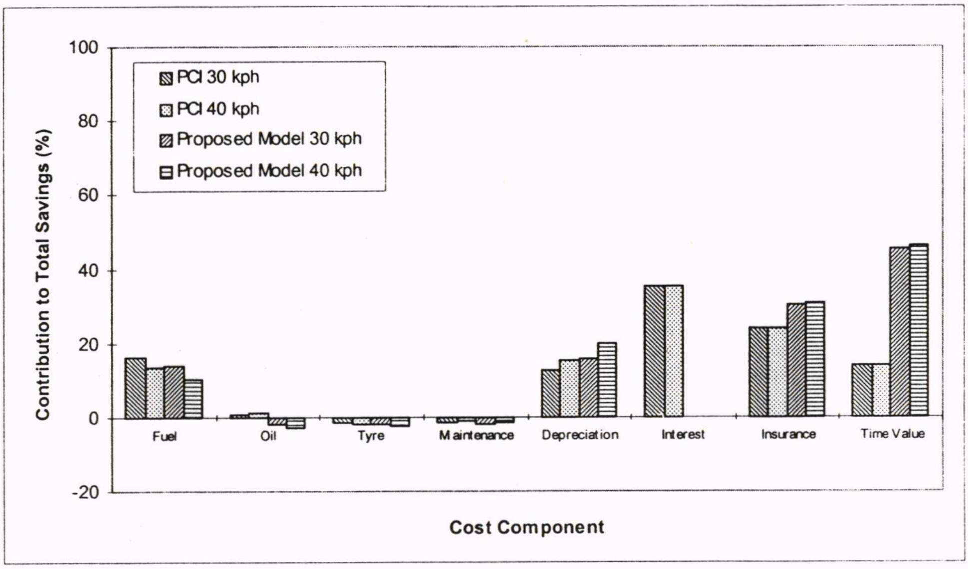


**Figure 5 Saving Contribution from Each Component (Srondol-Krapyak, Semarang)**

Based on current toll rate Table 6 shows a percentage of toll rate relative to savings gained by users in several stretch of toll road in Java. The table also shows the percentage savings calculated with and without the time value.

It can be seen from the table that the toll rate expressed as percentage savings vary depending on the locations. The majority of the toll rates are in the range of 30%-80% savings, with few exception, such as Prof. Soediyatmo (airport link) and Cawang-Tomang where more than 100% savings were encountered. Those majority represent the toll road financed by the Jasa Marga, while Cawang-Tomang is the BOT financed scheme.

The difference between results obtained from the PCI and the proposed model can be explained as follows. Without time savings, the difference lies in the interest component as previously explained. While with time savings, apart from the interest, the difference is also contributed by the difference in time value assumption. The PCI model assumed that the utilization of the vehicle contribute to the savings, not the occupant's value of time. In the proposed model, the value of time were adapted from previous feasibility studies with modification to reflect the inflation. These are listed in the Appendix.

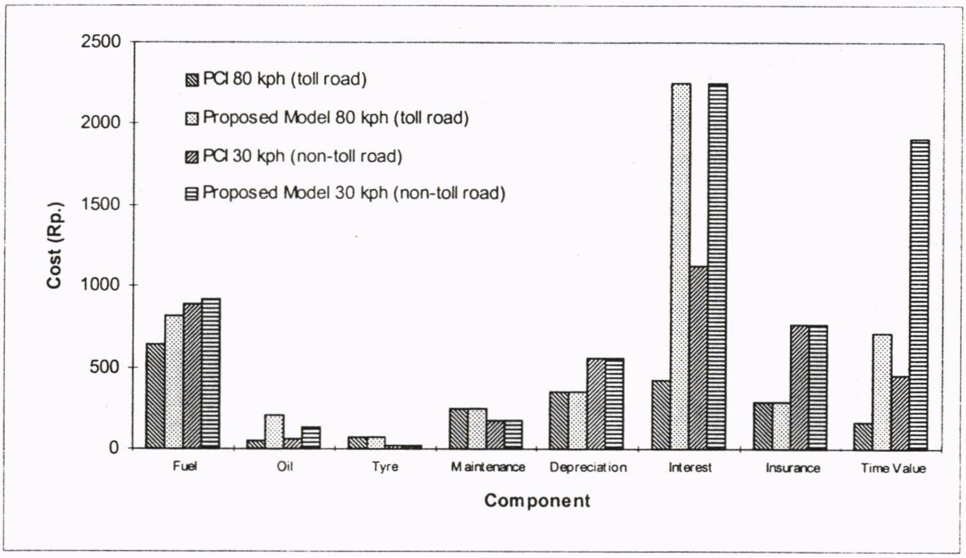


**Figure 6 VOC per Component for Each Speed (Cawang-Tomang, Jakarta)**

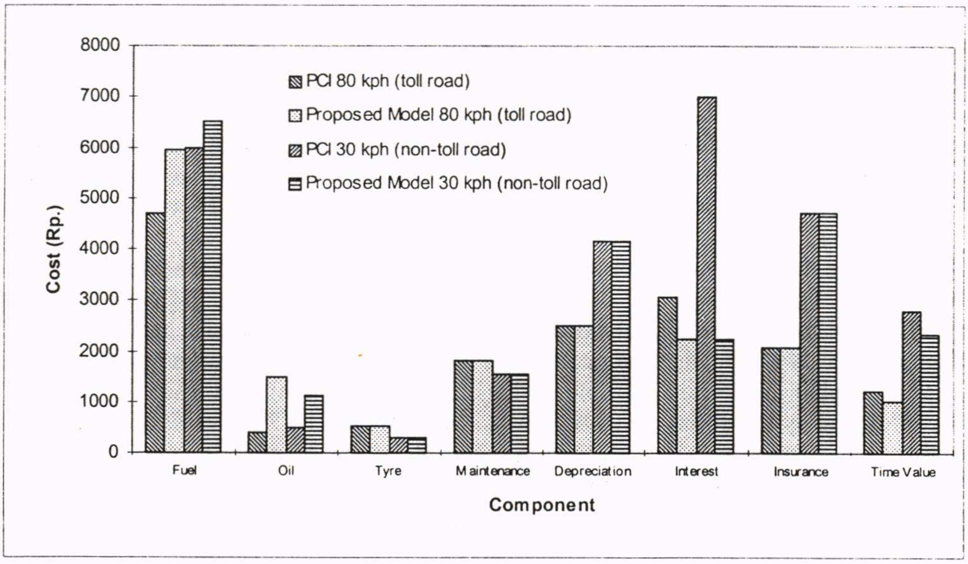


**Figure 7 VOC per Component for Each Speed (Jakarta-Cikampek)**

## Table 6 Toll Rate as Percentage of Savings

| No. | Location | Link Length (km) | | | | Toll Rate as %-age of Savings (with v.o.t) (%) | | | | Toll Rate as %-age of Savings (without v.o.t) (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | toll road | non-toll | Toll Rate (Rp) | Rate/km (Rp) | PCI model 30 kph* | PCI model 40 kph* | proposed model 30 kph* | propose d model 40 kph* | PCI model 30 kph* | PCI model 40 kph* | propose d model 30 kph* | propose d model 40 kph* |
| 1 | Jagorawi | 50 | 57 | 4.000 | 80 | 34 | 54 | 64 | 109 | 39 | 64 | 83 | 144 |
| 2 | Jakarta-Tangerang Barat | 27 | 30 | 2.500 | 93 | 41 | 67 | 79 | 140 | 48 | 79 | 104 | 189 |
| 3 | Jakarta-Cikampek | 73 | 83 | 6.500 | 89 | 38 | 61 | 72 | 122 | 44 | 71 | 93 | 163 |
| 4 | Cawang-Tomang | 16 | 16 | 3.000 | 188 | 103 | 184 | 104 | 195 | 122 | 221 | 311 | 766 |
| 5 | Prof.Dr.Ir.Sediyatmo (airport link) | 14.3 | 14.3 | 3.000 | 210 | 115 | 206 | 117 | 218 | 137 | 247 | 348 | 857 |
| 6 | Padalarang-Cileunyi | 41.09 | 39.33 | 3.000 | 73 | 44 | 83 | 47 | 95 | 53 | 101 | 148 | 487 |
| 7 | Semarang (Srondol-Krapyak) | 13.7 | 16.6 | 700 | 51 | 19 | 30 | 24 | 39 | 22 | 35 | 45 | 72 |

Note.
* Assumed speed on non-toll, speed on toll road = 80 kph.
No congestion on toll road
Congestion on non-toll road

### 5.2 Toll rate adjustment

This section discuss the periodical toll rate adjustment due to factors which influence the amount of savings e.g. inflation. One of the key principles of toll rate determination is toll charges plus the vehicle operating cost using the toll road shall not be higher than the total vehicle operating cost using the alternative (non-toll) road. Therefore, the toll rate change is influenced by the change in the vehicle operating cost that has a direct relationship with the national economy. Inflation rate is assumed as a factor with the greatest influence to the vehicle operating cost increase.

Applying an inflation rate basically for the basic price data, then the vehicle operating cost is calculated in order to find the value of the vehicle operating cost savings up to several years in the future. By doing so it is expected that an increase in savings was found, hence can be used as an indication for the determination of periodical toll rate adjustment.

For example vehicle operating cost calculated from Padalarang-Cileunyi toll road in West Java is examined using 8.5% inflation rate. The average savings obtained per kilometre per year and are shown in the Table 7. From the table can be seen that in the first 5 years the increase in savings reach 50% above the base year savings, and 100% in the $9^{th}$ year. Judging from this technical approach, there is a strong reason to increase the toll rate as the savings increase.

The value of the toll rate adjustment shall not create a difficulty in transaction at the toll gate. It is preferred to increase the rate by an additional Rp 500 or a multiplication of it, since the smallest common note is Rp 500. As the period of adjustment is concerned it should be examined from the financial aspect in addition to the technical calculation given in this example.

**Table 7 Value of Average Savings per Kilometre per Year**

| Number | Year | Average Saving per Km per Year | |
|---|---|---|---|
| | | With Time Value | Without Time Value |
| 0 | 1996 | 100.39 | 39.37 |
| 1 | 1997 | 108.93 | 42.72 |
| 2 | 1998 | 118.19 | 46.35 |
| 3 | 1999 | 128.23 | 50.29 |
| 4 | 2000 | 139.13 | 54.56 |
| 5 | 2001 | 150.96 | 59.20 |
| 6 | 2002 | 163.79 | 64.23 |
| 7 | 2003 | 177.71 | 69.69 |
| 8 | 2004 | 192.82 | 75.62 |
| 9 | 2005 | 209.21 | 82.04 |
| 10 | 2006 | 226.99 | 89.02 |

## 6. CONCLUDING REMARK

Savings gained by users from traveling on the toll road vary according to the road traffic environment. The savings include time and vehicle operating cost (VOC) savings. For an inter-urban toll road the proportion of VOC savings is larger than the time savings. From our test on inter-urban toll road, we found VOC savings in the range of 70%-80% of total savings, and 30%-50% on intra-urban toll road. The remaining savings is due to time. i.e. 20%-30% for inter-urban and 50%-70% for intra-urban toll road.

In the study it was found that the current toll rate vary in the range of 30%-80% for toll road financed by Jasa Marga, and 100%-180% for BOT toll road depending on the trip length examined.

Toll rate adjustment is indeed required to reflect the condition of national economy. Two approaches can be used : (i) technical and (ii) financial. From technical approach as our study revealed, putting 8.5% interest rate, it was found that the savings increased some 50% after 5 years, and some 100% after 9 year.

Evidence on behavioral value of time for any transportation choice set is very scarce found for Indonesia condition. In the future it is vital to study this more comprehensively, since this will affect the calculation of benefit of any transportation investment.

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## APPENDICES

### Value of Time (Rp/hour, 1996) for Bandung

| | Category I | | | | | | Category II A | | Category II B |
|---|---|---|---|---|---|---|---|---|---|
| | car | jeep | pick up | small bus | light truck | middle bus | middle truck | large bus | large truck |
| Number of Passenger | 2,5 | 2,5 | 2 | 5,2 | 2 | 25,2 | 2 | 58,9 | 3 |
| Value of Time per Hour | 5.425 | N/A | N/A | 3.385 | 3.827 | 16.405 | 3.827 | 38.344 | 5.716 |

### Value of Time (Rp/hour, 1996) for Semarang

| | Category I | | | | | Category II A | | Category II B |
|---|---|---|---|---|---|---|---|---|
| | car | utility | small bus | light truck | middle bus | middle truck | large bus | large truck |
| Number of Passenger | 2.5 | 5 | 5.2 | 2 | 25.2 | 2 | 58.9 | 3 |
| Value of Time per Hour | 3,411 | 4,353 | 1,284 | 878 | 6,221 | 878 | 14,541 | 1,506 |

### Value of Time (Rp/hour, 1996) for Inter Urban (Jakarta-Cikampek)

| | Time Value Rp./hour/veh. |
|---|---|
| Light Vehicle | 1,128 |
| Bus | 9,263 |
| Heavy Vehicle | 6,621 |
| Motorcycle | 347 |

### Value of Time PCI (1995)

| | Time Value Rp./hour/veh. |
|---|---|
| Car | 1341 |
| Bus | 3827 |
| Truck | 3152 |

**Value of Time PT Jasa Marga (1990-1996)**

| | **Time Value Rp./hour/veh.** |
|---|---|
| Category I | 12,287 |
| Category IIA | 18,534 |
| Category IIB | 13,768 |