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Determining Initial Toll Road Tariff Based On BKBOK, ATP and WTP (Case study: Tebing Tinggi-Pematangsiantar Toll Road Section)

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ABSTRACT

Indonesian government initiated the Trans Sumatra Toll Road, such as the Tebing Tinggi-Pematangsiantar toll road section, to increase the connectivity inter-region, travel time, logistic cost and overall economic growth. Toll rates and traffic volumes (or demand) are the two major factors affecting revenue, higher toll rates should decrease traffic volumes, hence leading to the overestimation of traffic volumes In Indonesia, the initial toll road tariff must consider three things, namely the ATP (Ability To Pay), BKBOK, and also the return on investment (Law No. 2 of 2022). This paper is aimed to determine the initial toll tariff based on BKBOK, ATP and Willingness to Pay (WTP). The BKBOK is calculated based on savings in vehicle operating costs (VOC) and the value of the travel time. The VOC calculation uses the Binamarga method in 2005 (Pd-T-15-2005), while saving the travel time value uses the income approach method. ATP is calculated using the travel budget method and WTP is calculated by using the perception of travellers. This study the calculation of saving VOC and VOT (vehicle operating time) based on comparison scenario between toll road and arterial road. The recommended initial toll tariff of Tebing Tinggi Pematangsiantar Toll Road is Rp. 1055 per km or Rp 47,475. This tariff is willing to be paid by ± 22% of toll road users and able to be paid by ± 87% of toll road users.

Keywords: ATP, BKBOK, toll tariff, VOC, WTP

1. Introduction

The Tebing Tinggi-Pematangsiantar toll road with total length ± 45 km will operate in 2024. The investment of toll road will shorten travel time between Medan and Lake Toba which is the the Super Priority Tourism destination in North Sumatera. The Toll Road infrastructure investment will improve logistics efficiency, increase regional connectivity, competitiveness and create new regional economic growth [1].

The Total vehicle operating cost savings (BKBOK) and Ability To Pay (ATP)-Willingness To Pay (WTP) approaches are used to calculate initial tariff, and for evaluating current tariff. This method is widely used in Indonesia, for example: Pandaan-Singosari toll road 2021 tariff calculation based on ATP-WTP[2], Jakarta Cikampek toll road 2021 tariff calculation[3], Banda Aceh-Sigli toll road 2019 tariff determination study[4] and Semanggi-Cawang toll road and Bekasi Timur-Cibitung toll road 2014 evaluation using BKBOK and ATP-WTP method[5].

The objective of this paper was conducted to determine the initial toll tariff of the Tebing Tinggi-Pematangsiantar Toll Road by using the BKBOK, ATP and WTP based on user's perceptions. In principle,

when determining the initial toll road tariff, the return on investment for the construction of the toll road should be taken into account[6], but this study focuses on the calculation of the tariff from the direct user side with two scenarios, before and after the operation of toll roads.

The research site selected for this study is the Tebing Tinggi-Pematangsiantar toll road section, which is part of the Trans Sumatra Toll Road (JTTS). The road section under study starts from Tebing Tinggi toll plaza to Sinaksak toll plaza as shown in figure 1.

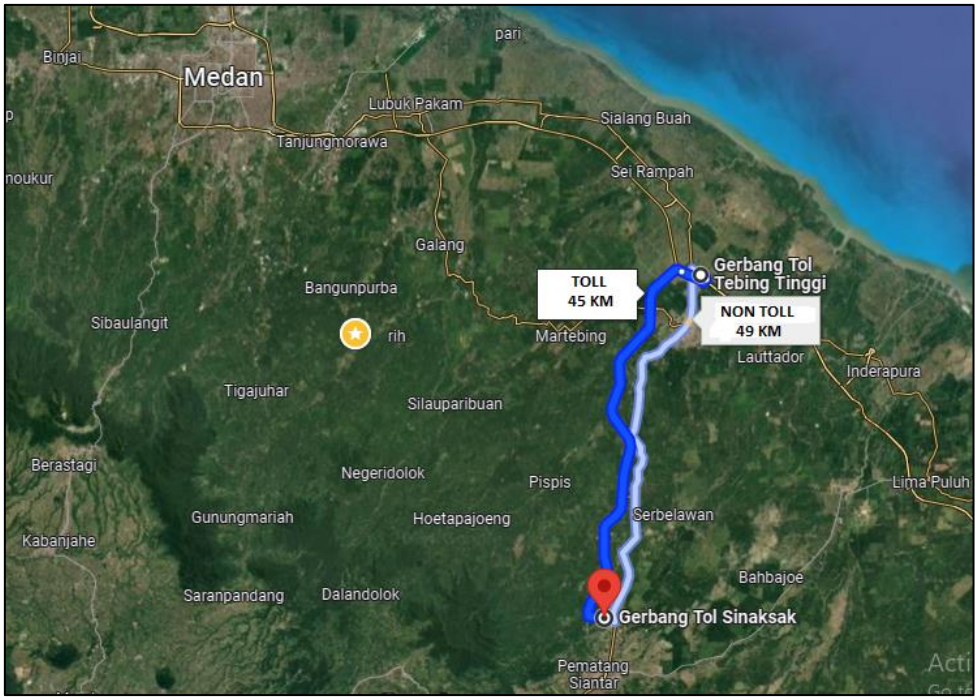

Figure 1 Study Location

From Figure 1, we can see the length of the road section through the toll road is 45 km, while the length of the non-toll road is 49 km. The road IRI used is the average road IRI of the existing section, which is 2.5 m/km for the toll road (BPJT data) and 4.5 m/km for the non-toll road (BPJN data). The VCR data used for the non-toll road is 0.72 smp/hour (BPJN data) and for the toll road is 0.16 smp/hour (BPJT data). While the speed data (Vr) was obtained from a survey using a speed gun at the 85th percentile [7] of vehicle speed, which is 30 km/h for non-toll roads, and 93 km/h for toll roads (survey).

The Tebing Tinggi-Pematangsiantar Toll Road section was selected because this toll road will be operational in 2024, so it is appropriate to propose tariff from the user side. The limitation of this study is only for passenger car users, class I according to Kepmen PU No.370/KPTS/M/2007[8], and the IRI value of the road is taken as the average value of the road segment. The car used in the calculation is the Toyota Avanza Type G, 1500 cc, which is the best-selling car for 5 years based on Gaikindo data for 2019-2023.

2. Method

This study was conducted with 3 steps of calculation, which are: calculating the amount of total saving in vehicle operating cost (BKBOK) after the operation of Tebing Tinggi-Pematangsiantar Toll Road, then calculating the amount of ability to pay (ATP) and also the amount of willingness to pay (WTP) of the potential toll road users, then at the final stage determining the initial tariff for Tebing Tinggi-Pematangsiantar Toll Road.

Tariffs are calculated with tariffs < 70% of the total BKBOK [9], and ideally tariffs are taken with tariff values of 35-45% of the total BKBOK [14]. Then the tariff is analysed by considering the ATP and WTP

values, i.e. the tariff should be between the average ATP and average WTP values [15]. Finally, by considering the above tariff constraints, the final tariff recommendation can be determined.

The data used in this study consisted of primary and secondary data. Secondary data is obtained through interviews with agencies: Central Bureau of Statistics (BPS), BPJN (National Road Implementing Agency), BUJT (Toll Road Business Entity), BPJT (Toll Road Regulatory Agency), car dealers, oil shops, car maintenance workshops, tire shops. Secondary data collected in this study include Tebing Tinggi Pematangsiantar Toll Road Length Data, Tebing Tinggi Pematangsiantar Non-Toll Road Length Data, Tebing Tinggi Pematangsiantar Non-Toll Road Section Geometric Data, Tebing Tinggi Pematangsiantar Non-Toll Road Section IRI Data, Tebing Tinggi Pematangsiantar Non-Toll Road Section Income Data in the study area, Traffic Volume Data, Population, GDP Data for the Regency related to the study location, VCR (Volume Capacity Ratio) Data for Toll and Non-Toll Road.

The primary data obtained from the results of the field surveys include speed data on non-toll roads and toll roads using the 85 percentile speed method [7],travel time data on non-toll roads and toll roads on the Tebing Tinggi-Pematangsiantar road, willingness and ability to pay data, respondent characteristics (income, education, occupation, income, toll expenditure, transport expenditure), traffic patterns and toll road usage/utilisation rates.

The method used to collect data to determine ATP and WTP uses indirect interviewing techniques using questionnaires distributed via WhatsApp. The survey was conducted using a modification of the Stated Preference (SP) method. The data was collected by interviewing toll road users of passenger cars.

2.1 Estimation of Total Vehicle Operating Cost Saving (BKBOK)

Vehicle operating costs are lower on toll roads than on non-toll roads. This may be due to the shorter distance travelled on toll roads, or because the average speed on toll roads is higher than on non-toll roads, so that travel time is reduced on toll roads. The amount of vehicle operating cost savings (BKBOK) can be calculated using the following formula[9].

BKBOK = [Saving VOC or ΔVOC] + [Saving VOT or ΔTv]

BKBOK = [(VOCnt*Dnt) - (VOCt*Dt)] + [(Dnt/Vnt - Dt/Vt)*Tv]

2.2 Estimation of Vehicle Operating Cost (VOC)

The VOC calculation uses the VOC model developed by the Ministry of PUPR in 2005, namely Pd-T-15-2005[10]. This model was used for the following reasons: Most recent in Indonesia: It was developed according to Indonesian conditions, through a long study 1997-2001 by: Puslitbang Infrastructure Transport + Balitbang Kimpraswil +TRL (Transport Research Laboratory) UK, It was developed by adapting some equations and parameters in HDM IV 2000. Then, this model was discussed as a concept and received input from experts. In addition, this guideline has referred to the applicable legislation in Indonesia, namely Law No. 14 of 1992 on Road Traffic and Transport, Law No. 38 of 2004 on Roads [10].

The total vehicle operating costs VOC (BTT) is the sum of all fuel costs (BiBBMj), spare parts costs (BPi), maintenance personnel salaries (BUi), oil costs (BOi) and tyre costs (BBi) as described in the following formula:

BTT = BiBBMj + BPi + BUi + BOi + BBi

BiBBMMjj = KBBMi x HBBMj

BPi = Pi x HKBi /1000000

BUi = JPi x UTP/1000

BOi =KOi x HOj

BBi = KBi x HBj /1000

2.2 Estimation of Value of Time (λ) and Saving VOT (ΔTv)

The income approach method is used to calculate the fair value of time. In this method, 2 components are taken into account, namely PDRB (Gross Domestic Regional Product) per person and the amount of time worked per person in a year. The value of time is calculated using the following formula[11]:

$$\lambda = \frac{GDRP/person}{Annual\ working\ time}$$

The calculation of the saving VOT (ΔTv) uses the income approach method, and the vehicle survey is carried out to determine the average passenger capacity (P) (person), the difference in travel time (hours) of vehicles using toll roads and non-toll roads (ΔT). To calculate the saving VOT, the following formula can be used [11].

ΔTv = λ x P x ΔT

2.3 Estimation of ATP and WTP

ATP calculation using household method. The estimation of willingness-to-pay (WTP) was conducted using Googleform questionnaires that were distributed to toll road users in the area of the proposed toll road, namely Tebing Tinggi City, Pematangsiantar, Sergai, Simalungun Regency, and also to residents of Medan City. The number of respondents was determined using the quota sampling method using the Slovin formula with an error rate of 10%[12].

The questionnaire design is based on a similar study[5] and also on the basic theory of ATP WTP [13], where the questionnaire consists of the following questions: place of residence, last education, type of work, purpose and destination of the trip, main reason for using toll roads, total income per month, total expenditure on transport per month, frequency of using toll roads per month, expenditure on toll fees per month and willingness to pay at the study location.

3. Result and Discussion

According to the representative vehicle used, namely Avanza Type G, 1500 cc, it is obtained from the study: the price of the vehicle is Rp. 279,750,000, the oil used is Fastron brand, 10W-40 Rp. 85,000, the tyres used are Gajah Tunggal, 185-65R15 for Rp. 600,000, the maintenance cost is Rp. 25,000 / hour, and the price of pertalite fuel is Rp. 10,000 / litre. The results of the VOC calculation obtained using the Pd-T-15-2005 model [10] are summarised in Table 1.

Table 1 shows that the VOC on non-toll roads VOC_nt is Rp 3,112 per km, which is higher than the VOC on toll roads VOC_t of Rp 2,107 per km. Regarding the proportion of cost components in VOC, it can be seen that the maintenance cost component BUi is the largest cost, followed by fuel consumption cost BBMi, then spare parts cost BPi, tyre consumption cost BBi, and the smallest is oil consumption cost BOi. This shows the same behaviour for both toll and non-toll roads.

Substituting the distances D_t (length of toll road=49km) and D_nt (length of non toll road=45km) for the VOC per kilometre gives VOC_nt=Rp 152,463. And we also get VOC_t = Rp 94,834.

Tabel 1 VOC Calculation Summary

VOC COMPONENT	VOC NON_TOL	VOC TOL
BBMi (Rp/Km)	932.5	960
BOi (Rp/Km)	14.1	15
BPi (Rp/Km)	261.6	88
BUi (Rp/Km)	1,858.9	1,022
BBi (Rp/Km)	44.5	22
TOTAL(Rp/Km)	3,112	2,107

Then we can find the difference in the value of ΔVOC, which is the difference of VOC using toll roads and non-toll roads, namely ΔVOC = VOCnt-VOCt = Rp 152,463-Rp 94,834 = Rp 57,629.

The calculation of the value of time is based on the income approach method by considering the average GRDP (Gross Regional Domestic Product) of Simalungun Regency, Pematangsiantar City and Tebing Tinggi City, Serdang Bedagai with working hours throughout the year for 2080 days. From the calculation results, the GRDP per capita in 2023 = Rp. 51,527.83 (Rp/year). The value of travel time λ obtained = Rp. 24,773 (Rp/person/hour), while the amount of time value savings ΔTv = Rp. 78,035. Thus, the total value of BKBOK obtained is ΔVOC + ΔTv = Rp 57,629 + Rp 78,035, which is Rp 135,664.

The results of the interview with 100 toll users showed that the average ATP (ability topay) is Rp. 1,878 per km, the average WTP value was Rp. 827 per km.

The determination of the tariff according to previous studies is subject to the following tariff constraints: The tariff is calculated with a tariff < 70% of the total BKBOK [9] and ideally the tariff is taken with a tariff value of 35-45% of the total BKBOK[14].Then the tariff is analysed by considering the ATP and WTP values, namely the tariff must be between the average ATP and average WTP values [15]. A summary calculation of tariff constraints is shown in table 2.

Table 2 Tariff Constrain

TARIFF CONSTRAINT	
Tariff <70 % BKBOK	< Rp 2,110 per km
Tariff > 35 % BKBOK	> Rp 1,055 per km
Tariff <45 % BKBOK	< Rp 1,357 per km
Tarif < ATP Avarage	Rp 1,878 per km
Tarif > WTP Avarage	Rp 827 per km

The tariff constraint in table 2 can also be shown in figure 2. It shows that taking into account BKBOK, ATP and WTP, the tariff interval with the slice in bold is the recommended final tariff based on BKBOK, ATP and WTP.

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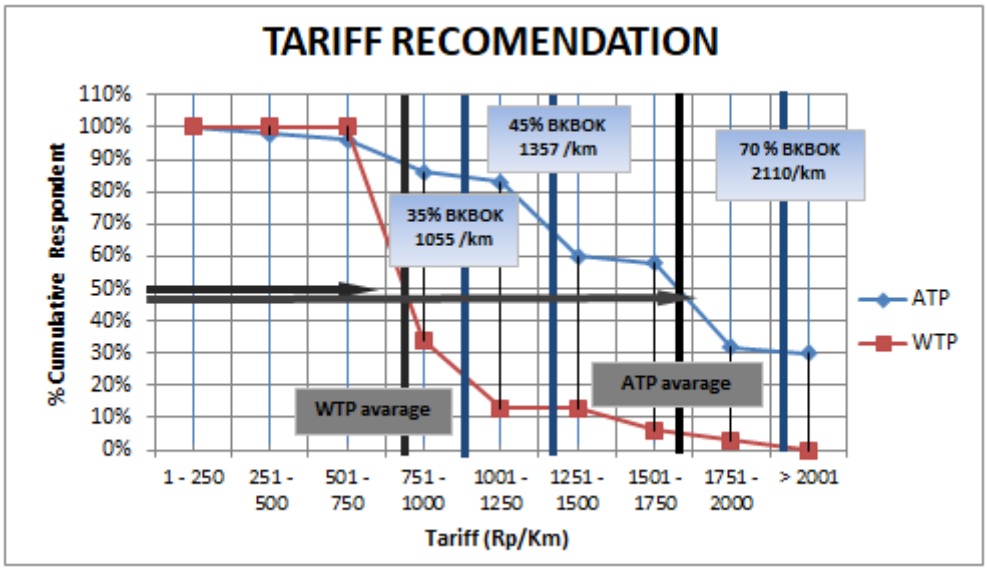

Figure 2 Tariff Recomendation

In Figure 2, the tariff shown by the vertical black line is the tariff based on the average of ATP and WTP. The tariff shown by the vertical blue line is the tariff based on BKBOK. The recommended initial tariff for the Tebing Tinggi Pematangsiantar Toll Road is a 35% BKBOK tariff because it has the most bold slices of all tariff constraints, namely Rp 1,055 per km or Rp 47,475.

4. Conclusion

In the calculation of VOC for passenger cars with model PD-T-15-2005, the VOC saving by using the toll road is Rp 57,629.

The study also found that the value of time is Rp 24,773 per hour and the VOT saving by using the Tebing Tinggi Pematangsiantar Toll Road is Rp 78,035.

The VOT savings was 35% higher than VOT savings. and VOT savings contribute 58% of total vehicle operating cost savings, which is Rp 135,664.

The recommended initial toll tariff of Tebing Tinggi Pematangsiantar Toll Road is Rp. 1055 per km or Rp 47,475. This tariff is willing to be paid by ± 22% of toll road users and able to be paid by ± 87% of toll road users.

5. Acknowledgement

This study is an attempt to provide input to decision makers in determining tariffs that consider the public user side as toll road users, and to open thoughts for further study to obtain toll roads that are sustainable and have a good impact on Indonesia's future development. the author would like to thank various parties who helped this study to run smoothly.

6. Conflict of Interest

The authors of the articles in this journal declare that they have no conflicts of interest.

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