Evaluation of toll rates based on ATP / WTP and BKBOK case studies: Medan-Binjai and Medan-Tebing Tinggi toll roads

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Abstract. The government is obliged to provide road infrastructure inadequate supply of infrastructure, either to accelerate the regional economy. Due to the limited budget in efforts to fulfill road infrastructure, so the government carries out various policies to attract the private sector to invest in the road sector, especially toll roads. One of the parameters of toll road investment is related to the initial of toll rate to be applied, where toll rates are determined by saving in vehicle operating costs and value of time and considering the Ability to Pay and Willingness to Pay (ATP / WTP). This study aims to evaluate toll rates are set for the Medan-Binjai and Medan-Tebing Tinggi sections with BKBOK and ATP/WTP analysis, as a reference in the basic operation of the toll road.

1. Introduction
Transportation is an activity that is derived demand, where the need for transportation cannot be separated from the development of the region, activity patterns, population, and economic growth. Road infrastructure improvements such as additional road capacity will reduce travel time and transportation cost, which has a major impact on improving productivity, distribution of goods and competition in the production sector. Therefore, the transportation sector cannot be separated from the regional economy. At its most basic level, transportation must be able as a logistic function (Taking Raw Materials; manufacture to consumer) and providing access to people [1].

Transportation in Indonesia is dominated by road transportation, but the condition of road infrastructure is still lagging behind Asian countries. According to the World Bank in the Logistic Performance Index (LPI) report, Indonesia's position on LPI for infrastructure is ranked 54th while Malaysia is ranked 40th, Thailand is ranked 41st, Vietnam is ranked 47th, and Singapore is ranked 5th[2]. The Indonesian government views the development of road infrastructure as a very important requirement in efforts to develop the regional economy. Therefore, the government continues to make the provision of road infrastructure. Due to the limited budget in efforts to fulfill road infrastructure, the government needs to involve the private sector to be given the opportunity to participate in the provision of roads through Private Public Partnership (PPP) scheme, one of which is toll roads [3].

Toll revenues are obtained from road user charges, then determining the amount of toll rate becomes an important discussion for investors and this will affect the concession period of the toll road. The basic principle of determining the toll rate is to consider the financial situation of both the toll authorities and the road users. Toll rates should meet the following conditions:
Revenues from toll roads should be sufficient to cover capital investment, operating and maintenance costs within the required time period.

Toll rate should be within the affordable range of road users, taking into account the difference in benefits obtained using toll roads compared to non-toll roads (benefit from using the toll road). Both of the foregoing conditions have to be met. If the toll rate is too high, the toll road becomes less attractive to the users. In contrast, if the toll rate is too low, the investment cannot be adequately recovered, which would affect further investment and development on toll road projects. Then the purpose of this paper is to review the toll rates applied for the Medan-Binjai and Medan-Tebing Tinggi toll roads, by comparing the rates set by toll authorities with the rates calculated by saving vehicle operating cost and value of time (BKBOK) and Ability to Pay/Willingness to Pay (ATP/WTP).

2. Literature review
Based on UU No 38 the year 2004, The operation of toll roads is to: facilitate traffic in areas that have developed, distribution of goods and services to increase regional economic growth, reduce the burden of government budgets through the participation of road users.

2.1. Study of the development of toll roads in Indonesia
The history of developing toll roads in Indonesia was started in 1978 with operating the Jagorawi toll road with a length of ± 59 km, which connects Jakarta, Bogor, and Ciawi. Development of toll roads in Indonesia is still considered as very slow, from 1978 until 2008 only 684 km of the toll road was built in Indonesia. It is still very far compared to Malaysia and China that have already built toll roads for about 1500 km and 40,000 km even though both particular countries have just recently built toll roads in 1980 and 1990. Road development until 2005 or 25 years of construction of the Indonesian toll road, only 600 km[4]. The growth of toll roads in Indonesia from 1978 to 2015 can be seen in Table II.1.

| Period | Years          | Length (km) | Toll roads develop (km/year) |
|--------|----------------|-------------|------------------------------|
| I      | 1978-1983      | 58          | 11.80                        |
| II     | 1983-1987      | 302         | 60.75                        |
| III    | 1987-1993      | 524         | 37.00                        |
| IV     | 1993-1998      | 561         | 7.40                         |
| VI     | 2002-2005      | 649         | 27.00                        |
| VII    | 2005-2008      | 688         | 13.00                        |
| VII    | 2008-2012      | 774         | 21.50                        |
| VIII   | 2018-2012      | 774         | 21.50                        |
| IX     | 2012-2015      | 820         | 15.30                        |
| X      | 2015-…        | 1,064       | 122.00                       |

From table II.1, we can see the number of planned toll roads and those already operating in Indonesia. When compared to China, until 2000 China has built 17,900 km [5].

2.2. Determination of toll rates
In economic theory, tariffs can be interpreted as prices or costs imposed as compensation in the consumption of a product, both goods, and services. Therefore, toll rates can be defined as the rates charged as compensation for consuming toll road services. In determining the toll road tariff in Indonesia, it is calculated based on the profit of vehicle operating costs (BKBOK), investment feasibility, ability to pay and willingness to pay from toll road users [6]. Determination of the initial toll rate is determined based on the regulation of Law No. 38/2004 article 48 paragraph (4) uses 3 approaches, namely:
2.2.1. Saving of vehicle operating cost and value of time (BKBOK)
The determination of the toll rate is based on the profit that is resulted from savings of vehicle operating costs and amount of time. The amount of this profit, which is more commonly referred to the Benefit of Vehicle Operating Cost (BKBOK) can be calculated by using the following equation [7]:

\[
BKBOK = (BOK_n \times D_n) - (BOK_t \times D_t) + ((D_n/V_n - D_t/V_t) \times T_v)
\]  

(1)

Where BOK is the vehicle operating cost, D is the distance travelled and V is the speed of vehicles compared from non-toll road and toll road.

2.2.2. Ability to pay/willingness to pay (ATP/WTP)
Ability to Pay (ATP) is the ability to pay for services received based on income. The approach used in ATP analysis is the allocation of transportation costs from the amount of income earned (ability to pay). ATP is analyzed by the following equation [8]:

\[
ATP = \frac{I \times P_p \times P_t}{T_r}
\]  

(2)

Where I (IDR) is the level of respondent’s income, Pp is a percentage of transportation budget per month, Pt is a percentage of transportation cost allocation per destination and Tr is the total length of trip of respondents per month. Willingness to Pay (WTP) is the willingness of users to pay for services obtained. The approach used in the analysis of tariff determination is based on the preferences of the users of transportation services. The results of the WTP analysis are the most optimum toll rate and in accordance with the willingness of the users to pay. use the formula as follows [8]:

\[
Tariff_n = \left[\frac{D_{non-tol}}{V_{non-tol}} - \frac{D_{tol}}{V_{tol}}\right] \times WTP_{opt}(1 + i)^{(n-2012)} \times okp
\]  

(3)

Where Tariff\(_n\) is initial toll rate, D is the length of road and V is the speed on road. The main issue for calculating toll rate according to WTP is that the rate will be set at what number% -tile (or at the percentage of willingness to pay).

3. Result
Toll rates and changes are under the control of the government, so investors cannot monopolize. The following are the toll rates applicable in Indonesia.

Table 2. Toll rates group I in Indonesia.

| NO | TOLL ROADS                    | LENGTH (km) | TOLL RATES (IDR/km) |
|----|-------------------------------|-------------|---------------------|
| 1  | Purwakarta-Bandung-Cileunyi   | 58.5        | 786                 |
| 2  | Palimanan–Kanci               | 26.3        | 304                 |
| 3  | Bakauheni-Palembang          | 140.9       | 774                 |
| 4  | Kanci-Pejagan                 | 35.0        | 829                 |
| 5  | Surabaya-Gresik               | 20.7        | 435                 |
| 6  | Medan-Binjai                  | 16.8        | 563                 |
| 7  | Medan-Tebing Tinggi          | 61.8        | 720                 |

Medan–Binjai Toll Road is a toll road connecting to Medan from Binjai, with a length of ± 16.8 Km. This initial toll rate for this corridor is IDR, 9,500. The Medan–Kuala Namu–Tebing Tinggi Toll Road is a toll road that connects Medan, Kualanamu International Airport and Tebing Tinggi, in Sumatra, Indonesia, and set the initial toll rate is IDR 45,000. Both toll roads are part of the Trans-Sumatra Toll
Road network. Following is the calculation of initial toll rates using ATP/WTP and BKBOK analysis, the toll tariff rates were obtained as seen in the following table:

| No | Analyzes       | Toll rates (IDR/Km) | Total Toll rates (IDR) |
|----|----------------|----------------------|------------------------|
| Ruas Medan – Binjai               |                   |                      |
| 1  | WTP Opt(70%)   | 507                  | 8,517                  |
| 2  | 50% ATP        | 551                  | 9,256                  |
| 3  | WTP (60%)      | 660                  | 11,088                 |
| 4  | BBOK           | 687                  | 11,542                 |
| Ruas Medan – Tebing Tinggi        |                   |                      |
| 1  | WTP Opt(70%)   | 515                  | 31,827                 |
| 2  | 50% ATP        | 555                  | 34,299                 |
| 3  | WTP (60%)      | 660                  | 40,788                 |
| 4  | BBOK           | 710                  | 43,878                 |

Based on the conditions mentioned above, analysis of determining the Medan-Binjai and Medan-Tebing Tinggi toll rates which are adjusted with the ATP/WTP and BKBOK of the direct users, as comparison data with the rate that has been determined by the government.

**Figure 1.** Toll rates analysis.

4. Conclusion

In determining toll rates must consider the road user side and return on investment, so the toll rate may be set by the government, but the minimum toll rate is required to attract private investment. For the Medan-Binjai toll road, with a length of 16.8 km, the toll rate is set at IDR 9,500. This rate is greater than 70% of the BKBOK value, but below the WTP value. Although the toll rate is still above the ATP value, this shows the desire of users to pay for transportation services is greater than the ability to pay.

For the Medan-Tebing Tinggi toll road, with a length of 61.8 km, the toll rate is set at IDR 44,500. This rate is greater than of BKBOK and ATP/WTP values. From the ATP/WTP relationship, the toll rate is IDR 40,878, but ATP is lower than the WTP value, which means that road users have a relatively low income but the utility of toll roads is very high, so it tends to be more affected by its utility (captive riders).

Evaluation and adjustment of toll rates are carried out every 2 (two) years, based on the initial toll rate adjusted to the inflation rate (UU No. 38/2004 article 48 paragraph (3), PP 15/2005 article 68 paragraph (1). This does not take into account the traffic conditions (traffic growth), where this is the criterion for determining the initial toll rates, so regulation needs to be adjusted for this. We hope this can balance the affordability or prospective road users and the sustainability of the project with the project's attractiveness to the private sector.
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