

Study Of Toll Road Tariffs Based On Bkbok, Atp, And Wtp For Fleet Owners Or Drivers Of Goods Transport Truck On The Tebing Tinggi – Pematang Siantar Toll Road Section

Frans Irvan Putra Siahaan

Program Studi, Nmagister Teknik Sipil, Fakultas Teknik, Universitas Sumatera Utara, Indonesia

Anthoni Veery Mardianta

Program Studi Perencanaan Wilayah dan Kota, Fakultas Teknik, Universitas Sumatera Utara, Indonesia

Ridwan Anas

Program Studi, Magister Teknik Sipil, Fakultas Teknik, Universitas Sumatera Utara, Indonesia

Corresponding Author: fransirvans322@gmail.com

Abstract

Toll roads are transportation infrastructure that play an important role in improving the efficiency of freight movement by reducing travel time and vehicle operating costs. However, toll tariff determination should consider the balance between the economic benefits received by users, their ability to pay, and their willingness to pay. This study aims to analyze Vehicle Operating Cost Savings (Besaran Keuntungan Biaya Operasional Kendaraan/BKBOK), Ability to Pay (ATP), and Willingness to Pay (WTP), as well as to determine the feasible toll tariff for Class II and Class III freight vehicles on the Tebing Tinggi–Sinaksak Toll Road. BKBOK was calculated using the Pd T-15-2005-B method by comparing vehicle operating costs on toll and non-toll road segments. ATP was analyzed using the Household Budget Approach (HBA), based on respondents' income, transportation cost allocation, and travel frequency, while WTP was analyzed using the Stated Preference (SP) method based on respondents' responses to several tariff scenarios. The results show that the BKBOK value for Class II vehicles is Rp193,833/trip or Rp4,293.83/km, while for Class III vehicles it is Rp311,608/trip or Rp6,924/km. The ATP value for Class II vehicles is Rp50,071/trip or Rp1,113/km, while for Class III vehicles it is Rp66,494/trip or Rp1,478/km. Meanwhile, the WTP value for Class II vehicles is Rp64,571/trip or Rp1,435/km, while for Class III vehicles it is Rp81,143/trip or Rp1,803/km. The higher WTP than ATP in both vehicle classes indicates that

1913



users' willingness to pay is influenced by the perceived benefits of toll road use, while their actual ability to pay remains more limited. Based on the comparative analysis of ATP and WTP, the feasible tariff range for Class II vehicles is Rp50,071–Rp64,571/trip, whereas for Class III vehicles it is Rp66,494–Rp81,143/trip. The existing tariff of Rp78,000/trip exceeds the feasible tariff range for Class II vehicles but remains within the feasible range for Class III vehicles. The implication of this study highlights the need to evaluate the toll tariff structure based on the characteristics of each vehicle class so that tariff policy can support investment sustainability, user affordability, and the optimal utilization of toll roads by freight vehicles..

Keywords: Vehicle Operating Cost Savings (BKBOK); Ability to Pay (ATP); Willingness to Pay (WTP); Toll Road Tariff; Tebing Tinggi–Sinaksak

INTRODUCTION

Transportation infrastructure development is a key pillar in driving economic growth, improving logistics efficiency, and expanding market access. Toll roads, as a form of modern transportation infrastructure, play a crucial role in accelerating the flow of goods and services, reducing distribution costs, and strengthening inter-regional integration. In line with this, a study on the economic impact of tolls on freight vehicles confirmed that toll roads significantly contribute to reducing logistics costs, increasing transportation efficiency, and ultimately strengthening regional competitiveness (Widiawati et al., 2024).

In Indonesia, toll road development is a top priority within the National Strategic Projects (PSN) framework, aiming to improve interregional connectivity while reducing national logistics costs. This urgency stems from the fact that Indonesia's logistics costs remain very high, ranging from 23–28% of Gross Domestic Product (GDP), significantly higher than those of other countries in Southeast Asia. This situation underscores the need to accelerate toll road infrastructure development as a strategic instrument to improve the efficiency of goods distribution and enhance national economic competitiveness (Wibawa, 2023).

Regulatoryly, toll tariffs are set out in Government Regulation Number 15 of 2005 concerning Toll Roads. In addition, Law Number 38

The 2004 Roads Act and other related provisions stipulate that toll rates must consider users' ability to pay and the investment feasibility of toll road operations. In practice, the initial



toll rate is calculated by considering key indicators, namely Vehicle Costs and Vehicle Operating Costs (BKBOK), Ability to Pay (ATP), and Willingness to Pay (WTP) (Wathan, 2019).

Conceptually, the BKBOK represents the direct economic benefits obtained by toll road users compared to using alternative non-toll roads. The BKBOK value is calculated based on the difference in vehicle operating costs and travel time between toll road and alternative public road conditions. Thus, the BKBOK reflects transportation efficiency resulting from improved infrastructure quality, higher travel speeds, and reduced vehicle operating costs during the toll road's usage period. Meanwhile, the ATP reflects users' financial ability to pay toll fares, and the WTP reflects users' willingness to pay based on their perceived benefits. The balance between these three indicators is an important basis for determining appropriate, proportional, and equitable toll tariffs (Wardman et al., 2023).

Various previous studies have examined toll tariff determination based on BKBOK, ATP, and WTP in various regions of Indonesia. For example, this study is similar to the case studies of the Medan–Binjai and Medan–Tebing Tinggi toll roads, where the results indicate that the initial tariffs set by the government are above the ATP value, but still within the WTP and BKBOK ranges (Anas, Sembiring, & Puji Hastuty, 2020). This condition illustrates that road users' willingness to pay is higher than their actual ability to pay, so that toll utility plays a dominant role in usage decisions, especially for the group of "captive riders" with relatively low incomes.

Toll road tariffs must be set proportionally, not only based on the financial aspects of the investment but also by considering the ability and willingness of users. Research on the Pandaan–Singosari Toll Road emphasized the importance of ATP and WTP analysis in determining a reasonable initial tariff, ensuring that the tariff is not burdensome and acceptable to the public (Voronina, 2022). Meanwhile, a study on the Jakarta–Cikampek Toll Road found that the discrepancy between ATP and WTP directly impacted low toll road utilization, indicating that tariff policies that ignore affordability factors have the potential to reduce infrastructure effectiveness (Tamin, 2000). A similar finding was demonstrated by research on the Banda Aceh–Sigli Toll Road, where higher toll tariffs compared to the public's WTP led to low user interest in switching from arterial roads to toll roads (Shofwan et al., 2021).

In the context of North Sumatra, the Tebing Tinggi – Pematang Siantar Toll Road holds strategic significance. This toll road serves a dual function as an interregional logistics distribution route and access to the priority tourist area of Lake Toba. For the logistics sector, this toll road is expected to reduce the cost of distributing goods from Belawan Port and the Medan Industrial



Estate to Pematang Siantar and the trade distribution area. However, the primary users of this toll road are truck owners or drivers, who have unique characteristics in terms of their ability and willingness to pay. If the toll rate is set too high, it is feared that truck users will continue to choose cheaper non-toll routes, even if the travel time is longer. Based on this, there is an urgent need to conduct a study on the affordability of the Tebing Tinggi – Pematang Siantar Toll Road (Santoso et al., 2021)..

This study focuses on three main aspects, namely Vehicle Costs and Vehicle Operating Costs, Ability to Pay (ATP), and Willingness to Pay (WTP) of owners (fleet owners) or truck drivers as the main users. Thus, this study has academic and practical urgency to fill the gap in previous research that has not highlighted the affordability of toll rates for entrepreneurs and truck drivers Class II-III with the BKBOK, ATP, and WTP approaches (Sánchez Bardales et al., 2025). The results of this study are expected to provide a comprehensive picture of appropriate toll rates, as well as provide input for the government and toll road operators in formulating fairer, more efficient, and sustainable tariff policies.

METHODS

The location of this research is the Tebing Tinggi–Pematang Siantar Toll Road section which is part of the Trans-Sumatra Toll Road (JTTS) network. This toll road section has a length of approximately 45 km, consisting of two main segments, namely Tebing Tinggi–Serbelawan and Serbelawan–Pematang Siantar, with the starting point at the Tebing Tinggi Toll Gate and ending at the Sinaksak Toll Gate (Redinata et al., 2021). The research location is considered relevant to examine the relationship between Vehicle Costs and Vehicle Operating Costs (BKBOK), Ability To Pay (ATP), and Willingness To Pay (WTP), especially for the main users in the form of fleet owners or Class II and III truck drivers.

This study focuses on the analysis of the Tebing Tinggi–Pematang Siantar Toll Road tariffs by considering three main aspects, namely Vehicle Costs and Vehicle Operating Costs (BKBOK), Ability to Pay (ATP), and Willingness to Pay (WTP). The research objects are fleet owners or truck drivers in Class II and III as the main users of the goods distribution route on the toll road section. The final objective is to assess the suitability of toll tariffs with respondents' ability and willingness to pay, and to formulate recommendations for appropriate and sustainable tariffs (Rahma et al., 2024).



The sampling technique used in this study is non-probability sampling, specifically purposive sampling, namely the selection of respondents based on certain criteria that have been determined by the researcher.

The selection of a sample of 70 respondents also corresponds to the characteristics of a homogeneous population, namely the group of Class II and III truck owners/drivers, so it does not require a large sample size like research with a heterogeneous population. Thus, the sampling technique applied is included in the non-probability sampling (purposive) category with a sample size of 70 respondents, who were selected in a targeted manner to support accurate BKBOK, ATP, and WTP analysis (M. P. Umum, 2007).

The next stage in this research is data collection consisting of primary data through field surveys of fleet owners or Class II and III truck drivers as respondents, as well as secondary data obtained from related agencies such as the Toll Road Regulatory Agency (BPJT), the Central Statistics Agency (BPS), the Ministry of Public Works and Public Housing (PUPR), and the 2005 Vehicle Operational Cost (BOK) guidelines.

The collected data is then processed in the analysis stage, which includes the calculation of Vehicle Costs and Vehicle Operating Costs (BKBOK) referring to the 2005 BOK guidelines, measuring Ability To Pay (ATP) using the Household Budget Approach, and estimating Willingness To Pay (WTP) using the Contingent Valuation Method (CVM) through the stated preference and revealed preference approaches. The calculation results are then compared to examine the relationship between ATP, WTP, and BKBOK as a basis for evaluating the level of toll tariff affordability on the Tebing Tinggi–Pematang Siantar section (T. A. Litman, 2024).

In addition to CVM, the transportation economics literature also proposes several alternative methods for estimating user preferences and WTP. One such method is the Discrete Choice Experiment (DCE), which estimates WTP based on respondents' choices across several fare or service attribute scenarios using probability models such as logit or nested logit. This approach captures the trade-offs between fare characteristics, travel time, and operating costs in road users' decision-making processes. This approach is comprehensively discussed in a study on WTP estimation based on discrete choice models (T. Litman, 2022).

Another widely used approach in economic valuation studies is the Travel Cost Method (TCM), a revealed preference method that calculates the economic value of a trip based on actual user costs derived from real-world behavioral data. This method has been systematically



discussed in the cross-sector economic valuation literature for public services (Lestari et al., 2021).

This research aligns with previous studies. Anas et al. (2020) in the Medan–Binjai and Medan–Tebing Tinggi cases showed that BKBOK calculations often yield higher tariffs than ATP, necessitating a WTP analysis to assess social feasibility. Furthermore, a study specifically examining the Tebing Tinggi–Pematang Siantar section found that a balance between BKBOK, ATP, and WTP is key to determining a sustainable initial tariff (Anas et al., 2024). Similar results were also seen in a study highlighting the importance of tariff setting strategies in maintaining stable operator revenue while maintaining user affordability (Hidayati et al., 2021).

RESULTS AND DISCUSSION

Overview of Research Object

Condition Existing Toll and Non-Toll Roads

By presenting the results of the analysis and discussion compiled based on primary and secondary data collected in accordance with the research methodology in Chapter III. Primary data was obtained through field surveys and direct interviews with fleet owners or drivers of Class II and III freight trucks as the main users of the Tebing Tinggi–Pematang Siantar Toll Road. Meanwhile, secondary data includes road technical data, vehicle characteristics, operational cost component prices, as well as relevant regulations and calculation guidelines. The following is a recapitulation of the BOK data used in the table below (Maps, 2026):

Table 1. Road and Traffic Condition Data

No	Data Details	Non-Toll Value	Toll Value	Unit	Data source
1	Study Segment	Tebing Tinggi – Pematang Siantar Road Section (Tebing Toll Gate – Sinaksak Toll Gate)			
2	Segment Length	49	45	km	BPJT & BPJN
3	Road Width	9.8	7.2	meters	BPJT & BPJN
4	Shoulder Width	1.5	4.5	meters	BPJT & BPJN



5	Road Roughness (IRI)	4, 5	2.5	m/km	BPJT & BPJN
---	----------------------	------	-----	------	-------------

The average vehicle speed (V_r) for each road condition was determined based on the results of a field speed survey conducted at a single observation point considered representative of the study segment, using a *speed gun*. The average speed values used in the analysis were 30 km/h for non-toll roads and 93 km/h for toll roads. This speed difference was used to calculate travel time for each road condition. (Anas et al., 2024).

Vehicle Classification and Cost Component Prices

In this study, vehicle analysis focused on two main categories of freight vehicles, namely Category II and Category III, in accordance with the vehicle classification system on toll roads in Indonesia which is based on the number of axles and physical characteristics of the vehicle. The determination of representative vehicles for each category was carried out based on the results of a field survey of fleet operators and drivers operating on the Tebing Tinggi–Pematang Siantar corridor (Gomez et al., 2017).

For Class II, the representative vehicle is a Mitsubishi Canter FE 74 HD with a two-axle, six-wheel configuration. Meanwhile, for Class III, a FN61FS truck with a three-axle, ten-wheel configuration is used. The selection of these two vehicle types is based on field observations and interviews with freight transport operators, which indicate that these two models are the most dominant fleets used in the research segment, both for medium-distance and intercity goods distribution (Farida et al., 2019).

Vehicle dimensions, wheel configuration, fuel tank capacity, and suspension and braking systems are the basis for determining operational loads and driving safety levels under varying road geometric conditions. Meanwhile, engine data, including cylinder capacity, maximum power, and peak torque, are used as primary inputs in estimating fuel consumption and vehicle performance on flat and uphill roads.

Travel Time Value Analysis

Condition social regional economy is one of the aspect important in study transportation, in particular in analyze mark economy time journey users road. Activity level economy an area



can describe ability economy public as well as mark productivity time owned by the user transportation. In research this, condition social regional economy analyzed using Product data Gross Regional Domestic Product (GRDP) per capita in the areas passed through Tebing Tinggi–Pematang Toll Road Section Siantar.

Results of Calculation of Large Vehicle Operating Cost Profit (BKBOK)

This presents the results of the calculation of the Comprehensive Vehicle Operating Costs (BKBOK) on the Tebing Tinggi – Pematang Siantar section, which were analyzed for Class II and Class III freight vehicles on toll and non-toll road conditions. The calculation was carried out to identify the magnitude of the difference in vehicle operating costs between the two alternative routes as a basis for assessing the economic benefits of using toll roads. In this study, the structure of vehicle operating costs is divided into two main groups, namely variable costs (*running costs*) and fixed costs (*ownership costs*). The calculation of variable costs (*running costs*) refers to the Guidelines Pd-T-15-2005-B on Calculation of Vehicle Operating Costs Part I. The guidelines state that vehicle operating costs per unit distance traveled are influenced by the parameters of vehicle operating conditions and road section characteristics, especially the average vehicle speed, road surface roughness (IRI), total vehicle weight, and road geometric conditions. The cost components calculated in this group include fuel costs, lubricant costs, spare parts costs, maintenance labor costs, and tire costs. Meanwhile, fixed costs (*ownership costs*) are calculated using an approach that is in line with the development of the HDM-IV (*Highway Development and Management Model*), which considers the cost of vehicle ownership over its economic life (Ekocahyanto et al., 2021).

Calculation of BKBOK on Toll and Non-Toll Road Sections of Class II

Calculation BKBOK costs on the section toll and non- toll roads done For determine size cost operational vehicle transport goods / logistics Group II and Group III in rupiah per kilometer (Rp/km) based on conditions operation The actual cost of each section. This calculation forms the basis for analyzing operational cost efficiency and savings resulting from toll road use.

BKBOK is calculated as the sum of variable costs and fixed costs. Variable costs are calculated referring to the Pd-T-15-2005-B Guidelines which include the costs of fuel, lubricants, tires, spare parts, and maintenance labor, taking into account operational parameters such as vehicle speed and road surface conditions (IRI). Fixed vehicle costs in this study are calculated



using the vehicle ownership cost approach which refers to the vehicle operating cost analysis framework developed in international models, including HDM-IV (*Highway Development and Management Model*), the Road User Cost Model approach by *the Transport Research Laboratory* (TRL), and *the Vehicle Operating Cost concept* commonly used in road transportation economic analysis. Calculations are carried out separately for Class II and Class III due to differences in vehicle technical characteristics that affect the operational cost structure. BKBOOK values on toll and non-toll roads are then compared to obtain the difference in operational costs as an indicator of savings in toll road use. Based on the calculation of vehicle operating costs according to the T-15-2005-B Guidelines, the BOK components for non-toll and toll roads consist of fuel consumption costs, oil costs, spare parts costs, maintenance wages, and tire costs.

Table 2. Recapitulation Results BOK Calculation Class II

Component	Non-Toll BOK (Rp/Km)	Toll BOK (Rp/Km)	Difference	%Non Toll	%Toll
BBMi	1676	1600	76	26	53,237
BOi	255	255	0	4	8,487
BPi	261	16	246	4	0.529
B U i	3932	919	3013	61	30,595
BBi	309	215	94	5	7,152
Total	6433	3005	3429	100	100

Next, after done identification and comparison every component cost operational vehicles on both route, stages next is count size BOK savings obtained users road if use road toll road. The results show that use route toll give savings cost operation vehicle Rp. 180,018.86 per trip For vehicle Group II.

Besides the benefits from BOK savings, BKBOOK calculations also take into account benefit savings time journey. Based on the analysis mark time, obtained benefit savings time journey amounting to Rp. 13,203.58/trip shows size benefit economic gains users vehicle consequence decrease time journey moment use road toll compared to non- toll route.

After being obtained mark savings Cost Operation Vehicle (BOK) of Rp. 180,018.86/trip and savings time journey amounting to Rp. 13,203.58/trip, then furthermore done calculation benefit total economic gain users vehicle Class II consequences use of the Tebing Tinggi– Sinaksak Toll Road. Economic benefits the counted with add up benefit BOK savings and benefits savings



time journey so that obtained mark Magnitude Profit Cost Operation Vehicle (BKBOK) which reflects total profit accepted economy users vehicle in every journey.

Calculation of BKBOK on Toll and Non-Toll Road Sections of Group III

After calculating the operating costs of Class II vehicles, the next analysis is directed at Class III vehicles to determine the amount of vehicle operating costs and the economic benefits obtained from using toll roads compared to non-toll roads. In this study, Class III vehicles are represented as medium trucks, so that the entire calculation process refers to the parameters and coefficients of the vehicle category as stipulated in the Guidelines for Pd T-15-2005-B Part I: Variable Costs (*Running Cost*). This guideline is used as the basis for calculations because it provides an empirical model that is designed according to vehicle characteristics and road operational conditions in Indonesia (Doll et al., 2017).

Calculations for Group III are carried out by differentiating the operational conditions of vehicles on non-toll roads. and toll roads, thus obtaining a clearer picture of the differences in vehicle operating costs on the two types of roads (D. P. Umum, 2005). According to the guidelines, vehicle operating costs are calculated by adding up several variable cost components, namely fuel consumption costs (BBMi), oil consumption costs (BOi), spare part consumption costs (BPi), vehicle maintenance wages (BUi), and Tire consumption cost (BBi), expressed entirely in rupiah per kilometer (Rp/km). With this approach, the BOK value obtained is a technical estimate based on vehicle parameters and road conditions, not based on road user perceptions.

The recapitulation of the calculation results for BOK Group III components is presented in the following table (Djakfar et al., 2021):

Table 3. Recapitulation Results BOK Calculation Group II I

Component	Non-Toll BOK	Toll Road BOK	Difference	% Non-Toll	% Toll
BBMi	2680	2155	525	27.37	53.4 8
BOi	510	510	0	5.21	12.66
BPi	869	30	839	8.88	0.75
B U i	5051	880	4171	51.59	21.83
B B i	680	455	225	6.95	11.29
Total	97 90	4029	5760	100	100

Chart vehicle BOK comparison Group III on non- toll routes and routes toll can seen in the following image :



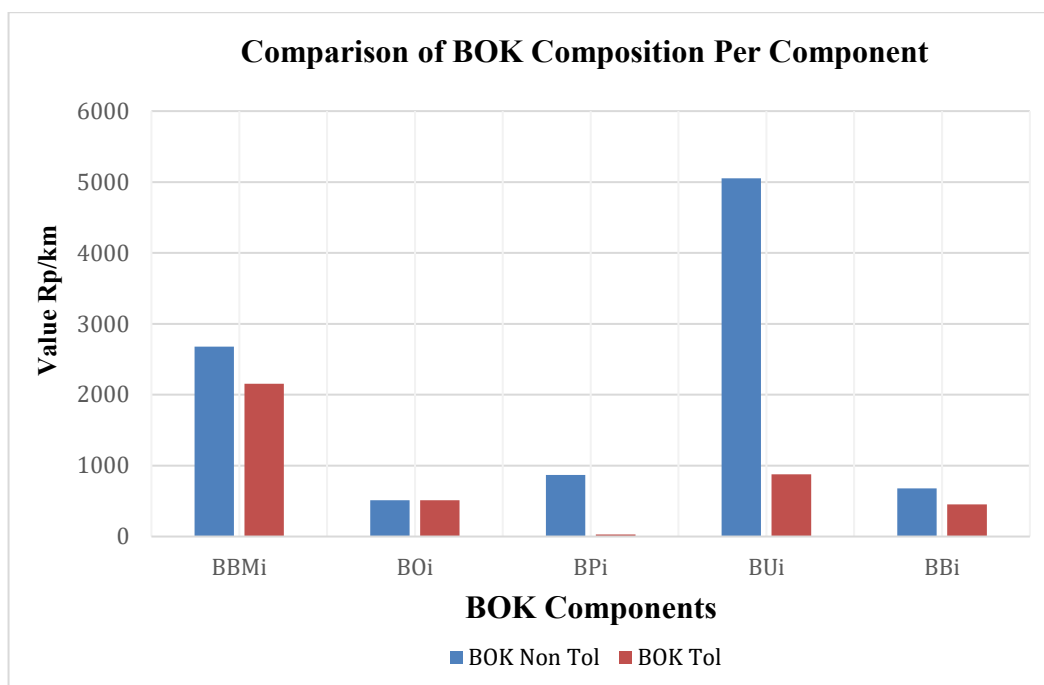


Figure 1. Comparison of BOK Composition Per Component in Group III

Based on the Graph said, the components cost the largest in both route is cost wages maintenance vehicles (BUi). On non- toll routes, the value Jail amounting to Rp. 5.05 1, while on the route toll amounting to Rp. 8.80. In addition, the cost consumption material burn oil (BBMi) also showed quite a difference significant, namely of Rp. 2.680 /km on non- toll routes and Rp. 2.155 / km on toll routes This shows that the use of toll roads can reduce vehicle operating costs, especially on fuel and vehicle maintenance components.

Recapitulation of Vehicle Operating Cost Profit Amount (BKBOK)

Based on the calculation results of the vehicle operating cost (VOC) and time saving benefits, a recapitulation of the Vehicle Operating Cost Benefit (VOC) is then carried out to obtain the amount of economic benefits obtained by users due to the use of the Tebing Tinggi–Pematang Siantar Toll Road. Recapitulation the become base in evaluate benefit use road toll on vehicles Group II and Group III, as follows presented in Table 4.13

Table 1 Recapitulation of BKBOOK Calculation Results

Vehicle Type	BOK Benefits (Rp)	Time Saving Benefits (Rp)	Total BKBOOK (Rp)
Goal II	180,018	13,203.58	193,222
Goal III	298,405	13,203.58	311,608

Based on Table 4.13, it can be understood that the use of toll roads in the research corridor provides direct economic benefits for Class II and Class III vehicle users. This is indicated by the total BKBOOK value which reaches Rp 1,932,222 per trip for Class II and Rp 311,608 per trip for Class III, respectively. The large value indicates that the shift from non-toll roads to toll roads can produce real savings, both in terms of vehicle operating costs and travel time. Thus, the BKBOOK in this study not only represents the cost difference, but also reflects the magnitude of the economic benefits directly felt by users due to the improvement in road service performance on toll roads.

To obtain the WTP value, respondents who choose the categories Definitely Choose Toll Road (1) and Maybe Choose Toll Road (2) are considered willing to pay the offered tariff. The results of the WTP processing are presented in the table below :

Table 3. Cumulative WTP of Respondents in Group I I

Fare (Rp/trip)	WTP (Rp/Km)	Cumulative WTP (Person)	Cumulative WTP (%)
40,000	888.89	70	100
60,000	1333.33	67	96
80,000	1777.78	10	14
100,000	2222.22	1	1
120,000	2666.67	0	0

Based on the table, the cumulative WTP values of Group II respondents show a decreasing trend as the toll road tariffs offered increase. At a tariff of Rp40,000/trip, all respondents (100%) were still willing to pay, then this decreased to 96% at a tariff of Rp60,000/trip. 14% at a rate of Rp80,000/trip, 1% at a rate of Rp100,000/trip, and no respondents were willing to pay at a rate of Rp120,000/trip. These results indicate that increasing the rate has an effect on decreasing the



level of willingness to pay of respondents, so that the range of Rp40,000–Rp60,000/trip is still an acceptable range for most respondents in Group II.

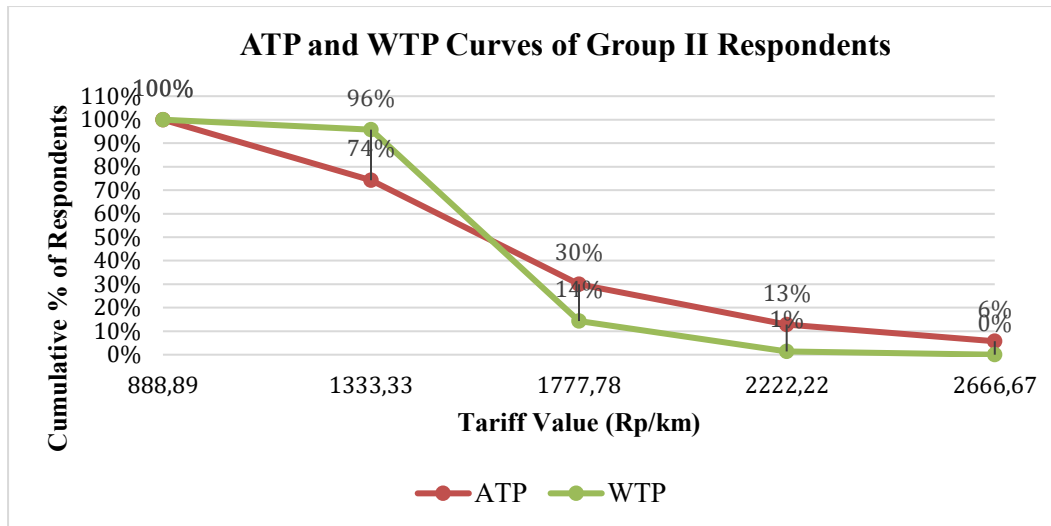


Figure 2. Graph of the relationship between ATP and WTP in group II

Based on the Figure, respondents in Group II tend to be in the $WTP > ATP$ condition. This condition indicates that the level of willingness to pay for toll road users is higher than their ability to pay. These results indicate that the benefits of using toll roads, such as saving travel time, comfort, and smooth distribution of goods, are the main considerations in user decision-making. This finding is in line with research Adani et al. (2024) that obtained the $ATP < WTP$ condition, where users with relatively limited economic capacity still show a higher willingness to pay because the utility or benefits of transportation services are perceived to be quite large.

ATP and WTP Analysis of Class III Vehicles

ATP and WTP Group III analysis was carried out against 70 respondents users of the Tebing Tinggi– Pematang Toll Road Siantar. Analysis This aim For know ability and willingness respondents in pay rates road toll road, so that can give description about level affordability and acceptance rates by user vehicle Group III (Daly et al., 2023).

The height frequency journey will implications direct to size burden cost transportation that must be borne by the respondent in One month. Therefore that, analysis to the total trip become important For understand pattern mobility respondents as well as level dependence to

use road toll road on the corridor Research. The higher the travel intensity, the greater the total expenditure allocated to transportation (Bukhari, 2021).

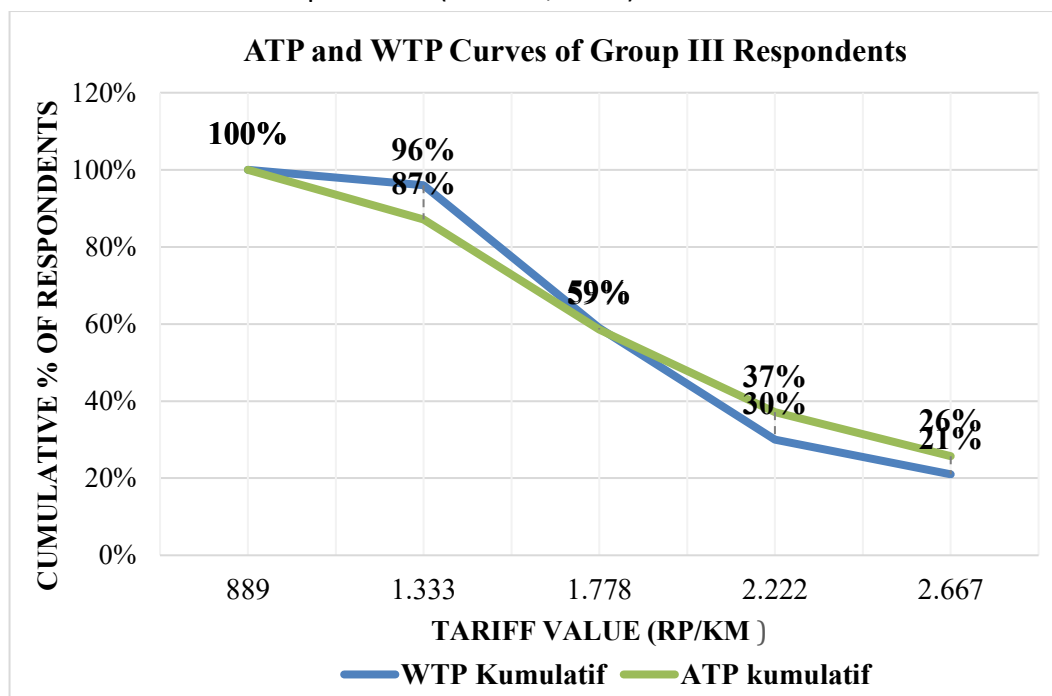


Figure 3. Graph the relationship between ATP and WTP in group III

Based on the Figure, the relationship between ATP and WTP of respondents Group III shows that ability pay and willingness pay change every level rates offered. At a rate of Rp. 40,000/trip and Rp. 80,000/trip, you can get ATP = WTP condition, which shows existence balance between ability and willingness pay respondents. At a rate of Rp. 60,000/trip, WTP > ATP condition, which indicates that respondents own level willingness pay more tall compared to ability pay it. On the other hand, at a rate of Rp. 100,000/trip and Rp. 120,000/trip, you get ATP > WTP condition, which indicates that although part respondents Still own ability For pay rates said, the level willingness pay it relatively more low (Binsuwadan et al., 2022).

Recapitulation of the Results of the Analysis of *Ability to Pay* (ATP) and *Willingness to Pay* (WTP) for Class II and Class III Vehicles

After analyzing the *Ability to Pay* (ATP) and *Willingness to Pay* (WTP) on Class II and Class III vehicles, a recapitulation of the results was conducted to obtain a comprehensive picture of the ability to pay, willingness to pay, and their relationship to existing toll road tariffs. This

1926

recapitulation aims to compare the characteristics of ATP and WTP in both vehicle categories as a basis for evaluating the level of affordability and acceptability of the Tebing Tinggi–Pematang Siantar Toll Road tariffs.

Calculation Analysis of Class II and Class III Tariffs

Analysis rates road toll on research This done use Big Profit approach Cost Operational Vehicle (BKBOK) for know benefit economic gains users road consequence use road toll compared to non- toll road. Determination rates referring to the Law Number 38 of 2004 Article 48 paragraph (4) which states that adjustment rates road toll done with consider ability pay users paths and benefits use road toll road. In addition, the provisions The tariff also refers to the Decree of the Minister of PUPR No. 388/KPTS/M/2018 concerning determination Trans Sumatra Toll Road rates (Bank, 2023).

In this study, tariff analysis was conducted using the BKBOK, ATP, and WTP approaches. BKBOK was used to calculate the economic benefits of toll road use, ATP was used to assess users' ability to pay, while WTP was used to determine users' willingness to pay for tariff scenarios. Furthermore, these three results were compared with the existing tariff of IDR 78,000/trip to assess the feasibility of tariffs for Class II and Class III vehicles.

Based on the table, Class III vehicles have a BOK savings benefit of IDR 298,405/trip. and time saving benefit of Rp13,203.58/trip, so that the total BKBOK obtained is Rp311,608/trip. The BKBOK value is then used as the basis for compiling alternative tariffs, namely **70 %** BKBOK of Rp4,847.24/km, 45% BKBOK of Rp3,116.08/km, and 35% BKBOK of Rp2,423.62/km.

Before conducting a feasible tariff analysis, alternative tariffs are based on The Class III BKBOK was first compared with the respondents' ATP and WTP values. This comparison aims to determine the extent to which the calculated tariffs are economically consistent with users' ability and willingness to pay. Therefore, the following graph is used to show the cumulative relationship between ATP and WTP for the Class III tariff alternative.

Based on the graph cumulative ATP and WTP of vehicles Class III, visible that improvement rates followed by a decline percentage respondents who are able and willing pay. At a rate of Rp. 889/km, the ATP and WTP values are still reached 100%, while at a rate of Rp. 1,333/km, ATP decreased to 87% and WTP of 96%. This show that at the level rates early, majority respondents Group III still own ability and willingness pay relatively tallV(Yusup, 2018).



Point balance between ATP and WTP is in the range of Rp. 1,778/km, with percentage respondents around 59%. This value show condition when ability pay and willingness pay respondents be in a relative position balanced (Ghozali, 2021). Therefore that, the rate of Rp. 1,778/km or around Rp. 80,000/ trip assessed as rates worthy Group III based on ATP and WTP approaches.

Temporary that, alternative rates based on BKBOK show that 35% of BKBOK is Rp. 2,423.62/km, 45% of BKBOK is Rp. 3,116.08/km, and 70% of BKBOK is Rp. 4,847.24/km is above point ATP–WTP balance. Conditions This show that rates based the percentage of the BKBOK in a way economy Still reflect benefit users, but Not yet fully in accordance with level ability and willingness pay respondents Group IIIV (Anugerata & Anas, 2024).

With Thus, the rates worthy Group III more appropriate is in the range of Rp. 1,778/km, because mark the approach rates existing, is at the point ATP–WTP balance, as well as Still show level reception respondents by 59% (Adani et al., 2024). Findings This show that determination rates worthy For vehicle Group III no Enough only is based on BKBOK values, but must consider balance between benefit economy, ability pay, and willingness pay user (Adurthi et al., 2022).

When compared with Anas et al. (2024), research the discuss determination rates the beginning of the Tebing Tinggi– Pematang Toll Road Siantar with BKBOK, ATP, and WTP approaches, as well produce recommendation rates as big as Rp1,055–Rp1,688/km. Research results This Still in line in a way approach, because You're welcome show that rates worthy must consider balance between BKBOK, ATP, and WTP (Anas et al., 2024).

However, the value rates worthy Group III in research this, namely Rp. 1,778/km, a little more tall compared to limit on recommendations of Anas et al. (2024). Differences This can explained Because study This in a way special analyze vehicle Group III, which has characteristics cost operational more big compared to vehicle the higher class low. With Thus, the results study This No compared upside down, but is development from study previous to the object different vehicles (Anas et al., 2020).

CONCLUSION

Based on the results of the analysis of the Tebing Tinggi–Sinaksak Toll Road tariffs for Class II and Class III goods transport vehicles using the approach The amount of Vehicle Operational Cost Profit (BKBOK), *Ability to Pay* (ATP), and *Willingness to Pay* (WTP), then the following conclusions are obtained:



1. The analysis results show that the use of the Tebing Tinggi–Sinaksak Toll Road provides economic benefits in the form of savings in vehicle operational costs and travel time compared to the use of non-toll roads. Based on calculations using the Pd T-15-2005-B method, the BKBOK value for Class II vehicles is Rp193,833/trip or Rp4,293.83/km, while for Class III vehicles it is Rp311,608/trip or Rp6,924/km. These values indicate that the use of toll roads can increase the efficiency of freight vehicle travel costs on the studied section.
2. Based on the method *Household Budget Approach* (HBA), ability pay users counted from income monthly allocation cost transportation, and frequency journey. Analysis results show that the average ATP for Class II is Rp. 50,071/trip or Rp. 1,113/km, while ATP for Class III is Rp. 66,494/trip or Rp. 1,478/ km. Meanwhile that, based on the method *Stated Preference* (SP), willingness pay obtained from response respondents to a number of scenario the rates offered. The results show that the average WTP for Group II is Rp64,571/trip or Rp1,435/km, while the WTP for Group III is Rp81,143/trip or Rp1,803/km. The difference in ATP and WTP values occurs because the two approaches represent different aspects. ATP with the Household Budget Approach describes the respondents' actual ability to pay based on economic conditions, transportation cost allocation, and travel frequency. Meanwhile, WTP with the *Stated Preference approach* describes the respondents' willingness to pay based on their perceptions of the benefits of toll roads, such as travel time savings, smooth travel, and vehicle operational cost efficiency. Therefore, the condition of $WTP > ATP$ indicates that respondents assess the existence of toll roads as having high enough benefits that they are willing to pay more, but their actual ability to pay is still more limited. Thus, tariff determination is not enough to only consider the willingness to pay, but also needs to pay attention to the users' ability to pay so that the tariff set remains affordable and sustainable.
3. Based on the results analysis comparative between BKBOK, ATP, WTP, and tariffs existing, known that vehicle Group II and Group III on the Tebing Toll road section Height– Sinaksak own rates the same existing, namely Rp. 78,000/trip or around Rp. 1,733/km at a distance a 45 km journey. However, even though rates existing second group same, result analysis show that level its suitability different because each group own ability pay and willingness pay what is not The same.



On the vehicle Class II, point The balance of ATP and WTP is in the range of Rp. 1,591/km or equivalent with around Rp. 71,595/trip. This value more low compared to rates existing Rp. 78,000/trip. This means that the fare existing Group II has be on top point ATP–WTP balance. Conditions This show that applicable rates moment This Not yet fully in accordance for users Class II, because rates the Already beyond limit balance between ability pay and willingness pay respondents.

On the vehicle Class III, point The balance of ATP and WTP is in the range of Rp. 1,778/km or equivalent with around Rp. 80,010/trip. When compared with rates existing which is also IDR 78,000/trip, then rates the Still is at a little below point ATP–WTP balance. The difference around Rp. 2,010/trip or about 2.6% more low from point balance. With Thus, the rates existing For Group III still is at in a relative zone can accepted by the user.

With however, although Group II and Group III are applied rates the same existing, namely Rp. 78,000/trip, the result analysis show that rates the more in accordance For Group III compared Group II. In Group II, tariff existing has pass point ATP–WTP balance, whereas in Group III the tariff existing Still approaching and a little be under point balance. Therefore that, the rate worthy based on results study This is around Rp. 71,595/trip for Class II and around Rp. 80,010/trip for Group III.

REFERENCES

- Adani, A. K., Murtejo, T., & Chayati, N. (2024). Studi Penentuan Tarif untuk Buy the Service Trans Pakuan Koridor 1 dengan Metode Ability to Pay dan Willingness to Pay. *Journal of Applied Civil Engineering and Infrastructure Technology*, 5(1), 7–14. <https://doi.org/10.52158/jaceit.v5i1.567>
- Adurthi, N. M., Bari, C. S., Navandar, Y. V, & Dhamaniya, A. (2022). A Study on User Acceptable Road Pricing Policy for Toll Roads: A Case of Eethakota, India. *Transportation Research Procedia*, 62, 656–663. <https://doi.org/10.1016/j.trpro.2022.02.081>
- Anas, R., Hasibuan, G. C. R., & Nasution, M. I. (2024). The Determining Initial Toll Road Tariff Based On BKBOK, ATP And WTP (Case Study: Tebing Tinggi - Pematang Siantar Toll Road Section). *International Journal of Architecture and Urbanism*, 8(3), 401–407. <https://doi.org/10.32734/ijau.v8i3.16953>
- Anas, R., Sembiring, I., & Hastuty, I. P. (2020). Evaluation of toll rates based on ATP / WTP and BKBOK case studies: Medan-Binjai and Medan-Tebing Tinggi toll roads. *IOP Conference*



Series: Materials Science and Engineering, 801. <https://doi.org/10.1088/1757-899X/801/1/012011>

- Anugerata, N., & Anas, E. P. (2024). Evaluation of Toll Rates with the Ability to Pay and Willingness to Pay Approach to Implementation on the Trans Sumatra Toll Road Pekanbaru Dumai Section. *International Journal of Current Science Research and Review*, 07(12). <https://doi.org/10.47191/ijcsrr/V7-i12-80>
- Bank, W. (2023). The Impact of Infrastructure on Development Outcomes A Qualitative Review of Four Decades of Literature. <http://www.worldbank.org/prwp>
- Binsuwadan, J., De Jong, G., Batley, R., & Wheat, P. (2022). The value of travel time savings in freight transport: a meta-analysis. *Transportation*, 49(4), 1183–1209. <https://doi.org/10.1007/s11116-021-10207-2>
- Bukhari, S. A. R. (2021). Sample Size Determination Using Krejcie and Morgan Table. <https://doi.org/10.13140/RG.2.2.11445.19687>
- Daly, A., Hess, S., & De Dios Ortúzar, J. (2023). Estimating willingness-to-pay from discrete choice models: setting the record straight.
- Djakfar, L., Kusumaningsih, R., Pandika, E., & Ratriadi D, G. (2021). Effect of Toll Road Pricing Strategy on Revenue.
- Doll, C., Mejia-Dorantes, L., Vassallo, J. M., & Wachter, K. (2017). Economic impacts of introducing tolls for heavy-goods vehicles: A comparison of Spain and Germany. *Transportation Research Record*, 2609, 36–45. <https://doi.org/10.3141/2609-05>
- Ekocahyanto, I., Supriyadi, I., Program,), Teknik, S., Jalan, P., Jembatan, D., Negeri, P., Jl, J., & Siwabessy, G. A. (2021). Analisis Tarif Tol Berdasarkan Ability to Pay dan Willingness to Pay Rencana Jalan Tol Jakarta-Cikampek II Selatan. 3(2).
- Farida, I., Anasarida, A. A., Susetyaningsih, A., & Kurniawati, R. (2019). Revenue components of road construction operations based on economic feasibility analysis. *Journal of Physics: Conference Series*, 1402(2). <https://doi.org/10.1088/1742-6596/1402/2/022017>
- Ghozali, I. (2021). Aplikasi Analisis Multivariate dengan Program IBM SPSS 26 Edisi 10. Universitas Diponegoro.
- Gomez, J., Papanikolaou, A., & Vassallo, J. M. (2017). Users' perceptions and willingness to pay in interurban toll roads: identifying differences across regions from a nationwide survey in Spain. *Transportation*, 44(3), 449–474. <https://doi.org/10.1007/s11116-015-9662-6>
- Hidayati, N., Waloejo, B. S., & Firdausiyah, N. (2021). PENETAPAN TARIF JALAN TOL PANDAAN-



- SINGOSARI BERDASARKAN KONDISI SOSIAL EKONOMI DENGAN PENDEKATAN ATP/WTP.
- Lestari, A., Winarsih, C., Loreнна, N., Muflih, A., & Muthaher, M. (2021). Jurnal Proyek Teknik Sipil Analisis Tarif Jalan Tol Bakauheni-Terbanggi Besar Berdasarkan Pendekatan Ability to Pay (ATP) dan Willingness to Pay (WTP). *Journal of Civil Engineering Project*, 8(1), 40–52. <https://ejournal2.undip.ac.id/index.php/potensi>
- Litman, T. (2022). Reduced Carbon and Energy Footprint in Highway Operations: The Highway Energy Assessment (HERA) Methodology. *Networks and Spatial Economics*, 16(1), 395–414. <https://doi.org/10.1007/s11067-014-9225-y>
- Litman, T. A. (2024). Evaluating Transportation Diversity Multimodal Planning for Efficient and Equitable Communities. *Transportation Research Record*, 1756. <http://www.vtpi.org>
- Maps, G. (2026). Google Maps.
- Rahma, N. N., Kuswati, A. R. S., & Kurniawan, S. (2024). Ability To Pay (ATP) and Willingness To Pay (WTP) Jakarta Mass Rapid Transit. 341–349. https://doi.org/10.2991/978-94-6463-384-9_30
- Redinata, J., Siswanto, H., & Supriyanto, B. (2021). Analysis of vehicle operating costs and optimal vehicle speeds using the PCI method on primary arterial road and toll road: Surabaya-Malang. *AIP Conference Proceedings*, 2447. <https://doi.org/10.1063/5.0072749>
- Sánchez Bardales, E., García Rosero, L. M., Arellanos Carrion, E. S., Bravo Campos, E., & Cruz Caro, O. (2025). The Synergy Between the Travel Cost Method and Other Valuation Techniques for Ecosystem Services: A Systematic Review. *Environments*, 13(1), 18. <https://doi.org/10.3390/environments13010018>
- Santoso, S., Nurhidayat, R., Mahmud, G., & Arijuddin, A. M. (2021). Measuring the Total Logistics Costs at the Macro Level: A Study of Indonesia. *Logistics*, 5(4). <https://doi.org/10.3390/logistics5040068>
- Shofwan, M., Cahyono, D., Setia, L., & Wibowo, B. (2021). ANALISIS ATP DAN WTP PADA RENCANA JALAN TOL KERTOSONO-KEDIRI PROVINSI JAWA TIMUR. 6(1).
- Tamin, O. Z. (2000). *Perencanaan dan Pemodelan Transportasi*. Penerbit ITB.
- Umum, D. P. (2005). Perhitungan biaya operasi kendaraan Bagian I: Biaya tidak tetap (Running Cost).
- Umum, M. P. (2007). Penetapan Golongan Jenis Kendaraan Bermotor pada Ruas Tol. <https://binamarga.pu.go.id/index.php/peraturan/detail/keputusan-menteri-pekerjaan-umum-nomor-370kptsm2007-tentang-penetapan-gol-jenis-kendaraan-bermotor-pada->



ruas-jalan-tol-yang-sudah-beroperasi-dan-besarnya-tarif-tol-pada-beberapa-ruas-jalan-tol

- Voronina, N. (2022). Substantiation of tariffs for using toll roads: Socio-economic aspect. *Transportation Research Procedia*, 63, 1288–1293. <https://doi.org/10.1016/j.trpro.2022.06.137>
- Wardman, M., Neki, K., & Humphreys, R. M. (2023). *Mobility and Transport Connectivity Series Meta-analysis of the Value of Travel Time Savings in Low-and Middle-Income Countries*. Meta-analysis of the Value of Travel Time Savings in Low-and Middle-Income Countries.
- Wathan, Q. H. (2019). STUDI PENENTUAN TARIF TOL RENCANA RUAS JALAN TOL BANDA ACEH – SIGLI. *TERAS JURNAL*, 9(2), 133. <https://doi.org/10.29103/tj.v9i2.223>
- Wibawa, R. (2023). Evaluasi Penentuan Tarif Jalan Tol Berdasarkan Pendekatan Biaya Operasional Kendaraan dan Nilai Waktu.
- Widiawati, D. D., Salasa, B. S., & Dzakwan, H. (2024). Studi Komparasi Biaya Operasional Kendaraan di Jalan Tol dan Jalan Poros Samarinda-Balikpapan, Provinsi Kalimantan Timur. 9.
- Yusup, F. (2018). Uji Validitas dan Reliabilitas Instrumen Penelitian Kuantitatif. *Jurnal Tarbiyah : Jurnal Ilmiah Kependidikan*, 7(1), 17–23. <https://doi.org/10.18592/tarbiyah.v7i1.2100>

