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Jurnal Pensil Pendidikan Teknik Sipil

Journal homepage: http://journal.unj.ac.id/unj/index.php/jpensil/index

# FACTORS AFFECTING THE DEVELOPMENT OF AN INTEGRATED TOLL TRANSACTION SYSTEM TO IMPROVE TRAFFIC VOLUME DISTRIBUTION

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P-ISSN: 2301-8437
E-ISSN: 2623-1085

ARTICLE HISTORY

Accepted:
15 Juni 2023
Revision:
28 September 2023
Published:
29 September 2023

ARTICLE DOI:
10.21009/jpensil.v12i3.36337



**Abstract**

The Indonesian Government has attempted to reduce traffic congestion on toll roads by implementing a non-cash toll transaction system that has been valid on all Indonesian toll roads since October 2017. However, heavy traffic that causes traffic congestion on toll roads in urban areas often occurs. This study aimed to find out the factors affecting the development of the toll transaction system and vehicle distribution through the preferences of whether road users choose to enter the toll road or not. The research method used was a quantitative descriptive approach with survey through Stated Preference. Respondents were class I – V vehicle users who traveled from the Jakarta Intra Urban Toll Roal to Prof. Dr. Ir. Soedijatmo Toll Road. The study's findings indicated that the implementation of Electronic Toll Collection (ETC) can reduce the interest of road users to enter toll roads if fines are imposed, but road users are still highly interested in entering toll roads because there is a toll transaction time cut service. The distribution of traffic volume increased under the congestion pricing scenario since road users' interest to enter the toll road decrease in entering the toll road owing to the higher toll rate rise.

**Keywords:** Congestion, Stated Preference, ETC, Congestion Pricing, Travel Time Savings

## Introduction

Rapid economic growth in cities cannot be separated from crucial problems. These problems include the increase in the movement of goods and services to the city center which causes a high number of vehicles crossing the road and leads to traffic congestion. An example is the cities in the Jakarta-Bogor-Depok-Tangerang-Bekasi (Jabodetabek) area. Traffic congestion can occur on non-toll roads and toll roads. Based on the Jabodetabek Urban Transport Policy Integration Project Report Phase 2 in the Republic of Indonesia, Appendix 02 (Japan International Cooperation Agency (JICA), 2019), a mapping of the condition of the speed of vehicles passing on the DKI Jakarta toll road network and its surroundings was produced. A traffic speed survey conducted on 14 October - 30 November 2018 during rush hour showed that some vehicle speeds in the Jakarta urban toll road area were ≤ 40 km/h. One of the toll roads in the DKI Jakarta area with a high level of congestion is the Prof. Dr. Ir. Soedijatmo Toll Road. This toll road is the only main toll road that connects the Jakarta Intra Urban Toll Road (JIUT) to Soekarno-Hatta International Airport, Cengkareng, Tangerang City. In the JICA research, traffic speeds on the toll road (traveling from JIUT) ranged between 20 and 40 km/h, causing a bottleneck in that area. The performance of toll roads in serving the community is measured based on Minister of Public Works Regulation No. 16/PRT/M/2014 concerning Toll Road Minimum Service Standards (Kementerian PU, 2014) and the service substance for the average travel speed under normal conditions on inner-city toll roads is ≥ 40 km/h. As a result, the JICA study's traffic speed fails to meet the Toll Road Minimum Service Standards.

Regarding traffic congestion, city expansion can also enhance traffic growth. This can be observed in the rapid expansion of the northern area of Jakarta and its environs, which has the potential to give rise to a greater generation of vehicles in the surrounding areas. For instance, Soekarno Hatta International Airport in Tangerang City will be developed into an airport city and aerotropolis which is influenced by the condition of the airport as the highest flight path in Indonesia (Adrian & Pradoto, 2017). In the JICA report, it is also estimated that the major impact of annual economic losses due to traffic congestion in Jabodetabek is the occurrence of economic losses of IDR 100 trillion during 2018. This loss is equivalent to a loss of IDR 3 million per person for a year.

The significant difference in rates on the toll road network causes a high public interest in deciding which toll road to pass. Thus, many vehicles going through the toll roads in the DKI Jakarta area pick cheaper toll roads, causing traffic congestion. An example is the rate for class I vehicles, namely the Soedijatmo Toll Road rate of IDR 8,000.00 and the JIUT rate of IDR 10,500.00 which is relatively cheaper compared to the JORR 1 rate of IDR 16,000.00. The rates for several toll roads in the DKI Jakarta area and its surrounds in 2022 are as follows.

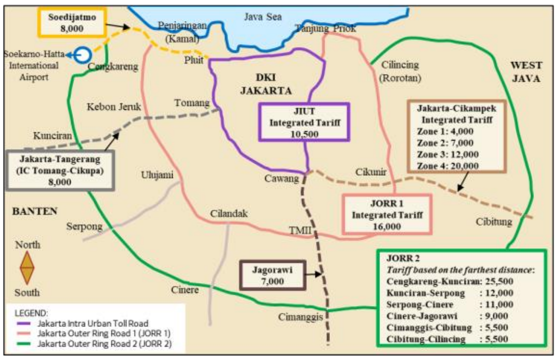


Figure 1. Toll rates of class I vehicles on several DKI Jakarta toll road and its surroundings in 2022

The government has implemented non-cash toll transactions (using electronic cards) which have been 100% valid since October 2017 to alleviate traffic congestion at toll gates. However, the toll transaction system still has toll booths, so according to the statement by (Tan et al., 2017), when a vehicle has to stop when paying a toll, it can cause traffic congestion and reduce fuel efficiency. Currently, the government is developing a toll transaction system as a form of digital transformation from non-cash to contactless (electronic toll collection (ETC)) with Global Navigation Satellite System (GNSS) technology based on multi-lane free flow. In other words, multi-lane free flow is a form of ETC and the latest system in multi-lane non-stop transactions without stopping or reducing vehicle speed at toll gates by (Harnanda et al., 2022). The system will be implemented in stages on all toll roads in Indonesia. The development of the toll transaction system is carried out based on Minister of Public Works and Housing Regulation Number 18 of 2020 concerning Contactless Non-Cash Toll Transactions on Toll Roads (Kementerian PUPR, 2020). This transaction system will eliminate toll gates, resulting in no more queues of vehicles at toll gates. Therefore, the ETC system is designed to ensure that traffic runs smoothly during toll collection/toll transactions (Popoola et al., 2017).

GNSS technology uses three alternative payment tools where each option can be adapted to the conditions (convenience/needs) of road users. Vehicles crossing the toll road will be equipped with a position sensor device on the On-Board Unit (OBU) that will automatically track the vehicle's position and calculate the distance traveled as well as the toll fee that must be paid (Velaga & Pangbourne, 2014). Another tool option is an electronic OBU for a smartphone mobile application which is equipped with a choice of payment methods/bank accounts and other information (Dias et al., 2014). Aside from these two tools, another transaction tool that can be used by road users without OBU installation is purchasing tickets (Numrich et al., 2012). In several prior studies, the public responded positively to time savings in implementing ETC utilizing OBU. Research by (Ho et al., 2019) shows that queue time can be lowered by 50% to 60% by using OBU compared to transaction systems using electronic cards. The results of the study by (Rizal et al., 2019) on the Jakarta-Tangerang-Cengkareng Toll Road showed that 92% of respondents agreed with the implementation of ETC with OBU devices because no more queues at toll gates and only 23% of respondents were willing to buy OBU devices. This is because the price of the OBU device of IDR 500,000 is not equal to the savings in lost time value attained. In this study, no research was conducted regarding fines that must be paid by road users if there is an insufficient or empty balance in the transaction tool.

The delay in the movement of goods and passengers caused by traffic congestion and delays has several effects, including increased cost of roads, increased vehicle pollution due to emissions, and gas waste (Selmoune et al., 2020). The implementation of ETC will eliminate queues at toll gates, however, this will not always result in a reduction in the number of vehicles crossing a toll road. As a result, other techniques of responding to supply-demand traffic are required. Another way to deal with congestion besides implementing ETC is to use traffic demand management (TDM) through the application of congestion pricing. The advantage that GNSS technology has for ETC devices is its flexibility because it can be used for other purposes such as traffic control, congestion charges, parking payments, and others (Milenković et al., 2018). The scheme for implementing congestion pricing is carried out by providing several levels of tariff increases for road users who cross a road during peak hours. According to prior studies, this has the potential to reduce the number of vehicles on the road as well as vehicle exhaust emissions. According to Yamamoto et al. (in (Rizki et al., 2016)) one of the promising TDM schemes is congestion pricing which causes road users to change routes, departure times, activity involvement, or means of travel. In addition, negative externalities caused by traffic, such as congestion, accidents, and different emission levels can be reduced by urban roadpricing (Croci, 2016). In the identification of (Hamilton et al., 2014), the three major groups of attitudes related to congestion charges are attitudes toward various pricing policies, public interventions, and environmental concerns. When entering a traffic restriction zone, road users will be offered various rate levels and their opinions to cancel trips or choose alternative modes (Mirbaha et al., 2014). (Hermawan et al., 2013) developed a method of increasing toll road fare scenarios during peak hours, which were divided into four scenarios, namely increases of 10%, 25%, 50%, and 100% rate rise. Another example proves that if rates are applied differently for each lane in one direction, as researched by (Alemazkoor & Burris, 2014), demand can be optimized for each lane when toll rates are set differently on different lanes during traffic peak hours. Further, the total value of travel time savings reaches 11% of the total value of time spent when compared to a uniform toll rate for all lanes on the toll road. Based on research by (Bueno et al., 2017), truck drivers who regularly use toll facilities for long-distance trips are more likely to accept a fixed-cost strategy. Another study conducted by (Brent & Gross, 2018) indicated a reduction in usage of 1.6% for an average response to an increase in toll rates of 10%. Time-saving commute reliability was valued by drivers despite heterogeneity in the relative value of time and reliability by destination to or from work and time.

A survey of respondents' road use preferences for implementing congestion pricing was performed utilizing the Stated Preference (SP) method. Several SP indicators used by (Bueno et al., 2017) include gender, age, region, income, type of user, type of trip, type of vehicle, quality of toll road facilities, perceptions of toll road costs, qualitative willingness to pay (WTP), the perception of the contribution of toll roads to save time, and others. Based on research (Purba et al., 2020), income and expenses on transportation attributes are the factors that most significantly influence route selection by road users when deciding to travel on toll roads. (Abulibdeh, 2022) examined the effect of the average WTP of respondents on the frequency of trips and travel destinations of the most widely used toll roads. As a result, there is no significant difference in respondents' WTP when experiencing congestion at the same fare on the four main toll roads in the city. In terms of gender-related demographic data, research by (Chiou & Fu, 2017) found that high-income male respondents will continue to drive during the morning rush hour and pay congestion charges. The result of the study by (Linn et al., 2016) revealed that individual travel behavior is more likely to be influenced by CP in making discretionary trips than those who are commuting. Congestion reduction improves not just the environment by lowering air pollution caused by vehicles delayed in traffic and increasing travel times and reliability, but it also reduces the risk of accidents and fatalities. At the same time, spatial, temporal, and specific types of vehicles can lead to unwanted substitution as traffic and accidents move to other nearby areas, hours, and vehicles that are not charged (Green et al., 2014). The successful introduction of CP in major cities is due to an alliance between three groups: environmentalists want environmental benefits, traffic planners want increased efficiency, and politicians seek revenue streams. In cities that have successfully and unsuccessfully introduced CP, both can be learned about what to do and what to avoid (Eliasson, 2019).

Currently, there has never been a policy related to congestion pricing specifically on toll roads in Indonesia. Referring to the above matters, this study aims to determine the factors that influence the development of integrated toll transactions with the implementation of the MLFF-based ETC as well as the application of CP, the distribution of traffic volume, and the mode shift of land transportation for class I vehicle users when CP is implemented.

## Research Methodology

The variables used in this study were exogenous latent variables (independent) such as socio-economic demographic characteristics, travel characteristics, existing rates and services, willingness to pay CP, ETC, and endogenous latent variables (dependent) such as reduction in traffic congestion and decision change in the mode of transportation. Then, the intervening variables, namely travel time savings. The intended travel time savings were higher time savings when ETC and CP were applied together.

Secondary data was taken from the Indonesia Toll Road Authority, Ministry of Public Works and Housing, while the primary data came from respondents who crossed the Soedijatmo Toll Road with directions from the JIUT. This study used a quantitative descriptive approach through online and offline Stated Preference surveys and data analysis using the Structural Equation Modeling method and the Smart Partial Least Square application. The sampling technique used was a proportionate stratified random sampling method with clean data obtained from as many as 341 respondents based on vehicle type consisting of 316 respondents in class I vehicles, 17 respondents in class II vehicles, 4 respondents in class III vehicles, 2 respondents in class IV vehicles, and 2 respondents in class V vehicles.

Types of vehicles (Kementerian PU, 2007) that cross the Soedijatmo Toll Road are as in Table 1. On this toll road, an open payment system or one-time transaction with a flat rate applies along the toll road (Kementerian PUPR, 2021) as shown in Table 2. To facilitate data processing, particularly for the WTP analysis, the fare increase scenario is ranked by percentage uniform rate increase by rounding up to the nearest IDR 500.00 for each class of vehicles, as shown in Table 3.

Table 1. Types of vehicles

| Class | Vehicle Type |
|---|---|
| I | Sedan, Jeep, Pick Up/Small Truck, and Bus |
| II | Truck with 2 (two) axles |
| III | Truck with 3 (three) axles |
| IV | Truck with 4 (four) axles |
| V | Truck with 5 (five) axles |

Table 2. Existing toll rates for vehicle classes

| The Group of Vehicle | | | | |
|---|---|---|---|---|
| **I** | **II** | **III** | **IV** | **V** |
| 8,000 | 10,500 | 10,500 | 11,500 | 11,500 |

Table 3. The scenario of toll rates increase based on vehicle classes

| The Scenario of toll rates (%) | The Rates of Vehicle Classes | | | | |
|---|---|---|---|---|---|
| | **I** | **II** | **III** | **IV** | **V** |
| 50% | 12,000 | 16,000 | 16,000 | 17,500 | 17,500 |
| 75% | 14,000 | 18,500 | 18,500 | 20,500 | 20,500 |
| 100% | 16,000 | 21,000 | 21,000 | 23,000 | 23,000 |
| 125% | 18,000 | 24,000 | 24,000 | 26,000 | 26,000 |

The questionnaire in this study used a Likert scale for preferences for the use of the toll road or non-toll roads as shown in Table 4.

Table 4. Likert scale for road use preference

| No | Preference |
|---|---|
| 1 | Certainly choose non-toll road |
| 2 | Probably choose non-toll road |
| 3 | Probably choose toll road |
| 4 | Certainly choose toll road |

The relationship between the number of vehicles entering the toll road due to the implementation of CP during peak hours based on the Likert scale is illustrated through three conditions as shown in Table 5.

Table 5. Conditions for reducing vehicle volume based on prefences table 4

| Condition | Vehicle Reduction (%) |
|---|---|
| Pessimistic | (1) |
| Moderate | (1) + (2) |
| Optimistic | (1) + (2) + (3) |

Preferences for switching modes of transportation by class I vehicle users when implementing CP can be seen in Table 6.

Table 6. Likert scale for land transportation mode preference

| No | Preference |
|---|---|
| 1 | Certainly use private vehicle |
| 2 | Probably use private vehicle |
| 3 | Probably use public transportation |
| 4 | Certainly use public transportation |

## Research Results and Discussion

Following are the results of the variable characteristics of socio-economic demographic, travel characteristics, and opinions of road users on existing rates and toll road services. In this study, it was discovered that female respondents had a higher percentage than male respondents, with women having 53.37% and men having 46.63%. The respondents of the Soedijatmo Toll Road were dominated by users who had an income of around IDR4,000,00.00–IDR8,000,000.00 or medium-level income as many as 58.36%. The toll road users exited at the Cengkareng Toll Gate were found to be 78.89%, the remainder at the Kamal Toll Gate at 15.25%, and the Benda Interchange at 5.87%. The type of vehicle that dominated the trip was class I vehicles for the sedan/passenger car/private car category as many as 86.51%.

According to the survey results, the variables in the relationship between the increase in toll rates and the decrease in traffic volume on the toll road, the increase in toll rates of 50%, 75%, 100%, and 125% for 20 minutes of time-saving when CP is applied caused a reduction in the number of vehicles that access the toll road. This can be seen in class I vehicle, where a 50% increase in toll rates and a 20-minute time saving resulted in 48% of vehicles certain to access the toll road and 52% of vehicles certain not to access the toll road. In this class I vehicle, the higher the increase in toll rates, the smaller the percentage of vehicles that are certain to enter the toll road, so that the number of vehicles that are not to enter the toll road increases. Meanwhile, all respondents from class III-V vehicles chose to enter the toll road with certainty if CP is applied to all variations of the toll rate increase with a time saving of 20 minutes and 30 minutes.

Electronic toll collection (ETC), travel time savings, traffic congestion reduction, and the decision to convert to switch transportation modes are other variables in the road usage preference category. According to the survey results, if the ETC was applied, as many as 63.64% of respondents would prefer to use the toll road because there is a time cut for toll transactions, and only 3.81% of respondents would prefer to enter the non-toll road. In the fine indicator that is applied if the balance is empty or insufficient when crossing the Soedijatmo Toll Road, only 23.75% of respondents chose to continue entering the toll road, whereas up to 33.72% of respondents might choose the toll road. The approach used for the perception of the number of fines that must be paid at certain times to road users if the balance is lacking or empty is the Government Regulation Number 15 of 2005 concerning Toll Roads which refers to Article 86 paragraph 2 which is twice the toll rate (Indonesia, 2005). In the decision variable to switch to land transportation when CP is implemented, 25.51% of respondents selected to use public transportation when driving on toll roads, with up to 37.83% potentially using public transportation.

Hypothesis testing in this study was undertaken using SmartPLS 3.0 software and structural model analysis by looking at the direct and indirect effects. Convergent Validity is a measure of the validity of a reflexive indicator as a variable measure which can be observed from the outer loading of each variable indicator. The test results produce several outer loading values below 0.50, which must be dropped. The outer loading value can still be tolerated up to 0.50 and an indicator is said to have good reliability if the outer loading value is above 0.70 (Haryono, 2019). The remaining indicators on the socio-economic demographic characteristic variables are age, income, and status as a driver/passenger & vehicle ownership. For variable travel characteristics, the remaining indicators are toll exits, the frequency of trips before and after the COVID-19 pandemic on the toll road (per year), and the type of vehicle used. Furthermore, the toll rate indicator is an indicator of the remainder of the existing rates and services variable, while other variables in this study have fulfilled the outer loading value.

The number on the average variance extract (AVE) is used to determine whether the average indicator variance for each variable is homogeneous or not for each research variable shows a number greater than 0.5. Thus, the data collected meets the requirements to be homogeneous. Because the discriminant validity number is greater than 0.6 based on the measurement findings, all variables are declared valid. Furthermore, the composite reliability value of all research variables is more than 0.7, which means that all independent latent variables are appropriate and feasible to be used as variables tested to determine their effect on dependent latent variables. In PLS, the reliability test is strengthened by the presence of Cronbach's alpha where the consistency of each answer is tested. Cronbach's alpha is said to be good if $\alpha \geq 0.6$ and is said to be sufficient if $\alpha \geq 0.3$. The Cronbach's alpha value for the ETC variable is 0.516. These results indicate that

ETC variables are quite reliable and the other variables in this study are reliable and good. Based on the results of the inner model test, the R Square value ranges from 0.012 to 0.504 and the average is 0.2 for all variables, indicating that this value is considered weak. According to Jogiyanto (Haryono, 2019), the higher the R Square value in the proposed research model the better the prediction model. For example, the R Square value of 0.7 implies that the variation in changes in the dependent variable that can be explained by the dependent variable is 70% and the rest is explained by other variables outside the proposed model. However, the basis of the theoretical relationship is the most important parameter in explaining the causality relationship, hence R Square is not an absolute parameter in determining the accuracy of the prediction model. The prediction relevance test (Q Square) for all variables is 0.768. This indicates that exogenous constructs have great predictive relevance for endogenous constructs.

The results of testing the direct influence research hypothesis show that of the eleven hypotheses, three hypotheses are rejected. The first hypothesis that was rejected was the social-economic and demographic characteristics of the WTP Congestion Pricing (CP) as indicated by the original sample value of 0.049 and the t-statistic of 0.866. The measurement results showed that the t-statistic <T table (5% = 1.96), implies that the research hypothesis is rejected. It can be interpreted that the sample data on the social-economic and demographic characteristics such as age, income, and status as a driver/passenger & vehicle ownership of toll road users do not have a significant influence on the WTP CP variable in the form of an increase in variation toll rates and reduced travel time savings. The results of this study are consistent with the results of research (Sunitiyoso et al., 2020) on the relationship between demographic characteristics and acceptance of Electronic Road Pricing policies, which suggests that this has no significant influence. Gender, age, income, expenses, and car ownership were all indicators of demographic characteristics of road users in a prior study. The second hypothesis that was rejected (the highest t-statistic value) was the relationship between the effect of WTP CP on the decision to switch to land transportation with a t-statistic of 1.071 and the original sample value of -0.108 with a negative relationship. This value means that the rising toll rates during peak hours on the toll road will not entice the interest of road users to switch modes of transportation from private vehicles to public transportation. It can be indicated that people’s culture prefers to use private cars to get to their destination.

In the accepted hypothesis, it was found that the measurement results of the t-statistic value > T table (5% = 1.96 significance level). The highest t-statistic value of 11,036 and the original sample value of 0.511 were obtained in the relationship between the effect of ETC on travel time savings, with a positive relationship direction. This shows that ETC has a positive effect on cutting toll transaction time so that travel time is saved on the toll road. The smallest t-statistic value for the accepted hypothesis has been proven successful in the effect of travel characteristics on WTP CP with an original sample value of 0.156 and a t-statistic of 2.563, with a positive relationship direction. Based on this, it can be interpreted that the travel characteristics of the choice of road users for the intended exit gate category, the frequency of trips before and after the COVID-19 pandemic on the toll road (per year), and the type of vehicle used, all have a significant influence on the willingness of toll users to pay increased toll rates when CP is implemented.

In addition to testing the direct effect, hypothesis testing was also carried out to test the indirect effect. In the twenty hypothesis tests for this indirect effect research, eight hypotheses were accepted and twelve hypotheses were rejected. An example of a rejected hypothesis is the relationship between the effect of WTP CP → travel time savings → traffic congestion as indicated by the original sample value of 0.014 and the t-statistic of 0.819 with a positive relationship. Thus, the results of the effect analysis showed that variations in the increase in toll rates when implementing CP on the toll road have a positive effect on travel time savings but have no significant influence on reducing congestion. It can also be indicated that travel time savings is not commensurate with the large amount of traffic demand. In a previous study conducted by (Hermawan et al., 2013), the results showed that limited road capacity and time values and high transportation needs caused the level of service and volume capacity ratio (VCR) values to not significantly change as a result of price increases. Meanwhile, for example, the indirect effect hypothesis that is accepted is the relationship between the effect of existing rates and services → WTP CP → traffic congestion with an original sample value of -0.086 and a t-statistic of 3.918 showing a significant influence with a negative relationship. It can be concluded that the increase in toll rates from the existing toll rates will reduce the interest of vehicle users passing on the toll road, resulting in a decrease in vehicles and congestion. However, the smaller the value of the increase in toll rates chosen by road users (particularly from class I vehicles) in the variation of toll rates compared to the existing toll rates, the more road users will choose to enter the toll road, resulting in only slight decrease in congestion. This is in line with the results of a study conducted by (Hadji Hosseinlou et al., 2016) in Tehran, Iran, which found that the most significant influenceis observed in the increase in toll rates, which causes the willingness of road users to pay tolls to decline drastically.

Aside from the studies mentioned above, there are several other previous studies with research results that are similar or different from the existing literature. For example, (Cornago et al., 2019) stated that road pricing can encourage behavioral changes that urge persons to switch to environmentally friendly modes of transportation. This immediately decreases demand for travel by private motorized vehicles, such as cars or motorbikes. Research by (Milenković et al., 2019) regarding the introduction of CP in the city of Belgrade, Serbia, showed that around 16% of respondents switched modes of transportation from cars to public transportation. Furthermore, based on the results of a survey on perceptions about the value of travel time-saving in Oman by (Javid et al., 2022), it was revealed that more than 73% of people used cars for transportation, indicating that most do not like waiting for a mode of public transportation. This can be viewed as these people preferring private transportation over public transit to save time. A study related to the implementation of CP (Özgenel & Günay, 2017) in Istanbul, Turkey was carried out by asking several questions about travel characteristics and demographics of road users through a stated preference survey, such as age, income, education, travel purpose, and travel time. The research results related to the age of the respondents revealed that the highest number of respondents were aged 25-35 years, accounting for 34% of the total respondents. According to 66% of the age group, the congestion charge will not reduce the level of congestion. According to (Shatanawi et al., 2020), in the congestion charge policy, the congestion charge scheme for each area or city must be designed uniquely for the best results. In addition, the potential benefits of implementing congestion pricing policies may vary according to the length of time after implementation and the type of road user (Singichetti et al., 2021).

## Conclusion

According to the survey results, the most targeted toll road exit was the Cengkareng Toll Gate with a total of 78.89% of respondents.

In a moderate scenario, the increase in toll rates was 50% and a 20-minute travel time savings during rush hour reduced the interest of class I vehicle users to enter the toll road by 15%. This indicates that the number of vehicles can be lowered by 15% in normal conditions. Furthermore, the greater the increase in toll rates, the smaller the interest of road users to enter the toll road. This is evident from the 75%, 100%, and 125% increases in toll rates, which have the potential to reduce the number of vehicles by 25%, 44%, and 55%.

The results of a survey on plans to implement ETC showed that as many as 63.64% of respondents were interested in entering the toll road because there was a toll transaction time cut. However, when fines are imposed if the balance is empty or insufficient while crossing the toll road, only 23.75% of respondents chose to continue to enter the toll road.

Hypothesis testing was carried out on the factors affecting the increase in the distribution of traffic volume through the analysis of the hypotheses of direct and indirect effects. In general, it appears that the indirect effect hypotheses are rejected since they have no significant effect. The factors of socioe-conomic demographics (age, income, and status as a driver/passenger & vehicle ownership) and travel time savings (bigger time savings (the application of CP & ETC)) have no significant influence. Meanwhile, the most influential criteria include travel characteristics, existing prices, and services, willingness to pay congestion pricing, and electronic toll collection.

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