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The Impact of Toll Roads on The Modes Choice Transportation Case Study: Banyuwangi-Surabaya

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Abstract

As the population increases, the level of activity and mobility will also increase. To facilitate people's movement, the Indonesian Government built infrastructure in the form of toll roads. The Trans-Java Toll Road stretches between Merak Harbor, Cilegon, Banten Province, and Ketapang Harbor, Banyuwangi, East Java Province. The Surabaya-Banyuwangi section is currently in the development stage. The existence of the Banyuwangi-Surabaya toll road will impact behavioural patterns in using transportation modes. Currently, several modes of land transportation can be used, i.e., buses via toll and non-toll (economy), trains, and private cars. The current travel time from Banyuwangi-Surabaya is 6 hours 30 minutes using a toll bus and 8 hours 15 minutes using a non-toll bus. In comparison, the travel time for the Wijayakusuma train mode (Banyuwangi-Surabaya) is 6 hours 2 minutes. Private vehicles (cars) also use a variety of different routes, causing the travel time and travel costs of private cars to be affected. Differences in travel time and routes used due to the existence of the Banyuwangi-Surabaya toll road change mode preferences between toll buses, non-toll buses (economy), trains, and private vehicles (cars). This research is a model for selecting transportation modes for the Banyuwangi-Surabaya route using the split modal method with an exponential function or difference function (β) with a value of NMAE= 0.0000087, where the NMAE value is close to 0, and can be used to estimate the proportion of modal choices on the Banyuwangi Surabaya route.

Keywords

Mode choice, NMAE, modal split, toll roads, revealed preference, stated preference

INTRODUCTION

East Java Province is one of the most densely populated provinces in Indonesia. The population of East Java Province in 2021 based on population census results is around 40.666 million. The population density per km2 is 855 people/km2. The largest population in 2021 is in Surabaya with a population of around 2.874 million people and a population growth rate in 2020-2021 of 0.28. Meanwhile, the population of Banyuwangi Regency is 1.718 million people with a population growth rate in 2020 2021 of 0.81 [1].

As the population increases, the level of community activity and mobility will increase. To facilitate people's mobility, the Indonesian Government is building infrastructure like toll roads. In 2022 the Banyuwangi Surabaya toll road section will operate to Probolinggo City and will continue to Banyuwangi. According to the Main Director of PT Jasamarga Probolinggo Banyuwangi (JPB) Adi Prasetyanto, progress on the Probolinggo-Banyuwangi toll road segment, Probolinggo-Besuki, is planned to be completed by the end of 2024 [2]. The Probolinggo Banyuwangi Toll Road with a total length of 171,516 km will be the final point of the Trans Java Toll Road network. When it is built, the western tip to the eastern tip of Java Island will be connected to a toll road, making the mobility of people, goods, and services even easier.

The existence of the Banyuwangi-Surabaya toll road will have an impact on behavioural patterns in using transportation modes. Currently, several modes of land transportation can be used, namely: inter-city transport in Indonesia known as AKDP (Inter-City Inner Province) buses via toll (fast and limited) and non-toll (economy), trains, and private cars. The current travel time from Banyuwangi-Surabaya is 6 hours 30 minutes if using the AKDP bus via toll road and 8 hours 15 minutes using the non-toll AKDP bus. Meanwhile, the travel time for the Wijayakusuma train mode (Banyuwangi-Surabaya) can be reached in 6 hours and 2 minutes and is not affected by the existence of toll roads because the routes used are different. Private vehicles (cars) also use a variety of different routes, which causes travel times and private car travel costs to vary. The difference in travel time and routes used due to the existence of the Banyuwangi-Surabaya toll road segment changes the mode choice preferences between AKDP buses via toll, non-toll AKDP buses (economy), trains, and private vehicles (cars). The choice of transportation mode between zone A and zone B is based on a comparison between various operational characteristics of the available transportation modes (for example travel time, tariff, waiting time, etc.) [3]. The mode choice factor plays quite an important role. Someone who will move from one city to another will certainly consider many things. The movements carried out will use

private vehicles or will use public transportation. In this case, there are many choices of modes of transportation that can be used. All these things are closely related to various characteristics of the mode, type of travel, and the characteristics of the traveler themselves. The problem that will be discussed in this research is the impact of the existence of the Banyuwangi-Surabaya toll road as a new form of competition which causes the choice of mode between AKDP buses and trains to change in terms of costs, distance and travel time. The travel attributes reviewed are in the form of travel costs and travel times which differ between AKDP buses via toll, non-toll AKDP buses (economy), and trains. This research aims to look at the proportion model for mode choice between toll buses , non toll buses (economy), trains, and private vehicles (cars) if all toll roads are connected from Banyuwangi-Surabaya.

The method used in this research is split capital based on cost ratio. Cost ratio-based split capital is a method for analyzing and understanding the distribution of transportation modes based on cost comparisons between various transportation modes. In this context, cost ratio refers to the comparison of costs incurred by individuals to use one mode of transportation compared to other modes of transportation. The costs incurred are influenced by several attributes, including Vehicle Operational Costs (VOC), toll rates, and public transportation ticket rates which add up to a generalized cost. This generalized cost will be a variable for selecting transportation modes with the influence of distance and travel time.

RESEARCH SIGNIFICANCE

This research aims to determine the characteristics of mode voters for the Banyuwangi-Surabaya route as a new form of competition due to the existence of toll roads. Apart from that, knowing the right model for modeling the choice of modes between toll buses, non-toll buses (economy), trains, and private cars on the Banyuwangi-Surabaya route as a new form of competition due to the existence of toll roads. and finally, to get the proportion/demand for each mode of transportation if all sections of the Banyuwangi Surabaya toll road corridor are connected.

METHODOLOGY

A. RESEARCH PREPARATION STAGES

The research preparation stage is in the form of activities carried out before carrying out the research. The preparatory stage in this research is questionnaire design and determining the number of respondents who use transportation modes.

1. Questionnaire design

Questionnaire design is the questionnaire design stage which produces a questionnaire form to determine the characteristics of users of the mode of transportation under study when there are changes in attributes that influence travel from Banyuwangi-Surabaya.

In designing the questionnaire in this research, the Revised Preference and Stated Preference methods were used.

- Revealed preferences
  The variables used in the revealed preferences questionnaire are limited to socio-economic conditions. The researcher accompanied the process of filling out the questionnaire to explain the points referred to in the questionnaire. Points on socio-economic conditions obtained from the book Transportation Planning and Modeling by Ofyar Z. Tamin and several previous studies include gender, age, highest level of education, occupation, monthly income, travel needs, private vehicle ownership, origin and destination, and frequency of travel [4].
- Stated preferences
  The stated preference survey technique is a form of survey using a situation hypothesis where the hypothesis is used as an approach for respondents to find the best alternative [5]. In the table 1 below, a scenario table is shown that will be used in the questionnaire stating preferences.

Table 1 Transportation Mode Selection Scenario

Variable	SCENARIO
X1	If the economy buses remain and do not pass through the Banyuwangi-Surabaya toll road
X2	If there is no train, there will be changes to the travel time and ticket fare
X3	If the bus via toll road uses the combined Banyuwangi-Probolinggo route without passing the toll road and Probolinggo-Surabaya uses the toll road
X4	If a private car uses the combined Banyuwangi Probolinggo route without passing the toll road and Probolinggo-Surabaya uses the toll road
X5	If the bus via the toll road uses the full toll road from Banyuwangi-Surabaya
X6	If a private car uses the full toll road from Banyuwangi Surabaya

2. Determining the Number of Respondent Samples

Population is a generalization area consisting of: objects/subjects that have certain quantities and characteristics determined by researchers to be studied and then conclusions drawn [6]. The sample is part of the number and characteristics of the population [6]. If the population is large, and it is impossible for researchers to study everything in the population, for example due to limited funds, energy and time, then researchers can use samples taken from the population.

The number of samples was determined after knowing the number of passengers on the Banyuwangi-Surabaya bus and Banyuwangi Surabaya train. To determine the number of samples from the population, Slovin's formula is used as follows in formula (1) [7]:

$$n = \frac{N}{1+N(e)^2} \quad (1)$$

where:

n = Number of samples
N = Number of population
e = Percentage error rate

B. DATA COLLECTION

In this research, there are two types of data, namely primary data and secondary data.

1. Primary Data

Primary data is data obtained from the first source, either from individuals, such as the results of interviews or the results of filling out questionnaires which are usually carried out by researchers [8]. Primary data is a source of research data obtained directly from sources (not through intermediary media) [9].

Primary data is data obtained by direct field surveys. Primary data was obtained by distributing questionnaires to train and bus users who had traveled from Banyuwangi-Surabaya. Respondents fill out the questionnaire form that has been provided using a direct interview approach to the respondent. A direct approach to users is taken so that bus and train users can fill out the questionnaire properly and correctly.

2. Secondary Data

Secondary data is primary data that has been further processed and presented either by the primary data collector or by another party, for example in the form of tables or diagrams [8]. Secondary data is a source of research data obtained by researchers indirectly through intermediary media (obtained and recorded by other parties [9].

Secondary data is in the form of the Generalized cost component which is used to calculate the costs incurred by transportation mode users when traveling Banyuwangi-Surabaya. This secondary data is in the form of Vehicle Operating Costs (VOC), time value, toll rates, bus tickets, and train tickets. The required data was obtained from the official website of Indonesian Railways (KAI), Toll Road Regulatory Agency (BPJT), DAMRI, Akas Mila buses, and other related agencies.

C. DATA ANALYSIS

The data that has been obtained is processed and then analyzed using statistics. This research uses modal split to determine the proportion model for mode choice for the Banyuwangi-Surabaya route.

1. Determining Generalized Cost Modes

It is quite common in some cases, especially in Western countries, to combine time and cost as a measure for transportation connections, which is usually called combined cost. This cost is expressed in the form of a monetary value (Rp) which consists of the total travel costs (tickets, parking, petrol and other vehicle operating costs) and the value of travel time. Of course, a special way of expressing time in terms of money is needed, and several studies have been developed for this purpose [4].

Generalized costs are the total costs incurred in carrying out activities, in this study it is travel costs. Cost determination is determined based on the type of mode studied. For private vehicles (cars), the total cost details are toll road ticket costs, vehicle operating costs (VOC), and time value. Meanwhile, for public transportation, buses and trains, only the ticket value and time are reviewed. Toll rates for public transport buses using toll roads are not included in general costs because they are included in the ticket price issued. The most frequently used method is to define cost as a linear combination of distance and time [4] If written the equation is as follows (2):

$$Generalized\ cost\ (private\ vehicle) = a_0 + a_1x_1 + a_2x_2 \quad (2)$$

where:

α_0 = Toll rate + parking ticket
α_1 = Vehicle Operating Costs (VOC)
x_1 = Distance traveled
α_2 = Time value
x_2 = Travel time

The general costs of public transport are as follows (3) [4]:

$$Generalized\ cost\ (private\ vehicle) = a_0 + a_1x_1 \quad (3)$$

where:

α_0 = Travel ticket fare
α_1 = Time value
x_1 = Travel time

2. Descriptive Statistics

Descriptive statistical analysis is statistics that has the task of collecting, processing, and analyzing data and then presenting it in the form of a description or picture. Some of the things included in this section are collecting data, processing data, analyzing data, and presenting data [10].

Descriptive statistics is a method related to collecting and presenting data to produce useful information. The presentation of the socio-economic conditions of transportation users on the Banyuwangi-Surabaya route is presented in the form of a graphic diagram.

3. Modal Split Analysis

Modal Split (mode selection) is used to estimate the number of passenger trips that will use the available modes from each movement that occurs in each zone. Generally, there are two choices, namely private vehicle modes and public transportation modes [11]. In the book by Ortuzar and Willumsen (1992), it is stated that the character of the discrete choice model is more stable or transferable because it is based on the theory of individual behavior, it is more efficient because it requires less data, the variability of information for each individual can be used, it can avoid bias, it can be used for aggregation, and can be used according to the principles of conditional probability [12]. For the power function, the mode selection equation used to form the model can be seen in the following equations (4) until (7):

$$PBusTol = \frac{CBusTol^{-\alpha BusTol}}{CBusTol^{-\alpha BusTol} + CBusNonTol^{-\alpha BusNonTo} + CKP^{-\alpha KP} + CKA^{-\alpha KA}} \quad (4)$$

$$PBusNonTol = \frac{CBusNonTol^{-\alpha BusNonTo}}{CBusTol^{-\alpha BusTol} + CBusNonTol^{-\alpha BusNonTol} + CKP^{-\alpha KP} + CKA^{-\alpha KA}} \quad (5)$$

$$PKP = \frac{CKP^{-\alpha KP}}{CBusTol^{-\alpha BusTol} + CBusNonTol^{-\alpha BusNonTo} + CKP^{-\alpha KP} + CKA^{-\alpha KA}} \quad (6)$$

$$PKA = \frac{CKA^{-\alpha KA}}{CBusTol^{-\alpha BusTol} + CBusNonTo^{-\alpha BusNonTo} + CKP^{-\alpha KP} + CKA^{-\alpha KA}} \quad (7)$$

The exponential function or deterrence function (β) used to find the modal equation model can be seen in the following equations (8) until (11):

$$PBus\ Tol = \frac{EXP(-\beta BusTol.GCBusTol)}{EXP(-\beta BusTol.GCBusTol) + EXP(-\beta BusNonTol.GCBusNonTol) + EXP(-\beta KP.GCKP) + EXP(-\beta KA.GCKA)} \quad (8)$$

$$PBusNonTol = \frac{EXP(-\beta BusNonTol.GCBusNonTol)}{EXP(-\beta BusTol.GCBusTol) + EXP(-\beta BusNonTol.GCBusNonTol) + EXP(-\beta KP.GCKP) + EXP(-\beta KA.GCKA)} \quad (9)$$

$$PKP = \frac{EXP(-\beta KendaraanPribadi.GCKendaraanPribadi)}{EXP(-\beta BusTol.GCBusTol) + EXP(-\beta BusNonTol.GCBusNonTol) + EXP(-\beta KP.GCKP) + EXP(-\beta KA.GCKA)} \quad (10)$$

$$PKeretaApi = \frac{EXP(-\beta KeretaApi.GCKeretaApi)}{EXP(-\beta BusTol.GCBusTol) + EXP(-\beta BusNonTol.GCBusNonTol) + EXP(-\beta KP.GCKP) + EXP(-\beta KA.GCKA)} \quad (11)$$

where:

CBusTol = Total cost or generalized cost of toll buses
CBusNonTol = Total cost or generalized cost of non toll/economy buses
CKP = Total cost or general cost of private vehicles
CKA = Total cost or general cost of the train
α = Power function
β = Barrier function or prevention function

The initial analysis uses the assumptions α = 1 and β = 0.00001. Then the value of the proportion of mode choices with α = 1 and β = 0.00001 is reduced by the existing value of the proportion of mode choices, in this case obtained from primary survey data. This difference in proportions must be positive or absolute. Then the results of the difference in proportions are added up cumulatively. This value is the NMAE indicator which is used as an indicator of error 2 in research results. The smaller the value of the difference between these two proportions or the mean absolute error value, the more appropriate the planned model is. To obtain a model that suits existing conditions, the function value must be calibrated so that the difference between the model and existing proportions is small or close to 0.

Generalized Reduced Gradient (GRG) algorithms, introduced by Abadie and Carpentier [13] are widely used to solve small to medium size problems, mainly through the FORTRAN codes GRG2 [14] and OPT [15] and the interpretive PC based system GINO [16].

Calibration using the Excel Solver program. The method chosen in the Excel solver is GRG Nonlinear. The steps to use Excel Solver are as follows:

1. Load Excel Solver with Options > File > Add-In > Excel Add-In > Go to > Solver Add-In then check the Solver Add-in option.
2. Open Excel on the Data tab > Excel Solver and the Excel Solver window will appear as in Figure 3.4 below.
3. To calibrate the value of the obstacle function or prevention function (β), the "Set Objective" column is filled with the value that is the aim of the calculation. In this case, the "Set Objective" column is filled with the total proportion of the difference between the model and the existing one.
4. Select the “Min” parameter for the smallest value of the recommendations given.
5. Fill in the "By Changing Variable Cells" column with any numbers that are changed, in this case, it is selected in the obstacle function (β) column which will later change according to the "Objective" that has been determined.
6. The "Solving Method" column was chosen as GRG nonlinear because this option is the simplest and most accurate analysis for the data used in this research.
7. Click “Solve” to see the results.
8. The results of the values of the two functions are entered into the split modal equation to determine the equation for choosing the transportation mode for the Banyuwangi-Surabaya route.

RESULTS AND DISCUSSIONS

1. Determination of Sample Number

In this research, end-to-end sampling of trips between Banyuwangi and Surabaya was used. The sample used in this research was only users of this mode of transportation who departed in Banyuwangi and stopped in Surabaya. Users of this mode of transportation who stopped at stations or terminals between Banyuwangi and Surabaya were not sampled.

The sample size was determined using a reference population of public transportation users in Banyuwangi Regency. The number of samples required is calculated using the Slovin formula. The following is a calculation to determine the number of research samples needed. The table below shows the number of passengers on the Wijayakusuma Train on the Banyuwangi-Surabaya route each year.

It was obtained from calculations that the number of train passengers was 280.320 and the number of bus passengers was 11.315. The total of the two populations = 280.320 + 11.315 = 291.635. This sample selection uses an e value or error coefficient value of 7% or 0.07 [7].

$$n = \frac{N}{1 + N(e)^2} = \frac{291.635}{1 + 291.635(0.7)^2} = 200\ samples$$

From the equation above, the minimum sample size required is 200 respondents. However, it does not rule out the possibility of invalid data, and incomplete answers, thus providing a bad model, so this research used a sample of 203 samples with assumptions to prevent data invalidity.

2. General Cost Components

Cost combined is an inappropriate measure to use in some cases because does not show the difference in importance between time and cost separately. This may be true in measuring accessibility; the usual time is the best size, which is set based on each mode [17].

Common costs used in this research are vehicle operating costs (VOC), time value, public transport tickets, and toll rates. Each of these components is added up to get the general cost. This research uses four types of general costs, namely: general costs for passenger cars, general costs for buses via toll buses, general costs for non-toll buses/economy buses, and general costs for trains.

In general, costs are divided into several components, including Vehicle Operating Costs (VOC), Time Value, Toll Rates, and Bus and Train Tickets. Each general cost analysis of these transportation modes will be explained in the sub chapters below.

1. Vehicle operating costs (VOC)

Recapitulation of all Vehicle Operating Cost Component (VOC) values can be seen in the table 2 below. while the capital interest component is developed by Bina Marga through projects [18].

Table 2 Recapitulation of all components of vehicle operating costs (VOC)

Component	V Km/hour	Basic Consumption	Consumption	Price	VOC RP/1000 km
BBM	60	60,056	60,056	10.000	972.907
Lubricating Oil (Oil)		0,0027	0,0027	65.000	237
Forbid		0,048	0,048	650.000	124.800
Maintenance (spare sk.)		0,0009407	0,0009407	259.063.000	243.701
Maintenance (Mechanical)		0,58	0,58	20.000	11.597
Depreciation		0,0036	0,0036	129.531.500	466.313
Capital Interest		0,22%	0,22%	259.063.000	569.939
Insurance		0,00127	0,00127	259.063.000	328.146
		Total (Rp/1000 km/vehicle)			2.717.640
		Total (Rp/km/vehicle)			2.718

2. Time value

The calculation of value of time is calculated using a study from LAPI-ITB which funds Jasa Marga with the following formula (12) [19]:

Time value: Max {(K x Base time value); minimum time value) (12)

The results of the time value calculation can be seen in the following table 3:

Table 3 Basic and Minimum Time Values

Value K	0,74	
Calibration value	**6,572**	
Year	**1996**	**2025**
Basic time value		
LV (Rp/jam/vehicle)	Rp 9.092	**Rp 64.030**
HV (Rp/jam/vehicle)	Rp 10.188	**Rp 71.748**
Minimum time value		
LV (Rp/jam/vehicle)	Rp 6.000	Rp 42.253
HV (Rp/jam/vehicle)	Rp 6.723	Rp 47.344

The time value used is the highest value of the basic and minimum time values. The table above shows that the basic time value has the highest value, so the time value used is the basic time value. LV/Goal time value. I = Rp. 64,030 (Rp/hour/vehicle) and HV/Gol. III = Rp. 71,748 (Rp/hour/vehicle).

3. Public transport tickets

In this study, there were two types of buses. Non-toll/economy buses and buses via toll. For buses via toll use Damri buses and for economy buses use Akas Mila buses. Meanwhile, the bus ticket fare for the Banyuwangi-Surabaya route for the Damri Bus is 160,000 and the Akas Mila Bus is 95,000.

Meanwhile, for the train ticket fare of 240,000, it is assumed that there will be no price increase because there are no additional facilities and time savings. Therefore, train ticket prices in 2025 and 2023 will remain the same.

4. Toll rates

To obtain the planned toll rate for Probolinggo Banyuwangi, it is planned to use the toll rate per km on the Pasuruan-Probolinggo toll road [20]. The length of the toll road section obtained from the Toll Road Business Entity (BUJT) for Probolinggo-Banyuwangi is 172.9 km. The length of the toll road section is multiplied by the rate /km of the Pasuruan-Probolinggo toll road. Table 4 is a recap of the Surabaya-Banyuwangi toll rates.

Table 4 Banyuwangi-Surabaya Section Planned Toll Road Tariff Plan for 2025

Toll roads	**Banyuwangi-Surabaya toll road tariffs in 2025**		
	Group 1	**Group II & III**	**Group IV & V**
SBY-Gempol	Rp 10.112	Rp 15.730	Rp 20.787
Gempol-Pasuruan	Rp 43.820	Rp 66.292	Rp 88.764
Pasuruan-Probolinggo	Rp 33.708	Rp 50.562	Rp 67.416
Probolinggo-BWI	Rp 10.112	Rp 15.730	Rp 20.787
Total	**Rp 272.356**	**Rp 409.658**	**Rp 546.398**

3. Characteristics of Users of the Banyuwangi Surabaya Route Transportation Mode

The general characteristics of respondents using the Banyuwangi-Surabaya route transportation modes can be seen in the following figure 1 until figure 8.

1. Gender

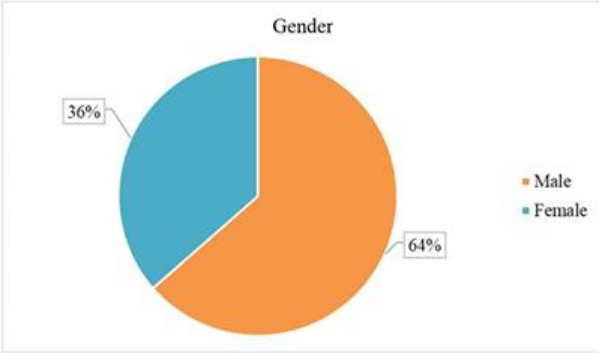

Figure 1 Percentage of Transportation Mode Users on the Banyuwangi-Surabaya Route Based on Gender

2. Age

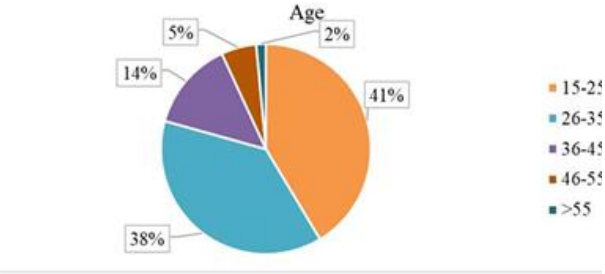

Figure 2 Percentage of Transportation Mode Users on the Banyuwangi-Surabaya Route Based on Age

3. Last education

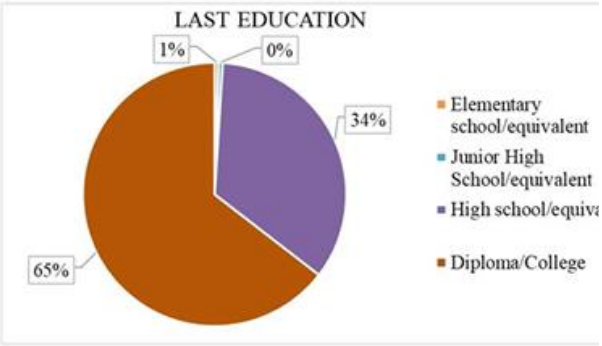

Figure 3 Percentage of Transportation Mode Users on the Banyuwangi-Surabaya Route Based on Last Education

4. Work

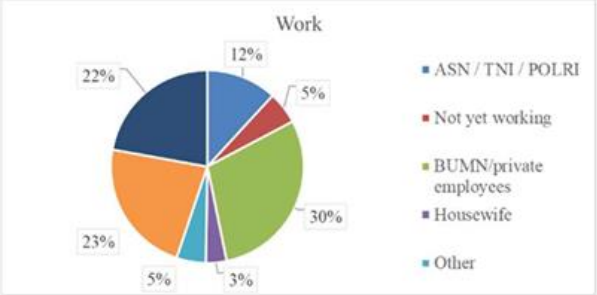

Figure 4 Percentage of Transportation Mode Users on the Banyuwangi-Surabaya Route Based on Occupation

5. Income Per Month

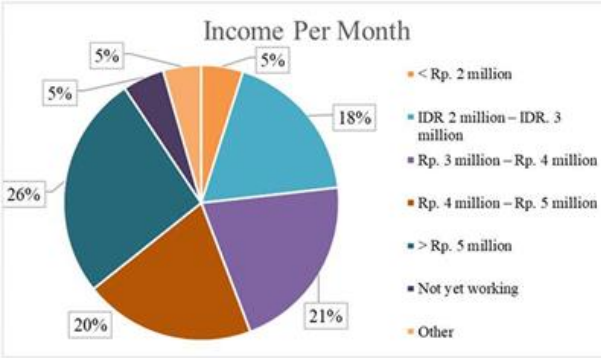

Figure 5 Percentage of Transportation Mode Users on the Banyuwangi-Surabaya Route Based on Monthly Income

6. Reasons to Travel

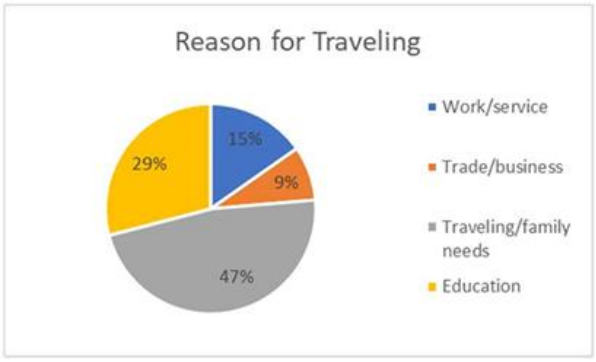

Figure 6 Percentage of Transportation Mode Users on the Banyuwangi-Surabaya Route Based on Reason for Traveling

7. Motor Vehicle Owership

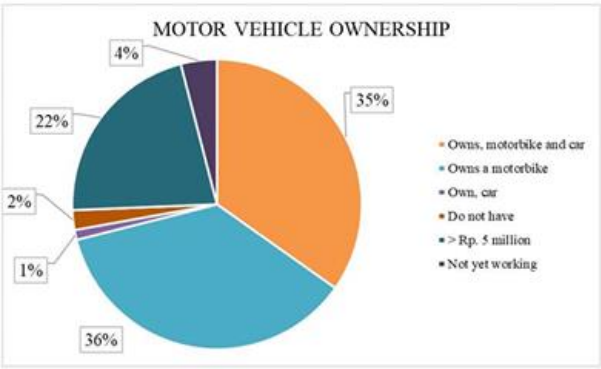

Figure 7 Percentage of Transportation Mode Users on the Banyuwangi-Surabaya Route Based on Motor Vehicle Ownership

8. Ownership of a Driving License (SIM)

For ownership of a driving license (SIM) can be seen Figure 8.

4. Modal Split Analysis

The mode selection in this research uses split capital analysis based on the cost ratio. This analysis uses generalized cost as a calculation to determine the mode choice equation. The modes that will be reviewed in this research are highway buses, non-toll buses, private cars, and trains.

After the proportions of the two functions have been found, the next step is to calibrate the values of these functions so that the model suits the existing conditions of transport mode voters on the Banyuwangi-Surabaya route. The calibration uses the Normalized Mean Absolute Error method and from this calibration, the model with the function that is best in modeling the mode choice of the Banyuwangi Surabaya route is selected.

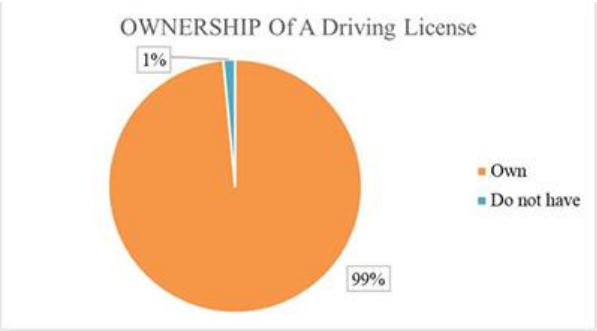

Figure 8 Percentage of Transportation Mode Users on the Banyuwangi-Surabaya Route Based on Ownership of a Driving License (SIM)

Nonlinear GRG is a method for optimizing a value by looking at the slope of the objective function as an input or fixed variable. With the help of a solver, α and β will be found using the total difference between the two alpha proportions so that the two differences between the two proportions are close to 0 or in other words the values of α and β can be included in the model function because the difference between the model and the existing one is close to or equal to zero.

From the calculation results, the results obtained for the deterrence function equation (β) are as follows table 4:

Table 4 Values of the exponential function equation or deterrence function (β)

Cost Mode Transportation		
CBusTol	Rp	554.612
CBusNonTol	Rp	668.982
CKP	Rp	1.412.212
CKA	Rp	624.180
Value of β		
β BT		0,000012
β BNT		0,000013
β KP		0,000004
β KA		0,000008

Transportation mode	Model	Existing	E= P model-P eksisting	NMAE= Mean E/Mean Full toll
P BT	0,09359	0,09360	0,0000014	
P BNT	0,01478	0,01478	0,0000043	
P KP	0,47783	0,47783	0,00000054	**0,0000087**
P KA	0,41379	0,41379	0,0000024	
Jumlah	1	1	0,0000087	
Mean		0,25	0,0000022	

CONCLUSIONS

1. Socio-economic characteristics of transportation mode voters on the Banyuwangi-Surabaya route are dominated by males with a percentage of 63.5%, ages between 15-25 years with a percentage of 41.4%, last education is a diploma/college with a percentage of 64 .5%, type of work is BUMN/private employees with a percentage of 29.6%, dominated by people with >5 million placements with a percentage of 29.1%, the most reasons for traveling are traveling/family needs with a percentage of 47.3%, and As many as 97.1% of mode users surveyed owned motorized vehicles. The mode characteristics used in the model are travel time and travel cost.
2. The model obtained from the analysis of two models, the power function and the exponential function/deterrence function. Because the smaller the resulting NMAE value or the closer it is to 0, the smaller the error in the estimated data. So the function used is the exponential function or deterrence function (β) with the value: NMAE β = 0.0000087 < NMAE α = 0.00036 with the following equation:

$$Bus\ Tol = \frac{EXP(-0{,}000012.GCBusTol)}{EXP(-0{,}000012.GCBusTol) + EXP(-0{,}000013.GCBusNonTol) + EXP(-0{,}000004.GCKP) + EXP(-0{,}000008.GCKA)}$$

$$PBusNonTol = \frac{EXP(-0{,}000013.GCBusNonTol)}{EXP(-0{,}000012.GCBusTol) + EXP(-0{,}000013.GCBusNonTol) + EXP(-0{,}000004.GCKP) + EXP(-0{,}000008.GCKA)}$$

$$PKP = \frac{EXP(-0{,}000004.GCKendaraanPribadi)}{EXP(-0{,}000012.GCBusTol) + EXP(-0{,}000013.GCBusNonTol) + EXP(-0{,}000004.GCKP) + EXP(-0{,}000008.GCKA)}$$

$$PKeretaApi = \frac{EXP(-0{,}000008.GCKeretaApi)}{EXP(-0{,}000012.GCBusTol) + EXP(-0{,}000013.GCBusNonTol) + EXP(-0{,}000004.GCKP) + EXP(-0{,}000008.GCKA)}$$

3. The proportion/demand for each mode of transportation if all sections of the Banyuwangi Surabaya toll road corridor are connected are as follows:

Bus Toll	= 9,36%
Non-Toll Bus	= 1,48%
Private Vehicle	= 47,78%
Railway	= 41,38%

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