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Aleksander Purba

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ASSESSING FACTORS INFLUENCING ROUTE CHOICE A CASE STUDY OF TERPEKA TOLL ROAD, INDONESIA

Aleksander Purba[1], Darmawan Adi Susanto[2], Rosalia Dwi Werena[3] and Tiara[4]
[1,3,4]Engineering Faculty, the University of Lampung, Indonesia
[2]Post Graduate Program, Civil Engineering, the University of Lampung, Indonesia

ABSTRACT

TERPEKA is part of the Trans Sumatera toll road network that is planned to connect the northern part of Sumatera to the southern part and will link the province of Nanggroe Aceh Darussalam with Lampung. The TERPEKA section is located in the Lampung and South Sumatera provinces with a total length of 189 km and expected to increase accessibility to and from regions located in close proximity to the toll road and to stimulate economic growth, particularly in palm oil and rubber sectors. A total of 190 respondents were collected in the rest area of KM 234A and KM 215B on end year vacation of 2019. Respondents in the age range of 26 to 55 years who were in the productive age category had a percentage of 84%, and age range of 36 to 45 years was recorded as 32% which included the most productive age category. These figures indicate that Indonesia is enjoying a demographic bonus. The most significant factor influencing route choice when deciding to determine to travel using toll road is income followed by spending for transport attribute. The equation of $Y = -1.711 – 0.00000921X_1 + 0.186X_2 + 0.446X_4$ is differences in the utility related to the attributes or characteristics of TERPEKA route which was analyzed. With the correlation coefficient, the income level and time saving variables are those variables that most influence the TERPEKA's toll road users. Instead, increase in toll fares reduces vehicle use.

Keywords: TERPEKA, Fare, Income, Spending for transport, Indonesia

INTRODUCTION

A Terbanggi Besar–Pematang Panggang–Kayu Agung (TERPEKA) along 189 km is part of the planned development of 2,974 km of Trans Sumatra toll road. The construction of this toll road is one of the packages of a national strategic project initiated by the central government. At the beginning of development, the TERPEKA toll road segment was declared economically feasible but financially unfeasible, so the central government assigned a state owned company to build it. According to the feasibility study document, the total volume of traffic of TERPEKA is 14,000 vehicles per day and segments that are considered financially viable are usually with total volume more than 20,000 vehicles per day. Such conditions are not only phenomena in developing country such as Indonesia but also in the developed country, since costs derived from through traffic would also not be covered by the fees, but this issue may be moot, as most through traffic uses arterials that are funded by higher levels of government [1].

Hence, through Presidential Regulation No. 117/2015 jo. No.100/2014 the central government assigned PT Hutama Karya (Persero) to implement the acceleration of development of Trans Sumatera toll road [2]. After constructed around two years, in mid-November 2019 the TERPEKA segment began operating with toll fares of Rp170,500 from the starting point of Terbanggi Besar to the end point of the segment in Kayu Agung or Rp902/km. Generally, the determination of toll fares is decided by considering the financial condition of the government, investors and road users and fares must meet user benefits and meet environmental requirements [3]. Toll road financing is allocated for construction, operation and maintenance. Toll fare and the number of users are the two main factors affecting revenue, investment and development of toll roads. Travel demand depend on the number and type of trips to be selected by individuals under certain conditions. Factors that influence travel demand in general are demographic, geographic and economic factors, which the available space can exceed capacity faster than the predicted as found by Selmoune et. al in many cities such as Singapore, Stockholm, and London [4]. Demographic factors are the individual preference of road users and economic factors usually related to travel expenses. Travel expenses include fares, additional travel time, inconvenience and risks. Modeling the relationship factors will be useful in estimating the trip behavior and future transport policy strategies. Changes in fares can affect the frequency, route, mode, and destination of the trip and their impact can be known through measuring price impacts [5] and change of utility function [6]. Study area in China has found the travel cost and travel time have a significantly negative impact on the utilities [7]. The purpose of

the study is to model user preference on the selection of routes between toll roads or non-toll road.

MATERIAL AND METHOD

Study Area

TERPEKA is part of the Trans Sumatra toll road which is planned to link from the north of the island of Sumatra to the south and connects the province of Nangroe Aceh Darussalam to Lampung province. This section is located in Lampung and South Sumatra provinces and is divided into three sections namely section 1 Terbanggi Besar - Menggala, section 2 Menggala - Simpang Pematang and section 3 Simpang Pematang - Kayu Agung. So that this section is a combination of the Terbanggi Besar – Pematang Panggang (100 km) section which was built and operated first and Pematang Panggang - Kayu Agung (89 km) section which was operated later as shown in Fig. 1.

As part of the main network of the island of Sumatra, this section is important to support the transportation of goods and people from the Bakauheni port and is expected to be able to open access to the surrounding areas and support economic growth, especially natural resources of oil palm and rubber plantations. In addition, one of the vital roles expected is to reduce travel time and reduce logistics costs from the Bakauheni port to South Sumatera and surrounding areas [8].

Fig. 1 A section of TERPEKA toll road

Stated Preference Techniques

The stated preference (SP) technique is widely used in research and practice in travel behavior. Generally, this method is applied to identify behavioral responses to selected situations that are not or have not yet been fully revealed in the market. In practice the SP method is modified in such a way as to the importance of the attributes in the choices provided as conducted by Saeed & Majid [9]. An example of a choice not revealed on the market is the case of choosing a route between using a toll road or non-toll road. In this case study condition, there is no specific information or data that can be processed with statistics to get the desired route choice. With the stated preference technique, researchers can fully control the factors that exist in a hypothetical situation. In the case of choosing a route between a

toll road and a non-toll road, alternative options are designed that show variations in toll fares and time saving (compared to non-toll routes). Individuals will state their response to these alternatives. Then the data is processed using statistical software to determine the choice of the route by considering the factors of toll fare and time saving variations.

RESULT AND DISCUSSION

Field Survey

A total of 190 respondents were collected in the rest area of KM 234A and KM 215B of TERPEKA on December 26 and 27, 2019 between 9am and 6pm. It is important to note that the number of respondent is not large enough compared to about 18,000 vehicles per day of TERPEKA at the time the survey was conducted, as is also stated by Xiao et. al [10], biases may occur in the process of characterizing the population by using samples [11], each person has a characteristic daily motif [12], and the underestimation of the relatively high mobility at the city scale [13]. The socioeconomic characteristics of respondent are described below: they are age group, education level, job, monthly income range, spending for transport, annual travel frequency, trip purpose, and reason for using toll road, respectively.

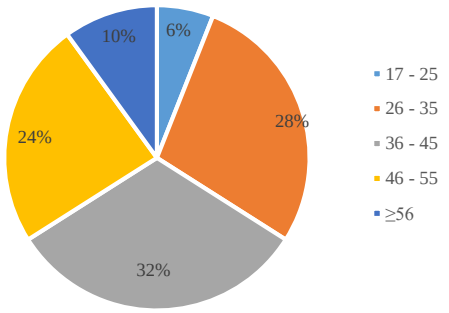

Fig. 2 Age group

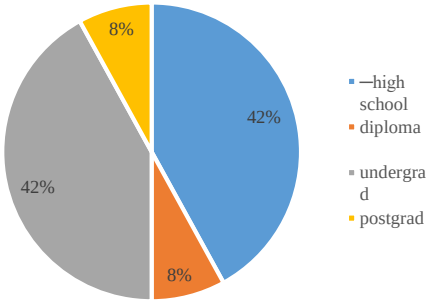

Fig. 3 Education level

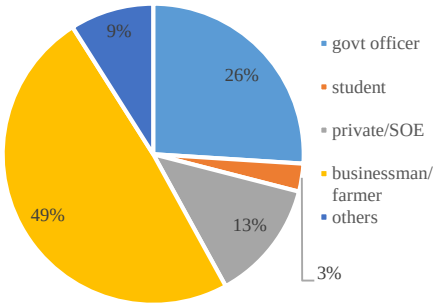

Fig. 4 Job

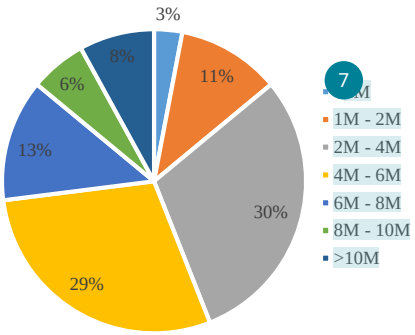

Fig. 5 Income range

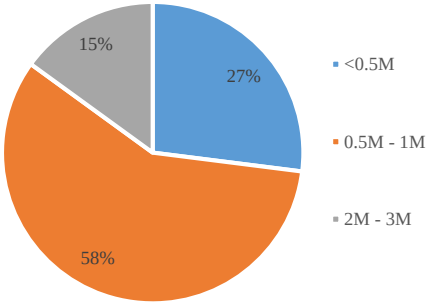

Fig. 6 Spending for transport

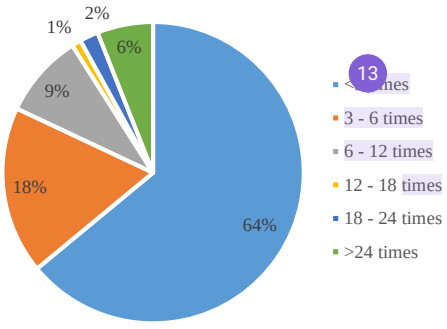

Fig. 7 Annual travel frequency

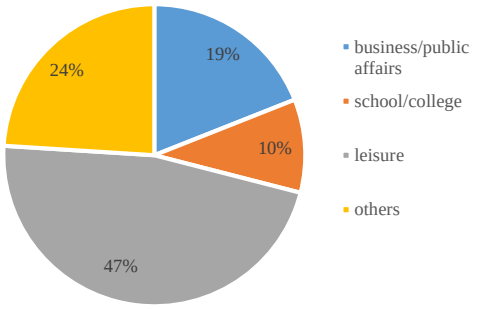

Fig. 8 Trip purpose

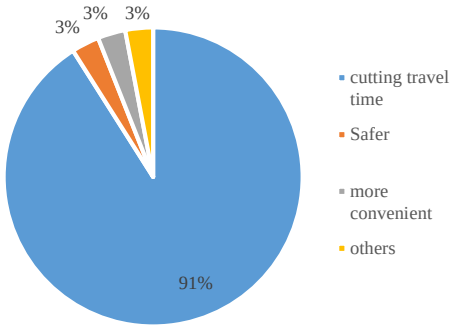

Fig. 9 Reason for using toll road

Correlation Analysis

Correlation analysis of respondent characteristics was conducted to determine the influence of a number of socioeconomic factors in determining route choice. The correlation coefficient of variables expressing the respondents' characteristics is shown in Figure 10 below. The figures of correlation coefficient were obtained from the correlation analysis by using statistical software. The significance test of the correlation coefficient is conducted based on probability with a confidence level of 95%.

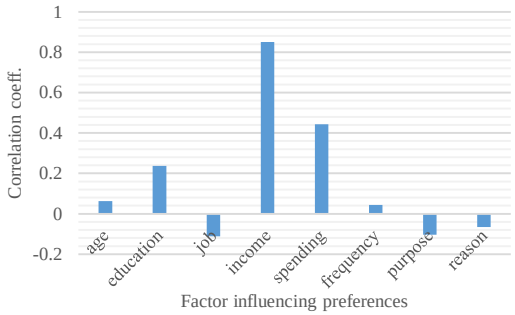

Fig. 10 Correlation coefficient of toll user characteristics

Here are the four most important factors influencing preferences (Fig. 10). First, respondent characteristics that influence the route choice are education, income and spending for transport, respectively. Second, the correlation coefficient related to education factor for route choice using toll road is 0.237 (low correlation). The sign (+) indicates a positive correlation, meaning that the higher education, the higher tendency of respondents to choose toll road. Third, the correlation coefficient in terms of income related to route choice of TERPEKA is 0.851 (very strong). This figure indicates that the income factor is the most influential factor comparing to other characteristic factors while determining the option of using toll roads. The sign (+) indicates a positive correlation, meaning that the higher income the higher tendency to determine to travel using toll road. Fourth, the correlation coefficient associated with spending for transport over route choice of toll road is 0443 (moderate). The sign (+) indicates a positive correlation, which means the higher spending for transport the more people use toll road.

Route Choice Probability

Based on the toll fare variables, the respondent's largest preference for "may be not use toll" if the fare increase amounted to Rp50,200 was 20.50% for income group of 2M to 4M. These income groups have the potential to switch for choosing non-toll road if toll fares increased more than Rp50,200. The respondent preference on the route choice can be seen in the following Table 1.

Table 1. Income group, fare, and route choice

Income	Preference	Δ-Fare	%
2M-4M	May be not use toll	50,200	20.50
4M-6M	May use toll	25,200	17.89
1M-2M	Definitely not use toll	80,200	10.53
6M-8M	Definitely use toll	9,200	6.32

In terms of time saving variable, the respondent's largest preference for "may be not use toll" if the time saving range is only two hours with a percentage of 11.58% for income group of 2M to 4M.

These income groups have the potential to switch for choosing non-toll roads if time saving is less than two hours. Route choice preferences for various income group categories and time saving ranges is shown in Table 2.

Furthermore, based on the results of the respondent's preference, an equation approach can be made to predict the binary logit model of route choice between toll roads and non-toll roads.

Table 2 Income group, time-saving, and route choice

Income	Preference	Δ-t-save	%
2M-4M	May not use toll	2	11.58
4M-6M	May use toll	3	8.95
2M-4M	May not use toll	1	7.89
1M-2M	Definitely not use toll	1	7.37

The model is to specify differences in the utility associated with both available routes. Hence, equation (U_{toll} - $U_{non\text{-}toll}$) is the difference in the utility of toll road route and non-toll road route. The general form of a multiple linear regression analysis formed is as follows:

$$Y = a + b_1(X_{1toll} - X_{1non\text{-}toll}) + b_2(X_{2toll} - X_{2non\text{-}toll}) + \ldots + b_n(X_{ntoll} - X_{nnon\text{-}toll}) \quad (1)$$

Furthermore, the model with the best performance on the backward elimination validation set is selected as below:

$$Y = -1.711 - 0.00000921X_1 + 0.186X_2 + 0.446X_4$$

with,

X_1: toll fares

X_2: time saving

X_4: income level

With the correlation coefficient, the variables X_4 and X_2 are those variables that most influence the TERPEKA's toll road users. Instead, increase in toll fares reduces vehicle use.

CONCLUSION

Respondents in the age range of 26 to 55 years who were in the productive age category had a percentage of 84%, and age range of 36 to 45 years was recorded as 32% which included the most productive age category. This figure is almost three times higher compared to the HOT and HOV – HOT markets of the USA which is only 12% [14]. These findings indicate that Indonesia is enjoying a demographic bonus, which are shown through a high percentage of the age range of productive categories and also the most productive age range, which is much higher compared to developed countries such as the USA. Respondents with education level of high school and diploma have the largest percentage of 42%. In terms of job, respondents with self-employed/farmers had the highest percentage of 49%. According to monthly income, respondents with 2M to 4M income range had the highest percentage of 30%. Respondents with a spending for transport of 0.5 M to 1M were recorded at 58% and respondents with the annual travel frequency less than three times had the highest percentage of 64%. Respondents with trip purpose for leisure have the highest percentage of 47% and the respondents determined a toll road with a percentage of 91% due to the reason would cutting travel time. The most significant factor influencing route choice when deciding to determine to travel using toll road is income with a correlation coefficient of (+) 0.851. This figure indicates that the higher income the higher tendency to determine to travel using toll road. Findings on this research are not much different compared to respondent behavior of other cities as expressed by Atlanta [15, 16] and Abu Dhabi [17]. Attribute related to spending for transport is quite influential on the route choice for determining toll roads with a correlation coefficient of (+) 0,443. It means the higher spending for transport of respondents, they have tendency to determine for using toll road compared to non-toll road. The equation of $Y = -1.711 - 0.00000921X_1 + 0.186X_2 + 0.446X_4$ is differences in the utility related to the attributes or characteristics of TERPEKA route which was analyzed. Route choice probability between the toll roads and non-toll roads is represented by attributes of toll fares, time saving and income level and its differences in utility would maximized by respondents according to his/her characteristics individually in deciding of available options. With the correlation coefficient, the income level and time saving variables are those variables that most influence the TERPEKA's toll road users. Instead, increase in toll fares reduces vehicle use.

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