International Journal of Multidisciplinary Research and Growth Evaluation.

Analysis of Route Choice for Travel Between Bekasi and Jakarta After the Operation of the Becakayu Toll Road

Jafar Shadiq [1], Muhammad Isradi [2*]
[1] Bachelor of Civil Engineering, Department of Civil Engineering, Universitas Mercu Buana, Jakarta, Indonesia
[2] Department of Civil Engineering, Universitas Mercu Buana, Jakarta, Indonesia

* Corresponding Author: **Muhammad Isradi**

Article Info

ISSN (online): 2582-7138
Volume: 05
Issue: 04
July-August 2024
Received: 28-06-2024
Accepted: 05-08-2024
Page No: 1198-1202

Abstract
Transportation is one of the problems that is the key to the success of a city. The city of Bekasi, as the gateway and shelter of the capital of Jakarta, has a high mobility due to the density of the city of Jakarta. The research aims to identify the characteristics and variables that influence the traveler to be able to determine the toll road route from Bekasi city to Jakarta city, the factors that affect the choice of toll route, and also to obtain a model of route choice that can explain the probability and sensitivity if there is a change in its attributes. The data collection was done using offline and online questionnaires. In this study, the survey was conducted using the Logit Binary Ratio method with stated preference. Further, the data from the survey was processed using regression analysis to evaluate the relationship between the response variable, i.e. the choice of the traveler (Y), and the change in the attributes analyzed, the difference in travel costs (X1), and the travel time. (X2).
The data analysis was carried out from the questionnaire data distributed to 100 respondents, of whom 70 respondents were tax users Jakarta-Cikampek and 30 respondents tax users Becakayu. The result obtained when the cost attribute changes is that the user of the toll Becakayu will change the toll while the Jakarta-Cikampek toll user will continue to use the toll, and when the time attributes change the users of the tol Becakayo and the Jakarta -Cikempek would prefer to keep using the tolls respectively. Sugegestions in the future need to be further research related to the convenience, feasibility, and facilities on each toll road.

Keywords: Route Selection, Inner City Toll, Becakayu Toll, Binary Logit, Stated Preference

Introduction

Every traveler tries to find the best route to minimize travel costs, such as reducing travel time by considering various factors (Madani et al. 2024) [8]. The uncertainty in travelers' behavior when choosing a route has many variations that need to be considered. Traditionally, in transportation engineering and planning, this aspect of uncertainty is often overlooked or considered through a single paradigm approach, namely probability theory (Andika et al. 2022) [1].

Travelers heading from Bekasi to Jakarta often experience traffic congestion due to the high volume of vehicles, with the journey to Jakarta taking approximately 2 hours. With the operation of the Becakayu toll road, travelers can choose routes that can optimize distance, time, and costs required to reach their destination (Rifai et al. 2020) [13]. However, not every traveler will choose the same route; there are many factors that can influence route selection decisions made by travelers (Zhu et al. 2021) [15].

A toll road is a public road that is part of the road network system and serves as a national road where users are required to pay a toll. A toll is a specific amount of money paid for the use of the toll road (Kinasih et al. 2022; Li et al. 2018) [6, 7].

The Jakarta-Cikampek Toll Road, or Japek Toll Road, is a toll road that runs from Cawang, East Jakarta, DKI Jakarta, to Cikopo, Purwakarta Regency, West Java. This road passes through East Jakarta, Bekasi City, Bekasi Regency, Karawang Regency, and

Purwakarta Regency. To travel from Bekasi City to Kampung Melayu, one must cover a distance of at least 36 km along the Jakarta-Cikampek Toll Road (Dermawan, Bimantara, and Isradi 2021) [2, 5].

The Bekasi-Cawang-Kampung Melayu Toll Road, commonly abbreviated as Becakayu Toll Road, is an elevated toll road built along the Malang River in East Jakarta Administrative City, Bekasi City, and Bekasi Regency. It was constructed to alleviate traffic congestion around the Malang River, which frequently experiences high vehicle volumes. This road is 23.67 km long and connects to the city center.

Research Method

The literature review in this study is derived from research journals related to route choice research, which was conducted using a binary logit model (Rachmadina et al. 2023) [10].

In this study, the behavior of route choice investigated involves choosing between toll roads and non-toll roads. The probability of an individual choosing a toll road is a function of the difference in utility between the two routes. Assuming the utility function is linear, the difference in utility can be expressed in terms of the differences and relevant attributes between the two routes (Firdaus et al. 2021) [3]. The research method involved conducting direct field surveys to obtain primary and secondary data. The binary logit method was then used with Stated Preference to determine respondents' preferences in ranking, rating, travel costs, travel time, and questionnaires (Firdaus et al. 2022) [4].

Fig 1: Research location

The data collection technique in this research uses the Stated Preference method, which is presented to respondents through a questionnaire survey (Isradi et al. 2021) [2]. The questionnaire form was first created in Google Docs and distributed to each respondent by sending a link to the survey form (Mathew and Benekohal 2021) [9]. The responses are automatically saved in Google Docs as a spreadsheet (Excel file). In addition to using the online form, data collection was also conducted through direct field surveys to obtain appropriate samples (Rifai et al. 2021) [11].

The data used in the analysis of the performance of road sections and unsignalized intersections includes primary and secondary data (Rifai et al. 2022) [11]. Primary data is obtained by conducting surveys directly at the research location, which includes:

1. Respondent Characteristics

a. Distance from home to the toll road
b. Age of the respondent
c. Reasons for using the toll road
d. Purpose of the trip
e. Frequency of using the toll road
f. Respondent's income

Then, for secondary data obtained from related agencies as a research area, the secondary data needed in this research are:

1. Toll Costs Jakarta-Cikampek
2. Toll Costs Becakayu

Result and Discussion

Characteristics of Becakayu Toll Road Users

Distance from home to the toll road is 54% of users live more than 5km away from the toll, 50% of users are between the ages of 25-34 years, 63% of users concider price as a significant factor in their decision to use toll road, 47% of users travel for holiday or recreation, 33% of users use the toll road 2-3 times, and 60% of users have an income of less than 3 million Rupiah.

Characteristics of Jakarta-CikampekToll Road Users

Distance from home to the toll road is 40% of users live 2-3 km away from the toll, 51% of users are between the ages of 17-24 years, 36% of users concider time or speed as a primary factor in their decision to use toll road, 37% of users travel for holiday or recreation, 51% of users use the toll road 1-2 times, and 51% of users have an income of less than 3 million Rupiah.

Processing of data

Data testing is conducted to determine the validity and reliability of variables. In this context, the testing involves evaluating how well the model is constructed, including its independent and dependent variables, regression coefficients, and so on. The required tests include:

1. Pearson Product-Moment Validity Test
2. Multicollinearity Test
3. Cronbach's Alpha Reliability Test
4. Wald (Z) Test

These tests collectively help in validating and ensuring the reliability of the model, ensuring that the results are accurate and robust for decision-making and further analysis.

Questionnaire processing

Questionnaire testing involves several steps to ensure the reliability and validity of the data collected through the survey instrument (Weng et al. 2018) [14].

Table 1: Questionnaire Testing

	Toll Road	Validity test		Multicollinierity test			Wald Z test
		R	significance	B	Tolerance	VIF	
Constant	Becakayu	-	-	62,169	-	-	-
	Jakarta-Cikampek	-	-	58,874	-	-	-
Distance from home to the toll	Becakayu	-0,008	0,967	-	-	-	-
	Jakarta-Cikampek	0,15	0,108	-	-	-	-
Age of the respondent	Becakayu	0,562	0,001	-0,43	0,313	3,194	11,584

	Jakarta-Cikampek	0,511	0	1,011	0,026	38,672	16,275
Reasons for using the toll road	Becakayu	0,582	0,001	1,372	0,659	1,517	7,261
	Jakarta-Cikampek	0,654	0	2,178	0,061	16,314	14,321
Purpose of the trip	Becakayu	0,285	0,127	-	-	-	-
	Jakarta-Cikampek	0,796	0	-0,874	0,032	20,891	15,151
Frequency of using the toll road	Becakayu	0,544	0,002	-2,165	0,59	1,696	12,926
	Jakarta-Cikampek	0,628	0	-1,709	0,047	21,08	12,775
Respondent's income	Becakayu	0,695	0	0,137	0,297	3,364	8,226
	Jakarta-Cikampek	0,243	0,021	-0,65	0,035	28,864	14,024
Reability test	Becakayu	0,601					
	Jakarta-Cikampek	0,565					
R Table (N=30)	Becakayu	0,361					
R Table (N=70)	Jakarta-Cikampek	0,235					

Interpretation of the Utility Function

The utility function for Becakayu Toll users is represented as: UToll-Becakayu = 62,169 + 0,423 (Age of Becakayu Toll Users) + 1,372 (Reason for Using Becakayu Toll) + - 2,165 (Frequency of Travel by Becakayu Toll Users) – 0,317 (Income of Becakayu Toll Users)

The utility function for Jakarta-Cikampek Toll Users is represented as:

UToll-Jakarta-Cikampek = 58,874 – 1,011 (Age of Jakarta-Cikampek Toll Users) + 2,178 (Reason for Using Jakarta-Cikampek Toll Users) – 1,700 (Frequency of Travel by Jakarta-Cikampek Toll Users) – 0,650 (Income of Jakarta-Cikampek Toll Users).

From the estimated parameters for the utility of the Becakayu Toll, the average age and frequency variables indicate that these factors are disliked by respondents. Thus, an increase in these variables will result in a decrease in utility. Conversely, for reasons for using the toll road and income, an increase in these variables will enhance utility. Therefore, respondents using the Becakayu Toll might consider switching to the Jakarta-Cikampek Toll.

For the Jakarta-Cikampek Toll, the estimated utility indicates that the purpose of the trip, frequency, and income variables are also disliked by respondents. An increase in these variables will lead to a decrease in utility. However, if the age and reason for using the toll road increase, the utility will rise. Consequently, respondents using the Jakarta-Cikampek Toll may think about switching to the Becakayu Toll.

Route Choice Grapichs

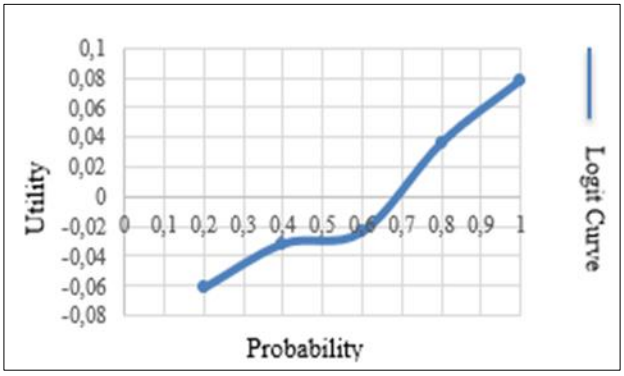

Fig 2: Difference in Utility and Probability of Jakarta-Cikampek Toll Users and Route Switching

The analysis of the graph shows a trend where the probability values follow the utility values of Jakarta-Cikampek Toll users. Specifically, as the utility value increases, it results in a higher probability of switching routes from using the Jakarta-Cikampek Toll to using the Becakayu Toll.

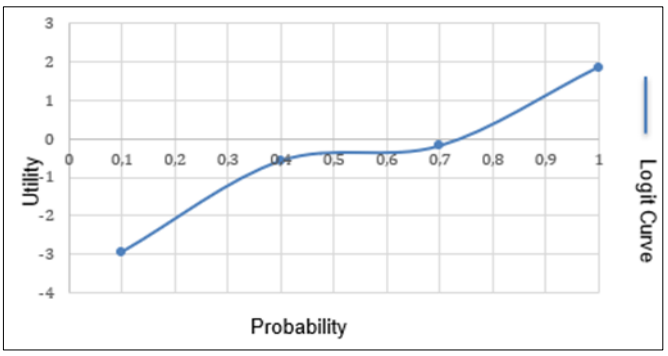

Fig 3: Difference in Utility and Probability of Becakayu Toll Users and Route Switching

The analysis of the graph shows a trend where the probability values follow the utility values of Becakayu Toll users. Specifically, as the utility value increases, it results in a higher probability of switching routes from using the Becakayu Toll to using the Jakarta-Cikampek Toll.

Model Sensitivity

Model sensitivity analysis is intended to understand how the probability values of route selection change when attribute values are altered gradually.

Sensitivity of the Utility Model for Becakayu Toll Users and Route Switching:

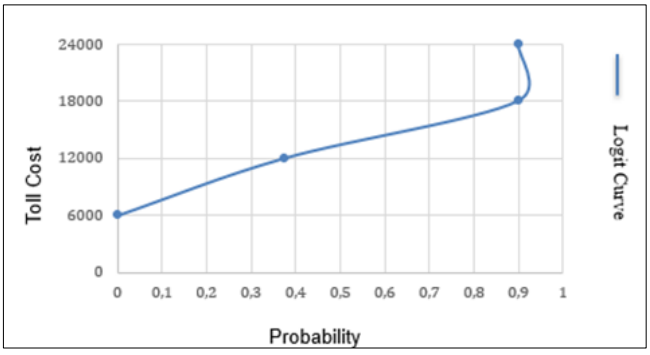

Fig 4: Sensitivity of Becakayu Toll Users to Changes in Cost Attributes

The graph above shows the sensitivity of Becakayu Toll users to changes in travel cost, while the time variable remains constant. Respondents are more likely to choose the Jakarta-Cikampek Toll if the travel cost increases. However, some respondents accept the lowest offered price, which is Rp. 6,000 more expensive than the Jakarta-Cikampek Toll.

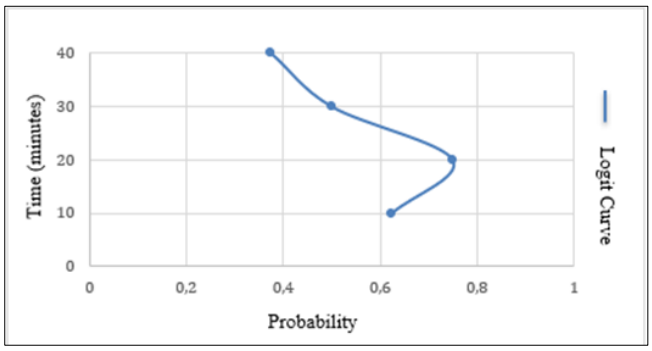

Fig 5: Sensitivity of Becakayu Toll Users to Changes in Time Attributes

The graph analysis indicates that the probability of Becakayu Toll users continuing to use the Becakayu Toll increases if the travel time is reduced, while the cost attribute remains constant. However, significant changes are observed when the offered reduction in travel time is between 10 to 20 minutes, as the probability rises sharply to between 0.6 and 0.8.

For sensitivity of the Utility Model for Jakarta-CikampekToll Users and Route Switching, can be seen in the following figure 6:

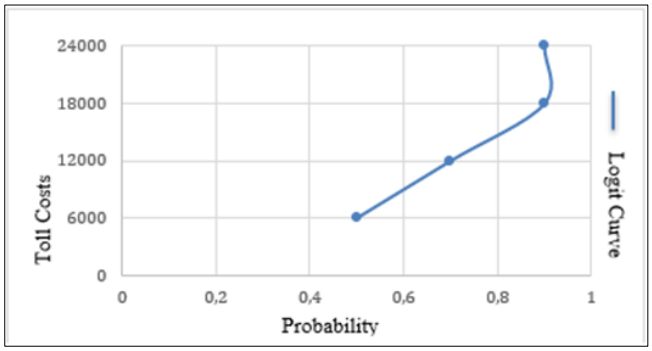

Fig 6: Sensitivity of Jakarta-Cikampek Toll Users to Changes in Cost Attributes

The graph above shows the sensitivity of Jakarta-Cikampek Toll users to changes in travel cost, while the time variable remains constant. Respondents are more likely to choose the Becakayu Toll if the offered cost is lower. However, some respondents accept the highest offered price, which is Rp. 24,000 more expensive than the Jakarta-Cikampek Toll.

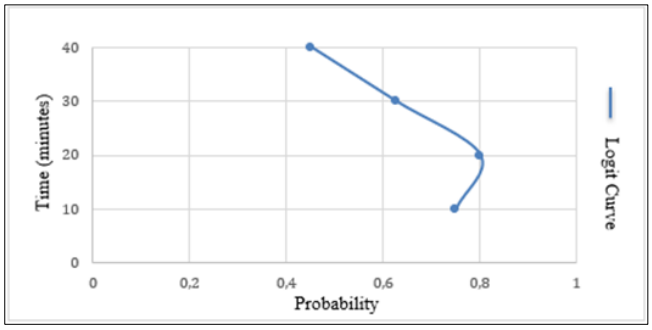

Fig 7: Sensitivity of Jakarta-Cikampek Toll Users to Changes in Time Attributes

The graph analysis shows that the probability of Jakarta-Cikampek Toll users continuing to use the Jakarta-Cikampek Toll is low if travel time is reduced while the cost attribute remains constant. However, when the offered reduction in travel time is between 10 to 20 minutes, Jakarta-Cikampek Toll users are more likely to remain on the Jakarta-Cikampek Toll rather than switching to the Becakayu Toll.

Conclusions

Based on the results of the analysis, the following conclusions are obtained:

1. Characteristics of Becakayu Toll Users include 54% Distance from home to the toll road >5km, 50% Age 25-34 Years, 63% Price consideration in choosing the toll road, 47% Leisure/recreation as the purpose of travel, 33% Use the toll road 2-3 times, and 60% Income <3 million Rupiah. Meanwhile, Characteristics of Jakarta-Cikampek Toll Users include 40% Distance from home to the toll road 2-3km, 51% Age 17-24 Years, 36% Time consideration/faster in choosing the toll road, 37% Leisure/recreation as the purpose of travel, 51% Use the toll road 1-2 times, and 51% Income <3 million Rupiah.
2. From the parameter estimation results for Becakayu Toll Users, the scenarios with the largest impact leading users to switch to Jakarta-Cikampek Toll are (Acceleration, Price): (10,18), (10,24), (20,18), (20,24), (30,24). Respondents likely to switch are those who consider faster travel time and have an income <3 million Rupiah. Meanwhile, the scenarios with the largest impact causing Jakarta-Cikampek Toll Users to switch to Becakayu Toll are (Acceleration, Price): (30,6), (40,6). Respondents likely to switch are those aged 17-24 years and with an income <3 million Rupiah.
3. Graph analysis in Figure 4.14 shows that the probability values of Jakarta-Cikampek Toll Users follow the utility values, where a higher utility value results in a higher probability of switching from Jakarta-Cikampek Toll to Becakayu Toll. Meanwhile, graph analysis in Figure 4.15 shows that the probability values of Becakayu Toll Users follow the utility values, where a higher utility value results in a higher probability of switching from Becakayu Toll to Jakarta-Cikampek Toll. For sensitivity analysis, it shows the impact of changes in cost and time variables on the route switching probability, as follows:

Sensitivity of Becakayu Toll Users

a. Becakayu Toll Users tend to switch to Jakarta-Cikampek Toll if the travel cost offered is high.
b. A reduction in travel time will encourage Becakayu Toll Users to remain on the Becakayu Toll. However, a travel time reduction of 10-20 minutes makes Becakayu Toll Users uncertain, with the probability sharply increasing to 0.6-0.8.

Sensitivity of Jakarta-Cikampek Toll Users

a. Jakarta-Cikampek Toll Users prefer to remain on the Jakarta-Cikampek Toll if the travel cost changes while the time remains constant.

A reduction in travel time offered makes Jakarta-Cikampek Toll Users less likely to switch. However, with a time reduction of 10-20 minutes, Jakarta-Cikampek Toll Users are more likely to stay on the Jakarta-Cikampek Toll rather than switching to Becakayu Toll.

References

1. Andika I, Rifai AI, Isradi M, Prasetijo J. A traffic management system for minimization of intersection traffic congestion: Case Bengkong Junction; c2022.
2. Dermawan WB, Bimantara F, Isradi M. Passenger satisfaction analysis on Bekasi Station service performance. IJTI International Journal of Transportation and Infrastructure. 2021;5(1):36-43.
3. Firdaus HY, Isradi M, Prasetijo J, Rifqi M. Performance analysis and passenger satisfaction on Trans Jakarta Bus services (Cibubur Route – BKN). Journal of Science, Technology, and Engineering (JSTE). 2021;1(2):73-81.
4. Firdaus HY, Isradi M, Prasetijo J, Rifqi M, Halim H. Analysis of Transjakarta service performance on the Cibubur-BKN by Servqual method. European Journal of Science, Innovation and Technology. 2022;2(1):113-123.
5. Isradi M, Tarastanty NA, Dermawan WB, Mufhidin A, Prasetijo J. Performance analysis of road section and unsignalized intersections on Jalan Cileungsi Setu and Jalan Raya Narogong. International Journal of Engineering, Science and Information Technology. 2021;1(2):72-80. doi: 10.52088/ijesty.v1i2.108.
6. Kinasih RK, Prasetijo J, Indriany S, Isradi M, Biantoro AW. Analyzing toll road as a solution to the existing highway problem. Res Militaris. 2022;12(route 1):6.
7. Li R, Rose G, Chen H, Shen J. Effective long-term travel time prediction with fuzzy rules for tollway. Neural Computing and Applications. 2018;30:2921-2933.
8. Madani MG, Isradi M, Hidayat A, Sudrajat KM, Yusman H, Prasetijo J. Analysis of service level of Trans Metro Pasundan Bandung Raya Corridor 2 based on importance performance analysis and customer satisfaction index; c2024.
9. Mathew J, Benekohal RF. Highway-rail grade crossings accident prediction using zero inflated negative binomial and empirical Bayes method. Journal of Safety Research. 2021;79:211-236.
10. Rachmadina Y, Isradi M, Prasetijo J, Dalimunte AK, Mufhidin A. Analysis of the choice of commuter line electric rail train (KRL) modes and Transjakarta buses for the Bekasi City - East Jakarta route. Engineering and Technology Journal. 2023;8(08):2655-2664. doi: 10.47191/etj/v8i8.23.
11. Rifai AI, Lista L, Isradi M, Mufhidin A. How did the COVID-19 pandemic impact passenger choice toward public transport? The case of Jakarta, Indonesia. Design Engineering. 2021;8:6816-6824.
12. Rifai AI, Putra MGD, Isradi M, Mufhidin A, Prasetijo J. Evaluation of selection of public transport mode corridor Blok M–Bundaran Hotel Indonesian in the new normal era with stated preference. IJEBD International Journal of Entrepreneurship and Business Development. 2022;5(4):792-805.
13. Rifai AI, Wibowo T, Isradi M, Mufhidin A. On-street parking and its impact on road performance: Case commercial area in Jakarta City. World Journal of Civil Engineering. 2020;1(01):10-18.
14. Weng J, Yang D, Qian T, Huang Z. Combining zero-inflated negative binomial regression with MLRT techniques: An approach to evaluating shipping accident casualties. Ocean Engineering. 2018;166:135-144.
15. Zhu Z, Mardan A, Zhu S, Yang H. Capturing the interaction between travel time reliability and route choice behavior based on the generalized Bayesian traffic model. Transportation Research Part B: Methodological. 2021;143:48-64.