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Analysis of Route Choice Between Toll Road and National Highway in Palembang - Prabumulih, South Sumatra

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Abstract.

The Palembang–Prabumulih Toll Road, part of the Trans-Sumatra network, was developed to enhance travel efficiency and reduce congestion on the national highway. However, traffic volumes remain below target, indicating limited public preference for toll use. This study analyses the factors influencing route choice between the toll road and the national highway along the Palembang–Prabumulih corridor. The research applies the Stated Preference (SP) method and the Binomial Logit Model using data from 200 private vehicle users. Results show that the majority of respondents were male (78.5%), aged 31–40 years (37%), self-employed (40.5%), and had an average monthly income of IDR 3–4 million. From five cost–time scenarios, 62–81% of respondents preferred the toll road when costs were lower, but preference declined with higher toll charges. The estimated Value of Time (VoT) was IDR 365 per minute. The model's chi-square test result (χ^2_a = 13.186 < χ^2_t = 14.067) confirms good model fit. Overall, travel cost was identified as the dominant factor influencing route choice, while time efficiency served as a compensatory factor encouraging toll road utilisation along the Palembang–Prabumulih corridor.

Keywords: ***Binomial Logit, Route Choice, Stated Preference, Toll Road, National Highway.***

1. INTRODUCTION

Transportation problems in Indonesia are still dominated by traffic jams and road damage due to traffic density (Edi Kadarsa et al., 2017; Bęczkowska, 2019). This problem is becoming increasingly complex in various regional areas with increasing population growth and mobility needs. South Sumatra Province, which consists of 13 regencies and four cities, with Palembang as its capital, is one of the regions with rapid infrastructure growth in the past five years (Agustien & Yulinar, 2022). Road network development is being undertaken to accommodate high traffic volumes, but increasing vehicles puts pressure on road capacity. Data from the South Sumatra National Road and Transportation Agency (BBPJN 2024) shows that the traffic volume on the Palembang-Prabumulih eastern cross-country road has reached 15,456 vehicles/day. This high traffic volume makes road access increasingly difficult (Al Qubro et al., 2022). In an effort to reduce the burden on national roads, the government is building the Trans Sumatra Toll Road (JTTS), including the 22 km Palembang–Indralaya (Palindra) Toll Road and the 64.5 km Indralaya–Prabumulih Toll Road. However, the toll traffic volume 2024 has not yet reached the target. For example, the Palindra toll road only recorded 9,914 vehicles/day out of a target of 31,600 vehicles/day. The Indralaya–Prabumulih toll road only recorded 5,600 vehicles/day out of a target of 13,344 vehicles/day (PT Hutama Karya, 2024).

Several previous studies have examined route choice behaviour. Halen et al. (2020) analysed the preferences of private vehicle users in choosing between toll roads and arterial roads using the Stated Preference method. The results showed that cost and travel time variables are strongly correlated and significantly influence toll road route choice. Adi et al. (2020) analysed route choice between the Terbangi Besar–Pematang Panggang Toll Road and the National Road using a Binomial Logit Model. The study revealed that an increase in toll rates reduces the likelihood of users choosing the toll road, whereas greater travel time savings increase the probability of choosing it. Furthermore, Budiman et al (2021) examined the factors influencing route choice between

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the Rangkasbitung–Serang arterial road and the Serang–Panimbang toll road using the Stated Preference method. Based on travel time attributes, the toll road route was found to be 76.7% faster compared to the regular road.

This phenomenon indicates that the presence of toll roads has not yet fully attracted public interest as an alternative travel route. With the availability of two route options, road users face a decision on which route to take for their journey (Suganda et al., 2023). Therefore, it is important to identify the factors influencing road users' preferences when choosing between toll and national roads. Several key variables affecting this decision include travel distance, time, and cost. The Stated Preference (SP) method has been widely used in transportation studies to understand individuals' preferences toward specific travel scenarios (Fisaini et al., 2024; Roza et al., 2017). By applying the SP method, user behaviour in decision-making within a road network context can be represented, and user perceptions can be directly measured based on travel attributes (Dovyanto & Widyastuti, 2024). Furthermore, analysis can be conducted using the Binomial Logit Model to determine the probability of individuals choosing between toll roads and national highways (Tong et al., 2025).

This study aims to analyse the socio-economic and travel characteristics of users of the Palembang - Prabumulih toll road and national highway routes. It will also analyse the results of the stated preference survey and the binomial logit model in choosing these routes.

2. MATERIALS AND METHODS

This study uses a quantitative approach, using the Stated Preference (SP) method and the Binomial Logit Model, to analyse route choice in the Palembang–Prabumulih toll road and national highway (Padri et al., 2022). The research location is on the Palembang – Prabumulih toll road and the national highway Palembang – Prabumulih. The research objects are private vehicle users travelling on both routes.

Figure 1: Map of the Location of the Palembang - Prabumulih Road Route
(Source: PT. Hutama Karya)

: The blue line indicates the toll road route.
: The yellow line indicates the national highway route.

2.1 Data Collection Method

The data used in this study consists of primary and secondary data. The primary data were obtained through a questionnaire survey. In contrast, the secondary data were collected from relevant institutions, namely PT Hutama Karya and South Sumatra's Regional Office of the National Road Implementation Agency (BBPJN).

The data samples in this study were obtained from the traffic volume population on both road sections, namely the Toll Road and the National Road. The number of samples was determined using the Slovin formula to represent the population accurately. The sample calculation in this study is presented as follows:

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This study's sample (population) was taken from the traffic volume on the Palembang – Prabumulih Toll Road section.

$$n = \frac{N}{1+N(e)^2} = \frac{15.514}{1+15.514(0,1)^2} = 100\ Sampel \quad (1)$$

This study's sample (population) represents the traffic volume on the Palembang–Prabumulih National Road section.

$$n = \frac{N}{1+N(e)^2} = \frac{15.456}{1+15.465(0,1)^2} = 100\ Sampel$$

Based on the calculation results, 200 samples were determined to be required for the distribution of questionnaires on both the Toll Road and the Non-Toll Road sections of the Palembang–Prabumulih corridor.

2.2 Route Choice Model

This study employs five choice scenarios, which were designed as a questionnaire for the stated preference survey. The choice scenarios used in this study are as follows:

Scenario 1: The difference in travel cost of IDR 67,500 is 15 minutes faster than the national highway.
Scenario 2: The difference in travel cost of IDR 78,500 is 30 minutes faster than the national highway.
Scenario 3: The difference in travel cost of IDR is 85,000, which is 45 minutes faster than the national highway.
Scenario 4: The difference in travel cost of IDR is 102,000, which is 60 minutes faster than the national highway.
Scenario 5: The difference in travel cost of IDR is 126,000, which is 75 minutes faster than the national highway.

The proportion of route choices was calculated to compare the number of respondents who chose the toll road and those who chose the national highway in the Palembang–Prabumulih choice. This proportion is expressed as a ratio (1-P)/P, where P is the probability of respondents choosing the toll road, while 1−P is the probability of respondents selecting the national highway. Next, the values of the dependent and independent variables are determined to derive the linear regression equation. The following equation can express the dependent variable (Yi):

$$Y_i = log\left[\frac{1-P}{P}\right] \quad (2)$$

Where Yi represents the road users and P denotes the proportion of route choice. The independent variable (Xi) in this equation is the logarithm of the ratio of the total combined cost of the toll road and the national highway for each route choice combination. The following equation expresses the determination of the independent variable (Xi):

$$X_i = log\left[\frac{C^I{}_1}{C^I{}_2}\right] \quad (3)$$

Where X is the logarithm of the travel time and travel cost ratio between the toll road and the national highway, and C represents the travel time and travel cost for the selected route. The nonlinear equation can be converted into a linear form as Yi = A + B Xi, where Yi represents the proportion of route selection and Xi is the logarithm of the ratio of total combined costs between toll roads and national highways. Therefore, applying linear regression analysis in SPSS 22.0 for Windows to obtain the values of α and β. Route choice uses a binomial logit model. The known α and β values obtained from the regression equation are then entered into the equation as the final model for mode choice for each combination, namely the binomial logit model (Tamin, 2008):

$$P_I = \frac{1}{1 + \alpha\,(\frac{C_1}{C_2})\beta} \quad (4)$$

Where P_1 represents the proportion of route choice for the toll road, C_1 denotes the total combined cost for the toll route, and C_2 represents the total combined cost for the national road route. Furthermore, a goodness-of-fit (Chi-square) test was conducted to evaluate whether the modelling results are consistent with the existing conditions and meet the expected probability distribution.

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3 RESULTS AND DISCUSSION

3.1 Respondents' Socio-Economic and Travel Characteristics

Respondents' socio-economic characteristics include age, gender, occupation, highest level of education, income/month, trip purpose, and route choice factors. These data analyse respondents' socio-economic characteristics when choosing the Prabumulih – Palembang toll road and the national highway.

3.1.1 Respondent characteristics based on age

According to the Decree of the Ministry of Health of the Republic of Indonesia (2009), age categories are classified into stages: early childhood, childhood, adolescence, adulthood, elderly, and advanced elderly. The following figure illustrates the characteristics based on respondents' age in choosing between the Toll Road and the National Highway Road on the Palembang–Prabumulih route can be illustrated in the following figure.

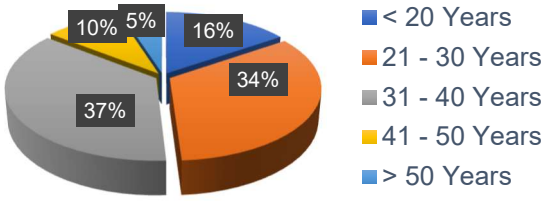

Figure 2: Characteristics Based on Age

Based on Figure 2, road users along the Palembang–Prabumulih corridor are predominantly aged between 31 and 40, accounting for 37% of respondents. They are followed by those aged 21 to 30, with a proportion of 34%.

3.1.2 Respondent characteristics based on gender

Gender-based characteristics can illustrate the dominant gender of respondents on the Palembang-Prabumulih toll road and the national highway. The survey results show the gender-based characteristics of respondents in the following figure.

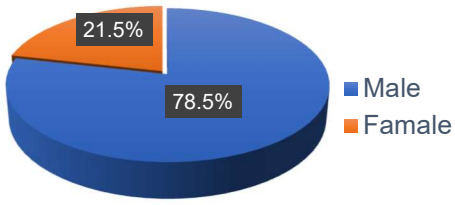

Figure 3: Characteristics Based on Gender

According to Figure 3, the male respondents represent the highest percentage among all participants, accounting for 78.5%.

3.1.3 Respondent characteristics based on the type of job profession

Job type characteristics can describe the number of job professions among respondents. The types of jobs among respondents can be seen in the figure below, based on the questionnaire results.

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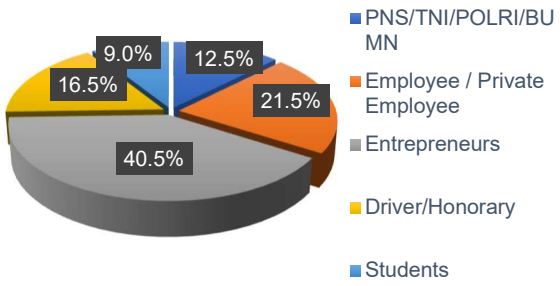

Figure 4: Characteristics Based on Occupation

Figure 4 shows that the highest % of respondents by occupation are entrepreneurs or self-employed, accounting for 40.5%. The second-highest percentage is private employees, representing 21.5%.

3.1.4 Respondent characteristics based on the highest level of education

The educational characteristics of the respondents reflect the intellectual level of road users, both on toll roads and the national highway. The questionnaire survey results regarding respondents' educational backgrounds are presented in the figure below.

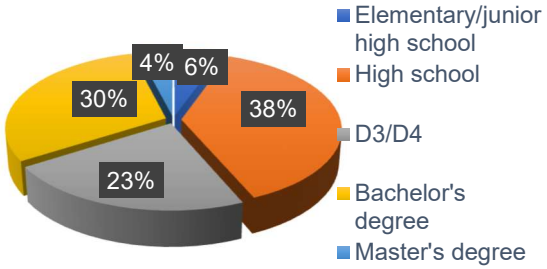

Figure 5: Characteristics Based on the Highest Level of Education

Figure 5 shows that the highest percentage of respondents by educational background is senior high school graduates, accounting for 38%. The second-highest percentage is bachelor's degree holders, representing 30%.

3.1.5 Respondent characteristics based on income/month

The characteristics based on the respondents' income/month can be seen in the figure below.

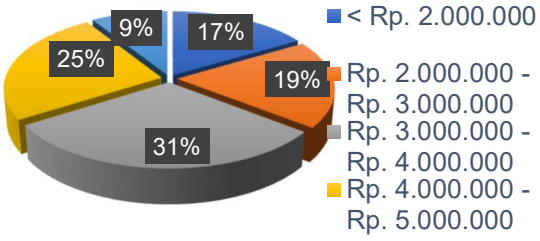

Figure 6: Characteristics Based on Income/Month

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Based on Figure 6, road users along the Palembang–Prabumulih corridor have an average monthly income of IDR 3,000,000–4,000,000, representing 31% of respondents. This is followed by those with an IDR 4,000,000–5,000,000 income range, accounting for 25% of respondents.

3.1.6 Respondents' characteristics based on trip purpose

The travel purpose characteristics of the respondents provide useful information for identifying the types of activities they carry out. The travel purposes of respondents on the Palembang–Prabumulih route are presented in the figure below.

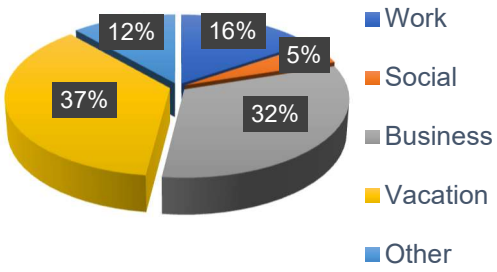

Figure 7: Respondents' Characteristics by Trip Purpose

Figure 7 shows that the highest percentage of respondents' travel purposes is for leisure, accounting for 37%.

3.1.7 Respondents' characteristics based on Route Choice Factors

The characteristics of respondents based on the route choice factors for the Palembang–Prabumulih corridor are presented in the figure below.

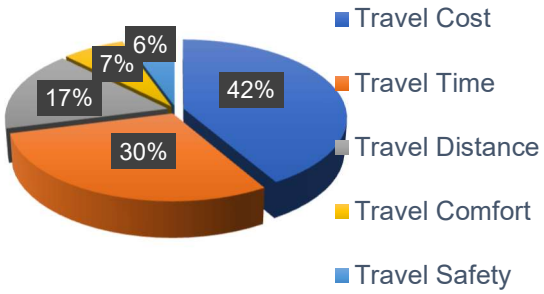

Figure 8: Respondents' Characteristics based on Route Choice Factors

As shown in Figure 8, travel time is the dominant factor influencing route choice along the Palembang–Prabumulih corridor, representing 42%, followed by travel cost at 30%.

3.2 Data Processing and Analytical Methods

The model development process is essential in analysing respondents' route choice behaviour. In constructing the model, it is necessary to identify the variables that play a role in the decision-making process. This study uses independent variables (Xi) and a dependent variable (Yi) to understand the factors influencing respondents' behaviour in selecting travel routes, particularly between the Toll Road and the National Road, as described below.

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3.2.1. Route Choice Probability

The resulting route choice probabilities are presented in Table 1. The summary of respondents' answers from the Stated Preference questionnaire was used to determine the value of variable Y in this study, which was then applied in the calculations incorporated into the Binomial Logit Model. The probability values of route choice in this study are shown in Table 1.

Table 1: Route Choice Probability

No	Cost Difference (Rp)	Travel Time	Choosing a Toll Road	Not Choosing the Toll Road	(1-P)/P	Log(1-P/P) <Y>
1	67.500	15 minutes faster than the national highway	19%	81%	4,405405	0,643986
2	78.500	30 minutes faster than the national highway	25%	75%	3,000000	0,477121
3	85.000	45 minutes faster than the national highway	38%	62%	1,631579	0,212608
4	102.000	60 minutes faster than the national highway	27%	73%	2,703704	0,431959
5	126.000	75 minutes faster than the national highway	21%	79%	3,651163	0,562431

Source: Author's Analysis (2025)

Based on Table 1, which presents the results of the stated preference survey showing the proportion of route choices, Scenario 1 indicates that 19% of respondents chose to use the Toll Road, while 81% preferred the Non-Toll Road. In Scenario 2, the proportion of respondents selecting the Toll Road increased to 25%, with the remaining 75% still opting for the Non-Toll Road. Furthermore, in Scenario 3, the percentage of Toll Road users rose to 38%, while 62% of respondents continued to choose the Non-Toll Road. However, in Scenario 4, the proportion of Toll Road users declined to 27%, and decreased in Scenario 5, only 21% of respondents selected the Toll Road, while 79% preferred the Non-Toll Road.

3.2.2. Conversion of the value of time

In this study, the value of time was derived from the average income of respondents on the Palembang–Prabumulih route, calculated as follows:

Table 2: Value of Time

No	Income/Month	Respondents	Median Value (Rp)	Total Income (Rp)
1	< Rp. 2.000.000	33	1.000.000	33.000.000
2	2.000.000 - 3.000.000	38	2.500.000	95.000.000
3	3.000.000 - 4.000.000	61	3.500.000	213.500.000
4	4.000.000 - 5.000.000	50	4.500.000	225.000.000
5	> Rp. 5.000.000	18	7.500.000	135.000.000
	Total	200		701.500.000
	Average Mothly Income			3.507.500
	Value of Time/(minutes)			365

Source: Author's Analysis (2025)

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Table 2 shows the results of the value of time calculation, which was derived from the average income of road users and divided by the standard working hours. The standard working time applied in this calculation is 8 hours per day and 5 days per week, equivalent to 160 hours per month. Based on this calculation, the time value obtained in this study is Rp365 per minute.

3.2.3 Calculation of combined costs

This model bases its calculations on the concept of combined utility, namely a combination of direct costs (toll rates) and indirect costs converted from travel time using the parameter (Value of Time, VoT).

Table 3: (Generalised Cost) on the Palembang – Prabumulih Toll Road and National Highways Choice Route

No	Cost Difference (Rp)	Travel Time (minutes)	Value of Time/(minutes)	Combined Fees (Rp)		Ratio (C_{toll})/ ($C_{National}$)
				Toll road (C_{tol})	National Road ($C_{National}$)	
1	67,500	15	365	177.941	83.941	2,119829
2	78,500	30	365	205.383	111.383	1,843936
3	85,000	45	365	228.324	134.324	1,451474
4	102,000	60	365	261.766	167.766	1,560305
5	126,000	75	365	302.207	208.207	1,699799

Source: Author's Analysis (2025)

The table above presents the combined costs of the Toll Road and the National Road along the Palembang–Prabumulih corridor. Furthermore, to calculate the ratio of total combined costs for each scenario, the total combined cost of the Toll Road was compared to that of the Non-Toll Road.

3.2.4 The Utility Equation

In this analysis, the variable Y denotes the logarithm of the ratio of respondents' preferences between the toll road and the national highway (log Y). In contrast, the variable X denotes the logarithm of the combined travel cost (log W). The variable Y is estimated using X through a linear regression model approach. The results of the calculations using Equations (2) and (3) for all input data are presented in the table below.

Table 4: Logarithmic Input Data for the Palembang – Prabumulih Toll Road

No	C(Toll)/C(National) <W_1>	Log(W) <X_1>	C(National)/C(Toll) <W_2>	Log(W) <X_2>	(1-P)/P	Log (1-P/P) <Y>
1	2,119829	0,326301	0,471736	-0,326301	4,405405	0,643986
2	1,843936	0,265746	0,542318	-0,265746	3,000000	0,477121
3	1,699799	0,230398	0,588305	-0,230398	1,631579	0,212608
4	1,560305	0,193210	0,640900	-0,193210	2,703704	0,431959
5	1,451474	0,161809	0,688955	-0,161809	3,651163	0,562431

Source: Author's Analysis (2025)

The dependent variable in this analysis is log (Y), whereas the independent variable is log (W). The resulting linear regression equation is expressed as follows:

$\alpha = 1{,}185$

$\beta = 2{,}092$

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3.2.5 The Binomial Logit Model

Based on the values of parameters α and β that have been determined, the binary logit ratio model for route choice between the toll road and the national road on the Palembang–Prabumulih corridor can be formulated using Equation (4). The calculated proportion of respondents who chose the Palembang–Prabumulih toll road is presented in the table below.

Table 5. Proportion of Respondents choosing the Palembang–Prabumulih Toll Road Route

No	C(Toll)/C(National) <W>	W^{β}	$P=1/(1+(\alpha \times W^{\beta})$
1	2,12	4,81	15%
2	1,84	3,60	19%
3	1,45	2,18	28%
4	1,56	2,54	25%
5	1,70	3,03	22%

Source: Author's Analysis (2025)

For the proportion of respondents to the Palembang Prabumulih toll road, with the calculated proportion, it can be depicted in the diversion curve as shown in the S curve below:

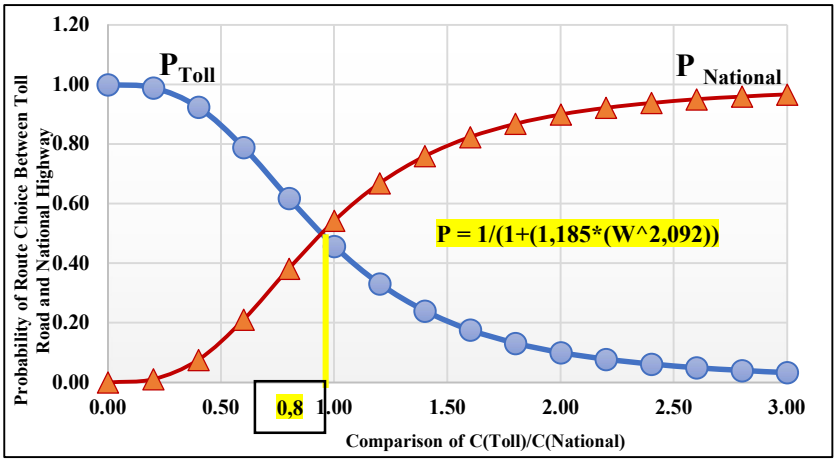

Figure 9: S-Curve Comparison of Toll Roads and National Highway

Based on the S-curve, the equilibrium point is reached at a cost ratio of 0.8, where the probability of choosing between the Toll Road and the National Road is nearly equal. As the cost ratio increases, there is a significant decrease in the proportion of Toll Road users. This finding indicates that road users are susceptible to changes in combined costs, including travel costs and travel time. Thus, the logit model represented by the S-curve effectively illustrates a realistic relationship between travel cost, travel time, and route choice decisions.

After the model development was completed, it was verified using the Chi-square goodness-of-fit test. The results show that the calculated Chi-square value (χ^2_a) was 13.186, compared to the critical Chi-square value (χ^2_t) of 14.067. Since $\chi^2_a < \chi^2_t$, the null hypothesis (H_0) is accepted, indicating that the observed data are consistent with the average values predicted by the model.

4. CONCLUSION

Based on the results of the socio-economic and travel characteristics survey, which employed a simple random sampling method with a total of 200 respondents on the Palembang–Prabumulih road section, the majority of road users were aged between 31 and 40 years (37%) and predominantly male (78%). Most respondents were self-employed (40.5%), had completed senior high school education (38%), and earned an average monthly income of IDR 3,000,000–4,000,000 (31%). The primary purpose of travel was for leisure (37%), the primary factors influencing route choice were travel time (42%) and travel cost (30%).

The stated preference survey results indicate that in Scenario 3, the proportion of respondents choosing the Toll Road was the highest at 38%. In contrast, for the Non-Toll Road, the highest proportion was observed in Scenario 1, with 81%. Furthermore, the Binomial Logit model results demonstrated exemplary performance in predicting the probability of route choice between the Toll Road and the Non-Toll Road. The Chi-square test results (χ^2 calculated = 13.186 < χ^2 critical = 14.067) indicate no significant difference between the observed data and the Binomial Logit model estimation.

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