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Research Article

Evaluating the Effects of Travel Time and Cost on Mode Choice in Transportation System

Ruslan[a,b,*], Firmansyah Rachman[a], Zulfhazli Abdullah[c]

[a]Department of Civil Engineering, Universitas Muhammadiyah Aceh, 23245, Banda Aceh, Indonesia

[b]Urban and Transportation Management Research Center, Universitas Muhammadiyah Aceh, 23245, Banda Aceh, Indonesia

[c]Department of Civil Engineering, Faculty of Engineering, Universitas Malikussaleh, 24355, Lhokseumawe, Indonesia

***Corresponding Author:** Ruslan (ruslan@unmuha.ac.id)

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Abstract

Mode choice in transportation is influenced by factors such as comfort, safety, travel time, cost, and reliability, with most commuters in Banda Aceh preferring private vehicles due to flexibility and efficiency. Travel time and travel cost are identified as major barriers preventing people from switching to public transport, which is often considered less attractive. While studies abroad examine elasticity from multiple perspectives, research in Indonesia has mainly focused on vehicle attributes. The objective of this paper is to analyze the elasticity of travel time and travel cost for users of private vehicles and public transportation. The study employs a binary probit model to estimate elasticity values, utilizing data from a Stated Preference survey of transportation users. The results show that both trip attributes and individual characteristics significantly influence transport mode choice. Longer travel distances, higher travel time, and increased operating costs raise the likelihood of choosing public transport, while being male and having higher education also increase the tendency to select it. Conversely, motorcycle ownership strongly favors private mode choice, and holding a valid driver's license is an important determinant of travel behavior. The elasticity analysis further reveals that reducing travel and access times for the TransK bus could significantly increase its usage, while policies restricting private vehicle use, such as the odd-even system, may also encourage shifts toward public transport. The study concludes that mode choice in Banda Aceh is mainly driven by travel time, with TransK highly responsive to time improvements, while private vehicles dominate despite cost changes. Encouraging public transport use requires faster, more reliable bus services and restrictions on private vehicle advantages.

Keywords: Public Transportation, Mode Choice, Stated Preference, Travel Time; Travel Cost, Elasticity

Introduction

In Indonesia, rapid urbanization and economic growth have spurred a significant increase in household car ownership, reflecting the rising demand for personal mobility. However, this surge in vehicle numbers has created

serious challenges, including worsening traffic congestion, higher levels of air pollution, and greater strain on already limited urban infrastructure. As a result, household car ownership has become a critical issue that requires careful attention in transportation planning and policy development [1,2]. Thus, public transportation is a very important choice in making sustainable transportation a success.

Mode choice is a key element of the transportation decision-making process, involving the identification of relevant performance factors, the selection of available modes, negotiation of fares and service quality, and assessment of mode performance [3,4]. In today's context, travelers tend to choose transportation modes by considering aspects such as comfort, safety, travel time, distance, reliability, and cost [5]. Furthermore, the choice of mode is often influenced by the specific purpose of the trip, with individuals selecting the option that best meets their travel needs [6,7].

The main issue in mode choice is that people generally prefer private vehicles due to their convenience, flexibility, time efficiency, and the sense of control they provide, as individuals can freely decide when and where to travel. As a result, public transportation is often perceived as less appealing [8]. In the case of Banda Aceh city's 109,000 commuters, about 95% rely on private vehicles or walking, expressing reluctance to shift to public transport because of its lengthy and impractical travel times.

One of the key obstacles preventing private vehicle users from switching modes is travel time [9], along with travel costs [10]. Research by Maduwanthi [5] revealed that in Sri Lanka, people's preference for private vehicles is primarily influenced by factors such as travel time, safety, comfort, and trip purpose. Similarly, Göransson & Andersson [11] noted that in Sweden, time and cost play a crucial role in mode choice decisions (between private vehicles, trains, and buses), while flexibility and convenience also significantly shape travelers' preferences.

Travel costs play a crucial role in shaping transportation mode choices [12,13]. Affordable public transport fares have been shown to encourage a shift from private vehicles to public transit [14]. Similarly, Moyano et al. [15] and Litman [16] observed that in Spain, cost considerations are a key determinant in people's choice of transport mode. Therefore, an indicator is needed to assess how people's decisions or behaviors change in response to policy interventions. Such an indicator enables policymakers to estimate how variations in transportation mode attributes influence travel activities and revenues. This measure, known as demand elasticity [16], is widely used to evaluate transportation demand management policies or programs aimed at modifying travel behavior to achieve planning objectives. Studies on public transport elasticity in other countries have examined not only vehicle-related attributes but also considered short and long term demand [12], [17], socio-demographic factors [18,19], and aspects of convenience [20]. In contrast, research on elasticity in developing countries, particularly Indonesia, has largely remained focused on vehicle attributes alone [21,22].

Building on this background, the purpose of this study is to examine the elasticity of private and public transport users. The analysis is conducted by estimating a Binary Probit Model using data from a Stated Preference questionnaire distributed to respondents in Banda Aceh City, Indonesia. The resulting elasticity values provide insights into the potential effects of transportation policies and contribute to a deeper understanding of user behavior in developing country contexts. This paper is divided into seven sections including this one. Section 2 reviews the literature, and Section 3 specifies the methods used. Section 4 describes the survey conducted. Section 5 analyses and interprets the results. Section 6 describes the implications to policy and Section 7 concludes the work.

Method

Data Collection

This study was conducted in the Banda Aceh area. The region has a total population of approximately 300,000 people, with around 7% identified as commuters. The preliminary survey in this study was carried out to refine and enhance the questionnaire intended for the main survey. Conducted over one week, from Monday, May 8 to Friday, May 12, 2023, it involved distributing 3 out of the 16 prepared questionnaires to 30 randomly selected respondents to identify weaknesses in the wording and structure of the questions. The purpose was to minimize potential misunderstandings by respondents when completing the questionnaire. Upon completion, the findings were used to revise and improve the instrument, after which the final version of the questionnaire was distributed between Monday, July 10 and Sunday, July 16, 2023.

The questionnaire used in this study was structured into three sections: socio-demographic information, travel characteristics, and stated preference. The socio-demographic section covered variables such as gender, age, educational background, occupation, monthly income, as well as ownership of private cars and motorcycles. The travel characteristics section included questions on trip purpose, departure time, travel duration, travel expenses, public transportation experience, place of residence, travel distance, and the modes of transport used for the first mile, last mile, and the main journey. The final section comprised a series of stated preference questions. In total, 16 sets of questionnaires were prepared, with each set containing 4 stated preference questions. The location of study conducted in Banda Aceh city as shown in Figure 1.

The minimum required sample size for this study was determined using the Slovin formula, resulting in a target of 400 respondents. In practice, 540 individuals completed the questionnaire, but 37 responses were found to be incomplete and were therefore excluded, leaving 503 valid responses for further analysis.

Design of Experiment

The experiment was structured to analyze how travel time and costs influence the selection of transportation modes in Banda Aceh City. Using these two

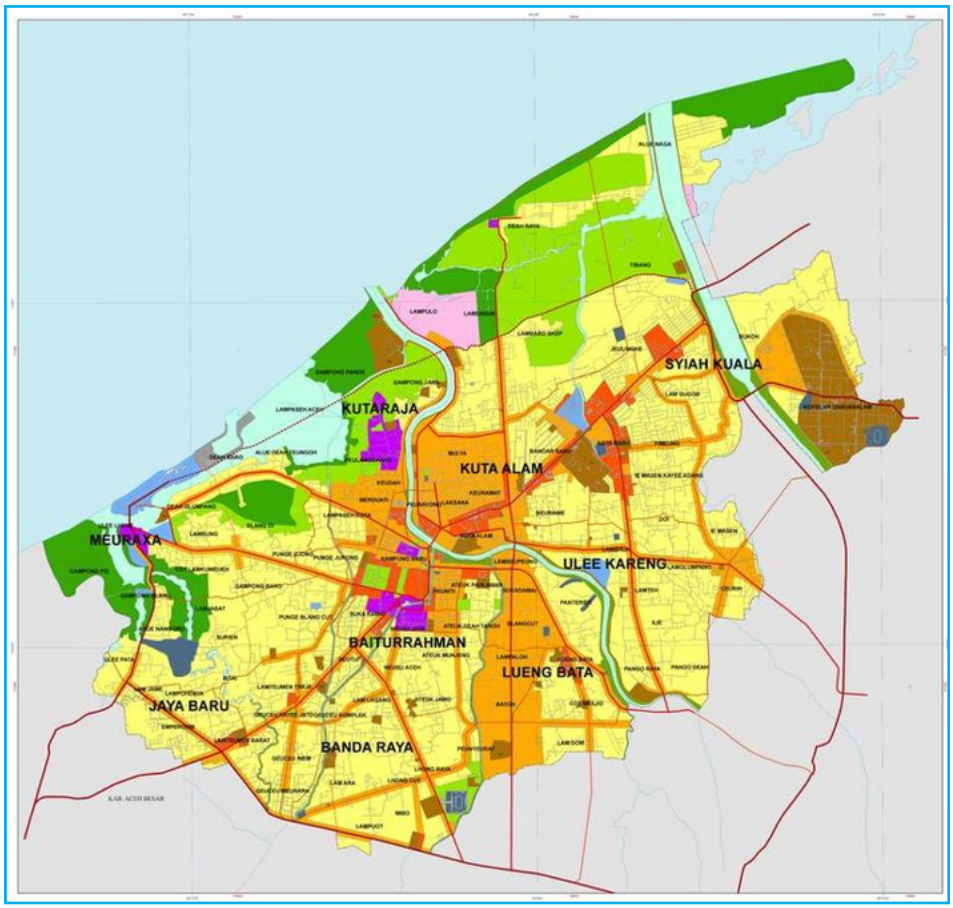

Figure 1. Map of Banda Aceh City, Indonesia

variables, the study identified and selected the attributes presumed to impact individuals' mode choice decisions.

The attributes considered in the Stated Preference questionnaire for transportation mode selection include: (1) fixed costs (fuel/tariffs), (2) parking fees, (3) transfer fees, (4) travel time, (5) waiting time, (6) walking time, (7) number of transits, and (8) delays. Broadly, these attributes are grouped into two categories: travel time comprising travel duration, walking time, and delays and travel costs, which consist of fuel costs for private vehicles, fares for public transport, parking fees, and transfer charges. Additionally, factors such as the number of transits, weather conditions, and trip purpose also influence overall travel time and cost.

The combination process was conducted to align the attributes and their levels used in the Stated Preference questionnaire. In this study, the combinations were generated using STATA Software to obtain appropriate sets of attributes and levels. This approach was necessary because short-term memory can typically retain information or stimuli for only about 30 seconds and is limited to storing around seven chunks of information at once. The study applied seven attributes, each with three levels. However, explanatory variables such as travel purpose and weather intensity were excluded from the combinations to ensure the Stated Preference questionnaire remained manageable within a single survey.

Discrete Choice Model

Theory of binary probit model in mode choice

The binary probit model is a type of discrete choice model used to analyze decisions where individuals must choose between two alternatives. In the context of mode choice, the model is applied when a traveler decides, for example, between using a private vehicle or using public transportation.

The foundation of the model lies in random utility theory (RUT), which assumes that individuals select the alternative that provides the highest utility. The utility Ui of an alternative is expressed as in Equation 1.

$$Ui = Vi + \varepsilon i \tag{1}$$

Where Vi is the observable (systematic) component of utility, usually a linear function of explanatory variables such as travel time, cost, income, or socio-demographic characteristics, and εi is the unobservable (random) component of utility, capturing factors not included in the model. In the binary probit model, the error terms (εi) are assumed to follow a standard normal distribution, which differentiates it from the binary logit model, where the errors follow a Gumbel distribution.

Choice probability

If a traveler faces two alternatives, say mode 1 (e.g., car) and mode 2 (e.g., bus), the probability of choosing mode 1 is as in Equation 2.

$$P(1) = \mathrm{P}\ (U_1 > U_2) = \mathrm{P}(V_1 - V_2 > \varepsilon_2 - \varepsilon_1) \tag{2}$$

Since the difference in error terms follows a standard normal distribution, this probability can be written as in Equation 3 where Φ is cumulative distribution function (CDF) of the standard normal distribution, X is vector of explanatory variables (e.g., travel time, travel cost, income), and β is vector of parameters to be estimated.

$$P(1) = \Phi\ (\beta' \mathrm{X}) \tag{3}$$

Elasticity

To assess the significance of changes in demand resulting from variations in transportation mode attributes, researchers commonly use demand elasticity. Elasticity reflects the sensitivity of demand to changes in specific determinant attributes [23], indicating the percentage change in the dependent variable in response to a percentage change in the independent variable [16]. The magnitude of this change is determined by the utility value expressed in Equation 1, which is shaped by respondents' preferences across different attribute conditions of available transportation modes. In essence, individuals select the mode of transport that provides the greatest utility or best meets their needs.

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In the context of mode choice, elasticity provides insight into how variations in travel attributes such as time and cost affect the dependent variable, namely the probability of selecting a particular mode of transport. According to Louviere [24], direct elasticity quantifies the percentage change in the probability of choosing a mode resulting from a percentage change in a single attribute within the mode's utility function.

Results and Discussion

Characteristic of Correspondence

Table 1 presents the descriptive statistics of the respondents based on their socio economic characteristics. A total of 400 individuals participated in the study. In terms of gender, the sample consisted of 58.25% males (233 individuals) and 41.75% females (167 individuals), indicating a slightly higher participation rate among male respondents.

Regarding the age distribution, the majority of respondents (77%) were in the 20–29-year age group, followed by 12% in the 17–19-year group, and 8.75% in the 30–39-year category. Only a small proportion were in the older age brackets, with 1.75% aged 40–49 years and 0.5% aged 50–59 years. This suggests that the sample was predominantly composed of young adults, particularly those in their twenties.

For education level, more than half of the respondents (54.75%) held a diploma, while 34.75% had a postgraduate degree. A smaller percentage had a bachelor's degree (5.75%) or only completed primary education (4.75%). These figures indicate a relatively well-educated sample.

In terms of employment type, the largest group consisted of housewives, accounting for 57.75% of respondents. Students represented 18.5%, followed by private employees (10%), civil servants (9%), and traders/entrepreneurs (4.75%). This distribution reflects a diverse range of occupational backgrounds, although non-wage earners formed the majority.

The distribution of monthly income indicates that most respondents earned between IDR 5 to 6.9 million (25.75%), followed by those earning 3–4.9 million (20.5%) and 7–9.9 million (20%). Respondents earning ≥ IDR 10 million comprised 13.25% of the sample, while those earning less than IDR 1 million made up 12%. The remaining 8.5% earned between 1–2.9 million per month. This income distribution highlights a relatively balanced representation across income brackets, with a slight concentration in the middle-income groups.

Overall, the descriptive statistics suggest that the sample is characterized by a relatively young, educated population with varied employment statuses and income levels.

Table 1 also presents the descriptive statistics related to the travel behavior of respondents, including travel time to the nearest bus stop, trip purpose, travel distance, and trip duration. With regard to travel time to the nearest bus stop, the majority of respondents reported access times ranging from 2 to 6 minutes.

Specifically, 21.25% of respondents required 2–4 minutes and 20.75% required 5–6 minutes to reach the nearest bus stop. A smaller proportion could access a bus stop in less than 2 minutes (11.75%). Meanwhile, 46.25% of respondents

Table 1. Statistic descriptive of correspondence characteristic

Variable	Frequency	Percent	Cumulative
Socio-economic characteristics			
Gender			
Male	233	58.25	58.25
Female	167	41.75	100.00
Total	400	100.00	
Age Group			
17 -19 years	48	12.00	12.00
20 - 29 years	308	77.00	89.00
30 - 39 years	35	8.75	97.75
40 - 49 years	7	1.75	99.50
50 - 59 years	2	0.50	100.00
Total	400	100	
Education Level			
Primary Education	19	4.75	4.75
Diploma	219	54.75	59.50
Bachelor's Degree	23	5.75	65.25
Postgraduate	139	34.75	100.00
Total	400	100.00	
Type of employment			
Civil Servants	36	9.00	9.00
Private Employees	40	10.00	19.00
Traders/Entrepreneurs	19	4.75	23.75
Housewives	231	57.75	81.50
Students	74	18.50	100
Total	400	100.00	
Monthly Income (Million Rupiah)			
< 1 million	48	12.00	12.00
1 - 2,9 million	34	8.50	20.50
3 - 4,9 million	82	20.50	41.00
5 - 6,9 million	103	25.75	66.75
7 - 9,9 million	80	20.00	86.75
≥ 10 million	53	13.25	100.00
Total	400	100.00	
Travel characteristics			
Travel Time to the Nearest Bus Stop			
< 2 minutes	47	11.75	11.75
2-4 minutes	85	21.25	32.66
5-6 minutes	83	20.75	54.15
7-8 minutes	64	16.00	69.91
9-10 minutes	61	15.25	85.1
>10 minutes	60	15.00	100.00
Total	400	100.00	

Table 1. Statistic descriptive of correspondence characteristic (continued)

Variable	Frequency	Percent	Cumulative
Travel destination			
Work	77	19.25	19.25
School/College	192	48.00	71.92
Shopping/Market	49	12.25	83.67
Social	23	5.75	87.68
Recreation/Entertainment	31	7.75	94.27
Working outside the home	28	7.00	100.00
Total	400	100.00	
Origin-Destination Distance (km)			
<4 km	118	29.50	29.50
4-6.9 km	104	26.00	57.88
7-9.9 km	74	18.50	76.22
10-12.9 km	50	12.50	87.39
> 13 km	54	13.50	100.00
Total	400	100.00	
Required Trip Duration (Minutes)			
< 10 minutes	29	7.25	7.25
10 - 19 minutes	7	1.75	9.00
20 - 29 minutes	38	9.50	18.50
30 - 39 minutes	68	17.00	35.50
40 - 49 minutes	155	38.75	74.25
> 50 minutes	103	25.75	100
Total	400	100	
Driver's License and Motorcycle Ownership			
Car License Ownership, Class A			
Yes	262	65.50	65.50
No	138	34.50	100.00
Total	400	100.00	
Ownership driving license, Class C			
Yes	79	19.75	19.75
No	321	80.25	100.00
Total	400	100.00	
Motorcycle Ownership			
No motorcycle	22	5.50	5.50
1 motorcycle	166	41.50	47.00
2 motorcycles	100	25.00	72.00
3 motorcycles	82	20.50	92.50
4 motorcycles	30	7.50	100.00
Total	400	100.00	

required more than 6 minutes, with 15% reporting travel times exceeding 10 minutes. This suggests that while many respondents have relatively convenient access to public transport, a significant share still face moderate to long walking distances.

Regarding travel destinations, nearly half of the respondents (48%) traveled for educational purposes (school/college), followed by work-related trips (19.25%) and shopping/market visits (12.25%). Other purposes included recreation or

entertainment (7.75%), social activities (5.75%), and working outside the home (7%). The predominance of education and work-related travel highlights the functional and routine nature of most trips.

In terms of origin-destination distance, 29.5% of respondents reported trip distances of less than 4 km, while 26% traveled between 4–6.9 km. A further 18.5% traveled 7–9.9 km, and 26% traveled 10 km or more. Notably, 13.5% of respondents traveled more than 13 km. This distribution reflects a mix of short- and medium-range urban travel, with a sizable proportion commuting across greater distances.

As for the required trip duration, the majority of respondents (38.75%) spent between 40–49 minutes on their trips, followed by 25.75% who traveled more than 50 minutes. Only 7.25% of respondents reported very short trips (less than 10 minutes). These findings indicate that most trips require substantial time commitments, possibly due to traffic congestion, long distances, or limited transport connectivity.

Overall, the descriptive statistics illustrate that while many respondents have reasonable access to public transport, travel durations and distances remain considerable, particularly for work and education, underscoring the importance of efficient and accessible transit systems.

The last in Table 1 outlines the distribution of respondents based on driver's license ownership (Class A and Class C) and motorcycle ownership. In terms of Class A driving license which permits operation of private passenger vehicles 65.5% of respondents reported possessing a valid license, while the remaining 34.5% did not. This indicates that a majority of the sample had legal authorization to operate a private car, suggesting a relatively high level of motorization and mobility potential within the population.

On the other hand, Class C driving licenses, typically required for motorcycle operation, were held by only 19.75% of respondents, while a substantial 80.25% did not possess such licenses. This contrast suggests that although motorcycles are a prevalent mode of transport in many urban settings, a large proportion of users may operate them without holding the appropriate license, pointing to a potential concern regarding compliance with traffic regulations.

Regarding motorcycle ownership, the majority of respondents owned at least one motorcycle. Specifically, 41.5% owned one motorcycle, 25% owned two, 20.5% owned three, and 7.5% owned four motorcycles. Only 5.5% of respondents reported not owning a motorcycle. This pattern reflects a high rate of motorcycle ownership in the study area, with nearly half of the sample owning multiple units, likely indicating the motorcycle's role as an essential household asset for daily travel needs.

The combined data on vehicle license possession and motorcycle ownership reveal that private motorized transport plays a prominent role in the respondents' mobility patterns. However, the low proportion of licensed motorcycle drivers may require attention from policymakers in terms of improving road safety awareness and licensing enforcement.

Travel Characteristic

Travel-related data show that many respondents accessed bus stops within 2–6 minutes, though nearly half required longer times, and trips were mainly for education (48%) and work (19.25%), often covering distances up to or exceeding 10 km with durations commonly 40 minutes or more. Regarding licensing, 65.5% held Class A driver's licenses, but only 19.75% had Class C licenses, despite high motorcycle ownership, with 94.5% owning at least one unit and nearly half owning multiple. Overall, the data indicate a relatively young and educated population with diverse employment and income levels, reliance on motorcycles for mobility, and significant travel demands for education and work, highlighting the importance of efficient, safe, and accessible transport systems.

Model Estimation Result

The binary probit regression model was employed to identify the factors influencing individuals' likelihood of choosing a particular mode of transportation, specifically public transport. Table 2 reveals the estimation results indicate that several variables significantly affect the probability of choosing such modes.

Variables such as travel distance greater than 4 km, travel time, and vehicle operating costs all have positive and statistically significant effects, suggesting

Table 2. Model estimate of mode choice

Mode Choice Public Transport	Coef.	St. Error	t-value	p-value	[95% Conf	Interval]	Sig
Travel distance to destination >4 Km	1.744	0.263	6.64	0.001	1.229	2.258	***
Travel time	0.24	0.065	3.67	0.001	0.112	0.368	***
Vehicle operating costs	2.155	0.224	9.62	0.001	1.716	2.594	***
Gender							
Male	0.535	0.193	2.76	0.006	0.156	0.914	***
Education Level							
Diploma	0.426	0.418	1.02	0.308	-0.393	1.245	
Bachelor's	1.495	0.668	2.24	0.025	0.186	2.804	**
Postgraduate	0.812	0.437	1.86	0.063	-0.044	1.668	*
Motorcycle Ownership		0.24	0.24	0.24	0.24	0.24	0.24
1 Motorcycle	0.656						
2 Motorcycle	0.859						
3 Motorcycle	1.006						
4 Motorcycle	1.445						
Ownership driving license		0.24	0.24	0.24	0.24	0.24	0.24
yes	0.48						
Constant	-4.343						
Mean dependent var.	*0.698*		*SD dependent var.*		*0.460*		
Pseudo r-squared	*0.412*		*Number of obs*		*400*		
Chi-square	*201.896*		*Prob > chi2*		*0.000*		
Akaike crit. (AIC)	*314.478*		*Bayesian crit. (BIC)*		*366.367*		
***** p<.01, ** p<.05, * p<.1**							

that as these factors increase, individuals are more likely to opt for public transport. Additionally, being male is positively associated with public mode choice, indicating that men are more inclined to choose certain transportation modes compared to women.

Regarding education level, respondents with a bachelor's degree show a significant positive effect, while those with postgraduate education are significant at the 10% level. This suggests that higher educational attainment is associated with more rational or efficient transport mode choices. The ownership of motorcycles, particularly owning two to four units, is also significantly and positively associated with private mode choice, indicating that greater vehicle access increases the tendency to choose private modes. Additionally, holding a valid driver's license significantly influences mode choice, emphasizing the importance of legality in travel behavior.

Overall, the model demonstrates strong performance with a pseudo R-squared of 0.412 and a highly significant Chi-square value of 201.896 ($p<0.001$). The Akaike Information Criterion (AIC) of 314.478 and Bayesian Information Criterion (BIC) of 366.367 indicate a satisfactory model fit. These findings confirm that both individual characteristics and trip attributes jointly influence transportation mode choice and should be considered in the formulation of user-oriented transportation policies.

Model Simulation

Effect of a 10% Reduction in Travel Time on Mode Choice Probabilities

The simulation results of the mode choice model for the travel time and travel cost attributes are presented in Table 3 and Table 4. In this analysis, both travel time and travel cost variables were adjusted by 10% to observe their impact on mode selection probabilities. This simulation provides insights into how changes in these key attributes can influence travelers' preferences between public and private transportation modes.

Table 3. Change in variable Travel time (-10%)

Before		After	
Transportation mode	Probability (%)	Transportation mode	Probability (%)
Public transport	30.25%	Public transport	33.25%
Private mode	69.75%	Private mode	66.75%

Table 3 presents the change in predicted probabilities of transportation mode choice resulting from a 10% decrease in travel time. Prior to the adjustment, the probability of choosing public transport was 30.25%, while private modes dominated with a probability of 69.75%. After the simulated reduction in travel time, the probability of choosing public transport increased to 33.25%, whereas the likelihood of choosing private modes decreased to 66.75%.

This shift indicates that travel time is a significant determinant in mode choice behavior, with improvements in time efficiency positively influencing the attractiveness of public transportation. A 10% decrease in travel time led to

a 3 percentage point increase in the probability of selecting public transport, suggesting that users are responsive to service improvements that reduce total travel duration.

The findings align with established transportation theories, which posit that time savings are highly valued by commuters and can play a critical role in shifting preferences toward public transit, especially in congested urban environments. These results highlight the potential of time-based service enhancements such as improved frequency, reduced waiting times, and faster travel speeds to increase public transport ridership.

From a policy perspective, the simulation emphasizes the importance of investment in infrastructure and operational efficiency for public transport systems, as even marginal reductions in travel time can lead to meaningful shifts in travel behavior. This reinforces the value of prioritizing time reducing strategies in transport planning aimed at promoting more sustainable and equitable mobility.

Effect of a 10% Reduction in Vehicle Operating Costs on Mode Choice Probabilities

Table 4. Change in variable vehicle operating costs (-10%)

Before		After	
Transportation mode	Probability (%)	Transportation mode	Probability (%)
Public transport	30.25%	Public transport	35.25%
Private mode	69.75%	Private mode	64.75%

Table 4 illustrates the shift in transportation mode choice probabilities before and after a simulated 10% reduction in vehicle operating costs. Prior to the cost adjustment, 69.75% of respondents were predicted to choose private modes, while 30.25% opted for public transport. Following the decrease in operating costs, the probability of selecting private modes declined to 64.75%, whereas the likelihood of choosing public transport increased to 35.25%.

This shift indicates that a reduction in the financial burden of operating private vehicles slightly reduces the attractiveness of private mode usage, contrary to the common expectation that lower private vehicle costs would increase private mode preference. Instead, the results suggest a possible threshold effect or saturation point, wherein further cost reductions do not significantly incentivize additional use, potentially due to other limiting factors such as congestion, parking constraints, or user preferences shifting toward more sustainable or efficient modes.

The observed increase of 5 percentage points in public transport usage also suggests that pricing dynamics in private transportation can indirectly influence public transport adoption. This counterintuitive finding may reflect a broader behavioral sensitivity to operational cost changes within a multi-modal urban transport context, underscoring the importance of integrating pricing policies with broader mobility management strategies.

Overall, the results highlight the complex interplay between travel cost structures and modal choice, offering valuable insights for policymakers aiming to promote sustainable transportation through economic instruments.

Discussion

In comparison with previous studies, notable variations in elasticity values are observed. For instance, the findings reported by Sugiyanto [22] indicate lower elasticity for travel time and higher elasticity for travel cost relative to the results of the present study, where travel time elasticity is found to be larger while travel cost elasticity is smaller. Similarly, research conducted by Wulansari [25] on private vehicle and monorail mode choice revealed lower elasticity values for travel time and higher elasticity values for travel costs compared to those obtained in this study. Furthermore, Espino et al [20] reported that the elasticity of BRT relative to private vehicles is lower for travel time, while the elasticity for travel cost is approximately similar to that observed in this research.

These discrepancies in elasticity values may be attributed to several factors, including differences in attribute level settings, types of transport modes under consideration, research locations, population characteristics, study periods, and other contextual conditions.

Based on the simulation value for public transportation, especially the TransK bus, a 10% reduction in travel time was found to influence mode choice probabilities, increasing public transport usage from 30.25% to 33.25% and decreasing private mode usage from 69.75% to 66.75%. This result highlights travel time as a key factor in mode choice decisions, with commuters showing sensitivity to time-saving improvements. The findings support transportation theories emphasizing the value of travel time savings and suggest that enhancing public transport efficiency through improved frequency, reduced waiting times, and faster travel speeds can encourage higher ridership. From a policy standpoint, investing in measures that reduce travel time can significantly promote sustainable and equitable transportation choices.

According to Iliopoulou and Kepaptsoglou [26], improved connectivity between transport modes facilitates travel by simplifying payments, enhancing access to public transportation, and reducing travel time. Policies that increase private vehicle travel time, such as odd-even traffic restrictions, can encourage a modal shift toward public transport, with studies showing up to a 45% shift [27]. Additionally, reducing waiting times for angkutan kota could significantly boost its usage, as uncertainty in service schedules is a major deterrent for passengers [28].

Meanwhile, the simulation of the travel cost plays a crucial role in influencing public transport usage, as fare affordability directly impacts passengers' mode choice decisions. Lower travel costs can make public transport more attractive compared to private vehicles, particularly for cost-sensitive users. Conversely, fare increases may discourage ridership, prompting a shift toward alternative modes, including private transport or informal services [29], [30].

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The simulation results for fuel costs indicate that changes in these costs have the greatest effect of mode choice. In contrast, TransK buses, and private vehicles are more sensitive to variations in fixed or fuel expenses. Similarly, adjustments in parking fees and transfer fees have minimal influence on the usage of public transport modes as well as private vehicles.

Conclusion

This study demonstrates that transportation mode choice can be predicted using both travel attributes and additional factors such as sociodemographic and travel characteristics in the model.

The parameter estimation results indicate that travel attributes, specifically travel time and travel costs, significantly influence transportation mode choice. This relationship is further supported by the calculated elasticity values for both attributes. Compared to earlier studies, the elasticity of travel time in this research is higher, while the elasticity of travel costs is lower. These differences may reflect longer travel times caused by increased traffic congestion and greater private vehicle usage, whereas public transport fares remain relatively affordable and accessible across different income groups.

The findings indicate that reducing both travel time and access time for TransK buses significantly increases their likelihood of being chosen by commuters. Conversely, longer travel times for private vehicles can further shift preference toward public transport. This suggests that improving TransK bus service efficiency while implementing measures that limit private vehicle convenience could effectively encourage public transport use. Achieving this requires enhancements in TransK bus infrastructure and operations, such as dedicated bus lanes, intersection priority, integrated transport networks, and traffic management policies like the odd-even system.

The elasticity results for fixed costs or fuel expenses indicate that these factors have little impact on the use of TransK buses and private vehicles. The strongest effect is observed for conventional and online taxis. This may be due to the relatively low travel costs associated with TransK buses, despite their longer travel times, while private vehicles also incur low operating costs but offer significantly faster travel compared to public transport. As a result, variations in fixed costs or fuel prices do not substantially influence mode choice for TransK buses or private vehicles.

Further research is recommended to include psychological attributes in order to identify the most influential factors in travel decisions and to better understand public responses to different transportation policies and their implementation methods.

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Conflicts of Interest

The authors declare no potential conflicts of interest with respect to the research, authorship, or publication of this article.

Author Contributions

Ruslan: writing-original draft, writing- reviewing and editing, methodology, investigation, formal analysis, visualization. **Firmansyah Rachman:** conceptualization, project administration, supervision, writing- reviewing and editing. **Zulfhazli Abdullah:** investigation, formal analysis, methodology, software.

Data Availability Statement

The data used to support the findings of this study are included within the article.

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