Analysis Probability Of Public Transportation Mode Choice Between Bus And Hiace Minibus On The Lhokseumawe - Banda Aceh Route

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Abstract

Transportation plays a vital role in supporting national development, serving as a driver, facilitator, and connector between regions. In transportation planning, mode choice modeling is essential due to the strategic role of public transport in shaping transportation policies. On the Lhokseumawe – Banda Aceh route, whether traveling during the day or night, passengers are faced with the choice between two types of road-based public transportation: the Putra Pelangi intercity bus and the HiAce minibus. This study aims to identify the characteristics of public transport users, the factors influencing their mode choice, and the probability of selecting either the Putra Pelangi bus or the HiAce minibus on the Lhokseumawe–Banda Aceh route. The stated preference method was used, and data were analyzed using the binary logit model through SPSS software. The survey results show a slight preference among respondents: 38 people chose the Putra Pelangi bus, while 62 opted for the HiAce minibus. Passengers were generally aged between 20 and 30 years. Male respondents tended to prefer the bus, whereas female respondents mostly chose the HiAce minibus. In terms of income, passengers earning between Rp500.000 and Rp1.000.000 per month tended to choose the bus, while those earning more than Rp3.000,000 preferred the HiAce minibus. These factors were found to significantly influence mode choice, as indicated by the coefficient of determination (R^2) of 0.963, or 96.3%, suggesting a strong explanatory power of the model. The utility function obtained from the binary logit model is: Ubus-UHiace = $0.569 + 0.022X_1 + 0.108X_2 + 0.019X_3 + 0.129X_4 + 0.018X_5$ The probability analysis showed that if both transportation options were offered at the same fare, the likelihood of choosing the Putra Pelangi bus was only 4%, while the HiAce minibus was preferred by 96% of respondents. However, if the Putra Pelangi bus fare were reduced by approximately Rp90.000, the probabilities would equalize, with each mode being chosen by 50% of passengers.

Keywords: *Mode Choice, Transportation, Probability, Stated Preference, SPSS*

Abstrak

Transportasi memegang peran penting dalam mendukung pembangunan nasional, berfungsi sebagai penggerak, fasilitator, dan penghubung antarwilayah. Dalam perencanaan transportasi, pemodelan pemilihan moda menjadi aspek krusial mengingat peran strategis angkutan umum dalam membentuk kebijakan transportasi. Pada rute Lhokseumawe–Banda Aceh, penumpang dihadapkan pada pilihan antara dua jenis transportasi umum berbasis jalan: bus antar kota Putra Pelangi dan minibus HiAce. Penelitian ini bertujuan untuk mengidentifikasi karakteristik pengguna transportasi umum, faktor yang memengaruhi pemilihan moda, serta probabilitas pemilihan bus Putra Pelangi atau minibus HiAce pada rute tersebut. Metode stated preference digunakan, dengan analisis data mengacu pada model binary logit melalui perangkat lunak SPSS. Hasil survei menunjukkan kecenderungan responden: 38 orang memilih bus Putra Pelangi, sedangkan 62 orang memilih minibus HiAce. Mayoritas penumpang berusia 20–30 tahun. Responden laki-laki cenderung memilih bus, sementara perempuan lebih memilih minibus HiAce. Dari segi pendapatan, penumpang dengan penghasilan Rp500.000–Rp1.000.000 per bulan cenderung memilih bus, sedangkan yang berpenghasilan di atas Rp3.000.000 lebih memilih minibus HiAce. Faktor-faktor tersebut terbukti signifikan memengaruhi pemilihan moda, dengan koefisien determinasi (R^2) sebesar 0,963 atau 96,3%, menunjukkan kekuatan penjelas model yang tinggi. Fungsi utilitas yang diperoleh dari model binary logit adalah: Ubus-UHiace = $0.569 + 0.022X_1 + 0.108X_2 + 0.019X_3 + 0.129X_4 + 0.018X_5$ Analisis probabilitas menunjukkan bahwa jika kedua moda transportasi ditawarkan dengan tarif yang

sama, kemungkinan pemilihan bus Putra Pelangi hanya 4%, sedangkan minibus HiAce dipilih oleh 96% responden. Namun, jika tarif bus Putra Pelangi diturunkan sekitar Rp90.000, probabilitas pemilihan kedua moda akan setara, masing-masing dipilih oleh 50% penumpang.

Kata Kunci: *Pemilihan Moda, Transportasi, Probabilitas, Stated Preference, SPSS*

1. Introduction

The transportation system is an important and strategic part of the development of a region. Transportation has a very important role for the growth of national development considering its nature as a driver, motivator, and glue for the gap between regions. In addition, it can be interpreted as an effort to move, move, transport or divert an object from one place to another, useful for certain purposes [1]. Transportation is very important for society because with transportation it is possible for people to move, and also facilitates the distribution of goods and services to meet the travel needs of the community. Road transportation as a means of inter-city transportation has the advantage of being able to channel people and goods with a larger capacity and road transportation costs are relatively cheaper compared to other transportation [2].

In planning the selection of transportation modes, the selection of modes is a very important model in its planning due to the key role of public transportation as a transportation policy [3]. No one can deny that public transportation uses road space more efficiently than private transportation [4]. In an intercity movement, the mode selection factor plays a fairly important role, someone who will move from one city to another will certainly consider many things, namely whether the movement carried out in this case uses public transportation, buses or minibuses [5]. In using this transportation, there are many choices of transportation modes that can be used, all of which are closely related to various characteristics, both modes, types of trips and characteristics of travelers [6].

Passenger characteristics such as age, gender, income and occupation also have a significant impact on transportation choices. For example, low-income people choose cheaper modes of transportation depending on their ability to pay. On the other hand, people with high mobility jobs tend to choose faster modes of transportation[7]. Buses or minibuses are public transportation that serve inter-city and inter-provincial travel, several bus transportation companies that serve inter-city and inter-provincial services that are in demand by the public from the past to the present. While several minibus hiace transportation companies or often known as travel are types of minibus transportation that serve inter-city and also one of the public transportation that is in great demand by people who travel between cities and provinces today [8]).

In traveling during the day or night on the Lhokseumawe - Banda Aceh route or vice versa, travelers will be faced with a choice of road transportation modes, namely by using Buses and Hiace Minibuses. To determine the choice of transportation mode, travelers consider various factors, such as the purpose of the trip, distance traveled, costs and so on [9]. This is the backroad for the author to analyze the probability of choosing a night transportation mode between Bus and Hiace minibus [10]. This study aims to examine the choice of night transportation mode between buses and Hiace minibuses (case study: Lhokseumawe-Banda Aceh route). This study is expected to make it easier for road users later in choosing a more flexible and more practical mode of transportation depending on several stages of need [11].

Based on the problems and results of previous research that the author has described above, the author will examine the Probability of Choosing Night Transportation Modes Between Buses and Hiace Minibuses (Case Study: Lhokseumawe-Banda Aceh Route).

2. Material and Methods

2.1 Analysis of Passenger Characteristics of Hiace Buses and Minibuses

Analysis of characteristics that influence mode selection is a descriptive analysis to identify passenger characteristics in choosing a mode of transportation. In the traveler characteristics group, all variables in the questionnaire are related to individual travelers and contribute to influencing travelers in choosing a mode. The variables are:

1. Gender
2. Age
3. Occupation

4. Monthly income
5. Last education
6. Purpose of travel
7. Mode chosen
8. Reason for choosing mode
9. Mode comfort
10. Mode safety

2.2 Linear Regression Analysis

Linear regression analysis is to determine the attributes of the independent variable X and the attributes of the dependent variable Y, this analysis is carried out to test whether there are factors that influence passenger decisions in choosing a mode. The dependent variable (Y) used in this study is the type of transportation mode chosen, namely the Putra Pelangi bus and the Hiace minibus and the independent variables (X) used are factors that influence the choice of mode, namely:

X1 = Travel Time
X2 = Waiting Time
X3 = Travel Cost / Tariff
X4 = Terminal Cost
X5 = Drop Off / Pick Up Cost

2.3 Utility Value Analysis

The utility value is measured from the total attributes of the transportation mode, namely travel time, waiting time, travel costs/fares, and terminal costs. To determine the utility value of each mode by using the utility formula in equation 2.1 because what is calculated is the value of the utility.

2.4 Probability Analysis Using Difference Binary Logit Model

The probability is calculated using the difference binary logit model. After obtaining the utility value for each mode, then the probability of each mode is calculated using the difference binary logit model in equation 2.4 because what is calculated is the probability value using the difference binary logit model.

2.5 SPSS software

SPSS software is one of the programs used for statistical analysis. This application has a fairly high data analysis capability and provides a data management system in a graphical environment, with descriptive menus and simple dialog boxes so that it is easy to operate [12].

SPSS can process various types of data, either by reading existing files or by entering data directly into the SPSS Data Editor. Regardless of the raw data structure, in the SPSS Data Editor, data must be arranged in rows (cases) and columns (variables). Cases represent one unit of analysis, while variables contain information collected from each case.

SPSS is very suitable for quantitative research because of its ability to process data accurately. In this study, SPSS was used for linear regression analysis, where through the stages of the regression method, an equation with various regression coefficients will be obtained. Thus, each constant produced can be calculated and analyzed further.

3. Results and Discussion

3.1 Analysis of Passenger Characteristics of Hiace Bus and Minibus

Respondent characteristics are a summary of information about respondents obtained from completed surveys [13]. The following are more specific details about respondents from each mode option that will be obtained from this data:

1. Gender of Traveler

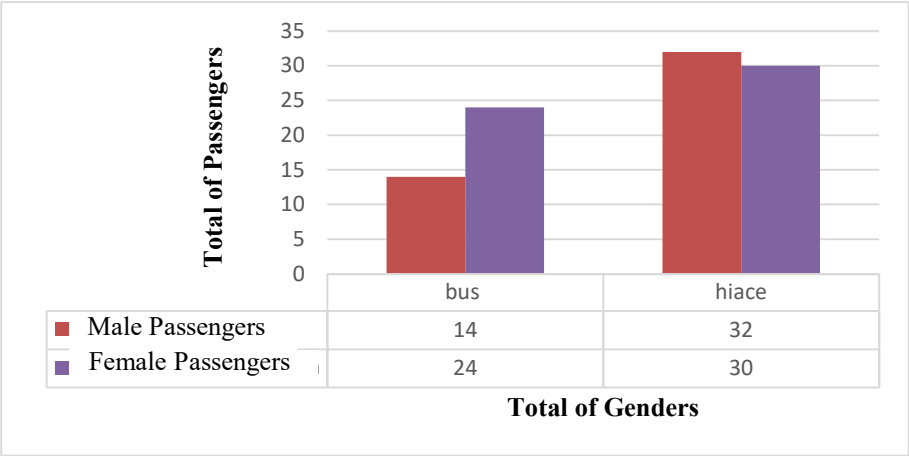

Figure 1 Graph of gender base percentage

Based on the image, respondents who chose the Pelangi bus were dominated by women (24 respondents) and men (14 respondents), while respondents who chose the Hiace minibus mode were dominated by women (32 respondents) and men (30 respondents). The gender difference between male and female passengers is too far, according to the comparison of respondent gender data based on direct observation in the field. Survey findings show that men prefer the Hiace minibus, while women choose the Putra Pelangi bus.

Based on age, the majority of respondents who chose Putra Pelangi Bus were between 10 and 20 years old (i.e. 0 people), followed by respondents between 20 and 30 years old (i.e. 20 people), respondents between 30 and 40 years old (i.e. 12 people), respondents between 40 and 50 years old (i.e. 4 people), and respondents between 50 and 60 years old (i.e.). In contrast, the majority of respondents who chose HiAce minibus were between 20 and 30 years old and 40-50 years old (i.e. 15 people) and 40-50 years old (i.e. 3 people). According to the research findings, there was no significant age difference between respondents who chose Putra Pelangi Bus and Hiace minibus; however, respondents between 20 and 30 years old preferred Hiace minibus, while respondents between 50 and 60 years old preferred Putra Pelangi Bus.

3.2 Factors Influencing the Selection of Transportation Modes

To find out whether there are factors that influence passengers' decisions in choosing a mode based on the attributes of the mode offered in this study, an analysis of the factors that influence mode selection was conducted using linear regression analysis. Specifically, the attributes of the independent variable X and the attributes of the dependent variable Y were determined. Four characteristics of each mode were given to respondents, and their answer choices were presented in the form of a numeric scale based on a questionnaire created using the expressed preference approach. The selected mode (Y) and its attributes-travel time (X1), waiting time (X2), travel cost/ticket (X3), terminal cost (X4), and shuttle cost (X5) were the independent variables, according to the linear regression analysis conducted using SPSS software [14].

3.3 Correlation Coefficient Test

The degree of relationship between two or more variables can be determined using a correlation test. The correlation coefficient, which ranges from -1 to 1, is used to express the results. The correlation test was conducted on each independent variable, specifically travel time (X1), waiting time (X2), travel cost/fare (X3), terminal cost (X4), and shuttle cost (X5), based on the findings of the correlation test between variables based on table 1. The largest relationship appears to occur and meets the important criteria.

Table 1 Correlation Coefficient Test

	Selected mode	Traveling time	Waiting Time	Travel Fare Costs	Terminal Fees	Shuttle
Selected mode	1	0.577	0.955	0.688	0.959	0.002
Traveling time	0.557	1	0.552	0.351	0.519	-0.093
Waiting Time	0.955	0.552	1	0.598	0.913	-0.024

Travel Fare Costs	0.608	0.351	0.598	1	0.549	-0.016
Terminal Fees	0.959	0.519	0.913	0.549	1	0.002
Shuttle	0.002	-0.093	-0.024	-0.016	0.002	1

3.4 T test

Based on the results of the T test using SPSS, it can be concluded as follows:

1. Travel time variable X1 sig 0.012 <0.05 and T count 2.548> 1.9852 T table, This shows that variable X (independent variable) has a significant effect on Y (dependent variable)
2. Waiting time variable X2 sig 0.000 <0.05 and T count 8.044> 1.9852 T table, This shows that variable X (independent variable) has a significant effect on Y (dependent variable)
3. Travel cost/fare variable X3 sig 0.034 <0.05 and T count 2.346> 1.9852 T table, This shows that variable X (independent variable) has a significant effect on Y (dependent variable)
4. Terminal cost variable X4 sig 0.000 <0.05 and T count 10.562 > 1.9852 T table, This shows that variable X (independent variable) has a significant effect on Y (dependent variable)
5. Shuttle cost variable X5 sig 0.391 > 0.05 and T count 0.861 < 1.9852 T table, This shows that variable X (independent variable) does not have a significant effect on Y (dependent variable).

3.5 F Test

The F table value for the F test is obtained in the following way: F table = F (0.05: n-k) = F (0.05; 95) = 1.985. The results of the F hypothesis test show the results of the SPSS calculation with a calculated F value of 485.711. Based on the F test, it is concluded that the calculated F> F table, namely 485.711> 1.985 and the sig value of 0.00 < 0.05 meets the requirements, so the conclusion is that all the attributes considered have a joint effect on passenger decisions in choosing modes.

3.6 Coefficient of Determination

The determination coefficient test is conducted to determine the percentage value of the contribution of independent variables simultaneously influencing the dependent variable or the determination coefficient is used to measure the extent to which the model's ability to explain variations in the dependent variable. Based on the test results using SPSS, the determination coefficient or R Square value is 0.963 or equal to 96.3%. This means that the independent variables of travel time (X1), waiting time (X2), travel costs/fares (X3), terminal costs (X4), and pick-up and drop-off times (X5) together influence the dependent variable of the selected mode (Y) by 96.3%.

3.7 Multicollinearity Test

Based on the results of the multicollinearity test using SPSS, it shows that each variable has a VIF value <10 and a tolerance value> 0.1 so that there is no multicollinearity. This means that there is no relationship or correlation between independent variables.

3.8 Heteroscedasticity Test

Based on the results of the heteroscedasticity test using SPSS, it can be concluded that:

1. The travel time variable (X1) has a sig value of 0.009>0.005, so there is no symptom of heteroscedasticity.
2. The waiting time variable (X2) has a sig value of 0.655>0.005, so there is no symptom of heteroscedasticity.
3. The travel cost/fare variable (X3) has a sig value of 0.235>0.005, so there is no symptom of heteroscedasticity.
4. The terminal cost variable (X4) has a sig value of 0.516>0.005, so there is no symptom of heteroscedasticity.
5. The shuttle cost variable (X5) has a sig value of 0.000<0.005, so there is no symptom of heteroscedasticity.

3.9 Model Determination Probability Analysis Using Difference Binary Logit Model

Based on the results, it can be seen that the survey was conducted for 4 days, namely Thursday, Friday, Saturday and Sunday so that the difference in the value of C bus and Cminibus hiace is known. After obtaining the value of C bus and the value of C minibus hiace, the next step is to calculate the regression analysis to obtain the values of α and β, so that the value of α = 3.1714 and the value of β = 0.0355 are obtained, the complete regression calculation results can be seen in Appendix A.

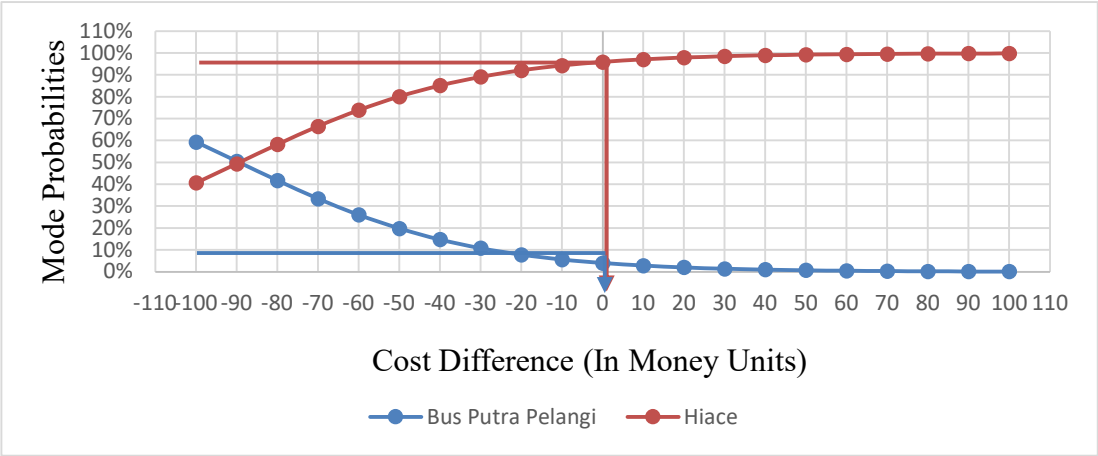

Figure 2. Mode Choice Diversity Curve of Bus and Hiace Minibus

Based on the binary logit diversion curve, the difference above is reviewed from the cost difference, it is known that, if the difference between the cost of the Putra Pelangi Bus and the Hiace Minibus (the mode fare is stated to be the same), then the probability of Bus users is 4% and the probability of Hiace Minibus users is 96%. This shows that users are more likely to choose the Hiace Minibus compared to the Putra Pelangi Bus when the travel cost does not provide additional incentives for users to switch modes.

If the cost of traveling with the Putra Pelangi Bus decreases compared to the Hiace Minibus, then the probability of users choosing the Putra Pelangi Bus will increase. Conversely, if the Bus fare is higher than the Hiace Minibus, then the likelihood of users choosing the Bus will be even smaller. Other factors that influence the choice of this mode of transportation can include comfort, speed, availability of facilities, and perceptions of security and safety [15].

By using the difference binary logit model, changes in the probability of choosing a mode of transportation can be further analyzed to determine the equilibrium point where both modes have an equal chance or see how price changes can increase the attractiveness of a mode of transportation to users.

The probability analysis for the utility of each mode can be narrated in several scenarios as follows.

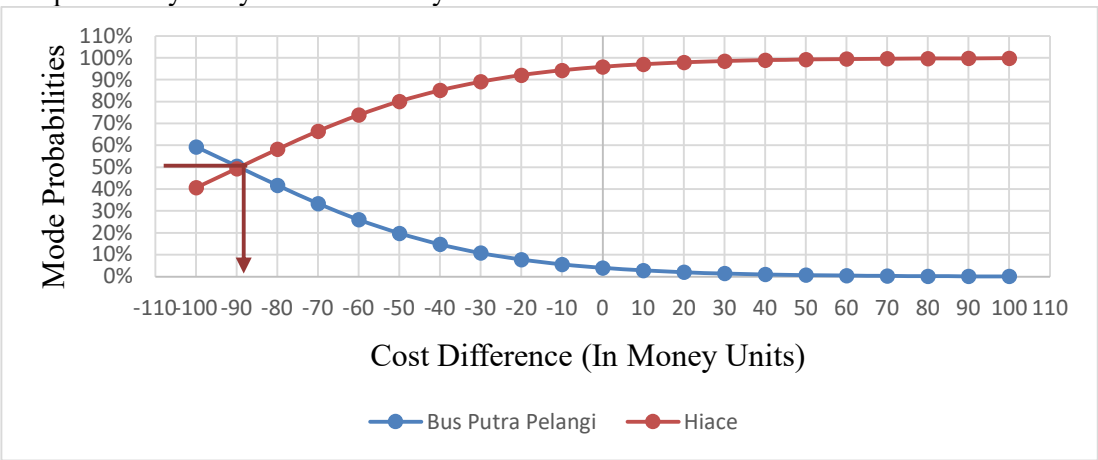

Figure 3. Binary Logit Diversion Curve Difference Between Bus and Hiace Modes

The transportation system is an important part of community mobility. On the Lhokseumawe - Banda Aceh route, the characteristics of choosing a mode of transportation between buses and Hiace Minibuses. From the results of the study, the majority of passengers who choose the Hiace Minibus are individuals aged 20 to 30 years, while respondents over 50 years old will choose the Putra Pelangi bus. Men are more dominant in choosing buses, while women are more likely to choose the Hiace Minibus. Respondents who choose the Putra Pelangi bus generally have an income of between IDR 500,000 and IDR 1,000,000, while respondents who have an income of more than IDR 3,000,000 are more likely to choose the Hiace minibus. There are several main factors that influence passengers' decisions in choosing a mode of transportation, namely: Travel time, waiting time, travel costs/fares, terminal costs, and shuttle costs. Furthermore, this study analyzed the data using the correlation coefficient test, T test, F test, multicollinearity test, and heteroscedasticity test with SPSS software. In addition, utility analysis and

mode choice probability were conducted using a binary logit difference model to calculate the probability of choosing a mode of transportation. The results of the analysis show that if the fares of both modes of transportation are the same, the probability of passengers choosing the Putra Pelangi bus is only 4%, while the Hiace minibus reaches 96%. However, if the Putra Pelangi bus fare is reduced by around IDR 90,000, the probability of choosing both modes becomes balanced, each at 50%.

4. Conclusion

Based on the results of the study on the selection of public transportation modes for the Lhokseumawe-Banda Aceh route, it can be concluded in the selection of the mode in several summary points obtained by the researcher in the conclusion as follows:

1. There is a slight difference in the respondents' choice of transportation, where 38 people choose the Putra Pelangi Bus and 62 people choose the Hiace Minibus. Passengers who choose this mode are generally between 20 and 30 years old. Male respondents prefer buses, while female respondents usually choose the Hiace Minibus. While passengers with incomes between IDR 500,000 and IDR 1,000,000 tend to choose the Putra Pelangi Bus, those with incomes of more than IDR 3,000,000 tend to choose the Hiace Minibus. Family reasons are the main reason for traveling, and the majority of respondents are self-employed.
2. Mode selection is highly influenced by variables such as travel time, waiting time, cost, terminal cost, and shuttle cost. These factors have a significant influence, as evidenced by the coefficient of determination (R2) = 0.963 or 96.3%. Ubus-UHiace = 0.569 + 0.022X1 + 0.108X2 + 0.019X3 + 0.129X4 + 0.018X5, where X1 to X5 indicate factors, is the optimal linear regression model for mode selection.
3. Probability analysis, there is a 4% chance of choosing Putra Pelangi Bus and 96% of choosing Hiace Minibus if the rates of both options are the same. The chance of choosing one of the two options is equal to 50% if Putra Pelangi Bus lowers its rates by Rp90,000. Furthermore, the possibility of using this mode increases to 98% if Hiace Minibus lowers its rates by Rp10,000. However, the possibility of using this mode increases to 10% if Putra Pelangi Bus lowers its rates by Rp30,000.

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