

Analysis Trip Generation and Trip Attraction Model of Passangers Movement of Light Rail Transit at Cikoko Station, Jakarta

Fitriani Sulistya Atmaja^{1*}, Juang Akbardin¹, Dadang Mohamad Ma'soem¹

¹Civil Engineering Study Program, Indonesia University of Education

*Corresponding Author: Fitriani Sulistya Atmaja. Email: fitrishutya93@upi.edu

Abstract

Cikoko LRT Station in South Jakarta is a strategic transportation hub that supports intermodal integration within the Jabodebek LRT network. The increasing number of passengers requires an analysis to understand user characteristics, develop movement prediction models, and identify the main influencing factors. This study aims to analyze passenger characteristics, develop trip generation and attraction regression models, and determine dominant factors using a quantitative approach through questionnaire surveys, analyzed with multiple linear regression, classical assumption tests, hypothesis tests, and factor contribution analysis. Passengers of Cikoko LRT Station are generally aged 21–30 years, working as private employees or students, with trip purposes mainly for work and recreation. Regression results using Microsoft Excel and SPSS V27 produced the trip generation model $Y = 4,014 + 6,904X_1 - 42,499X_3 - 46,563X_6 - 9,300X_{10} + 95,590X_{11}$ and the trip attraction model $Y = 923,109 + 27,357X_1 - 120,250X_3 + 99,839X_4 + 16,801X_5 - 99,156X_6 - 16,780X_7 - 21,124X_{10} - 444,905X_{11}$. Both models have high predictive accuracy, with dominant factors for trip generation being age (28%), education level (23%), and mode of transportation (23%), while dominant factors for trip attraction are age (23%) and mode of transportation (22%). These findings highlight the need for transportation planning based on user characteristics and travel patterns to improve service quality.

Keywords: Trip Generation, Trip Attraction, LRT, Passengers Movement, Linear Regression

1. INTRODUCTION

Since its inauguration on August 28, 2023, the Jabodebek LRT has shown a significant increase in passenger numbers, with a total of more than 21 million passengers in 2024, up from only 4.5 million in 2023 [1]. The Cikoko LRT station has become a strategic hub thanks to its connectivity with KRL, TransJakarta, and other public transportation services, experiencing a 19.88% surge in passengers during a certain period [2]. This situation highlights the crucial role of stations as multimodal integration points and their significant potential in driving passenger movement in the surrounding area. However, most previous studies have focused on macro aspects such as fares, travel intervals, and mode shifts, while research analyzing internal factors at the station level, particularly in the Jabodebek LRT, remains limited. Additionally, the Cikoko LRT station has yet to fully optimize its potential in encouraging the public to shift from private vehicles to mass rail-based public transportation. This study aims to analyze passenger travel characteristics at the Cikoko LRT Station, create a trip generation and attraction model for passenger movement, and identify the dominant factors influencing passenger trip generation and attraction at the station. The findings of this study are expected to contribute theoretically through a micro-level approach linking geographical aspects and LRT user behavior, as well as practically in formulating policies for station development and surrounding environments that are responsive to actual travel needs

1.1. Characteristics Trip Generation and Trip Attraction

In travel analysis, trip generation and attraction reflect two key aspects related to the origin and destination of travel. Passenger travel can be categorized based on various aspects, such as purpose, frequency, travel time, distance, and the spatial separation between origin and destination (O-D) and the mode of transportation chosen. Additionally, the socio-economic conditions of individuals and the households where they reside are also important indicators in predicting the travel behavior patterns of each passenger. According to the Western Australian Planning Commission (2016), trip generation and attraction characteristics are analyzed based on travel classification, including travel purpose, travel frequency, travel time, travel distance, and mode of transportation [3].

Table 1. Characteristics Trip Generation and Attraction

Travel Purpose	Travel Frequency	Travel Time	Travel Distance	Transport Mode
Work	Regular	Peak period	Local	Personal transport
Education	Infrequent	Business hours	To city centre	Public transport
Shopping	Occasional	Off-peak	Inter-suburb	Non-motorised
Personal business	One-off	Late night	Regional	
Social		Weekday	Inter-city	
Recreational		Weekend	Inter-state	
			International	

1.2. Trip Generation and Attraction Modelling

Trip generation is the number of trips generated from a zone based on demographic, socio-economic, and land use factors. Trip attraction is the number of trips directed toward that zone based on its capacity as an activity destination (Meyer & Miller, 2001) [4]. In the Four Step Travel Demand Model framework, the trip generation and attraction stages are the initial inputs that determine the results of the distribution, mode selection, and route determination stages (Tamin, 2018) [5]. One of the commonly used methods for modeling generation and attraction is multiple linear regression [6].

$$Y = A + B_1X_1 + B_2X_2 + \dots + B_zX_z \dots \dots \dots (1)$$

Description:

- Y = Dependent variable X₁...X_z = Independent variable
- A = Intercept or regression constant B₁...B_z = Regression coefficients

1.3. Factors Affecting Trip Generation and Trip Attraction

Factors influencing trip generation and attraction can be categorized into internal factors (passenger characteristics) and external factors (environment and infrastructure). Areas with high density and mixed-use development tend to generate and attract more trips. The following are factors influencing trip generation and attraction in human travel.

Table 2. Trip Generation and Attraction Factors

Type of Factor	Example Variable
Internal	Age, Education, Occupation, Transport Mode, Purpose, Frequency
External	Population Density, Land Use, Intermodal Integration, Parking
Facilities, Service Quality	

Based on the regression results, the relative contribution of each factor is calculated by converting the absolute values of the regression coefficients into percentages using the following contribution formula [5]:

$$Contribution (\%) = \frac{|\beta_i \bar{X}_i|}{\sum_{i=1}^n |\beta_i \bar{X}_i|} \times 100 \dots \dots \dots (2)$$

Description:

- β_i = Regression coefficient
- \bar{x} = Average independent variable
- x = Independent variable

2. METHOD

This research uses a quantitative approach with multiple linear regression to develop a predictive model for passenger movement generation and attraction at railway-based transportation nodes. The analysis process is based on field survey data that has been systematically collected and processed, ensuring the validity and reliability of the resulting model.

2.1. Population, Sample, and Sampling Technique

The population in this research is all Cikoko LRT users. Based on data from PT. KAI Jabodebek LRT Public Relations Division, the number of daily passengers at this station was recorded at 16,781 people. This population includes daily commuters from the Greater Jakarta area, so this station functions as a transit point and final destination. The sample in this research was taken from LRT passengers at Cikoko Station. The sample size in this research was determined using the Slovin formula. The formula is as follows:

$$n = \frac{N}{1 + N(e)^2} \dots \dots \dots (3)$$

Description:

- n = Sample (respondents)

N = Population (16.781)
 e = Error tolerance (10%)

$$n = \frac{N}{1+N(e)^2} = \frac{16.781}{1+16.781(0,1)^2} = 99,411 \approx 100 \text{ sample} \dots\dots\dots(4)$$

Although the sample size is below the ideal size, statistical validity can still be maintained through synthetic estimation and strengthening the analysis with regression tests and assumption tests. This research used 116 samples for trip generation and 104 samples for trip attraction, which is larger than the results of the data adequacy test. The sampling technique used was stratified proportional random sampling, chosen to obtain representative data that can be generalized (Sugiyono, 2021) [7]. The data used consisted of primary data from field questionnaire surveys via Google Forms and secondary data from PT KAI, the Transportation Agency, and BPS. The survey was conducted during rush hour and off-peak hours to obtain more representative data diversity, with a total of 220 respondents analyzed.

2.2. Analysis Technique

The data analysis technique in this quantitative research utilizes a statistical approach. The type of statistics applied is inferential statistics, because the sample was taken from a clearly defined population and the selection was done randomly [8]. The analysis used includes descriptive analysis, multiple linear regression, and factor contribution analysis.

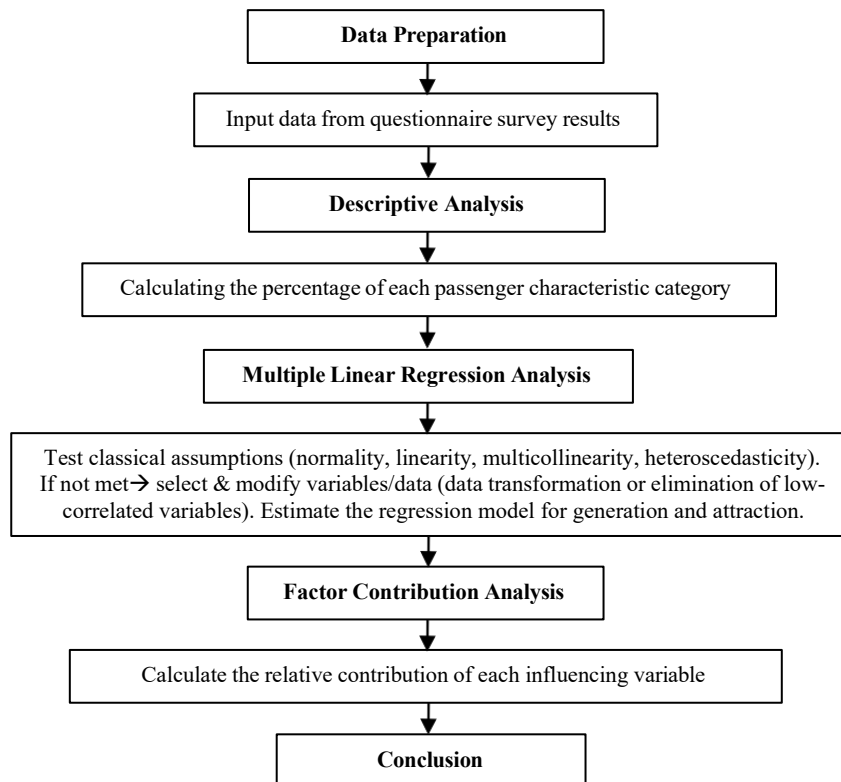


Figure 1. Analysis Technique Flowchart

2.3. Variable

In this research, the dependent variables are the generation and attraction of passenger movements at the Cikoko LRT Station. Meanwhile, the independent variables used in this research are passenger characteristics. These variables represent various socio-economic aspects and passenger travel behavior. In total, this research covers twelve independent variables, which have been selected based on their relevance to travel demand modeling and previous empirical studies in urban transportation research.

Table 3. Dependent and Independent Variables

Symbol	Variable	Description	Data Type	Measurement Scale
Y ₁	Trip Generation	Passenger movement generation starting from various zones towards Cikoko LRT Station	Continuous	Ratio
Y ₂	Trip Attraction	Passenger movement attraction ending at Cikoko LRT Station from various zones.	Continuous	Ratio
X ₁	Age	Age range of respondent	Discrete	Ordinal
X ₂	Gender	Respondent gender identity	Discrete	Nominal
X ₃	Education	Highest level of education attained by respondent	Discrete	Ordinal
X ₄	Job	Type of job held by respondent	Discrete	Nominal
X ₅	Income	Total income earned by respondents each month	Discrete	Ordinal
X ₆	Travel Purpose	Main purpose of respondent travel	Discrete	Nominal
X ₇	Travel Distance	Distance from/to Cikoko Station	Discrete	Ordinal
X ₈	Travel Time	Travel time from/to Cikoko Station	Discrete	Ordinal
X ₉	Transport Cost	Cost incurred from/to Cikoko Station	Discrete	Ordinal
X ₁₀	Travel Frequency	How often is the LRT used during a certain period	Discrete	Ordinal
X ₁₁	Transport Mode	Type of transportation used to/from Cikoko Station	Discrete	Nominal
X ₁₂	Waiting Time	Time spent waiting for the LRT before departure	Discrete	Ordinal

3. RESULTS AND DISCUSSION

3.1. Passenger Characteristic

Based on the survey results, the characteristics of passengers at Cikoko LRT Station show differences in patterns between passengers arriving at the station and those leaving the station. This analysis includes demographic variables and travel behavior to identify dominant user groups.

Table 4. Dominant Respondent for Each Variable

Variable	Dominant Category Arriving at the Station	Percentage (%)	Dominant Category Leaving the Station	Percentage (%)
Age	20 – 30 years old	53%	20 – 30 years old	58%
Gender	Female	63%	Female	57%
Education	Bachelor's degree	40%	High school/equivalent	39%
Job	Private sector employee	32%	Student	44%
Income	< Rp. 2.000.000	34%	< Rp. 2.000.000	44%
Travel Purpose	Work	41%	Work and recreation	26%
Travel Distance	< 10 km	38%	> 30 km	35%
Travel Time	10 – 25 minutes	40%	> 40 minutes	34%
Transport Cost	Rp. 5.0001 – Rp. 10.000	36%	Rp. 5.0001 – Rp. 10.000	32%
Travel Frequency	1 – 5 times	53%	1 – 5 times	50%
Transport Mode	KRL	43%	KRL	49%
Waiting Time	5 – 10 minutes	58%	5 – 10 minutes	52%

Most trips are made for work purposes and take place on weekdays on a regular basis. This finding is in line with research by Susilo et al. (2017), which shows that the main users of urban rail transport are from the productive age group with high mobility [9].

3.2. Passenger Movement Trip Generation and Trip Attraction Model

3.2.1. Classical Assumption Test

Before forming a regression model, a series of classical assumption tests were conducted to ensure that the model was statistically valid, namely:

a. Normality Test

To see whether the data distribution is normal, it was analyzed using SPSS Version 27 software, with the results shown in the following histogram and normal P-plot.

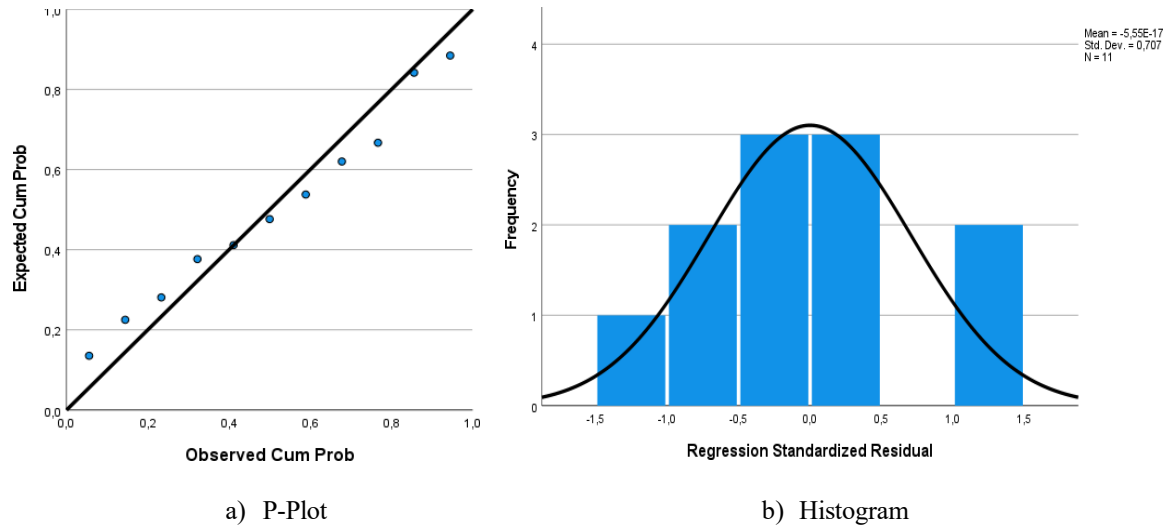


Figure 2. Graph of Trip Generation Normality Test

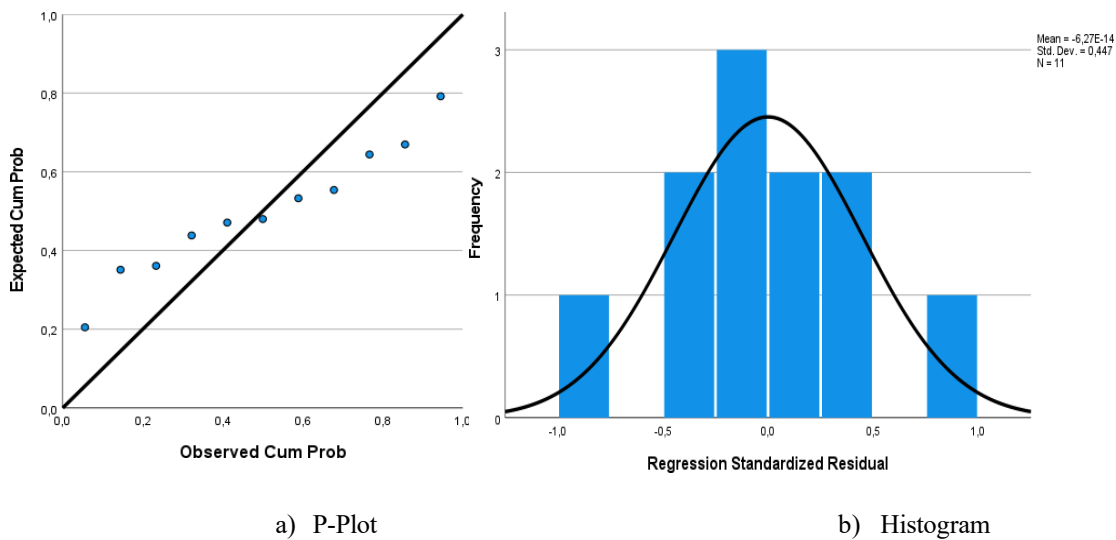


Figure 3. Graph of Trip Attraction Normality Test

Based on the histogram and P–P Plot graph, the residual distribution is close to the diagonal line and does not show any noticeable asymmetry patterns. This indicates that the residual data is normally distributed.

b. Linearity Test

Linearity testing is important to see if there is a linear relationship between the two types of variables.

Table 5. Linearity Test Results

Symbol	Calculated Sig.	Calculated F	Table F
Generation			
$\bar{Y} * X_1$	0,578	0,852	6,26
$\bar{Y} * X_3$	0,220	1,770	5,32
$\bar{Y} * X_6$	0,327	1,091	5,32
$\bar{Y} * X_{10}$	0,971	0,145	6,26
$\bar{Y} * X_{11}$	0,491	0,515	5,12
Attraction			
$\bar{Y} * X_1$	0,732	0,559	6,26
$\bar{Y} * X_3$	0,185	2,107	5,32
$\bar{Y} * X_4$	0,750	0,482	5,19
$\bar{Y} * X_5$	0,051	18,948	19,35
$\bar{Y} * X_6$	0,492	0,520	5,32
$\bar{Y} * X_7$	0,058	16,586	19,35
$\bar{Y} * X_{10}$	0,933	0,246	19,35
$\bar{Y} * X_{11}$	0,556	0,374	5,12

The results of the linearity test between the independent and dependent variables show a significance value of $> 0,05$ for deviation from linearity, so that the relationship between the variables can be stated as linear.

c. Multicollinearity Test

The following are the VIF and Tolerance values for the multicollinearity test.

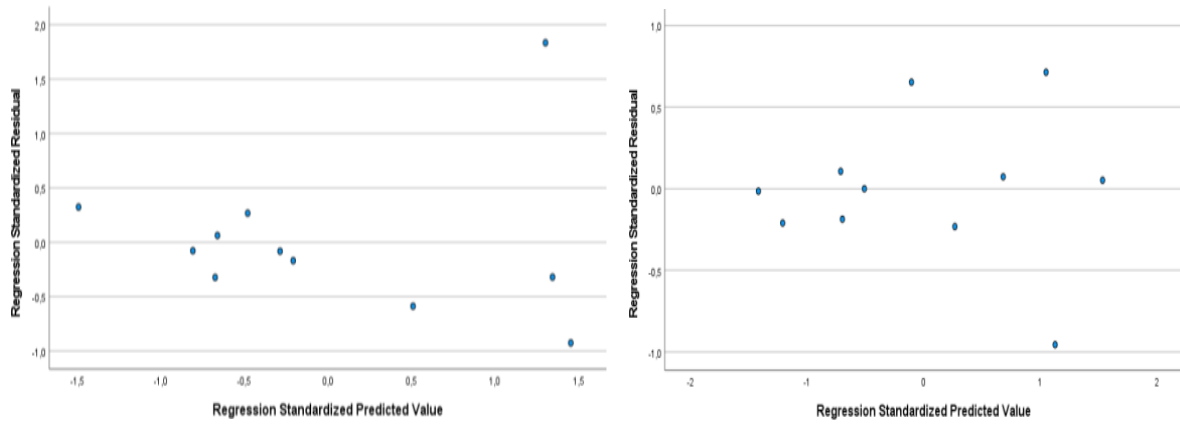
Table 6. Multicollinearity Test Results

Symbol	VIF	Tolerance
Generation		
X_1	1,859	0,538
X_3	3,930	0,254
X_6	6,288	0,159
X_{10}	2,891	0,346
X_{11}	7,834	0,128
Attraction		
$\bar{Y} * X_1$	5,744	0,174
$\bar{Y} * X_3$	8,144	0,123
$\bar{Y} * X_4$	5,128	0,195
$\bar{Y} * X_5$	4,405	0,227
$\bar{Y} * X_6$	8,163	0,122
$\bar{Y} * X_7$	5,037	0,199
$\bar{Y} * X_{10}$	7,818	0,128
$\bar{Y} * X_{11}$	1,974	0,506

The results show that all variables have VIF values < 10 and Tolerance > 0,1, so there is no multicollinearity between the independent variables.

d. Heteroscedasticity Test

To test whether there is variance inequality (variation) in the regression model from one observation to another, the data needs to be analyzed using SPSS software, with the results displayed in the following scatter plot.



a) Trip Generation

b) Trip Attraction

Figure 4. Scatter Plot Heteroscedasticity Test

Based on the residual scatterplot, the points are randomly distributed and do not form a specific pattern. This indicates that there is no heteroscedasticity in the model.

3.2.2. Hypothesis Test

Before forming a regression model, a series of hypothesis tests were conducted to ensure that the model was statistically valid, namely:

a. Coefficient of Determination

To determine the contribution of the independent variable for dependent variable, it is necessary to look at the R² value.

Table 7. Determination Coefficient Value of Trip Generation

Model Summary ^b				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0,944 ^a	0,891	0,782	6,42704606

Table 8. Determination Coefficient Value of Trip Attraction

Model Summary ^b				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0,990 ^a	0,980	0,900	3,91674818

Based on the table, it can be concluded that the influence of the independent variable on the dependent variable is very large, namely 89% for movement generation and 98% for movement attraction.

b. F Test

To determine the simultaneous (combined) effect of variable X on variable Y, an F test is performed.

Table 9. Results of the F-test for Trip Generation

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1688,193	3	537,639	8,174	0,019 ^b
	Residual	206,535	41	5,037		
	Total	1894,727	44			

Table 10. Results of the F-test for Trip Attraction

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1502,045	3	500,681	12,239	0,044 ^b

Residual	30,682	215,341
Total	1532,727	10

Calculated F value > F table value and Sig. value < 0,05. This means that the independent variables simultaneously have a significant effect on movement volume.

c. T Test

To determine whether variable X partially (individually) has a significant effect on variable Y, a T-test analysis is performed.

Table 11. T-Test Result

Symbol	Calculated Sig.	Calculated T	Table T
Generation			
X ₁	0,002	5,923	±2,571
X ₃	0,003	-5,290	±2,571
X ₆	0,002	-5,719	±2,571
X ₁₀	0,006	-4,531	±2,571
X ₁₁	0,002	5,939	±2,571
Attraction			
Y*X ₁	0,017	7,510	±4,303
Y*X ₃	0,014	-8,267	±4,303
Y*X ₄	0,022	6,677	±4,303
Y*X ₅	0,042	4,715	±4,303
Y*X ₆	0,030	-5,633	±4,303
Y*X ₇	0,020	-6,908	±4,303
Y*X ₁₀	0,029	-5,764	±4,303
Y*X ₁₁	0,024	-6,375	±4,303

All independent variables in the model have significance values < 0,05 and t-values > t-table values, so they have a partial effect on the dependent variable.

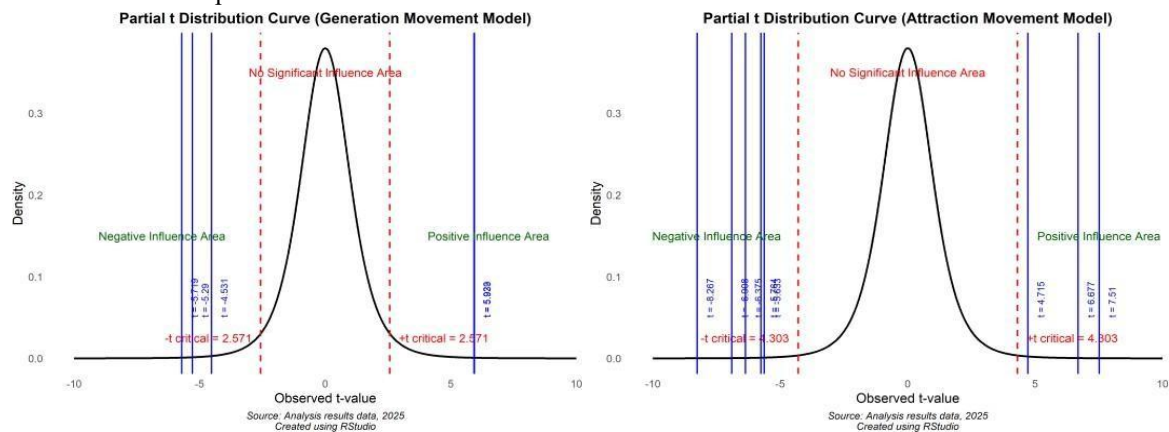


Figure 5. Partial t Distribution Curve

In the context of partial t regression testing, a negative t-value indicates that the independent variable has a negative (inverse) effect on the dependent variable. If the calculated t-value is positive, it means that the variable has a positive effect on the dependent variable (Y), in other words, the larger the value of X, the more likely the value of Y will increase, assuming that other variables remain constant.

3.2.3. Linear Regression Equation Model

The regression equation model obtained from the analysis of passenger movement generation at Cikoko LRT Station is as follows:

$$Y_1 = 4,014 + 6,904 X_1 - 42,499 X_3 - 46,563 X_6 - 9,300 X_{10} + 95,590 X_{11} \dots \dots \dots (5)$$

Keterangan:

- Y_1 = Passenger Movement Trip Generation X_1 = Age (years old)
- X_3 = Education
- X_6 = Trip Purpose
- X_{10} = Trip Frequency (times) X_{11} = Transport Mode

From the equation, it can be interpreted that every increase in passenger age will increase generation by 6,904 movements per day. A decrease in education level will reduce generation by 42,499 movements per day. If the purpose of the trip is not for work, then generation will decrease by 46,563 movements per day. A decrease in the frequency of trips per week will reduce the number of trips by 9,300 per day. The mode of transportation chosen, such as the KRL, can increase the number of trips by 95,590 per day. The constant value of 4,014 represents the minimum average number of trips when all variables are considered neutral.

The regression equation model obtained from the analysis of passenger movement attraction at Cikoko LRT Station is as follows:

$$Y_2 = 923,109 + 27,357 X_1 - 120,250 X_3 + 99,839 X_4 + 16,801 X_5 - 99,156 X_6 - 16,780 X_7 - 21,124 X_{10} - 444,905 X_{11} \dots \dots \dots (6)$$

Keterangan:

- Y_2 = Passenger Movement Trip Attraction
- X_1 = Age (years old)
- X_3 = Education
- X_4 = Job
- X_5 = Income (Rp)
- X_6 = Trip Purpose
- X_7 = Trip Distance (km)
- X_{10} = Trip Frequency (times)
- X_{11} = Transport Mode

From the equation, it can be interpreted that every increase in passenger age has a positive effect on ridership, increasing it by 27,357 movements per day. Lower education level reduces ridership by 120,250 movements per day. Occupation type, especially students, increases ridership by 99,839 movements per day. Higher income increases ridership by 16,801 trips per day. Travel purposes other than work or education decrease ridership by 99,156 trips per day. Longer travel distances decrease ridership by 16,780 trips per day. Lower travel frequency reduces attraction by 21,124 movements per day. Choosing a specific mode of transportation can reduce attraction by 444,905 movements per day. The constant value of 923,109 indicates the average attraction value when the independent variables are in their baseline condition.

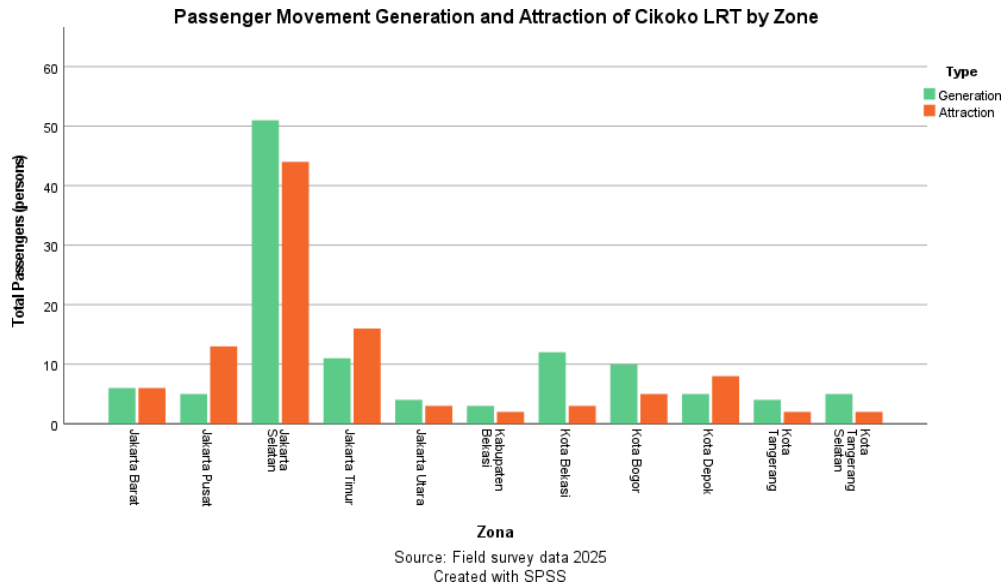


Figure 6. Comparison of Passenger Movement Generation and Attraction Based on Field Results

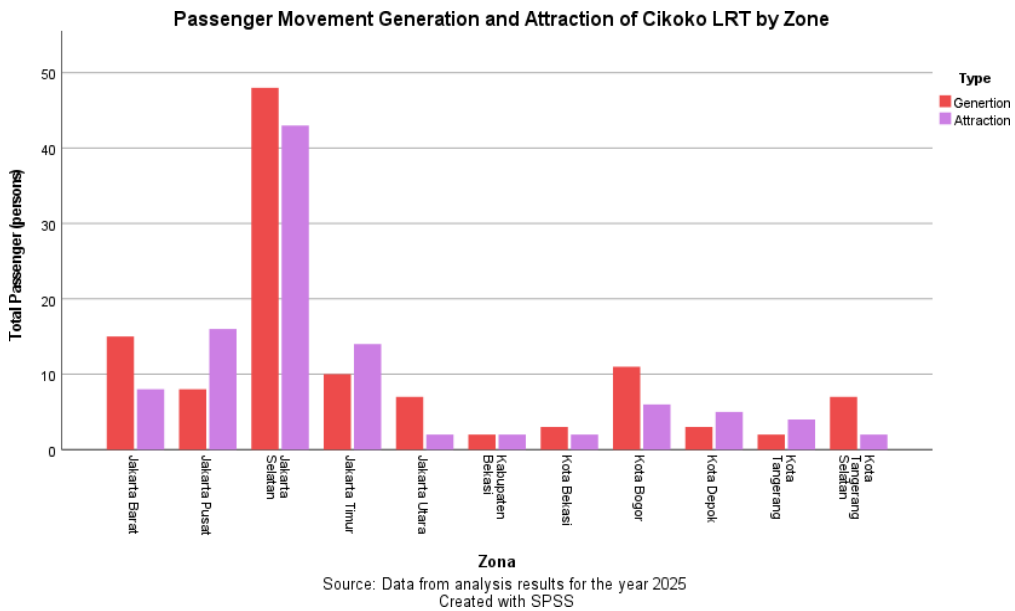


Figure 7. Comparison of Passenger Movement Generation and Attraction Based on Analysis Results

The figure shows the distribution of LRT Cikoko passenger generation and attraction based on field results and analysis for 2025. South Jakarta is recorded as the zone with the highest movement, followed by East Jakarta. Meanwhile, zones such as Bekasi Regency and Tangerang City show lower movement, reflecting the concentration of activity in major urban areas.

3.3. Factors Influencing Passenger Trip Generation and Trip Attraction

Contribution analysis is obtained from the mean value of each significant variable. These mean values are crucial for determining the actual magnitude of each factor's influence. These values will be multiplied by their respective regression coefficients to determine the absolute impact of each factor. The following table shows the calculation of the contribution of factors influencing trip generation using the contribution formula described above.

Table 12. Contribution of Variable Factors to Trip Generation

Category of Factor Variables	Coefficient	Average	Absolute Contribution	centage (%)
Age	6,904	29	199,312	28%
Education	-42,499	4	169,641	23%
Trip Purpose	-46,563	3	119,758	17%
Trip Frequency	-9,300	7	69,313	10%
Transport Mode	95,590	2	165,932	23%
Total			723,954	100%

The most significant factor influencing generation is age (28%), followed by highest level of education and mode of transportation (each 23%). Travel purpose and travel frequency contribute less, at 17% and 10% respectively. These factors fall under socio-economic characteristics and transportation systems. For further details, see the following visualization graph.

The Most Significant Factors Affecting Trip Generation

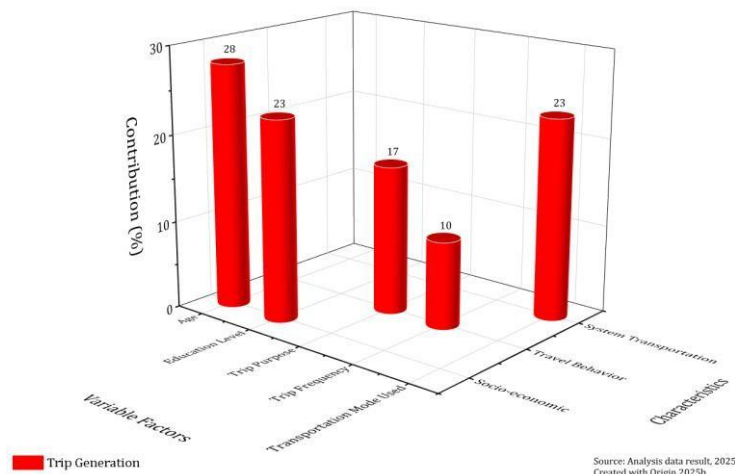


Figure 8. Graph of Analysis Results of Factors Contributing to Trip Generation

The following table shows the calculation of the contribution of factors influencing travel demand using the contribution formula described above.

Table 13. Contribution of Variable Factors to Trip Attraction

Category of Factor Variables	Coefficient	Average	Absolute Contribution	Percentage (%)
Age	27,357	28	756,488	23%
Education	-120,250	4	480,707	14%
Job	99,835	4	417,404	12%
Income	16,801	3	42,922	1%
Trip Purpose	-99,156	3	314,688	9%
Trip Distance	-16,780	24	407,608	12%
Trip Frequency	-21,124	9	184,460	6%
Transport Mode	-444,905	2	743,006	22%
Total			3347,283	100%

The most significant factors influencing travel demand are age (23%) and mode of transportation (22%). Moderate contributions are provided by education (14%), occupation and travel distance (12% each), travel purpose (9%), and travel frequency (6%), while income contributes very little (1%). These factors are included in socio-economic characteristics, travel behavior, and transportation systems. For further details, see the following visualization graph.

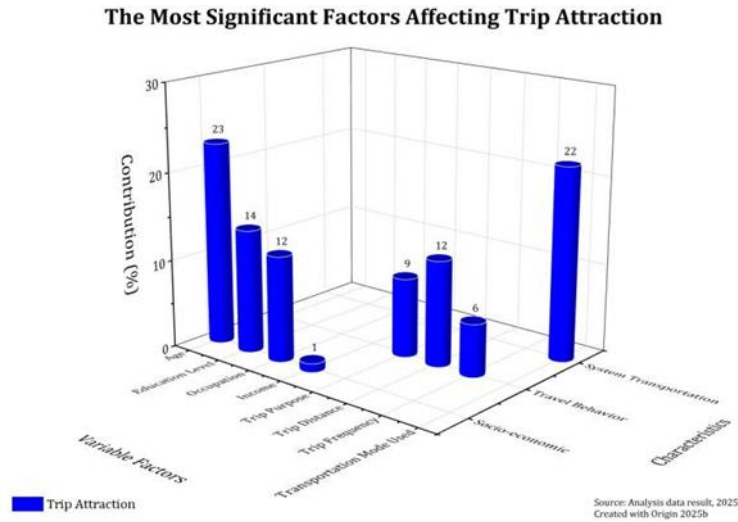


Figure 9. Graph of Analysis Results of Factors Contributing to Trip Attraction

4. CONCLUSION

An analysis of passenger characteristics at Cikoko LRT Station shows that users are predominantly in the productive age group of 20–30 years old, with the majority being female, and with a bachelor's degree for passengers arriving at the station and a high school diploma or equivalent for passengers leaving the station. Most work as private-sector employees or students, earn less than Rp2,000,000, travel for work or recreation, use the KRL commuter train as a connecting mode, travel 1–5 times per week, and have an LRT waiting time of 5–10 minutes.

Multiple linear regression modeling produced the movement generation model $Y_1 = 4.014 + 6.904X_1 - 42.499X_3 - 46.563X_6 - 9.300X_{10} + 95.590X_{11}$ with five significant variables (age, highest level of education, travel purpose, travel frequency, and mode of transportation). The movement attraction model obtained is $Y_2 = 923.109 + 27.357X_1 - 120.250X_3 + 99.839X_4 + 16.801X_5 - 99.156X_6 - 16.780X_7 - 21.124X_{10} - 444.905X_{11}$ with eight significant variables (age, highest level of education, occupation, income, travel purpose, travel distance, travel frequency, and mode of transportation). Both models are statistically valid with R^2 of 0.891 and 0.980, respectively. The use of multiple linear regression in this study is consistent with other transportation research that has successfully applied the same approach for modeling trip generation and attraction [10].

The dominant factors influencing movement generation are age (28%), highest level of education (23%), and mode of transportation (23%), while the dominant factors influencing movement attraction are age (23%) and mode of transportation (22%). These results confirm that the combination of socio-economic variables, travel purpose, and mode of transportation can be effectively used to predict passenger movement volume, and serve as the basis for public transportation planning and Transit Oriented Development (TOD)-based area development around Cikoko LRT Station.

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