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Modeling Trip Generation for an Educational Area: Insights from Bandung Street, Malang

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ABSTRACT
The rapid growth of urban activity in Malang City has increased student mobility, especially in educational corridors such as Bandung Street, where MIN 1, MTsN 1, and MAN 2 are located. Daily student travel during morning departure and afternoon return contributes significantly to traffic flow, positioning schools as generators and attractors of trips. The high concentration of private vehicles and public transportation in this corridor often leads to traffic congestion and reduced road performance, underscoring the importance of a systematic analysis of student travel behaviour. This study focuses on modelling trip generation and attraction in the educational zone of Bandung Street, Malang City. Data were collected through student surveys as primary sources and institutional records as secondary sources. The research employed multiple linear regression to examine the influence of travel characteristics, school traffic conditions, and after-school activities on student travel patterns. The analytical process was supported by quantitative methods to develop a trip generation model applicable to educational areas in urban settings.

Keywords: *Trip Generation; Educational Corridor; Student Mobility; Multiple Linear Regression; Urban Traffic.*

1. Introduction

Malang City is known as one of the educational centers in East Java, with a high concentration of schools, including major academic institutions, in areas such as Bandung Street. These institutions play an essential role in expanding access to education and improving the quality of human resources in the surrounding community [1].

The increasing number of students in Malang City has driven higher travel demand, primarily during school hours, resulting in traffic congestion on major roads around educational areas, such as Bandung Street. The road saturation level in these zones has reached approximately 0.43, indicating moderate congestion due to student commuting activities [2]. This condition is further intensified by population growth near educational institutions and the rise in private vehicle ownership among students and residents [3][4].

Trip generation refers to the number of trips that originate from a particular area, while trip attraction refers to the number of trips that end in that area. These two components are the initial stage of transportation planning and are essential for understanding travel patterns in urban areas, especially around educational zones [5][6]. In the context of schools and universities, student commuting activities significantly contribute to both trip generation and trip attraction, as academic institutions become dominant origins and destinations of daily movement [7][8].

Land use and transportation are closely connected, where improved accessibility, road networks, and transportation services influence mobility patterns and the use of urban space. Educational areas tend to attract housing, commercial activities, and supporting services, thereby increasing traffic density and parking demand in surrounding neighbourhoods [9][10]. A well-planned transportation system is necessary to accommodate student mobility, reduce congestion, and ensure a balance between land use and transportation development [11][12].

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2. Material and Method

Transportation refers to the activity of transferring people, goods, or services from one location to another, based on the assumption that the destination offers greater utility or perceived benefit compared to the origin. In essence, transportation plays a vital role in improving accessibility, supporting economic development, and connecting spatial areas at both urban and regional scales [13][14].

In transportation planning, one key component is the analysis of trip generation and trip attraction. These elements are crucial because they form the basis for understanding and modelling travel behaviour within a given area. Trip generation refers to the number of trips that originate in a given zone, whereas trip attraction represents the number of trips that are drawn to or end in that zone [15][16].

This study examines how the factors of children's travel behavior (X1), school-time traffic (X2), and after-school recreational activities (X3) influence the frequency of student trips (Y). We employ the overall F-test in multiple regression to determine whether X1, X2, and X3 together have a statistically significant impact on the number of trips; a p-value below 0.05 indicates that the predictors collectively matter. Furthermore, we conduct individual t-tests for each predictor to evaluate their independent significance. Each factor is considered significant if its p-value is less than 0.05. To assess the model's explanatory power, we review the adjusted R^2, which indicates how well the model predicts trip count while accounting for the number of predictors and penalising unnecessary variables [17][18].

2.1. Population and Sample

The students in this study are all active kids from three schools on Bandung Street, Malang City. The schools are MIN 1, MTsN 1, and MAN 2. The total number of students from these three schools is 4,605

- MIN 1 Kota Malang (1,680 students)
- MTsN 1 Kota Malang (1,575 students)
- MAN 2 Kota Malang (1,350 students)

Total population (N) = 4,605 students.

A sample is a small group that is like the larger group. We look at this small group in the study. We pick students using a fair way called proportional random sampling. This group means we choose students from each school in roughly equal numbers. We used a math rule called the Slovin formula to find the correct number:

$$n = \frac{N}{1 + Ne^2}$$

$$n = \frac{4605}{1 + 4605(0,05)^2} = \frac{4605}{1 + 11.5125} = \frac{4605}{12.5125} = 368$$

Where:

n = sample size
N = total population
e = margin of error (5% in this study)

2.2. Research Variable

Rules help us focus on what we study and stop making mistakes. This study has two types of things:

- Dependent Variable
  The dependent variable is the one that changes in response to other things. We call it Y. Here, Y is Trip Generation.
- Independent Variables
  These are things that make Y change. We call them X. Here, there is one Y and three Xs: Travel Ways (X1), Traffic near School (X2), and After-School Fun (X3).

2.3. Hypothesis Testing

1. Simultaneous Test (F-Test)

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The F-test checks if all the X things together change Y a lot. If the test statistic is less than 0.05, it indicates that Travel Ways, School Traffic, and After-School Fun all affect Trip Generation simultaneously. But if the test statistic is greater than 0.05, it means these things do not change together. Then, we use a smaller test called t-test to check one by one.

2. The t-test
   We use a test to see how each X thing changes Y on its own. If the test number (sig.) is less than 0.05, it means the X thing changes Y a lot. But if the test number is more than 0.05, it means the X thing does not alter Y much. Then, we say yes or no to the idea about each X and Y.
3. Coefficient of Determination (R^2)
   R^2 tells us how well the model explains changes in Y. This study uses Adjusted R^2 because there are more than two X variables. Adjusted R^2 can go up or down if we add more X things to the model. A higher Adjusted R^2 indicates that Travel Ways, School Traffic, and After-School Fun explain more of the changes in Trip Generation. A smaller Adjusted R^2 indicates that these factors explain less of the variation in Trip Generation.

3. Result and Discussion

A. Validity testing

Validity testing is conducted to ensure that each questionnaire item accurately measures the intended variable, and in this study, the validity was tested using SPSS, as shown in Table [19].

Table 1. Validity Test Results

Variable	Indicator	r value	r table	Explanation
Travel Characteristics (X1)	X1.1	0.949	0.1023	Valid
	X1.2	0.877	0.1023	Valid
	X1.3	0.873	0.1023	Valid
	X1.4	0.846	0.1023	Valid
School Area Traffic Conditions (X2)	X2.1	0.952	0.1023	Valid
	X2.2	0.857	0.1023	Valid
	X2.3	0.870	0.1023	Valid
	X2.4	0.851	0.1023	Valid
After School Activities (X3)	X3.1	0.953	0.1023	Valid
	X3.2	0.873	0.1023	Valid
	X3.3	0.869	0.1023	Valid
	X3.4	0.854	0.1023	Valid
Trip Generation (Y)	Y.1	0.820	0.1023	Valid
	Y.2	0.734	0.1023	Valid
	Y.3	0.702	0.1023	Valid

Table 1 shows that all questions used to measure things in this study have a number greater than the critical r-value. With 368 students and four measures, the r-table value is 0.1023. The table means all the questions are good and work well for the study.

B. Reliability Testing

Reliability refers to a test's consistency in producing the same results when administered repeatedly. In this study, internal consistency was assessed using Cronbach's Alpha (α), and an α value of 0.60 or higher is generally considered acceptable for exploratory research [19]. The results are in Table 2 below.

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Table 2. Reliability Test Results

Variable	Cronbach's Alpha	Explanation
Travel Characteristics (X1)	0.907	Reliable
School Area Traffic Conditions (X2)	0.902	Reliable
After School Activities (X3)	0.907	Reliable
Trip Generation (Y)	0.618	Reliable

Table 2 shows that all variables, Travel Ways (X1), School Traffic (X2), After-School Fun (X3), and Trips (Y) have Alpha numbers bigger than 0.6. The value means all four are good. So, the questions for each are clear and can be used here.

C. Multiple linear regression

Multiple linear regression shows how each X variable changes Y, holding the others constant. Here, X things are Travel Ways (X1), School Traffic (X2), and After-School Fun (X3). The Y thing is Trip Generation. Results are in Table 3 below.

Table 3. Results of Multiple Linear Regression Analysis

Variable	Unstandardized Coefficients (B)	Std. Error	Standardized Coefficients (Beta)	t count	Sig.
(Constant)	0,079	0,318	–	0,249	0,803
Travel Characteristics (X1)	0,271	0,012	0,694	21,826	0
School Area Traffic Conditions (X2)	0,141	0,012	0,36	11,377	0
After School Activities (X3)	0,122	0,013	0,31	9,735	0

The number 0.079 means that if X1, X2, and X3 are all zero, then the student trips will be 0.079. But the number 0.803 says this number is not essential. So, we look only at X1, X2, and X3 to understand the trip counts in this model. X1 is about how students travel. It has a value of 0.271 and a significant level of 0.000. This means it helps explain trips a lot. The t-value 21.826 shows it is extreme. When students have better travel options, they make more trips. X2 talks about traffic. It has a number 0.141 and a critical level 0.000. This means good traffic helps students move more. X3 is about after-school fun. It has a number 0.122 and a level 0.000. This means more activities make more trips for students.

From Table 4.12, we see that X1, X2, and X3 all help increase student trips (Y). Of these, X1 (travel characteristics) is the strongest because it has the biggest number, 0.694.

D. Hypothesis Testing

- The coefficient of determination

The coefficient of determination shows how well the X things explain Y. The X things are Travel Ways (X1), School Traffic (X2), and After-School Fun (X3). The Y thing is Trip Generation. Table 4 below shows the result.

Table 4. Coefficient of determination test (R Square)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0,798	0,636	0,633	1,01105

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From Table 4, the R-square value of 0.636 indicates that Travel, Traffic, and Activities explain 63.6% of student trips. The other 36.4% comes from things not in the model, like money, where students live, and buses and trains that help them get around.

The Adjusted R Square of 0.633 indicates that the model performs well despite several independent variables. This value indicates that the model's variables continue to explain a large portion of the variation in the number of trips. In other words, the independent variables significantly clarify how and why trips occur. Therefore, the model can be considered reliable and effective in describing the relationship between the influencing variables and the trip generation that takes place.

- The F-test

The F-test checks if all the X things together change the trips. Here, the X things are Travel (X1), Traffic (X2), and Activities (X3). The Y thing is Trips and Attractions. Table 5 below shows the F-test results.

Table 5. The results of the F-test

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	651,387	3	217,129	212,407	0
Residual	372,092	364	1,022		
Total	1023,478	367			

From Table 4.14, the F-value of 212.407 and the p-value of 0.000 indicate that the three variables together have a significant effect on student trips and attraction.

So, the null-hypothesis idea (H_0) that X1, X2, and X3 do not affect Y is wrong. The yes-effect idea (H_1) is right. This means the model is good and can explain how the variables and Y are connected.

- The t-test

The t-test checks how each X thing changes the trips. The X things are Travel (X1), Traffic (X2), and Activities (X3). The trips (Y) results are in Table 6 below.

Table 6. The t-test

Variable	B	Std. Error	Beta	t count	Sig.	Explanation
(Constant)	0,079	0,318	–	0,249	0,803	Not Significant
Travel Characteristics (X1)	0,271	0,012	0,694	21,826	0	Significant
School Area Traffic Conditions (X2)	0,141	0,012	0,36	11,377	0	Significant
After School Activities (X3)	0,122	0,013	0,31	9,735	0	Significant

Variable X1 (Travel) has a small p-value of 0.000 and a large t-value of 21.826. This means X1 helps trips a lot and is very important. X1 has the most considerable effect, with a beta of 0.694. Variable X2 (Traffic) also has a p-value of 0.000 and a t-value of 11.377, so it helps trips, too. Variable X3 (Activities) has a p-value of 0.000 and a t-value of 9.735, indicating that it also allows trips. The constant 0.079 (0.803) is not essential, so we don’t count it.

In conclusion, X1, X2, and X3 all contribute to making trips (Y). This shows the research idea is right.

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4. Conclusion

A total of 368 students from three educational institutions in Malang City participated in this study. These students generally make two trips per day: one to school in the morning and one home in the afternoon. Most of them travel long distances and often use multiple modes of transportation, indicating varied and dynamic travel behaviour. The analysis shows that Travel Characteristics (X1), School Traffic Conditions (X2), and After-School Activities (X3) all influence Trip Generation (Y). Among these variables, Travel Characteristics (X1) contribute most significantly, with a coefficient of 0.694, indicating that the way students travel has the most significant impact on the number of trips generated.

The resulting trip generation model is expressed by the Equation $Y = 0.079 + 0.271X1 + 0.141X2 + 0.122X3$, with an R^2 value of 0.636. This means that those three variables can explain 63.6% of the variation in trip generation. These findings indicate that student travel patterns, traffic conditions around schools, and after-school activities collectively contribute to increased traffic volume along Bandung Street in Malang City. Consequently, the area experiences higher traffic intensity during peak school hours, reinforcing the importance of effective traffic management and planning in educational zones.

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