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Analysis of Trip Generation Modeling in The Higher Education Area: A Case Study of UNISSULA, Semarang City

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Abstract. Semarang City, the capital of Central Java Province, has various activities, one of which is higher education. The location of higher education activities on main roads can increase road service (LOS). This study aims to model the number of trips to UNISSULA and alternative routes in the event of a flood. This study uses quantitative methods with multiple linear regression analysis. One dependent variable and eight independent variables will be modeled using SPSS 26—the number of respondents representing the movement of 398 people. Based on the analysis results, the LOS level of UNISSULA Road on weekdays is 0.22 for attraction and 0.21 for generation. Then, on weekends, the LOS level of UNISSULA Road is 0.16 for attraction and 0.16 for generation. In the Jalan Raya Kaligawe section, the LOS value is 0.50 on weekdays and 0.55 on weekends. The resulting regression model is Y weekday pull = 752.624 + 3.138X1 + 7.418X2, Y weekday generation = 3728.412-4.635X1-8.075X2, Y weekend pull = 270.00 + 3.117X1 + 5.979X2, and Y weekend generation = 2493.733-2.841X1-4.938X2. The resulting model can be used by urban planners and policymakers to optimize traffic management and reduce congestion in the UNISSULA area. The traffic management strategies that can be applied to the resulting model include optimizing public transport use, encouraging shared vehicles, developing pedestrian and bicycle infrastructure, travel time management, and increasing the capacity of alternative roads.

Keywords: Trip Generation, Higher Education Area, Trip Modeling

INTRODUCTION

As the population continues to grow, the types of human activities are increasing rapidly [1]. One of them is education [2]. Semarang City, the capital of Central Java Province, has various types of educational activities ranging from basic to higher education. The number and completeness of higher education in Semarang City compared to other cities in Central Java make Semarang City a destination for continuing to the next level of education [3].

One of the universities in Semarang City is UNISSULA. UNISSULA, as one of the Islamic universities in Semarang City, offers a variety of completeness in the number of study programs, faculties, lecturers, infrastructure, and supporting facilities. This has become a unique attraction for UNISSULA, so 20,794 students are part of UNISSULA. In line with this, the number of students is also the reason for the high number of trips to UNISSULA. The location of UNISSULA in the Terboyo Industrial Area causes loading on the road that is passed, namely Jalan Raya Kaligawe. Employees and students make the same trip through Raya Kaligawe Street in the morning and evening. This can reduce the value of the road level of service (LOS), which can cause delays and congestion. The high volume of trips to and from UNISSULA, especially during peak hours, has led to traffic congestion and reduced road performance. However, there is a lack of specific trip generation models for higher education areas in Semarang, particularly for UNISSULA.

Therefore, this research aims to develop a trip-generation model for UNISSULA travelers. The resulting model can later be used to forecast the number of trips to and from UNISSULA so that traffic movement arrangements can be optimized and the potential for delays to congestion can be reduced [4]. The resulting model can be used for future traffic management planning.

METHODOLOGY

This research uses quantitative methods with multiple linear regression analysis techniques with 398 respondents. The multiple linear regression analysis will correlate the variables X1 domicile distance and X2 number of trips with Y number of trips to produce a regression model [5]. The resulting regression model can be used to forecast the number of trips in the future. For the research population and sample, 398 respondents were students, lecturers, and active employees at UNISSULA. Respondent data collection uses the type of work because they are travelers to and from UNISSULA and use a method of stratified sampling. The data used in this study are respondent data, average daily traffic data, and land use data for the length of observation, namely on Tuesdays and Fridays. This is because Tuesday is the day with the highest number of movements. At the same time, Friday is the day with the least number of movements. Then, in this study, the variables and indicators used are trip volume and residential distance [6]. The dependent variable in this study is trip volume, while the independent variables include distance of residence (distance) and number of trips in a day (number of trips) [7].

TABLE 1 Variable and Indicator Research

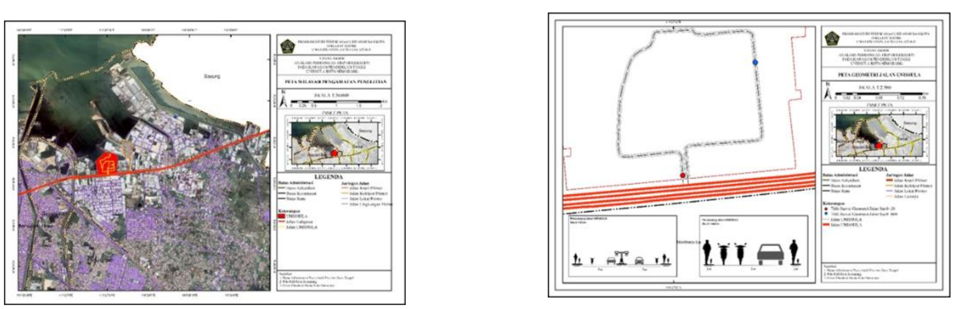
Variable	Definition	Indicator
Y (Trip Volume)	Number of trips to/from UNISSULA	Vehicle volume per hour
X1 (Distance)	Distance from residence to UNISSULA	Kilometers (Km)
X2 (Number of Trips)	Number of trips per day	Number of trips (1, 2, >2)

Then, after the analysis using this method, a development model is produced. The following is an example of a movement attraction and generation model equation:

$$\mathbf{Y = A + X1B1 + X2B2}$$

RESULT AND DISCUSSION

The research location is UNISSULA Semarang City. The following is a map of the UNISSULA's location in the surrounding area.



(a) (b)

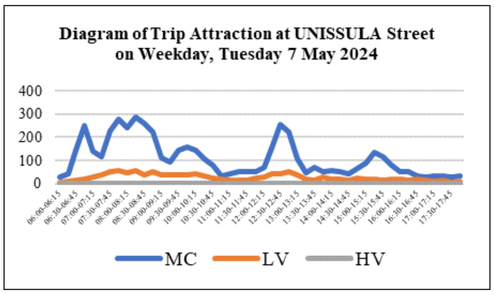
FIGURE 1 Research location map
(a) Orientation Map Of The Research Location To The Wider Region
(b) Traffic Observation Map

In this study, the number of vehicles used is the number of vehicles on weekdays and weekends. Weekday data comes from observations on Tuesdays and weekend data comes from observations on Fridays. The following is the observation data for the number of vehicles on weekdays and weekends.

TABLE 2 The volume of Trip Attraction and Trip Distribution Vehicles on Weekday

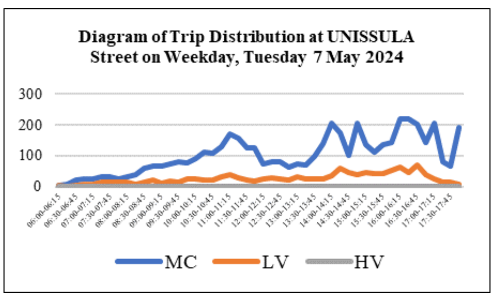
Time	Volume of Trip Attraction Vehicle on Weekday	The volume of Trip Distribution Vehicle on Weekday
Morning (06:00 – 10:00)	3.302	853
Noon (10:00 – 14:00)	1.972	2.106
Evening (14:00 – 18:00)	1.182	3.172

Based on the data volume of vehicles, it is known that the highest number of vehicles for trip attraction is 3.302 in the morning. Then the highest number of vehicles for trip generation is 3.172 in the afternoon. The following is a graphic image of movement conditions during weekday peak hours.



(a)

(b)



(c)

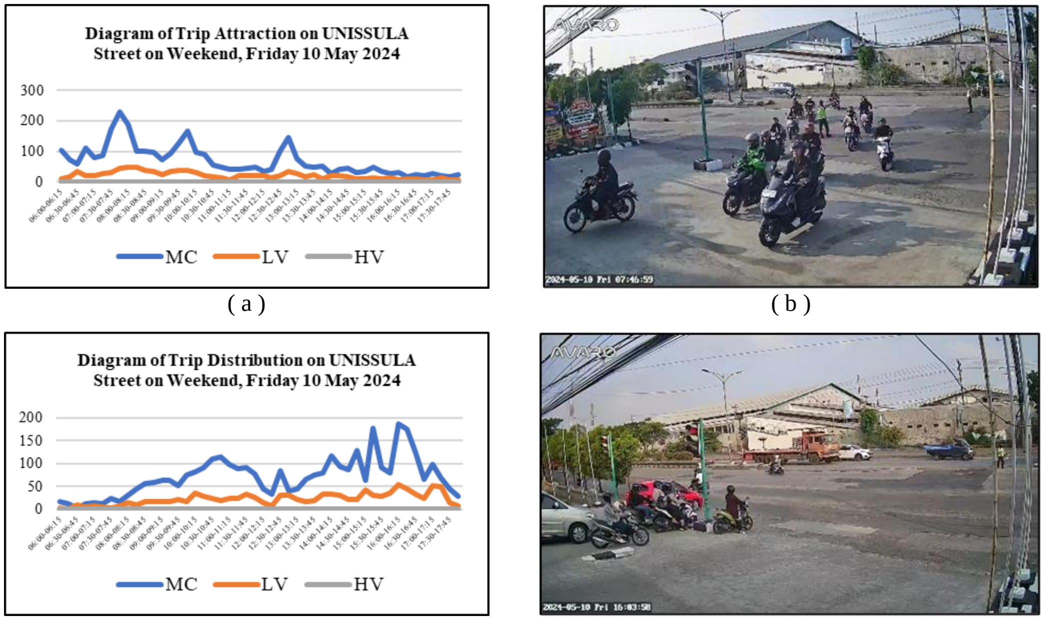
(d)

FIGURE 2 Diagram and Movement Conditional on Weekday
(a) Diagram of Trip Attraction on Weekday
(b) Movement Condition of Trip Attraction on Weekday
(c) Diagram of Trip Distribution on Weekday
(d) Movement Condition of Trip Distribution on Weekday

TABLE 3 The volume of Trip Attraction and Trip Distribution Vehicles on Weekend

Time	The volume of Trip Attraction Vehicle on Weekend	The volume of Trip Distribution Vehicle on Weekend
Morning (06:00 – 10:00)	2.373	735
Noon (10:00 – 14:00)	1.395	1.500
Evening (14:00 – 18:00)	659	2.153

Based on the data on the number of vehicles, it is known that the highest number of vehicles for trip attraction is 2.373 vehicles in the morning. Then the highest number of vehicles for trip generation is 2.153 vehicles in the afternoon. The following is a graphic image of movement conditions during peak weekend hours.



(c) (d)

FIGURE 3 Diagram and Movement Conditional on Weekend
(a) Diagram of Trip Attraction on Weekend
(b) Movement Condition of Trip Attraction on Weekend
(c) Diagram of Trip Distribution on Weekend
(d) Movement Condition of Trip Distribution on Weekend

TABLE 4 Total Number of Respondents Based on Distance of Residence

Distance of Residence	Total Number of Respondents
≤ 1,00 Km	83
1,01 - 10,00 Km	242
> 10,00 Km	73

Based on the data collection results using the questionnaire method, the highest number of respondents was obtained at a distance of 1.01-10.00 Km, totaling 242 people. Then, the lowest number of respondents was respondents who lived at a distance of> 10.00 Km, totaling 73 people.

TABLE 5 Total Number of Respondents Based on Number of Trips in One Day

Number of Trips In One Day	Total Number of Respondents
1 Trip	309
2 Trips	62
> 2 Trips	27

Then, related to the variable number of trips in a day, based on questionnaire data, the highest number of trips was obtained, namely respondents who traveled 1 time in a day, totaling 309 people. Then, for the lowest number, namely respondents who traveled> 2 times daily, 27 people.

After the required data is complete, then the data is analyzed using multiple regression analysis with the help of SPSS 26. The following are the results of multiple regression analysis for weekday attraction, weekday generation, weekend attraction, and weekend generation.

TABLE 6 Results of Multiple Linear Regression Analysis of Weekday Trip Attraction

Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	752.62	0.000		0.000	0.000		
X1 Distance	3.138	0.000	0.279	0.000	0.000	0.874	1.144
X2 Trips	7.418	0.000	1.064	0.000	0.000	0.874	1.144

a. Dependent Variable: Y Volume of Vehicle

Based on the analysis results on weekday trip attraction, the significance values of the two variables are all worth 0.000, which means they are appropriate. Then, for the VIF value, it is known that the two variables have a value of 1.144, which is in the range of DL and DU values, which means there is no autocorrelation. For the analysis results, the constant value is 752.62, the influence value of X1 Distance is 3.138, and the influence value of X2 Trips is 7.418. These results obtained a regression model in the form of Y = 752.62 + 3.138X1 + 7.418X2. From this model, the most influential variable is X2 Trips with a value of 7,418.

TABLE 7 Results of Multiple Linear Regression Analysis of Weekday Trip Distribution

Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	3728.41	0.000		0.000	0.000		
X1 Distance	-4.635	0.000	-.380	0.000	0.000	0.874	1.144
X2 Trips	-8.075	0.000	-1.069	0.000	0.000	0.874	1.144

a. Dependent Variable: Y Volume of Vehicle

Based on the analysis results on weekday trip distribution, the significance values of the two variables are all worth 0.000, which means they are appropriate. Then, for the VIF value, it is known that the two variables have a value of 1.144, which is in the range of DL and DU values, which means there is no autocorrelation. For the analysis results, the constant value is 3.728,41, the influence value of X1 Distance is -4,635, and the influence value of X2 Trips is -8,075. These results obtained a regression model in the form of Y = 3.724,41 – 4,635X1 – 8,075X2. From this model, the most influential variable is X2 Trips with a value of -8,075.

TABLE 8 Results of Multiple Linear Regression Analysis of Weekend Trip Attraction

Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Bet			Tolerance	VIF
(Constant)	270.04	0.000		0.000	0.000		
X1 Distance	3.110	0.000	.345	0.000	0.000	0.874	1.144
X2 Trips	5.979	0.000	1.069	0.000	0.000	0.874	1.144

a. Dependent Variable: Y Volume of Vehicle

Based on the analysis of weekend trip attractions, the significance values of the two variables are all worth 0.000, which means they are appropriate. Then, for the VIF value, it is known that the two variables have a value of 1.144, which is in the range of DL and DU values, which means there is no autocorrelation. For the analysis results, the constant value is 270,04, the influence value of X1 Distance is 3,110, and the influence value of X2 Trips is 5,979. These results obtained a regression model in the form of Y = 270,04 + 3,110X1 + 5,979X2. From this model, the most influential variable is X2 Trips with a value of 5,979.

TABLE 9 Results of Multiple Linear Regression Analysis of Weekend Trip Distribution

Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Bet			Tolerance	VIF
(Constant)	2.493,73	0.000		0.000	0.000		
X1 Distance	-2,841	0.000	-.381	0.000	0.000	0.874	1.144
X2 Trips	-4,938	0.000	-1.069	0.000	0.000	0.874	1.144
a. Dependent Variable: Y Volume of Vehicle							

Based on the analysis results on weekend trip distribution, the significance values of the two variables are all worth 0.000, which means they are appropriate. Then, for the VIF value, it is known that the two variables have a value of 1.144, which is in the range of DL and DU values, which means there is no autocorrelation. For the analysis results, the constant value is 2.493,77, the influence value of X1 Distance is -2,841, and the influence value of X2 Trips is -4,938. These results obtained a regression model in the form of Y = 2.493,73 – 2,841X1 – 4,938X2. From this model, the most influential variable is X2 Trips with a value of -4,938.

CONCLUSION

Based on the results of the research conducted, a travel forecast model was obtained, namely Y = 752,624 + 3,138X1 + 7,418X2 for weekday travel attraction, Y = 3728,412 - 4,635X1 - 8,075X2 for weekday travel generation, Y = 270,00 + 3,117X1 + 5,979X2 for weekend travel attraction, and Y = 2493,733 - 2,841X1 - 4,938X2 for weekend travel generation. The model can project the number of trips to and from UNISSULA. To reduce the number of trips that can impact road performance, it is recommended to streamline the variables that affect the number of trips. In this case, the number of daily trips and domicile distance. So that it can reduce the number of trips and improve the efficiency of road performance; in addition to the results, it is recommended to implement traffic management strategies such as optimizing public transportation routes and encouraging carpooling among students and staff. The traffic management strategies that can be applied to the resulting model include maximizing the use of public transport, promoting the use of shared vehicles, developing pedestrian and bicycle infrastructure, travel time management, and increasing the capacity of alternative roads.

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