AIR POLLUTION PREDICTION MODELS DUE TO TRAFFIC VOLUME AND GREEN OPEN SPACE AVAILABILITY

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ABSTRACT

As the population grows, the development of the city increases, as a result the movement of transportation also increases. The development of the city can also affect a decrease in green open space. Increased vehicle traffic affects the increase in air pollution. Hence, there is very little research that mathematically connects the influence of traffic volume (passenger car units) and green open space with the level of air pollution. Green open space and the level of air pollution are directly measured on the field. Subsequently, the measurement is calculated by using the regression analysis to obtain a model of the relationship between green open space and traffic volume with the level of air pollution. The research was directly conducted at 3 locations, 2 locations in Jakarta (Semanggi and Tanah Kusir) and 1 location in South Tangerang. This model can be applied to predict that air pollution will occur as a result of traffic volume and the availability of green open space.

Keyword: Air pollution, prediction, green open space, traffic volume.

INTRODUCTION

Increased population in various cities will escalate traffic among locations in a city and among cities in a country. Increased traffic followed by an increase in reducing air quality (increasing air pollution) due to motor vehicle pollution. The growth of population will decrease the availability of green open space which entails to the increase of air quality pollution.

DKI Jakarta ranks second as the worst air polluted city in the world which is classified as unhealthy city. The city has merely had 9.98% of green open space than it should have been 30% (Nugradi D.N.A., 2009), compare to its neighboring city, South Tangerang which has 20% of green open space (Prakoso P.; Herdiyansyah H, 2019). There is a connection among air quality, vehicle traffic volume, and green open space. Various studies have been carried out, among others: the effect of volume and speed of vehicles on noise (Sufanir A.M.S., 2017; Setiawan A., 2014; Maulana A.Z., 2012; Nugradi D.N.A., 2009; Syaiful & Ngadimo., 2014). However, it is hardly found studies alike which connect traffic volume (passenger car units) and green open spaces with air quality (air pollution)

Research Objectives

This research aims to find the mathematical relationship of the influence of traffic volume (passenger car units) and green open spaces simultaneously on air pollution.

Research Innovation

The novelty of this study is the breakthrough of a mathematical relationship on the influence of traffic volume (passenger car units) that

reflects the traffic and green open space towards air pollution

LITERATURE REVIEW

Sufanir A.M.S. (2017) has developed a model of the influence of vehicle volumes broken down into heavy, light vehicles, motorcycles, and their speed to noise. Setiawan A. (2014) has also examined the effect of speed and number of vehicles on noise. Maulana A.Z. (2012) examined air pollution caused by motorized vehicles. Syaiful and Ngadimo (2014) also examines the effect of traffic volume on noise. Previous research was detailed enough, but it did not take into account the existence of green open spaces (GOS) which together contribute to air pollution. More green open space around the road is expected to reduce the level of air pollution. Together, the effect of vehicle volume and green open space on air pollution has not yet been developed. If this model can be obtained, it can be used to predict noise and air pollution as a result of the relationship between vehicle volume and green open space.

METHODS

The study was conducted in the following order:

1) Direct observations by measuring vehicle volume, area of green open space and air quality. Measurement of air quality use the Air Quality Meter tool, and the vehicle volume measurement tool using the Counter tool.
2) Secondary data obtained through the South Jakarta Transportation Department data and South Tangerang Department of Transportation and various literatures
3) Data processing is done by linear regression analysis and multiple linear regression methods to determine the pattern of relationships between the variables involved such as vehicle volume, green open space, and air quality. From the results of the analysis it will get a graph and a significant level of related variables based on the results of the regression carried out.

Research data in the form of traffic volume from various types of motor vehicles, noise and air quality are measured directly in 3 locations namely in Jakarta (location: Sequis Center and Tanah Kusir) and in South Tangerang (location: BSD - Green Park Office), while Green Open Space (GOS) is calculated from secondary data.

Table 1. Noise Data, Vehicle Volume, RTH and Location

Noise (dB)	Vehicle Volume (pcu)	GOS (%)
Location: Sequis Center		
73	1207.25	30
76	1501.35	61
82	1397.05	68
77	1248.35	45
75	1093.60	60
79	1241.55	80
80	1288.50	81
81	1396.75	56
Location: Tanah Kusir		
70	204.10	44
72	198.30	24
75	275.10	57
74	270.10	61
75	236.00	38
79	327.00	21
80	324.75	47
77	368.25	41
Location: BSD		
75	724.00	10
72	783.25	45
78	789.50	88

75	804.25	70
73	597.75	54
79	684.50	75
76	757.75	83
77	834.25	90

Source: Direct measurement.

Table 2. Data on Air Pollution, Vehicle Volume, Green Open Space and Location

Air Pollution GOS ($\mu g/m^3$) (%)	Vehicle Volume (pcu)	
Location: Sequis Center		
119	1207.25	30
155	1501.35	61
153	1397.05	68
153	1248.35	45
114	1093.60	60
114	1241.55	80
153	1288.50	81
161	1396.75	56
Location: Tanah Kusir		
90	204.10	44
117	198.30	24
114	275.10	57
114	270.10	61
95	236.00	38
95	327.00	21
117	324.75	47
147	368.25	41
Location: BSD		
65	724.00	10
86	783.25	45
151	789.50	88
149	804.25	70
96	597.75	54
117	684.50	75
124	757.75	83
132	834.25	90

Source: Direct measurement.

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DISCUSSION

Based on the calculated data, it can be described various relationships between green open space and vehicle volume with noise and air pollution.
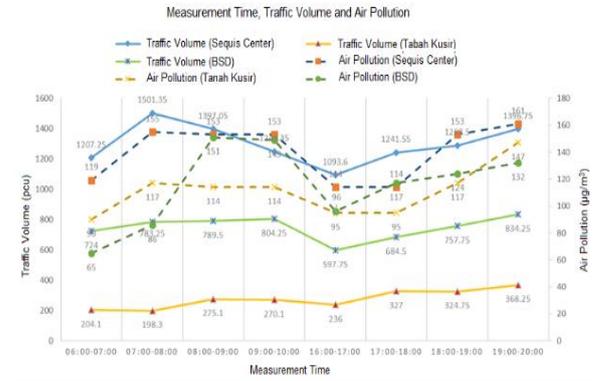

Figure 1. Vehicle volume and air pollution

Figure 1 shows that vehicle fluctuations are in line with air pollution fluctuations. There was a drastic increase from 08:00 to 16:00 in BSD due to the large number of heavy vehicles passing by. This indicates that heavy vehicles are the major contributor to air pollution.

Based on the analysis of data collected related to air pollution and green space, the results obtained are as shown in Table 3.

Table 3. Analysis of Air Pollution Results

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.666[a]	.443	.390	20.48689

a. Predictors: (Constant), GSO, Traffic Volume

Based on the above results, it is identified that the R square value of 0.443 indicates that the effect of vehicle Vol (X1) and RTH (X2) variables simultaneously on the Air Pollution variable (Y) is 44.3%.

Table 4. Results of ANOVA Analysis

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7020.663	2	3510.331	8.364	.002[b]
	Residual	8813.962	21	419.712		
	Total	15834.625	23			

a. Dependent Variable: Air Pollution

b. Predictors: (Constant), GOS, Traffic Volume

Table 5. Results of Coefficient Analysis

Coefficients[a]

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	76.989	12.243		6.289	.000
	Vol Kend	.025	.011	.420	2.396	.026
	RTH	.462	.211	.384	2.188	.040

a. Dependent Variable: Air Pollution

The multiple regression equation is as follows:
$$Y = a + b_1 . X_1 + b_2 . X_2$$
$$Y = 76.989 + 0.025\ X_1 + 0.462\ X_2 \dots\dots\dots(1)$$
From the results of data analysis using the SPSS program, the first hypothesis can be obtained that the sig value for the effect of X1 on Y is 0.026 <0.05 and the value of 2,396> T_{table} (2,080), it can be concluded that the volume of the vehicle influences the Air Pollution.

The data analysis of the second hypothesis (H2) states that the sig value for the effect of X2 on Y is 0.040> 0.05 and the value of 2.188 <2.080, it can be concluded that green open space has an effect on Air Pollution.

The conclusion of the two variables states that both the volume of vehicles and green open space affect the Air Pollution. Equation 1. The result can be used to predict the combination of the effect of vehicle volume and green open

space on air pollution. This can further be used to simulate the desired level of air pollution that can occur with the existing vehicle volume in order to provide how much green open space is needed.

The analysis of the relationship between vehicle volume and green open space to noise by using the SPSS program, the first hypothesis is obtained that the sig value for the effect of X1 (vehicle volume) on Y is 0.102> 0.05 and the value of 1264 <T_{table} (2,080), it can be concluded that vehicle volume has no effect on noise.

The data analysis from the second hypothesis (H2) the sig value for the effect of X2 (green open space) on Y is 0.220> 0.05 and the value of 1264 <2.080, it can be concluded that green open space has no effect on noise. Therefore, the analysis of the two variables stated that there is no influence of the volume of vehicles and green open space on noise.

Table 6. Noise Analysis

Coefficients[a]

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	72.322	1.674		43.206	.000
	Vol Kend	.002	.001	.347	1.710	.102
	RTH	.036	.029	.257	1.264	.220

a. Dependent Variable: Noise

The results of the analysis of the effect of X1 (vehicle volume) with Y (noise) using the SPSS program produces a sig value of 0.102> 0.05 and a value of 1264 <T_{table} (2,080) concluded that the volume of the vehicle has no effect on noise (the first hypothesis). Analysis of the data for the second hypothesis (H2) the sig value for the effect of X2 on Y was 0.220> 0.05 and the value of 1264 <2.080 be concluded that green open space has no effect on noise. The effect of vehicle

volume and green open space on noise from the analysis conducted has not yet been proven, meaning that it is assumed that there are many other factors that influence noise, not only in macro terms of vehicle volume but the composition of the types of vehicles passing through might also be impacted. Noise prediction due to traffic has been included in the Traffic Prediction Handbook (Departemen PUPR, 2004), so the purpose of simplifying noise prediction in this study has not yet been recognized.

CONCLUSION

Based on the data analysis, the following can be drawn as a conclusion: (1) the fluctuations in air pollution are in line with those of the fluctuations on vehicle volume; (2) both the volume of vehicles and green open spaces have an influence on the air pollution; (3) the model of the relationship between the volume of the vehicle and the green open space on air pollution can be applied as the simulation tool to minimize the increase on vehicle volume. If it is desired, certain level of pollution can be reached by providing the green open space coupled with decreasing volume of vehicle.

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