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ANALYSIS OF NOISE ON PANTURA ROAD TRIPE – SHOOT COMPARATION OF LINEAR AND LAGRANGE METHODS

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Abstract The purpose of this study was to determine the correlation of noise level with traffic volume on the pantura route, especially in the Babat-Pucuk sub-district section using the mathematical method of linear regression and the polynomial lagrangge method. The results of this study, it can be known the correlation between noise and traffic volume on the Pantura route, especially the Babat - Pucuk District section, it was found that the highest traffic volume results in the 2-way segment of Babat - Gresik with a value of 3348.9 emp / hour, for the highest noise was in the 4-way segment of Babat - Gresik with a noise value of 87.8 dBA. The results of the study were processed using linear regression methods and lagrange polynomials, followed by a comparison of the results in the linear regression method = t stat value = 0.007474 < critical t = 2.262157 then H0 was accepted which means there is no significant difference between the insitu noise value (Y) and the results of linear regression calculations. p value = 0.9 > α = 0.05 then H0 is accepted which means that there is no significant difference between the insitu noise value (Y) and the results of linear regression calculations. In the lagrange polynomial method = stat t value = 2.303102485 > critical t = 2.262157163 then Ha is accepted which means that there is a significant difference between the insitu noise value (Y) and the results of the lagrange polynomial calculation. p value = 0.046 < α = 0.05 then Ha is accepted which means there is no significant difference between the insitu noise value (Y) and the results of the lagrange polynomial calculation. So it can be concluded that the linear regression method is more feasible to use because there is no significant difference between the noise value and the calculation results.

Keywords: Flooding, Noise, Linear Regression, Lagrange Polynomials.

Introduction

Transportation has a major influence on the social and economic development of a region, while social and economic changes in a region will also affect the existing transportation system, transportation itself serves to move and coordinate the movement of people or goods from one place to another, the existence of highways is one of the infrastructure that must be fulfilled in the process of transportation, especially land transportation, In the operation of the transportation system can also cause various consequences, one of which is noise. (Aronoff, 1989).

Noise can be interpreted as unwanted sound as a form of pollution in the eardrum, noise comes from human activities, one of which is transportation (Djalante, 2010). In transportation, noise can be generated from the sound of vehicle engines, horns, exhaust, and also the sound of tires popping. Noise can also come from surrounding environments such as markets, terminals, stations, and factories (Ferial et al., 2016).

Lamongan is one of the regencies located in East Java and is one of the regencies that connects several regencies and cities in East Java, geographically the regency is located at 6°51'54" - 7°23'06" South Latitude and 112°33'45" - 112°33'45" East Longitude with an area of 1,813 km2, the northern area of Lamongan Regency is directly adjacent to the beach and has a coastline of 47 km, Lamongan is bordered by several regencies and cities in East Java such as Tuban and Bojonegoro in the west, Nganjuk, Jombang, and Mojokerto in the south, and Gresik in the east, therefore Lamongan Regency is one of the connecting areas between cities or regencies so that it makes traffic in Lamongan Regency busy and causes traffic noise, especially in the Pantura route area. Along Jalan Pantura, especially in the section of Babat District - Pucuk District, which is the object of research, is a road section adjacent to many public facilities, stations, markets, educational facilities, places of worship, and also health facilities directly facing the road. Jalan Pantura is a road with a high volume of density, especially during rush hour which can lead to an increase in noise pollution intensity (Purwanto et al., 2021).

As mentioned, researchers conducted a study to analyze the noise in the pantura line of Lamongan Regency, especially in the Babat District - Pucuk District. Noise analysis is carried out during rush hour both in the morning and evening which allows an increase in noise pollution intensity, noise on the highway comes from motorcycles (SM), light vehicles (KR) and heavy vehicles (KB), Noise analysis is carried out using 2 methods, namely the linear regression method and the lagrange polynomial method (Judd et al., 2014).

The survey results in the form of vehicle volume and noise will be calculated using the linear regression method and the lagrange polynomial method. Geospatial data and numerical calculation data obtained from research will be processed using a geographic information system (GIS) which functions as a tool in data collection while mapping research results into maps. This study is important to determine the noise level as well as to determine the comparison of linear regression methods and lagrange polynomial methods in analyzing vehicle volume against noise (Ding et al., 2021).

Method

Noise analysis on Jalan Pantura, Babat District – Pucuk District was carried out to determine the noise level and make noise-related mapping, so that it could be a reference data for conducting further research on the road section. Noise analysis was carried out on Jalan Pantura, Babat District – Pucuk District by taking vehicle volume data and noise data using sound level meter (SLM) tools and vehicle counters. Vehicle volume and noise data were processed using linear regression methods and lagrange polynomials and t-tests were carried out from the results of linear regression calculations and lagrange polynomials. According to KMLH No. 48 of 1996, noise calculation can be done with the following

formula:

Leq = 10 logs[]$\frac{1}{N}\sum_{i-1}^{n}(10^{\frac{Li}{10}}$

Linear regression can be interpreted as a relationship between variable (y) that has been known and variable (x) that is not yet known or still estimated in the form of mathematical equations. The relationship between two variables is expressed by a linear equation with y (dependent variable) and x (independent variable) (Subagyo, 2014). To find out the relationship of variables, namely with linear equations as follows

Y = a x bx

By finding the values of b and a with the following formula:

b = $\frac{n.(\Sigma\, x.y)-(\Sigma x).(\Sigma y)}{n.(\Sigma x\ \Sigma^2)-(\Sigma x)\text{^}2}$

a = $\frac{\Sigma y-(b.\Sigma x)}{n}$

Things to do when calculating noise analysis on Jalan Pantura section of Babat District – Pucuk District:

1) Record the results of noise and vehicle surveys according to the type of vehicle.
2) Determine the Leq value of noise.
3) Determine the value of the volume of the vehicle.

The tools needed in noise analysis on Jalan Pantura, Babat District – Pucuk District are as follows.

1) *Sound level meters* are used to measure noise levels.
2) Push meter to divide segments on road sections.
3) *Stopwatch* to measure the time at the time of the study.
4) *Counter* to count the number of vehicles based on the type of vehicle.
5) Stationery to record volume and noise survey results.
6) Cameras were used to take documentation at the time of the study.

Results and Discussion

Data collection in the field is carried out by direct measurement method using roller meters, checkers, sound level meters, and stopwatches as measuring aids. The road segment in this study was divided into 5 pantura route segments from Batat District-Pucuk District with a length of 2.86 kilometers. Geometric data is summarized in the following table:

Table 1 Road length and width survey data (Field survey results)

No.	Road Segments	Road Length (M)	Road Width (M)	Road Type	Width per lane (m)
1	Segment 1	790	8	4/2T	4
2	Segment 2	390	8	4/2T	4
3	Segment 3	940	8	4/2T	4
4	Segment 4	410	8	4/2T	4
5	Segment 5	330	8	4/2T	4

The recapitulation of the results of volume and noise calculations on the Pantura Highway section of Babat District – Pucuk District which is carried out during the morning rush hour at 06.00 – 08.00 and the afternoon rush hour at 16.00 – 18.00 is presented in the following table:

Table 2 Recapitulation of Volume and Noise Calculation Results on Pantura Highway, Babat District - Pucuk District (Field Survey Results)

Direction	Segment	Time	Volume Q(emp/h)	Noise (dBA)
Tripe - Gresik	1	06.00-07.00	691,4	83,0
		07.00-08.00	643,2	84,0
		16.00-17.00	1062,7	85,6
		17.00-18.00	619,2	83,8
	2	06.00-07.00	712,5	83,5
		07.00-08.00	770	81,1
		16.00-17.00	1171,7	85,6
		17.00-18.00	694,7	81,4
	3	06.00-07.00	712,5	81,7
		07.00-08.00	765,0	81,3
		16.00-17.00	1171,7	87,5
		17.00-18.00	694,7	82,2
	4	06.00-07.00	680,4	83,0
		07.00-08.00	691,7	83,2
		16.00-17.00	1021,6	86,1
		17.00-18.00	634,1	83,9
	5	06.00-07.00	711,8	80,8
		07.00-08.00	684,2	81,7
		16.00-17.00	1010,5	86,5
		17.00-18.00	653,6	80,8
Gresik - Tripe	1	06.00-07.00	679,5	83,3
		07.00-08.00	679,0	83,0
		16.00-17.00	1118,3	87,0
		17.00-18.00	682,4	83,1
	2	06.00-07.00	609,5	75,0
		07.00-08.00	650,3	83,0
		16.00-17.00	1067,0	84,8
		17.00-18.00	610,8	75,0
	3	06.00-07.00	609,5	78,1
		07.00-08.00	630,0	82,1
		16.00-17.00	1067,0	87,0
		17.00-18.00	610,8	82,6
	4	06.00-07.00	938,8	84,0
		07.00-08.00	616,4	82,2
		16.00-17.00	1083,8	87,8
		17.00-18.00	660,9	82,2
	5	06.00-07.00	938,4	84,0

Direction	Segment	Time	Volume Q(emp/h)	Noise (dBA)
		07.00-08.00	625,3	81,3
		16.00-17.00	1010,8	86,0
		17.00-18.00	633,8	82,5

From the recapitulation of vehicle volume and noise above, it can be seen that vehicle volume increases in the afternoon during rush hour 16.00-18.00 in the afternoon. The highest vehicle volume occurred in segment 3 in the direction of Babat – Gresik during the afternoon rush hour at 16.00 – 17.00 WIB with a value of Q = 1171.7 emp / hour. The highest noise value occurred in segment 4 of Gresik – Babat during the afternoon rush hour at 16.00 – 17.00 WIB with a noise value of 87.8 dBA.

From the results of the volume and noise recapitulation above, it can be seen if the vehicle volume does not have a steady increase in noise. The increase in vehicle volume does not always increase the noise value, this happens because there are differences in capacity between segments and noise generated from the surrounding environment such as markets, train stations, factories, shops. Noise is also generated from the sound of blown tires, exhaust leaks, modif exhaust, horns, etc.

After obtaining the value of vehicle volume and noise, the data is processed by linear regression methods such as the following table:

Table 3 Results of linear regression between volume and noise of segments 1-5 in the direction of Tripe - Gresik (Results of analysis using *Microsoft Office Excel)*

Regression Statistics	
Multiple R	0,463937887
R Square	0,215238363
Adjusted R Square	-0,046348849
Standard Error	0,710905405
Observations	5

ANOVA

	Df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0,42	0,42	0,82	0,431229326
Residuals	3	1,52	0,51		
Total	4	1,93			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	89,28253494	6,56	13,61	0,00	68,41	110,16	68,41	110,16
X Variable 1	-0,007523529	0,01	-0,91	0,43	-0,03	0,02	-0,03	0,02

From the results of the calculation table above, it can be known that the correlation value between X &; Y is 0.46 which is classified as a medium positive category. The value

of the coefficient of determination is 0.215 or 21.5% which means that volume can explain noise by 21.5% and the rest is influenced by other factors. can be known regression equation Y=89.28253494+(-0.007523529X).

Table 4 Results of linear regression between volume and noise of segments 1-5 in the direction Gresik - Tripe

Regression Statistics	
Multiple R	0,76860652
R Square	0,59075598
Adjusted R Square	0,45434131
Standard Error	1,42740612
Observations	5

ANOVA

	Df	*SS*	*MS*	*F*	*Significance F*
Regression	1	8,823525717	8,82353	4,33059	0,12887853
Residuals	3	6,11247647	2,03749		
Total	4	14,93599042			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	55,49309075	13,09	4,24	0,02	13,83	97,16	13,83	97,16
X Variable 1	0,03506073	0,02	2,08	0,13	-0,02	0,09	-0,02	0,09

From the results of the calculation table above, it can be known that the correlation value between X &; Y is 0.769 which is classified as a strong positive category. The value of the coefficient of determination is 0.59 or 59% which means that volume can explain noise by 59% and the rest is influenced by other factors. The regression equation Y=55.49309075+0.035060733X can be known.

To find out the results of calculations using formulas obtained from linear regression, calculations are carried out such as the following example:

To find out the comparison results before and after linear regression analysis, *a T-test* was carried out using *Microsoft Office Excel* and obtained the following results:

Table 5 T-test analysis of variable Y and regression calculation results

	Variable 1	*Variable 2*
Mean	83,02213	83,02
Variance	1,986492	1,130667

	Variable 1	*Variable 2*
Observations	10	10
Pearson Correlation	0,770084	
Hypothesized Mean Difference	0	
Df	9	
t Stat	0,007474	
P(T<=t) one-tail	0,4971	
t Critical one-tail	1,833113	
P(T<=t) two-tail	0,9942	
t Critical two-tail	2,262157	

From the calculation of *the T-test,* it is known that the value of t stat = 0.007474 < t critical = 2.262157 then H_0 is accepted, which means that there is no significant difference between the value of insitu noise (Y) and the results of linear regression calculations.
p *value* = 0.9 > α = 0.05 then H_0 is accepted which means that there is no significant difference between the insitu noise value (Y) and the results of linear regression calculations.

The calculation of the 4th degree lagrange with the variables of noise and vehicle volume is carried out and the results of the function formula are obtained as follows:

Polynomial lagrange direction Babat-Gresik=
f(x) =-0.0000007253x4+0.0023230925x3-2.788056625x2+1485,95006875001x-296661,795000001

Polynomial lagrange direction Gresik-Babat=
f(x) = 0.00000202663x4−0.0063168x3 +7.3775399999999999x2 −3826.50881x +743755.5

To find out the comparison results before and after polymomial lagrange analysis, a T-test was carried out using Microsoft Office Excel and obtained the following results:

Table 6 Recap of variable Y and lagrange calculation results

Noise Data (Y)	Lagrange Calculation Results
84,1	84,1003125085263
84,0	84,0000000088475
82,5	82,5000000088475
83,2	83,2000781344249
82,9	82,9003125096205
84,1	82,4365898214746
84,0	78,5409374758601
82,5	81,9989023185335
83,2	80,0999999721534
82,9	79,1334023145027

To find out the comparison results before and after *the lagrange polynomial*, a T-test *was* carried out using *Microsoft Office Excel* and obtained the following results:

Table 7Analysis of T-test variable Y and lagrange calculation results

	Y	*Result*
Mean	83,34	81,89105351
Variance	0,429333333	3,864053029
Observations	10	10
Pearson Correlation	0,130187262	
Hypothesized Mean Difference	0	
Df	9	
t Stat	2,303102485	
P(T<=t) one-tail	0,023380694	
t Critical one-tail	1,833112933	
P(T<=t) two-tail	0,046761388	
t Critical two-tail	2,262157163	

From the calculation of T-test, it is known that the value of t stat = 2.303102485 > t critical = 2.262157163 then Ha is accepted, which means that there is a significant difference between the value of insitu noise (Y) and the calculation results of the lagrange polynomial. p value = 0.046 < α = 0.05 then Ha is accepted which means there is no significant difference between the insitu noise value (Y) and the results of the lagrange polynomial calculation.

From the results of data analysis using paired T-test between the results of linear regression calculations against noise values (Y) and paired T-tests between the results of lagrange polynomial calculations against noise values (Y) there are differences in P values against α and t stats against critical t obtained results:

H0 : μLeq insitu = μLeq Regression: That there is no difference between the mean value of insitu noise and the noise resulting from linear regression.

Ha : μLeq Insitu ≠ μLeq Regression: That there is a difference between the average value of insitu noise and the noise resulting from linear regression.

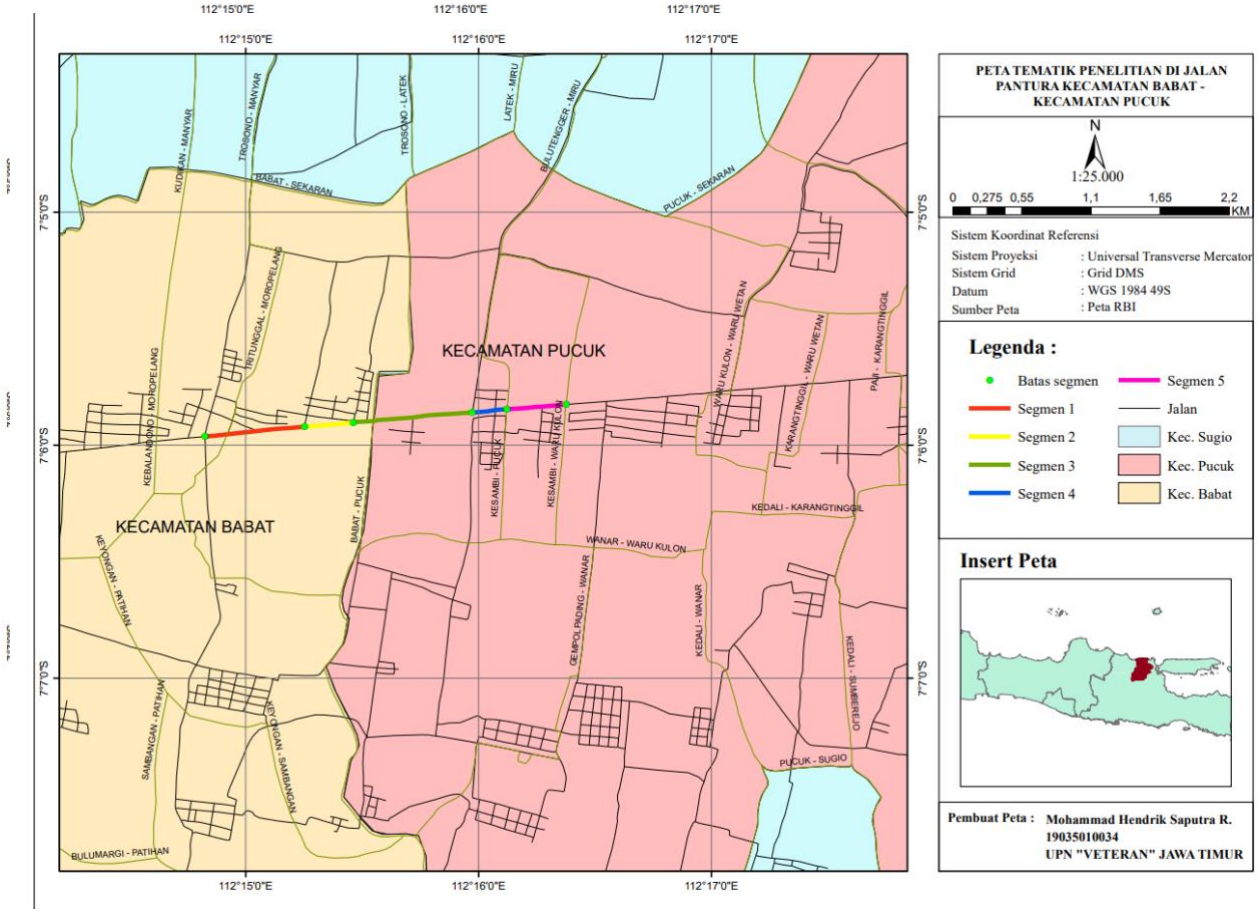
In the linear regression method = value of t stat = 0.007474 < t critical = 2.262157 then H0 is accepted which means there is no significant difference between the value of insitu noise (Y) and the results of linear regression calculations.

p value = 0.9 > α = 0.05 then H0 is accepted which means that there is no significant difference between the insitu noise value (Y) and the results of linear regression calculations.

In the lagrange polynomial method = stat t value = 2.303102485 > critical t = 2.262157163 then Ha is accepted which means that there is a significant difference between the insitu noise value (Y) and the results of the lagrange polynomial calculation.

p value = 0.046 < α = 0.05 then Ha is accepted which means there is no significant difference between the insitu noise value (Y) and the results of the lagrange polynomial calculation.

From vehicle volume and noise data, mapping is carried out using *ArcGIS 10.8 software* as follows:



Picture 1. Traffic volume map of Jalan Raya Pantura Kec. Babat - Kec. Pucuk (Analysis Results Using Picture 2 Noise map on Jalan Raya Pantura Kec. Babat- Kec. Pucuk (Analysis Results Using *Software ArcGIS*)

Conclusion

1. The volume of vehicles on the Pantura Highway section on the Babat – Pucuk District section in 2023 with research time at the morning rush hour 06.00 – 08.00 and afternoon rush hour 16.00 – 18.00 is:
   Segment 1 initial coordinates 637721.55 m E and 9215083.07 m S final coordinates 638508.19 m E and 9215168.06 m S direction Tripe – Gresik Total Q = 3016.5 emp/hour. As for the direction Gresik – Tripe Q total = 3159.2 emp / hour.
   Segment 2 initial coordinates 638508.19 m E and 9215168.06 m S final coordinates 638900.84 m E and 9215198.63 m S direction Tripe – Gresik Total Q = 3348.9 emp/hour. As for the direction Gresik – Tripe Q total = 2937.6 emp / hour.
   Segment 3 initial coordinates 638900.84 m E and 9215198.63 m S final coordinates 639834.56 m E and 9215272.35 m S direction Tripe – Gresik Q total = 3343.9 emp/hour. As for the direction Gresik – Tripe Q total = 2917.3 emp / hour.
   Segment 4 initial coordinates 637721.55 m E and 9215083.07 m S final coordinates 640246.01 m E and 9215307.15 m S direction Tripe – Gresik Q total = 3027.8 emp/hour. While the direction Gresik – Tripe Q total = 3299.9 emp / hour.
   Segment 5 initial coordinates 640246.01 m E and 9215307.15 m S final coordinates 640577.47 m E and 9215338.28 m S direction Tripe – Gresik Q total = 3060.1 emp/hour.

While the direction Gresik - Tripe Q total = 3208.3 emp / hour.

2. The noise level on Jalan Raya Pantura section of Babat District – Pucuk District in 2023 with research time in the morning rush hour 06.00 – 08.00 and afternoon rush hour 16.00 – 18.00 is:
   Segment 1 way Tripe – Gresik highest noise value = 85.6 dBA. While the direction Gresik – Tripe the highest noise value = 87 dBA.
   2-way segment Tripe – Gresik highest noise value = 85.6 dBA. While the direction Gresik – Tripe the highest noise value = 84.8 dBA.
   3-way segment Tripe – Gresik highest noise value = 87.5 dBA. While the direction Gresik – Tripe the highest noise value = 87 dBA.
   4-way segment Tripe – Gresik highest noise value = 86.1 dBA. While the direction Gresik – Tripe highest noise value = 87.8 dBA.
   5-way segment Tripe – Gresik highest noise value = 86.5 dBA. While the direction Gresik – Tripe the highest noise value = 86 dBA.
3. From the results of data analysis and discussion, it can be concluded that the volume of vehicles does not have a steady increase in noise. The increase in vehicle volume is not always directly proportional to the increase in noise value, this happens because there are differences in capacity between segments and noise generated from the surrounding environment such as markets, train stations, factories, shops. Noise is also generated from the sound of blown tires, exhaust leaks, modif exhaust, horns, etc.
   The hypothesis used is: H0 is accepted if there is no significant difference between the noise value (Y) and the calculation result Ha is accepted if there is a significant difference between the noise value (Y) and the calculation result.
   In the linear regression method = value of t stat = 0.007474 < t critical = 2.262157 then H_0 is accepted which means there is no significant difference between the value of insitu noise (Y) and the results of linear regression calculations.
   p *value* = 0.9 > α = 0.05 then H_0 is accepted which means that there is no significant difference between the insitu noise value (Y) and the results of linear regression calculations.
   In the lagrange polynomial method = stat t value = 2.303102485 > critical t = 2.262157163 then H_a is accepted which means that there is a significant difference between the insitu noise value (Y) and the results of the lagrange polynomial calculation.
   p *value* = 0.046 < α = 0.05 then H_a is accepted which means that there is no significant difference between the value of insitu noise (Y) and the results of the polynomial lagrange calculation.

   So it can be concluded that in the calculation of the correlation between vehicle volume and noise value, the linear regression method is more feasible to use because in the t test results there is no significant difference between the insitu noise variable (Y) and the calculation results of the linear regression function formula, while for the lagrange polynomial method, there is a significant difference between the insitu noise variable (Y) and the calculation results of the lagrange polynomial function formula.

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