The Effect of Road Characteristics on Motorcycle Accident in Batu East Java Indonesia

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Abstract. Safe of transportation on road is global problem with not only transportation problem, but also social teritory problem in sosial life. WHO pay attention to safe transportation on road to decide healthy day in the world 2004 with caption: Road Safety is no Accident. WHO is clariafy that road accident level in the world have to reach 1.2 mellion victim death and over 30 mellion injuries every year. As much 85% sacrifice death are accident in develop state, where vehicle number only 32% from vehicle number in the world. That becouse as the objective is to decide influence road charakteristics geometrics for motorcycle accident in Batu East Java Indonesia. Using some statistical analysis it is found that the best-fit motorcycle accident model is: $Acc = 0{,}009F^{0{,}703}\exp(-0{,}334SW - 0{,}361G + 0.077S)$
Where: Acc = number of accident, F= Flow, pcu/hr, SW= shoulder width (m), S= speed, km/hr, G= Gradient (0,1)
The model shows that the affecting factors are flow, shoulder width and speed, therefore local government should improve some related factor (flow, shoulder width, Gradient and speed) that can reduce the number of motorcycle accident at crossing road in Batu.

Keywords: The effect, accident, motorcycle, Batu Residence, General Liniearized Model, road

INTRODUCTION

Transportation is the all product to activity economy social, land use to create demand system with capacity and network road fasility as supply. The characteristics alteration land use or network road fasility will be effect to component else.

The alteration economy social will be effect need to action and transportation system, at last need to repair network system. If it need to promoted action without balanced to rise road network, therefore will be problem on demand. The concrete is over to much time and cost travels, the crowded on x-road to increase accident number of transportation and sure will be effect to safe teritory in social life.

Table 1. Data Acciden in Malang

Accident Casualities	Year	
	2006	2007
Fatal	69	100
Hospitalised	66	30
Slight Injury	281	426
Sum	416	556

Source: Polres Malang

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On table (1), the general accident number transportation now are higt complety, especially motorcycle accident and seriously threat for safe transportation.

For all accident, motorcycle accident are the biggest, about 63% for transportation accident. Becouse is not seriously to cultitative for road safe. Therefor as the objective is to decide influence road charakteristics geometrics for motorcycle accident and model development for motorcycle accident in Batu East Java Indonesia.

TRAFFIC ACCIDENT

Harnen et al. [6] described that an accident have five component with interaction, there are driver (man), traffic, road, vehicle and teritory (Miaou *et al.*, [8]). Transportation model is relationship land use and

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transportation with model mathematics equation (Ortuzar [4], Ofyar [5], Russo and Comi [2]).

Accident Model on x-roadsbe use *Generalized Linear Model* (Tony Swan, *et al*., 1994; Aitkin, *et al*.,1989), format model is:

$$A = kQ^{\alpha} e^{b_1 g_1 + b_2 g_2 + \ \ldots} \quad . \qquad (1)$$

where A is a motorcycle accident, Q is *traffic flow*, g_1, g_2 ...are geometric variable and α, k, b_1, b_2, ... are parameter estimate.

In models development traffic accident, espesially motorcycle accident obliget to work skenario to minimum accident number use about distibution in statistics.

To be based on background, writer do to research about traffic accident, espesially motorcycle accident on the x-road in Batu. Distribution is used Poisson distribution. Data input 45 x-road, then data is processed with about iteration. So that with 17 data x-road, model have to indicate is the best with significant parameter. For analysis motorcycle accident use software SPSS vol 16 (Ghozali [3]) and Software Easyfit vol 5.2 Standard.

MATERIAL AND METHOD

The research purpose to know factor influence for accident on mathematics **model with use Generalized Linear Model for motorcycle accident in Batu. Output are** hoped to made prediction models motorcycle accident in Batu.

Distribution Test

Before to make the motorcycle acciden model in Batu, therefore it must to investigation for distribution agreement to variables. For to know spread of data in research and know type to distribution which to agree. Test to distribution only variable accident number (Acc) as respon variable.

For determine to agree distribution be use Kolmogorov-Smirnov test with Software Easyfit 5.2 Standard and model:

$$D_{maks} = \sup\left[\left|F_n(x) - F_0(x)\right|\right]. \quad \ldots . \qquad (2)$$

The distribution test to 17 data x-road with one respon variable and 5 (five) predictor variable. They are accident number as respon variable, median, gradiant, shoulder width (SW), speed (S) and flow.

Table 3. Fitting Results Kolmogorov-Smirnov

#	Distribution	Parameters
1	Geometric	p=0.06855
2	Logaritmic	θ=0.98201
3	Neg. Binomial	n=4 p=0.25952
4	Poisson	λ=13.588

Table 4. *Goodness of Fit – Summary* Kolmogorov-Smirnov

#	Distribution	Kolmogorov Smirnov	
		Statistic	Rank
1	Geometric	0.30861	2
2	Logaritmic	0.44295	4
3	Neg. Binomial	0.33451	3
4	Poisson	0.27586	1

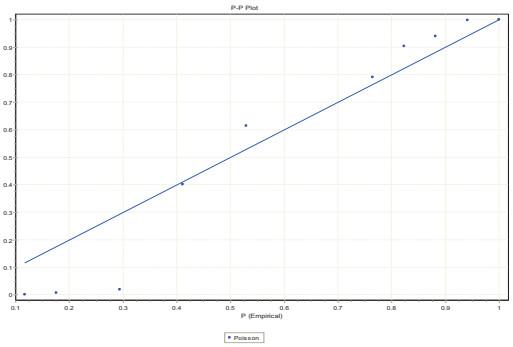
Kolmogorov-Smirnov Test

The based on calculation output aesyfit 5.2 standard can know critical value Kolmogorov-Smirnov that data motorcycle accident (Acc) is follow Poisson distribution, and to form the best distribution with value 0.27586. The next distribution is geometric distribution with value 0.30861.

Tab le5. Goodness of Fit – Detail

Poisson [#5]					
Kolmogorov-Smirnov					
Sample Size Statistic P-Value Rank	17 0.27586 0.12348 2				
α	0.2	0.1	0.05	0.02	0.01
Critical Value	0.25039	0.28627	0.31796	0.35528	0.38086
Reject?	Yes	No	No	No	No

H_0 = Data *Acc*is follow Poisson distribution
H_1 = Data *Acc*is not follow Poisson distribution
Statisticstset Kolmogorov-Smirnov= D_{maks} = 0,27586
Criticalvalue Kolmogorov-Smirnov 5% / *D* (5%) = 0,31796
Therefore : $D_{maks} < D$ (5%) so thatH_0not refuse
Conclution : with error degree 5 %,we talk that motorcycle accident*(Acc)*is follow Poisson distribution, with parameter λ = 13,588.



Picture 1. Graph P-P Plot Poisson Distribution

Result from distribution test and graph P-P Plot Poisson distribution are indicate that the best distribution is Poisson. Therefore conclution motorcycle accident distribution is Poisson.

Then counting Kolmogorov-Smirnov statitstics test for Poisson distribution the based on deviation absolut value maxsimum (D_{maks}), formula definition:

$$D_{maks} = \sup\left[\left|F_n(x) - F_0(x)\right|\right]$$

D_{maks} : deviation absolut maxsimum $F_n(x)$and$F_0(x)$

$F_n(x)$: Functioncummulatif probabilyti, n =17 (data number)

$$F_n(x) = \frac{1}{n}\left[\, observasi\ number \le x\right]$$

$F_0(x)$: Functioncummulatif Poisson distribution

$$F_0(x) = e^{-\lambda}\sum_{i=0}^{x}\frac{\lambda^i}{i!} = e^{-13,588}\sum_{i=0}^{x}\frac{13,588^i}{i!}$$

Poisson Distributionon Kolmogorov-Smirnov Test

Table 6. Poisson Distributionon Kolmogorov-Smirnov Test

x	Frek	Frek Kum	$F_n(x)$	$Fo(x)$	$\lvert F_n(x_i)-Fo(x_i)\rvert$	D_{maks} (1)	$\lvert F_n(x_{i-1})-Fo(x_i)\rvert$	D_{maks} (2)	D_{maks}
3	2	2	0.117647	0.000659	0.11699	0.27585	0.000659	0.261059	0.27585
5	1	3	0.176471	0.007289	0.16918		0.110358		
6	2	5	0.294118	0.018264	0.27585		0.158207		
12	2	7	0.411765	0.400149	0.01162		0.106032		
14	2	9	0.529412	0.614015	0.0846		0.20225		
16	4	13	0.764706	0.790471	0.02576		0.261059		
18	1	14	0.823529	0.904137	0.08061		0.139431		
19	1	15	0.882353	0.939105	0.05675		0.115575		
25	1	16	0.941176	0.998239	0.05706		0.115886		
30	1	17	1	0.999965	0.00004		0.058788		

Source : Analysis

The Kolmogorov-Smirnov analysis on table (6), we can value D_{maks}= 0,27585. It is same with D_{maks}value from software easyfit 5.2 standard. Thus

Prediction Accident Model

a. Earlier Estimation Parameter

Moreover , iteration earlier parameter estimation for regression analysis motorcycle accident problem in Batu be use software SPSS vol 16.0,

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.993[a]	0.987	0.981	0.096234

Table 7. Model Summary

Table 8. VarianceAnalysis

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	6.15	4	1.537	166.02	.000[a]
	Residual	0.083	9	0.009		
	Total	6.233	13			

a. Predictors: (Constant), Flow, Speed, Shoulder Width, Gradien

b. Dependent Variable : Acc.

Table 9. Coeffisient

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-4.409	0.509		-8.659	0
	Shoulder Width	-0.461	0.074	-0.297	-6.191	0
	Gradien	-0.456	0.075	-0.327	-6.058	0
	Speed	0.071	0.009	0.338	7.792	0
	Flow	0.723	0.037	0.816	19.703	0

Dependent Variable: Acc

To be based on table (7) can be resolved that coeffisient determination for this model is showed by adjusted R^2 value 0.981, that mean variabilitas motorcycle accident (Acc) as respon variable. They are shoulder width, gradient, speed and flow as predictor variable or independent variable 98% and else 1.9% is explain for other variable.

Influence of sumultaneous (F test) in Table (8) on varians analysis be used to know what the independent variable or predictor variable in a simultant manner influence respon variable. This is shown on F test value 166.016 and significans at 0.000 or $0.00 \langle 0.05$, that mean predictor variable flow, shouder width, gradient, and speed adalah in a simultant influence motorcycle accident.

On table (9) Coeffisient can know influence all independent variable for dependent variable. The all independent variable is significant on 0.05 or $0.00 \langle 0.05$, the conclusion that motorcycle accident can be been influence for factors flow, speed, gradient and shouder width.

b. Accident Models

Motorcycle accident models on x-road used Generalized Linear Models (GLM), the format models as eqution (1). We show on Tabel (9) mathematics eqution can made as:

$$Acc = k \quad Flow^{\beta_0} \exp(\beta_1 shoulderwidth + \beta_2 gradien + \beta_3 Speed)$$

Where: Acc = number of accident
F = Flow, pcu/hr
SW = shoulder width, m
S = speed, km/hr
G = Gradient (0,1)
k, β = coeffisient parameter

c. Regression non linear Analysis

For prediction equation regression non linear model can be use non linearregression analysis, whit use software software SPSS 16.0, where unstandardized coefficients on the table (9) can be use as earlier value for prediction model non linear equation. Input value unstandardized Coeffisient (B) on the table (9) will be result as like table (10).

Table 10. Parameter Estimate

Parameter	Estimate	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
k	0.009	0.006	-0.006	0.023
F	0.703	0.05	0.59	0.817
SW	-0.334	0.073	-0.5	-0.168
G	-0.361	0.054	-0.483	-0.239
S	0.077	0.012	0.051	0.104

On the table (10), Parameter estimate value can be seen to made equation regression non linear modes with to form motorcycle accident model on x-road in Batu, like is:

$$Acc = 0{,}009F^{0{,}703} \exp(-0{,}334SW - 0{,}361G + 0.077S)$$

RESULT AND DISCUSSION

Comparasion Data Observation dan Estimate Model

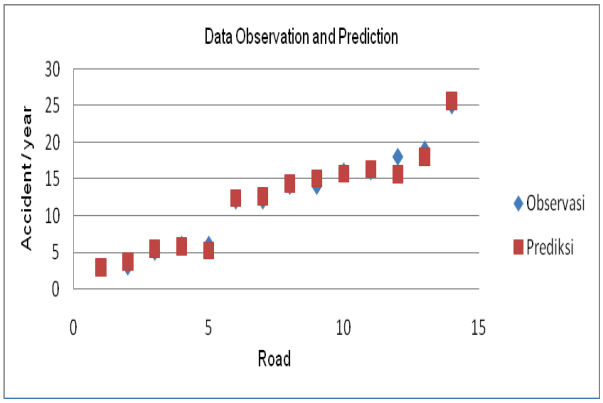
The best model is hoped to give prediction value to approach data observation, therefor must be investigation motorcycle accident model on the road. Table (11) and picture (3) see estmate model has

approached observation data (trust level 95%). That mean model is good.

Table 11. Data Observation dan Data Prediction in Malang

Road	Observation	Prediction	Residu	Residu^2
1	3	2.94	0.0641	0.0041
2	3	3.79	-0.788	0.621
3	5	5.55	-0.5476	0.2999
4	6	5.87	0.1323	0.0175
5	6	5.27	0.7266	0.528
6	12	12.42	-0.4157	0.1728
7	12	12.67	-0.6695	0.4482
8	14	14.42	-0.4199	0.1764
9	14	15.09	-1.0929	1.1945
10	16	15.7	0.2969	0.0881
11	16	16.34	-0.3427	0.1175
12	18	15.61	2.3918	5.7209
13	19	18	1.0026	1.0052
14	25	25.66	-0.6631	0.4397
			MSE	0.7738

Source: Analysis



Picture 2. Graph Data Observation Estimate Model in Malang

Paired Sample t_Test

Paired Sample t_Test for data obsevationand result of estimation, for to seehow relationship between two data.Result of program SPSS is:

Table12. Paired Samples Statistics

Paired Samples Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Observasi	12.07	14	6.662	1.780
	Prediksi	1.209465E1	14	6.5529645	1.7513534

Tabel 13. Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Observasi & Prediksi	14	.991	.000

Tabel 14. Paired Samples Test

		Paired Differences			t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean			
Pair 1	Observasi - Prediksi	-2.32E-02	0.912573	0.243895	-0.095	13	0.926

On table (12), Paired Sample Statistics to indicate that data observation to rise very small to data estimate about 12.07 to 12.09. Tabel (13) Paired Samples Correlation show that correlation data observation and data estmate are very strong (0.991). If we asymtot significant 0.000 < α, therefore conclution correlation is very significant.

Hipotesis:

H_0: $\mu_{Acc} = \mu_{estimasi}$

H_1: $\mu_{Acc} \neq \mu_{estimasi}$

On the table (14) Paired Samples Test, coulum sig(2-tailed) is probabilyti value for statistics value. For t_count (-0.095) < t_table (2.160) so that H_0 is not refuse and no significant. Sig (2-tailed) 0.926 > α (0.025), therefore H_0 is not refuse and, that mean data observation is not difference.

Contribution Accident Variable of Model in Batu

The already to be able to model motorcycle accident and we see coeffisient of every variable, therefore we can know to contribution of variables with influence motorcycle accident.

a. Influence flow for accident number

The model contibution are know that flow very influence for motorcycle accident. If variables shouder width, speed and gradient are constant, therefore with increase flow about 10% will be increase number motorcycle accident about 6.9%.

b. Influence shouder width for accident number

The model contribution are know that shouder width very influence for motorcycle accident. If variables flow, speed and gradient are constant, therefore if an addition flow 1 m (meter) will be predicted to increase motorcycle accident about multiple $e^{-0,334}$ or addition shouder width about 20%, therefore will be predicted to increase 15.4% motorcycle accident.
So with addition shouder width will be increase accident number on x-road.

c. Influence gradientfor accident number

The model know that gradient will influence motorcycle accident in Batu. If variables flow, speed and shouder width are constant, thereforeif x-road is climb or to go down will be decrease number motorcycle accident about multiple $e^{-0,361}$ or to go down decrease number motorcycle accident 30%.

d. Influence speed for accident number

For model we know that speed is influence for motorcycle accident. If variables flows, shoulder width, andgradient are constant, therefore addition speed about 1 km/h will be predicted to increase motorcycle accident about multiple $e^{0,077}$ or with addition speed 10%, therefore will be predicted to increase about 36% motorcycle accident.

The all independent variable significans model, speed variable is very influence for motorcycle accident on x-road in Batu east java indonesia. Becouse speed factor is enlarge accident number.

CONCLUSION

Result of research and data analysis for motorcycle accident on x-road in Batu can make several conclution:

a. Motorcycle accident model in Batu East Java is
$Acc = 0{,}009F^{0{,}703}\exp(-0{,}334SW - 0{,}361G + 0.077S)$

b. Geometrik factor with influenceto motorcycle accident on x-road in Batu region are shoulder width (SW) dan and Gradien (G).

c. Trafficfaktor with influenceto motorcycle accident on x-road in Batu region are speed and flow.

d. From result distribution test, therefore empirict data for research is correct Poisson distribution.

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