DETERMINATION OF PASSENGER CARS EQUIVALENCE (PCE) USING LINEAR REGRESSION ANALYSIS METHOD (THE CASE STUDY IS THE ROAD OFAHMAD YANIAND PB. SUDIRMAN STREET, JEMBER)

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Abstract

Passenger car equivalence (PCE) is the conversion factor of various types of vehicles to become passenger cars. Passenger car equivalence function is to make uniform heterogeneous traffic flow into homogeneous traffic flow. The value of passenger car equivalence of each type of vehicle is different in each size, because every road has different traffic characteristics and geometric condition. This study was conducted in order to get the appropriate value of passenger car equivalence in the research area. The researcher colleted the data of traffic volume and the road's geometry using Primer survey. The analysis method that is used to get the value of passenger car equivalence is multiple linier regression analysis. The finding values of passenger car equivalence in the PB. Sudirman street (2/2 UD) are MC = 0,32 and HV=2,31, the Ahmad Yani street (3/1) are MC= 0,34 and HV= 1,3. While, based on MKJI 1997 the passenger car equivalence values of PB. Sudirman street are MC=0,4 and HV = 1.3, andthe Ahmad Yani street are MC = 0.25 and HV = 1.3.So, the different values of passenger car equivalence in Sudirman Street are with rasio 11% for MC and 28% for HV. While, in Ahmad Yanistreet the different values are with rasio 14% for MC and 37% for HV. So that, in morning peak hours the value of DS regression in BP sudirman is smaller than MKJI and the difference is 7%. while in Ahmad Yani street, the value of DS regression is bigger than MKJI and the diference is 9%.

Keywords: passenger car equivalence (PCE), degree of saturation (DS), multiple linear regressions

Abstrak

Ekivalensi Mobil Penumpang (emp) adalahfaktorkonversiberbagaijeniskendaraanmenjadimobilpenumpang. Fungsiempadalahmenyeragamkanaruslalulintasheterogenkedalamaruslalulintashomogen. Besarnyanilaiempsetiapjeniskendaraanberbedauntuksetiapukuran, karenasetiapruasjalanmemilikikarakteristiklalulintasdankondisigeometri yang berbeda. Penelitianinidilakukanuntukmendapatkannilaiemp yang sesuai di ruasjalanlokasistudi. Pengumpulan data dilakukansecara primer untukmendapatkan data volume lalulintasdangeometrikjalan.Metodeanalisauntukmendapatkannilaiempmenggunakananalisisregresi linier berganda. HasilanalisanilaiempJalan PB. Sudirman (2/2 UD) diperoleh MC = 0,32dan HV = 2,31, Jalan Ahmad Yani (3/1) diperolehemp MC = 0,34 dan HV = 2,84. Sedangkanberdasarkan MKJI 1997 untukJalan PB.Sudirmanemp MC = 0,4dan HV = 1,3, danJalan Ahmad Yanidiperoleh MC = 0,25 dan HV = 1,3. Terdapat perbedaan emp MC sebesar 11% dan HV sebesar 28% untuk Jalan PB sudirman, serta MC = 14% dan HV = 37% untuk Jalan Ahmad Yani. Sehingga pada kondisi jam puncak pagi terjadi perbedaan nilai DS regresilebihkeciljikadibandingkandengan MKJI danperbedaannyasebesar 7% pada Jalan PB. Sudirman sedangkan terjadi perbedaan nilai DS lebihbesarregresijikadibandingkandengan MKJI denganperbedaansebesar 9% pada Jalan Ahmad Yani.

Key words: eqivalenmobilpenumpang (emp), derajat kejenuhan (DS), regresi linier berganda

INTRODUCTION

Geometric path planning can be calculated based on the volume of traffic that first converted into passenger car units (pcu). Conversion factors of various types of vehicles to

passenger cars is referred to as the passenger car equivalence (pce). The term passenger car equivalence has been introduced by Higway Capacity Manual (HCM) 1965 in Ingle (2004), which is used to analyze traffic flow. From here many emerging interpretations equivalence value of passenger cars produced by the researcher to make the value of the equation. The value of each type of vehicle emp is different for every city size. Each road segment is also different empnya value, since every street has traffic characteristics and different geometric conditions. Emp concept is used to overcome the difference in the space required by a vehicle while in traffic movement.

In 2010 the data traffic shaper is estimated to have been considerably increased, the data of vehicle ownership has reached more than 430 million registered vehicles in the composition of the motorcycle about 70% (Transport Safety Directorate, 2007). Judging from the increase in population in Jember large enough each year, resulting in activity in meeting the daily needs of the ever increasing With the increasing volume of traffic, thus affecting the value of PCE on the road.

Wulandari (2011) have similar research to get the value of emp various types of vehicles in an area corresponding to the location of JL. Kartasura Solo Surakarta.Emp different values obtained with MKJI 1997. PCE value of 1.28 obtained for a small bus, 1.39 for large buses, trucks 2AS 1.54, 1.89 to 2.08 for a truck 3AS and 5AS truck. The results of these calculations show a difference of 29% between calculations with MKJI 1997. But for Jember region has not been studied. So the research carried out to obtain the value pceof the type of road 2/2 UD and 3/1 with city size from 0.5 - 1 million. The method used in the calculation of PCE using multiple linear regression analysis.

METHODS

Passenger Car Equivalence (pce)
According MKJI (Manual KapasitasJalan Indonesia) is a passenger car equivalency factor that shows the various types of vehicles than the light vehicle with respect to its effect on the speed of light vehicles in the traffic flow. The analytical methods used to obtain the value of pce is multiple linear regression analysis. This method is often used to determine the shape of the relationship between the dependent variable and the independent variables and trace patterns of relationships that model is not known perfectly.

Here is the general form of the equation of multiple linear regression analysis method:

$$Y = b_0 + b_1X_1 + b_2X_2 + \ldots + b_ZX_Z \tag{1}$$

Where : Y $\quad$ = peubah tidak bebas
$\quad\quad$ $X_1 \ldots X_z$ $\quad$ = independent variables
$\quad\quad$ b_0 $\quad$ = regression constants
$\quad\quad$ $b_1 \ldots b_z$ $\quad$ = regression coefficient

Research Sites
Selection of study sites located in Jember on JL. PB.Sudirman with type 2/2 UD and on JL.Ahmad Yani with the type of road (3/1) on the size of the city of 0.5 - 1 million.

Stages in Research
Steps being taken in this study are:
1. Survey preliminary

2. Survey geometric
3. Survey traffic
4. Processing of data (multiple linear regression analysis using SPSS)
    a. - Identify the data that is the outlier test in SPSS
    b. - Hypothesis Testing (Test-F and Simultaneous Test TestTest Partial-T)

PCE Value Calculation With Linear Regression Analysis
Each type of vehicle has the effect of each of the other types of vehicles, therefore the calculation using multiple linear regression analysis. With the general form as follows:

$$Y = b_0 + b_1 X_1 + b_2 X_2 + \ldots + b_Z X_Z$$

PCE value calculation using multiple linear regression analysis using SPSS. In a regression analysis using SPSS we can do some statistical tests to obtain a model equation. There are several stages of multiple linear regression analysis,

1. Outlier Test (Notwithstanding Data)
2. Hypothesis Testing
    a. Partial Test (Test-T)
    b. Simultaneous Test (Test-F)

For see the effect of the correlation coefficient is done by t test (Student t) with hypothesis testing steps:

1. T_{hitung} test value compared to the value obtained t_{tabel}. If the test value $\geq$ thitungant$_{table}$ we can conclude there is a relationship between the variables x and y variables.
2. To ensure that formed linear regression equation could be accepted or not, the equation is tested using the test statistic F defined by:
3. The nature of this test is acceptable if the price of the F> Fα (np-1) or F <-Fα (np-1), with Fα (np-1) obtained from the F distribution table

RESULTS AND DISCUSSION

Calculation of Linear Regression Model
The volume of traffic that is used to calculate the value of the vehicle is pce 2 hour traffic volume at peak hours at intervals of 15 minutes six times observation Monday, so the amount of data obtained as many as 144 data. From the data on the number of vehicles passing perjenis entered into the regression equation:

1. The number of vehicles as the dependent variable / dependent (Y)
2. Motorcycle as the independent variable / independent (X1)
3. Vehicles weight as the independent variable / independent (X2)

Here is the output of the calculation by using statistical software SPSS 17 for the calculation of multiple linear regression analysis:

- Model 1 for JL. PB Sudirman
- Model 2 for JL. Ahmad Yani

Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin - Watson
1	.979^a	.958	.956	29.776	.662
2	.930^a	.864	.862	70.387	1.655

a. Predictors: (Constant), HV, MC
b. Dependent Variable: Q

Of the output can be seen that the independent variables are entered into the model is MC and HV while dependentnya variable is the total vehicle (Q).R shows the multiple correlation is the correlation between two or more independent variables on the dependent variable. The value of R ranges from 0 to 1. If the value is close to 1, then the relationship more closely.

The relationship between the independent variables to the dependent variable can be seen by calculating the correlation value. High-low, strong-weak, or the size of a correlation can be seen by looking at the size of a kofisien called correlation index numbers symbolized by r. Price r ranges between -1 <0 <+1, if the price of r = +1 states between these variables are positive influence in the direction of the correlation between the direction of the independent variable if the variable x1 is great paired with large y, or vice versa prices r = -1 states between these variables there are significant negative correlation with the opposite direction, which means that the independent variable if the variable x1 is great paired with a small y.

R rate of output results obtained for JL. PB.Sudirman and JL. Ahmad Yani are 0.979 and 0.930 meaning that the value of r ranges from 0 to 1 so that the correlation between variables and there is positive relationship occurs.

ANOVA^b

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	1364038.936	2	682019.468	147.193	.000^a
Residual	60289.008	68	886.603		
Total	1424327.944	70			
2 Regression	4232862.066	2	2116431.033	169.250	.000^a
Residual	663872.460	134	4954.272		
Total	4896734.526	136			

a. Predictors: (Constant), HV, MC
b. Dependent Variable: Q

Anova test or analysis of variance is regression coefficients for test the significance of influence of several independent variables on the dependent variable. From above anova table of F_{hitung} for JL.PB.Sudirman was obtained for 147 193 while F_{hitung} to JL. Ahmad Yani is 169 250

Coefficients^a

Model	Unstandardized Coeffisients		Standardized Coeffisients		
	B	Std. Error	Beta	t	Sig.
1 (Constant)	104.557	20.542		5.090	.000
MC	0.318	.028	.918	37.492	.000
HV	2.312	2.145	.204	.145	.885
2 (Constant)	267.509	41.530		6.441	.000
MC	0.338	.0338	.926	26.910	.000
HV	2.838	2.838	.109	.249	.804

a. Dependent variable: Q

At the output coefficient B are composed of constant values to the variables X_1 and X_2 are the MC is HV, whereas t is of significance testing to determine the effect of variables X_1 and X_2 on Y. The significance is the magnitude of the probability of getting an error in judgment. This test uses the 0.05 level, it means the opportunity to gain a maximum error of 5% with a 95% level of truth.

Partial Test
For see the effect of the correlation coefficient t test (t student).Value compared to the value of t ttabel $(1 - \alpha / 2)$ (dk), obtained from the student t $_{table}$ value of t $_{(0:05)\ (71)}$ = 1,668 for the Road Testament. Sudirman and t $_{(0:05)\ (137)}$ = 1,660 to JL. Ahmad Yani.

PB-T Road Test. Sudirman
$t_{hitungan\ MC}$ = 26.910> $t_{(0.05)(71)}$ = 1.668
$t_{hitungan\ HV}$ = 0.249< $t_{(0.05)(71)}$ = 1.668

Uji-T Jalan Ahmad Yani
$t_{hitungan\ MC}$ = 37.402 > $t_{(0.05)(137)}$ = 1.660
$t_{hitungan\ HV}$ = 0.145 < $t_{(0.05)(137)}$ = 1.660

If the test value thitungan> t table $(1 - \alpha / 2)$ (dk), we can conclude there is a relationship between the number of vehicles with a motorcycle (MC) in the location JL.AhmadYaniswhile HV t_{hitung} smaller than the T_{Table} $(1 - \alpha / 2)$ (dk) so that the number of vehicles with a heavy vehicle (HV) there is no relationship between the two this is because on both sides of the road is not passable HV HV so little volume that passed through path proficiency level.

Correlation coefficient test results in PB.Sudirman and Ahmad Yanistreet shown in Table 1:

Table 1 Correlation Coefficient Test Value on the JL. Sudirman and Ahmad Yani

Methods	Observation Location	Regression Coefficients		T table
		Motorcycle (MC)	*Heavy Vehicle* (HV)	T tabel $(1 - \alpha/2)(dk)$
Linear Regression	Jalan PB. Sudirman	37.402	0.145	1.668
	Jalan Ahmad Yani	26.910	0.249	1.660

Uji Simultan
Linear regression equations were formed and then tested with the F test, to ascertain whether the equation is acceptable or not. F values above compared with the value of F (1-α) (Ln-2) from the distribution table F. If the test value F calculated> F table value, it can be concluded that the regression equation is acceptable.

SPSS calculation results obtained from the following equation:

For JL. Ahmad Yani
Y   = 104.557+ 0.338X_1 -2.838X_2
Where:
$F_{(95\%)(71)}$ = 3.13
$F_{hit} = 169,250$ >$F_{(95\%)(71)}$ = 3.13

For JL. PB. Sudirman

Y $\quad = 267.509 + 0.318X_1 -2.312X_1$

Where:

$F_{(95\%)(137)} \quad = 3.06$

$F_{hit} = 147,193 > F_{(95\%)(137)} \quad = 3.06$

From the results of the calculations for JL.Ahmad Yani and PB.Sudirman obtained test value F calculated> F table value, it can be concluded that the regression equation is acceptable. Addition of the two equations above are also obtained pce value of the coefficient for each vehicle.

Calculation and Comparison of pce MC and HV in JL.AhmadYaniand Sudirman with pce calculation method and MKJI 1997 is shown in the following figure:

Value emp linear regression model

Comparison pce value of regression with MKJI hown in the following figure:

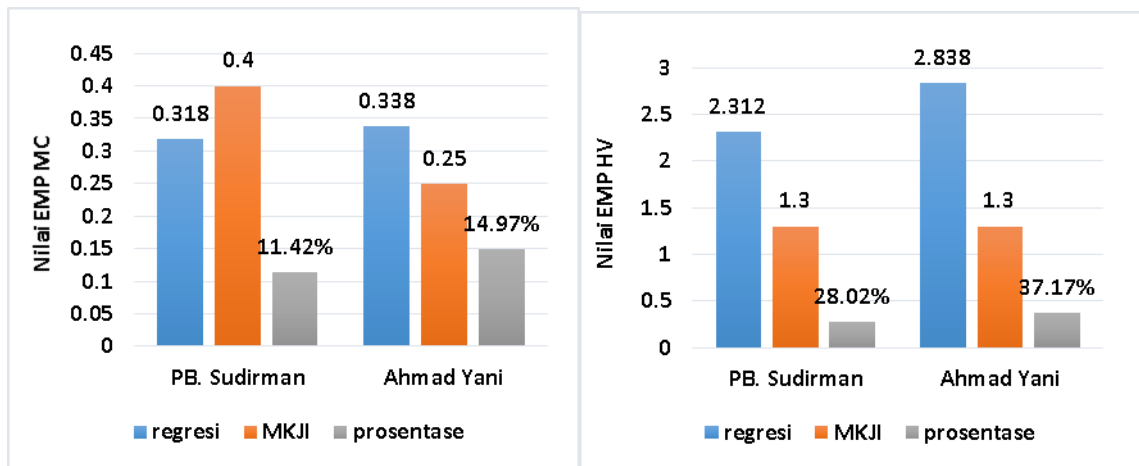**Figure 1**Comparison pcevalue MCand HV in JL.PB.Sudirman and Ahmad Yani

From the results of calculation and research on pce values obtained on the observation location in JL.PB.Sudirman by calculating the regression analysis method for MC and HV is 0.318 and 2.312, while the value obtained in MKJI 1997 methods, yhepce values for MC and HV of 0.4 and 1.3. From these results there is a difference between the two methods is equal to 11% and 28%, while the value of pce on the observation location on JL. Ahmad Yani regression analysis with the calculation method for MC and HV obtained are 0.338 and 2.838, while the value obtained in MKJI 1997 methods the values pce for MC and HV are 0.250 and 1.3. From these results there is a difference between the two methods with rasio 14% and 37%.

Performance comparison Road of regressionpce and MKJI

Recapitulation of road performance calculations in JL.PB.Sudirman and Ahmad Yani can be seen in table 2:

Table 2 Recapitulation of road performance with pce value Calculations

No	Methods	Observation Location	traffic flow (pcu / h)			Degree of Saturation (DS)		
			Pagi	Siang	Sore	Pagi	Siang	Sore
1	Linear Regression	Jln. PB. Sudirman	1829	1379	1675	0.564	0.425	0.516
		Jln. Ahmad Yani	2784	3116	2907	0.793	0.757	0.764

Table 3 Recapitulation of road performance with pcevalue MKJI 1997

No	Methods	Observation Location	traffic flow (pcu / h)			Degree of Saturation (DS)		
			Pagi	Siang	Sore	Pagi	Siang	Sore
1	MKJI 1997	Jln. PB. Sudirman	2118	1622	1904	0.653	0.522	0.613
		Jln. Ahmad Yani	2311	2610	2436	0.591	0.668	0.623

Here are the results of a performance comparison calculation JL. PB.Sudirman and Ahmad Yani with PCE calculation method and MKJI 1997:
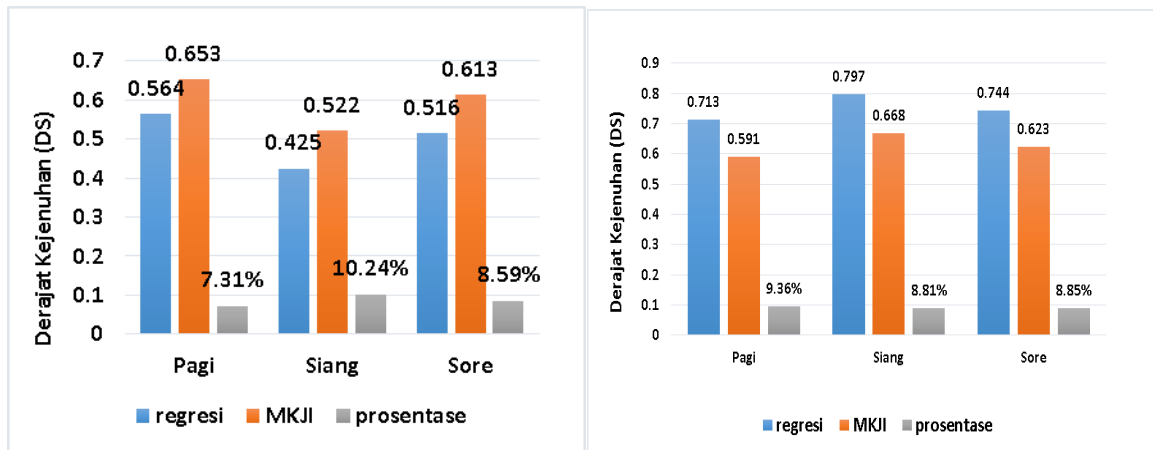
Figure 2 PerbandinganDerajatKejenuhan (DS) ruasjalanPB. Sudirmandanjalan Ahmad Yani

From the above table it can be seen that the greater the flow of traffic, the value the greater the degree of saturation as well. The results of the calculation of traffic flows and the degree of saturation with pce method has a linear regression analysis with the difference in MKJI. This is because MKJI 1997 have been outstanding for more than 15 years and has been a change to the traffic conditions at the time of designing MKJI 1997 compared to traffic conditions that exist at the present time. From the results of calculation and research on the DS values obtained at the observation location in JL. Ahmad Yani with the calculation method of regression analysis was 0.713 at peak hours in the morning while the

method MKJI 1997 DS value of 0.591. From these results there is a difference between the two methods is equal with rasio 9%.

CONCLUSION

From the calculation and analysis in the previous discussion it was concluded based computed values emp Motorcycle (MC) and Heavy Vehicle (HV) with linear regression analysis method to JL. PB.Sudirman amounted to 0.318 and 2.312 with a ratio of 11% and 28%, while the results of the calculation of the value of Motorcycle (MC) and Heavy Vehicle (HV) pce with linear regression analysis method to JL. Ahmad Yani is 0.338 and 2.838 with a ratio of 14% and 37%.

Analysis of the performance of the JL.PB.Sudirman at peak hours in the morning, afternoon and evening based on the calculation, the value of pce traffic flow for 1829, 1379 and 1675 (pcu/h) with a DS of 0.564, 0.425 and 0.516 with a ratio of 7%, 10% and 8%, while segment JL. Ahmad Yani traffic flow is obtained at 2784, 3116, and 2907 (pcu/h) with a DS of 0.713, 0.797 and 0.744 with a ratio of 9%, 8% and 8%.

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