https://dx.doi.org/10.22161/ijaers.5.8.31 ISSN: 2349-6495(P) | 2456-1908(O)

Analysis of the Impact of Generation of Housing on the Performance of Soekarno-Hatta Street in Kasongan City

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Abstract**—** *The purpose of this research is to analyze the effect of housing generation on the performance of Soekarno-Hatta Street in Kasongan City. The independent variable that is used as a factor that influences the generation is the number of family members who work, the number of family members who attend school, the number of family members who do not work and do not attend school, the size of the household, the number of car ownership in the vehicle unit, the number of motorcycle ownership, the number of bicycle ownership, total ownership of vehicles in one house, total income per family per month, and type of house. The research sample was taken at Wengga Housing, Katingan Karya Citra Housing, and Griya Cipta Housing. Analysis is using multiple regression methods. From the results of the research, it was found that the trip generation produced by a housing (pcu / hour) was influenced by the average of total ownership of vehicles in one house and the number of houses occupied in one housing. The form of the generation equation is y = -165,791 + 41,850 x (average of total ownership of vehicles in one house) + 0,321 x (number of occupied houses). To maintain the performance of Jalan Soekarno-Hatta is still stable (LOS□C) with the assumption that the external traffic flow growth is 3.5%, then in the fifth year housing development should not exceed 1.8 times (2350 units) or addition of houses can only be 1002 units.*

Keywords**— *effect of trip generation, generation model, traffic performance.***

I. INTRODUCTION

The increasing number of population that is growing rapidly at this time must be able to go hand in hand with an increase in the business of fulfilling life needs. The growing number of requests for housing needs attract investors to build a new residential area that provides comfort, security and affordable prices. Housing location can be said to have been well arranged if it has been able to meet the requirements including good accessibility and then reach the place of work [1].

Katingan Regency as one of the cities located in the Central Kalimantan Province cannot be separated from urbanization. With urbanization, the need for housing continues to increase. A housing area can be said to be good if it has good and easy accessibility and is safe to reach the destination. This means that the transportation system in the housing area must be properly regulated.

Soekarno-Hatta Street is the main road used for traffic from the Wengga Housing area, Katingan Karya Citra Housing, Griya Cipta Housing of Kasongan City. The development of these three housing will certainly cause loading problems on Soekarno-Hatta Street. Therefore, it is necessary to do research on how the trip generation model and its effect on the performance of the main road in the housing area. From the generated generation model, it can be predicted the recommended housing development limits so that the performance of a good main road can still be maintained.

II. THEORETICAL REVIEW

2.1 Transportation Planning

Transportation means moving or transporting something from one place to other place [2]. In a transportation system activity, there are several components that influence. These components can have different functions according to the type and form of the component itself. The component can be in the form of infrastructure and facilities [3].

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The component can be in the form of infrastructure and facilities [3].

Transportation planning is basically to predict transportation needs in the future which are related to economic, social and environmental aspects [4]. Transportation planning is a dynamic and responsive process to changes in land use, economic conditions, and traffic patterns.

The current popular transportation planning concept is the four-stage transportation planning model [5]. This planning model is a combination of several sub-model series, each of which must be conducted separately and sequentially, namely: accessibility, trip generation and trip attraction, trip distribution, modal selection, route selection and traffic flow on the network (dynamic traffic flow).

2.2 Traffic Generation

The traffic generation is the amount of traffic generated by a zone or area per unit of time. The amount of traffic depends on the activities of the city, because the cause of traffic is the human need to carry out activities that relate to and transport goods needed. The generation of the trip is assumed that the generation and attraction of trip as a function of some zone-based socio-economic attributes (x1, x2, ... xn) [6].

$P = f(x_1, x_2, \ldots x_n)$

$A = f(x_1, x_2, \ldots x_n)$

where:

P = Production/Generation

A = Attraction

$x_1, x_2, \ldots x_n$ = Variable land use

2.3 Performance of the Road Section

Service quality from road sections can be measured using a comparison of the volume of traffic flow to road capacity [7]. According to the Indonesian Highway Capacity Manual (1997), road capacity is defined as the maximum flow through a point on the road that can be maintained per hour at certain condition. For two-way roads (two-way combinations), but for multi-lane roads, the flow is separated by direction and the capacity is determined per lane. Capacity values are observed through field data collection as long as possible, capacity estimated from analysis of traffic conditions, and theoretically assuming mathematical relationship between density, speed and flow [8].

The equation to determine road capacity is as follows [8]; $C = C_0 \times F_{cw} \times F_{csp} \times F_{csf} \times F_{ccs}$. The level of service of a road section is a comparison between traffic volume and road capacity (V/C). Soekarno-Hatta is a type of primary collector road. Characteristics of road service levels on primary collector roads can be seen in Table 1.

Table.1: Road Service Level Characteristics of Primary Collectors [9]

Road service level	Characteristics of traffic	V/C Ratio
A	Free flow conditions with high speed and low traffic flow volume. The driver can have the desired speed without a hitch.	≤ 0,3
B	In a stable flow zone, the driver has enough freedom to make a maneuver	≤ 0,5
C	In this zone, the driver's steady flow is limited in speed	≤ 0,75
D	This zone is an unstable flow, where all drivers are limited in speed, traffic volume is close to road capacity	≤ 0,9
E	This zone of traffic volume close to or is in its capacity, the flow is unstable and often stops	≤ 1
F	This zone of forced flow will cause congestion, or the speed is very low, the queue of the vehicle is very long and many obstacles	>1,00

2.4 Multiple Linear Regression

In trip generation modeling, the Multiple Linear Regression Analysis method is most commonly used. Since 1950, most transportation planning researches have used linear regression analysis to examine trip generation [10]. Multiple linear regression techniques are of interest to transport analysts because they provide convenience in determining the degree of relationship between non-independent variables and independent variables. The concept of multiple linear regression analysis states that the relationship between a dependent variable with several independent variables [11].

This mathematical model has a form:

$Y = a + b_1X_1 + b_2X_2 + \ldots\ldots\ldots\ldots + b_nX_n$

with:

Y = dependent variable (number of production trips)

a = constants (numbers to look for)

b1, b2,...., bn = regression coefficients (numbers to look for)

$X_1, X_2, \ldots, X_n$ = independent variable (influential factors)

2.5 Classic Assumption Test

Classic assumption tests include multicollinearity, heteroscedasticity, autocorrelation, and normality tests. Multicollinearity classic assumption test is used to measure the level of association (closeness) relationship/influence between the independent variables through the magnitude of the correlation coefficient (r). Multicollinearity occurs when the correlation coefficient between independent variables is greater than 0.60. It is said that there is no multicollinearity if the correlation coefficient between independent variables is smaller or equal to 0.60 ($r < 0.60$). [12].

Heteroscedasticity test aims to test whether in the regression model there is a variance inequality from residuals of one observation to another observation. If the variance from one observation to another observation remains called homoscedasticity or heteroscedasticity does not occur. Or if the variance is different then it is called heteroscedasticity. A good regression model is homoscedasticity or heteroscedasticity does not occur [13]. If there are certain patterns such as the dots that form a certain regular pattern (wavy, widened and then narrowed) it indicates that heteroscedasticity has occurred. If there is no clear pattern and the points spread above and below the number 0 on the Y axis, heteroscedasticity does not occur. According to [14] heteroscedasticity can lead to inefficient estimation of parameters so that they do not have a minimum range. Parameter estimation is considered efficient because it has a minimum variety, so that the variety of tools is constant or also called that the assumption of homoskedasticity is fulfilled. Heteroscedasticity testing uses a graph test; it can be conducted by comparing the distribution between the predicted values of the dependent variable and the residuals, the output of the detection will be printed in the form of data distribution on a scatter plot.

A good regression equation is not having autocorrelation problems. If there is autocorrelation, the equation becomes not good or not suitable for prediction. The size in determining whether there is an autocorrelation problem with the Durbin-Watson (DW) test. Provisions of test results are if there is a positive autocorrelation if DW is below -2 (DW <-2) and autocorrelation does not occur if DW is between -2 and +2 or -2 <DW +2. [15].

Normality test is useful to determine the data that has been obtained is normally distributed. The normality test will be conducted using the chi square formula or chi square. Chi squared techniques are used to test the significance of frequency differences. It means that to interpret whether there are significant differences or not between the frequencies obtained with the expected frequency [16].

III. RESEARCH METHOD

3.1 Data Collection

Primary data from this research are household characteristics (independent variables and characteristics of the population's trip of the Wengga Housing area, Katingan Karya Citra Housing, Griya Cipta Housing of Kasongan City; independent variables (household characteristics) and the dependent variable in this research is total trips per-family per day for activities out of housing. Primary data is obtained by observing questionnaires distributed to each house to be filled in by the respondents. The numbers of respondents in this research were 300 household samples.

3.2 Reviewed Variables

The analysis used in this research is multiple regression analysis. The variables used in the analysis are total trips as the dependent variable (y) with the independent variable (x) including: the number of family members who work in units of people in the family (x_1); number of family members who attend school in units of people in the family (x_2); the number of family members who do not work and do not attend school in units of people in the family (x_3); household size in unit of people in the family (x_4); amount of car ownership in units of vehicles (x_5); the number of motorcycle ownership in units of vehicles (x_6); number of bicycle ownership (x_7); total vehicle ownership in one house (x_8); monthly family income scale (x_9); number of type 36 houses (x_{10}); number of type 45 houses (x_{11}); number of type 60 houses (x_{12}); number of inhabited houses (x_{13}); Housing area in scale (x_{14}).

3.3 Analysis and Interpretation

In this research, the number of generation generated through cross-category analysis and analysis using SPSS (Statistics Product and Service Solution) program [17]. This research is in the form of quantitative descriptive with the relationship test of all variables including regression normality, multicollinearity test, heteroscedasticity test, and autocorrelation test.

Whereas to analyze the load due to access road traffic in the Wengga Housing area, Katingan Karya Citra Housing area, Griya Cipta Housing area, Kasongan City uses the Indonesian Highway Road Capacity Manual approach of 1997.

IV. RESULT AND DISCUSSION

4.1 Generation Model

The generation model is built in two data approaches, namely; 1) household-based generation models, and 2) zone-based generation models. By means of “trial and error” by eliminating the insignificant “x” variable, the equation for the household-based generation model is as follows:

$$y = 0.308 + 0.326x_4 + 0.206x_8 + 2.010x_9$$

where;

y = total trips per family per day

x_4 = household size unit of people in the family

x_8 = the total number of vehicle ownership in one house

x_9 = income scale per family per month

Furthermore, the estimation and classical test results are shown in Table 2, Table 3, Figure 1, and Figure 2.

https://dx.doi.org/10.22161/ijaers.5.8.31 **ISSN: 2349-6495(P) | 2456-1908(O)**

Table 2. Results of Model Estimation (household-based)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	,559a	,313	,311	2,12077	,313	135,770	1	298	,000	
2	,615b	,378	,374	2,02149	,065	30,988	1	297	,000	
3	,624c	,390	,384	2,00537	,012	5,795	1	296	,017	2,285

a. Predictors: (Constant), x9
b. Predictors: (Constant), x9, x4
c. Predictors: (Constant), x9, x4, x8
d. Dependent Variable: y

From Table 2, the correlation value of the equation shows a strong relationship (0.624).

Table.3: Results of coefficients estimation (household-based)

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	*(Constant)*	,881	,582		1,513	,131
	x9	2,649	,227	,559	11,652	,000
2	*(Constant)*	-,205	,588		-,348	,728
	x9	2,331	,224	,492	10,399	,000
	x4	,448	,081	,263	5,567	,000
3	*(Constant)*	,308	,621		,496	,620
	x9	2,010	,259	,424	7,752	,000
	x4	,326	,095	,191	3,439	,001
	x8	,206	,085	,156	2,407	,017

a. Dependent Variable: y

From Table 3 it can be seen that partially there is a significant influence between X_4, X_8, and X_9 on Y_i. From the Sig value. the three independent variables show a value of <0.05.

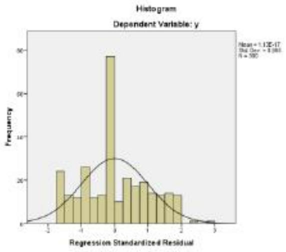

Fig. 1: Normal Curve (household-based)

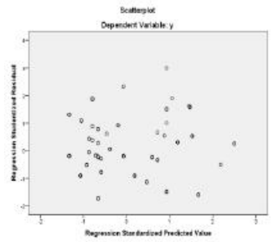

Fig. 2: Distribution Graph (household-based)

The resulting Durbin-Watson (DW) value is 2,285 (Table 2). From DW Table with 0.05 significance and number of data (n) equal to 300, and k by 3 (k is the number of independent variables), the DW value (2,285) is between dU and 4-dU, meaning there is no autocorrelation.

The normality test in Figure 1 shows the normal curve line (mean≈0), the points tend to approach the diagonal line, so it can be said to be normally distributed. Figure 2 shows the heteroscedasticity test graphically where the points are not patterned and spread above and below the *y* axis (number 0), meaning that there is no heteroscedasticity problem in the regression model. Multicollinearity test is that all the coefficient of determination (R^2) <R^2 value model, so it is concluded that there is no multicollinearity problem in the regression model.

In the same way for the equation of the zone-based generation model, the equation of the generation model can be as follows:

$$y = -165.791 + 41.850x_8 + 0.321\ x_{13}$$

where;

y = total trips per family per day

x_8 = total vehicle ownership in one house

x_{13} = number of inhabited houses

Furthermore, the estimation and classical test results are shown in Table 4, Table 5, Figure 3, and Figure 4.

Table.4: Results of Model Estimation (zone-based)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	,974a	,948	,913	9,81408	,948	27,192	2	3	,012	2,522

a. Predictors: (Constant), x8, x13
b. Dependent Variable: y

From Table 4, the correlation value of the equation shows a strong relationship (0.974).

Table 5. Results of estimated coefficients (zone-based)

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-165,791	52,115		-3,181	,050

https://dx.doi.org/10.22161/ijaers.5.8.31 ISSN: 2349-6495(P) | 2456-1908(O)

x13	,321	,052	,828	6,219	,008
x8	41,850	13,313	,418	3,144	,052

From Table 5, it can be seen that partially there is a significant influence between X_{13} and X_8, on Y_i. From the Sig value. both independent variables show a value of <0.05.

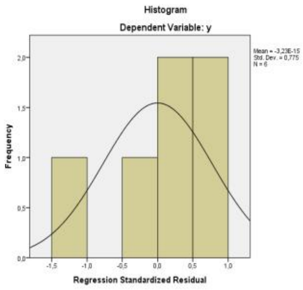

Fig. 3: Normal curve (zone-based)

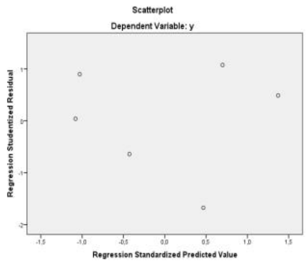

Fig. 4: Distribution Graph (zone-based)

The Durbin-Watson (DW) value generated is 2,522. From Table DW with 0.05 significance and number of data (n) equal to 300, and k by 2 (k is the number of independent variables), DW values (2,522) are between dU and 4-dU, meaning there is no autocorrelation.

The normality test in Figure 3 shows the normal curve line (mean≈0), the points tend to approach the diagonal line so it can be said to be normally distributed. Figure 4 shows the heteroscedasticity test graphically where the points are not patterned and scattered above and below the *y* axis (number 0), meaning there is no heteroscedasticity problem in the regression model. Multicollinearity test that all of value determination coefficient (R2) <R^2 value model, then concluded there was no multicollinearity problem in the regression model.

The classic test of the two generation model approaches shows results that have met the requirements. However, when viewed from the correlation value, the zone-based generation model shows a better value than the household-based generation model.

4.2 Analysis of Road Performance in Existing Conditions

Road performance analysis is carried out at peak hours using the value of degree of saturation (DS) that occurs. From the traffic data taken for 12 hours, the peak hours occur at 06.00 - 07.00 at 676.9 pcu/hour. Fluctuations in traffic flow then can be seen in Figure 5.

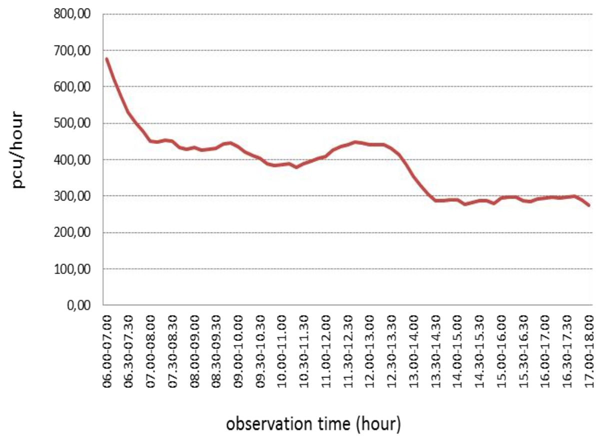

Fig. 5: Fluctuations in Traffic Flows of Soekarno-Hatta Street

The geometric data of Soekarno-Hatta Street are basic capacity (C_0) = 2900 pcu / hour for the undivided two-lane road type, road width adjustment factor (FC_w) = 0.56 for the undivided two-lane road type with effective traffic lane width (W_c) total of two-way 5m, directional separation adjustment factor (FC_{SP}) = 1, side barrier adjustment factor with kereb (FC_{CS}) = 0.97, and city size adjustment factor (FC_{CS}) = 0.9 for undivided two-lane road type with city size = 0.1 - 0.5 million inhabitants.

C1 = 2900 x 0.56 x 1 x 0.97 x 0.9

C1 = 11417.75 pcu/hour

By comparing the value of traffic flow and capacity, the value of DS = 676.9 / 11417.75 = 0.59 can be obtained, or in other words the LOS of Soekarno-Hatta Street in the existing condition is A.

Furthermore, we can forecast the performance of Soekarno-Hatta Street in the future by paying attention to the development of settlements using the zone-based generation model obtained

4.3 Use of the Generation Model to Estimate the Traffic Flow Charges

Traffic flow on Soekarno-Hatta Street based on the origin of the trip can be divided into two, namely the flow coming from the internal zone (settlement) and the external zone (trajectory/outside the settlement). At the same peak hour, the contribution of traffic loads originating from the reviewed generation zone is as shown in Table 6.

Table 6. Contribution of Traffic Loads from the Generation Zone (pcu / hour)

Location	Zone	Volume (pcu/hour)
Wengga Housing	Strawberry-Soekarno-Hatta	117.3
	Apple-Soekarno-Hatta	51.5
Karya Citra	Avocado-Soekarno-Hatta	101.5

Housing	Pineapple-Soekarno-Hatta	42.5
Griya Cipta Housing	Durian-Soekarno-Hatta	73
	Watermelon-Soekarno-Hatta	35.5
TOTAL		**421.3**

Based on the data from Table 6, the contribution of traffic flow burden from the reviewed settlement is 62.24% while the rest comes from the external zone which is 255.6 pcu/hour.

Furthermore, the increase of traffic flow in the future for the internal zone uses the zone-based generation model obtained and the external zone uses the regional traffic growth rate of 3.5%.

Assuming the traffic impact due to settlement development is up to 5 years [18], the value of vehicle ownership for each average house (X_8) is 4, so it can be estimated the addition of the number of occupied housing (X_{13}) by considering the performance of Soekarno-Hatta Street remains in a stable condition (DS $\leq$ 0.75). For example, in the next 5 years conditions with the addition of occupied housing to 1.5 times, the estimated flow at Soekarno-Hatta Street will be as follows:

Internal Flow:

$V_{settlement} = -165.791 + 41.850x_8 + 0.321\ x_{13}$

$= -165.791 + 41.850\ (4) + 0.321(1348\ \times 1.5)$

$= 650.67$ pcu/hour

External Flow:

$V_{external} = V_{external\ existing} \times (1+i)^n$

$= 255.6 \times (1+0.035)^5$

$= 303.57$ pcu/hour

So the value of DS of Soekarno-Hatta Street is (650.671 + 303.57) /1417.75=0.67. Furthermore, the estimation with alternative addition of occupied housing can be seen in Table 7.

Table 7. Estimated Addition of Occupied Housing to DS-Value

Condition	Total of Occupied Housing	$V_{internal}$ (pcu/hour)	$V_{external}$ (pcu/hour)	DS
Existing	1348	421.30	225.60	0.48
5-year Forecasting and housing growth of 1.5 x	2022	650.67	303.57	0.67
5-year Forecasting and housing growth of 1.8 x	2350	755.96	303.57	0.75
5-year Forecasting and housing growth of 2 x	2696	867.03	303.57	0.83

From Table 7, it can be seen that the performance of Soekarno Hatta Street still can be maintained in a stable traffic flow condition (LOS $\leq$ C) if the housing development is not more than 1.8 x (2350 units) or an additional of 1002 houses occur.

V. CONCLUSION

several tests on the relationship between total trips on Soekarno-Hatta Street as the dependent variable (y) and as an independent variable (x), the zone-based generation model resulted a better model compared to the household-based generation model. The best form of regression equation obtained is: $\boldsymbol{y}$ = -165,791 + 41,850x8 + 0,321x_{13} where y is total trips in one zone, x_8 is the total vehicle ownership on average in one house, and x_{13} is the number of inhabited houses.

Assuming that the rate of regional traffic growth is 3.5%, the average number of vehicle ownership is 4 units, and the traffic flow conditions on Soekarno-Hatta Street are still stable in the next 5 years, the allowable housing development is no more than 1.8 x (2350 units) or the addition allowed is only 1002 housing.

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