https://dx.doi.org/10.22161/ijaers.5.12.13 ISSN: 2349-6495(P) | 2456-1908(O)

Analysis of Volume Relationship, Traffic Speed and Density in the Tulukabessy Street with the Greenberg and Underwood Methods

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***Abstract*— *The city of Ambon, a city that is often called the city of music or often dubbed the "Ambon manise" also does not escape the problem of congestion. There are several areas which are the points of congestion in the city of Ambon, namely, the area of JalanSlametRiyadi, precisely in front of Makodim 1504 Ambon, to Tulukabessy. The congestion that occurred on Tulukabessy road was partly because there was a shopping center (Citra) and several offices on the road, there was also a road body that was used as a garage. To overcome the congestion that occurs in some of the regions mentioned above, a good traffic management is needed. Traffic parameters that need to be known, namely traffic flow or volume, speed and density. The performance of a road can be measured from these three parameters or often referred to as traffic characteristics. For this reason, the volume, speed and density of traffic will be analyzed using the Greenberg method and the Underwood method.*

This research is quantitative and data collection is done by means of surveys, namely speed surveys and traffic flow surveys. Volume and speed data are then processed to obtain density. Furthermore, the three traffic parameters were analyzed by the Greenberg and Underwood methods, resulting in a relationship between the three traffic parameters.

The most suitable method used for the Tulukabessy road is the Underwood method with a coefficient of determination (R2) = 0.960 with a maximum Density value (DM) = 200 smp / hour maximum volume (VM) is VM = 2481.84626 junior / hour. The relationship between the parameters of the Tulukabessy road traffic with the Underwood method, as follows: Relationship Speed-Density Ln S = 3.7394 - 0.005 D; Volume - Density Relationship V = 42,073 D e-0,005 D; Relationship Volume - Speed V = 747.88 S - 200 S Ln S. The most suitable method used for the Tulukabessy road is the Underwood method with a coefficient of determination (R2) = 0.960 with a maximum volume value (VM) is VM = 2481.84626 junior high school / hour.

***Keywords*— Traffic Parameters, Underwood, Greenberg.**

I. INTRODUCTION

Congestion is a classic problem faced by cities in the world, including in Indonesia. The problem of congestion is a daily problem that must be faced by urban communities, including the city of Ambon.

Tulukabessy Road which is one of the points of congestion in Ambon city is a secondary road which is a road network systemwith the role of the distribution of goods and services for the community in urban areas or in simple language is a road network in urban areas. The congestion that occurred on Tulukabessy road was partly because there was a shopping center (Citra) and several offices on the road, there was also a road body that was used as a garage. Besides that, on the Tulukabessy road there are several crossroads which are also one of the causes of congestion, namely from the PHB intersection, PU Bridge intersection, Citra intersection and Hotel Josiba intersection. Besides this, the burden of vehicles on the TulukabessyMardika road to the BatuMerah area is quite high, because drivers prefer the road to the Mardika coastal road to Ongkoliong(https://www.tribun-maluku.com). To overcome the congestion that occurs, a good traffic management is needed. Traffic management certainly requires information about the parameters of traffic on the road that is the point of congestion. Traffic parameters that need to be known, namely traffic flow or volume, speed and density.

https://dx.doi.org/10.22161/ijaers.5.12.13 ISSN: 2349-6495(P) | 2456-1908(O)

II. STUDY OF LITERATURE

1. Road

Definition of Road According to Law No. 38 of 2004 is land transportation infrastructure that covers all parts of the road, including complementary buildings and equipment intended for traffic, which are on the surface of the land, above the surface of the land, below the surface of the land and / or water, and above the surface of the water, except railroads, lorry roads and cable roads.

In accordance with the designation the road consists of public roads and special roads. Public roads are grouped according to system, function, status and class, while special roads are not intended for general traffic in the context of the distribution of goods and services needed.

Road characteristics will affect road capacity and performance if it is burdened with traffic. Road characteristics consist of:

a. Geometry

1) Road type: various types of roads will show different performance in loading certain traffic, for example a divided and undivided road; one way street.

The types of urban roads are as follows:

a) two-way two-lane road (2/2 UD)

b) Two-way four-lane road

- undivided (i.e. without median) (4/2 UD)
- divided (i.e. by median) (4/2 UD)

c) Split two-lane six-lane road (6/2 D)

d) One-way roads (1-3 / 1)

2) Traffic lane width: Free flow velocity and capacity increase with increasing traffic lane.

3) Kereb: kereb as the boundary between traffic lanes and sidewalks affects the impact of side obstacles on capacity and speed. The capacity of the road with kereb is smaller than the road with the shoulder. Furthermore the capacity decreases if there is a barrier that remains near the edge of the traffic lane, depending on whether the road has a kereb or shoulder.

4) Shoulders: urban roads without kereb generally have shoulders on both sides of the traffic lane. The width and condition of the surface affects the use of the shoulder in the form of additional capacity and speed at certain currents, due to increased shoulder width, mainly due to the reduction of side barriers caused by road side events such as stop public transport vehicles, pedestrians and so on.

5) Median: the median is the area that separates the direction of traffic in the road segment. Well-planned median increases capacity.

6) Road alignment: horizontal curves with small fingers reduce free flow velocity. Steep incline also reduces free flow speed. Because in general the speed of free flow in urban areas is low, this influence is ignored.

b. Flow Composition and Separation of Directions

1) Separation of traffic direction: the capacity of the two-way road is highest at 50-50 separation, ie if the currents in both directions are the same for the time period analyzed (generally one hour).

2) Traffic composition: traffic composition affects the velocity-flow relationship if the current and capacity are expressed in vehicle / hour, that is, depending on the ratio of motorbikes or heavy vehicles in traffic flows. If the current and capacity are expressed in passenger car units (pcu), the light vehicle speed and capacity (pcu / hour) are not affected by the composition of the traffic.

c. Traffic control

Speed limits are rarely applied in urban areas in Indonesia and therefore have little effect on the free flow velocity. Other traffic rules that affect traffic performance are: parking restrictions and stops along the side of the road, restrictions on access to certain types of vehicles, restrictions on access from side roads and so on.

d. Side Road Activity (Side Obstacles)

Many roadside activities in Indonesia often cause conflict, sometimes having a large effect on traffic flow. The most influential side constraints on urban road capacity and performance are:

1) Pedestrians

2) Public transportation

3) Slow vehicles (egpedicabs, horse carriages)

4) Vehicles enter from the land beside the road.

e. Driver Behavior and Vehicle Population

The size of Indonesia and the diversity and level of development of urban areas show that the behavior of the driver and vehicle population (age, power and condition of the vehicle, the composition of the vehicle) are diverse. Smaller cities show less agile driver behavior and less modern vehicles, causing lower capacity and speed at certain currents, compared to larger cities.

2. Characteristics of Traffic Flow

To be able to represent the characteristics of traffic flow well, there are 3 (three) main parameters that must be known where the three parameters are mathematically related to each other, namely (Wohl and Martin, 1967; Pignataro, 1973; Hobbs, 1979; Tamin, 1992e in Tamin, 2000):

a. Traffic flow or volume

Traffic flow is the number of vehicles that pass a certain point in a certain road segment in one unit of time.

General formula:

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$$V = \frac{n}{T} \ldots\ldots\ldots\ldots\ldots(2.1)$$

with:
V = Traffic flow (vehicle / hour, junior / hour)
n = Number of vehicles (vehicles, junior high)
T = Observation time interval (hours)

b. Average space speed

The average velocity of space is the speed value along the observed road segment which is the result of a comparison between the distance traveled with the average time to take the road.

General formula :

$$S = \frac{d}{t} \ldots\ldots\ldots\ldots(2.2)$$

with:
S = Average space speed (m / sec, km / h)
d = Length of the observed road (m, km)
t = Average travel time along d (seconds, hours)

c. Density

Density is the number of vehicles in one unit of a certain road length. Difficult density is measured directly but can be calculated from speed and volume.

The formula:

$$D = \frac{V}{S} \ldots\ldots\ldots\ldots\ldots(2.3)$$

with:
D = Vehicle density (vehicle / km, pcu / km)
V = Vehicle current / volume (Smp / hour, vehicle / hour)
S = Vehicle speed (km / h)

Analysis of the characteristics of traffic flow for a road segment can be done by studying the mathematical relationship between speed, flow and traffic density that occurs on the road section. The mathematical relationship can be expressed by the equation:

V = D.S ……………………. (2.4)

The mathematical relationship between these parameters can be explained using Figure 2.1. which shows the general form of mathematical relations between speed-density (S-D), current-density (V-D) and current-speed (V-S).

The mathematical relationship between speed-density is monotonically downward which states that if the traffic flow density increases, the speed will decrease. Traffic flow will be 0 (zero) if the density is very high so it does not allow the vehicle to move again. This condition is known as total traffic jam (D = Dj). in conditions of density 0 (zero) (D = 0), there are no vehicles on the road so that the traffic flow is also 0 (zero). If the density increases from zero, then the speed will decrease while the flow of traffic will increase. If the density continues to increase, conditions will be achieved where an increase in density will not increase the flow of traffic, on the contrary it decreases the flow of traffic (figure 2.1). The maximum point of the traffic flow is expressed as current capacity.

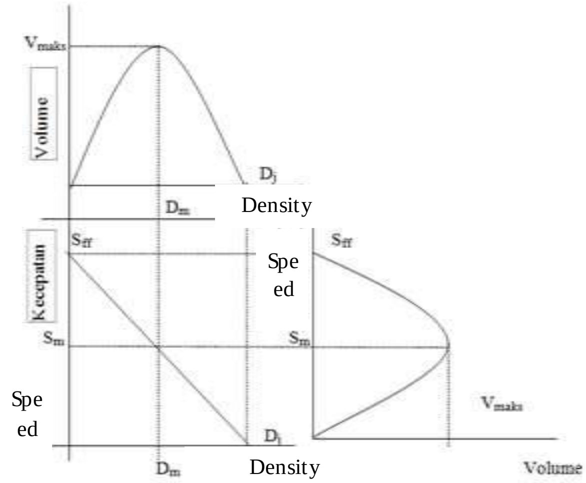

Fig.2.1.Mathematical relationship between speed, current and density

Figure 2.1 also shows some other important parameters of traffic flow which can be defined as follows (Wohl and Martin, 1967; Pignataro 1973; Salter, 1978; Hobbs, 1979; Tamin et al, 1992b; and Country, 1994, and Tamin, 1996 in Tamin 2000):

Vm = Maximum capacity or current (vehicle / hour)
Sm = Speed at maximum traffic flow conditions (km / h)
Dm = Density in maximum traffic flow conditions (vehicle / km)
Dj = Density in total traffic jam conditions (vehicles / km)
S_{ff} = The speed of traffic conditions is very low or at conditions close to zero or free flow velocity (km / h)

Free flow velocity (S_{ff}) cannot be observed in the field because the condition occurs when there is no vehicle (D = 0). Free flow velocity values can be obtained mathematically derived from the mathematical relationship between current-velocity that occurs in the field. Data that can be collected in the field by conducting surveys is the flow and speed of traffic. Traffic passes through various types so the traffic flow data must be stated in passenger car units (pcu). The number of vehicles observed is based on the type and will be equivalent to passenger cars. Emp value (passenger car equivalence) for each type of vehicle can be seen in Table 2.1.

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Table.2.1: The equivalent value of passenger cars with divided and one-way road types

Road type: one-way road and divided road	Traffic flow per track (vehicle / hour)	Emp	
		HV	MC
Two lanes one direction (2/1) and Four divided lanes (4 / 2D)	< 1050 ≥ 1050	1,3 1,2	0,4 0,25
Three lanes one direction (1/3) and Six divided lanes (6 / 2D)	< 1100 ≥ 1100	1,3 1,2	0,4 0,25

Source: Indonesian Road Manual Capacity 1997

III. METHODOLOGY

In this study the method used for data collection is by survey in the field.

1. Survey volume

The way is by direct observation in the field (counting every vehicle that passes per 15 minutes). The survey of traffic flow or survey of the number of vehicles in this study was carried out manually, namely recording the number of vehicles passing one observation point for one unit of time. The number of vehicles observed is based on the type and will be equivalent to passenger cars. The observation point for volume surveys is the front of the KDP building.

2. Speed survey

You do this by measuring the travel time of the vehicle through the observation point by using a stopwatch aid. In this study the average speed of the traffic flow space is determined by the speed of the point (spot speed) that is the observer recording the travel time of a vehicle with a certain distance. The assumption of using point speed is that the speed along the road is fixed. The spot used for speed surveys is the front segment of the PPK Building to the front of the Taspen office (+ 50 meters).

A. Analysis Method

Survey data in the form of volume data and velocity data are then processed to produce density. After that, these three parameters are analyzed further using the Greenberg method and the Underwood method, which can be described as follows:

1. The Greenberg Method

Greenberg (Wohl and Martin, 1967; Pignataro, 1973; Salter, 1978; and Hobbs, 1979 in Tamin 2000) assume that the mathematical relationship between speed-density is a logarithmic function. The basic equation of the Greenberg method can be expressed through equation (3.1).

$$D = C.e^{bS} \quad \text{(3.1)}$$

Where C and b are constants

The mathematical relationship between speed-density can then be expressed in equation (3.3).

$$S = \frac{Ln\,D}{b} - \frac{Ln\,C}{b} \quad \text{(3.2)}$$

Next is the mathematical relationship between current-speed:

$$.V = \frac{D.Ln\,D}{b} - \frac{D.Ln\,C}{b} \quad \text{(3.3)}$$

The mathematical relationship between current-density can be seen in the equation. The maximum current condition (VM) can be obtained when the current D = DM. The D = DM value can be obtained through the equation:

$$D_M = e^{LnC-1} \quad \text{(3.4)}$$

Next is the mathematical relationship between current and speed:

$$V = S.Ce^{bS} \quad \text{(3.5)}$$

The maximum current condition (VM) can be obtained when the current is S = SM. The value of S = SM can be obtained through the equation:

$$S_M = -\frac{1}{b} \quad \text{(3.6)}$$

2. Underwood method

Underwood (Wohl and Martin, 1967; Pignataro, 1973; Salter, 1978; and Hobbs, 1979 in Tamin 2000) assumes that the mathematical relationship between speed-density is an exponential function. The basic equation of the Underwood method can be expressed by the equation:

$$S = S_{ff}.e^{-\frac{D}{D_M}} \quad \text{(3.7)}$$

where: Sff = free flow velocity

DM = Speed at maximum current (capacity)

The mathematical relationship between speed-density can then also be expressed in equation (2.36).

$$.Ln\,S = Ln\,S_{ff} - \frac{D}{D_M} \quad \text{(3.8)}$$

mathematical relationship between current-density as follows:

$$V = D.S_{ff}.e^{-\frac{D}{D_M}} \quad \text{(3.9)}$$

The maximum current condition (VM) can be obtained when the current D = DM. While the mathematical relationship between current-velocity is as follows:

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$$V = S.D_M.(Ln\,S_{ff} - Ln\,S) \text{.........} \quad (3.10)$$

The maximum current condition (VM) can be obtained when the current is S = SM. The value of S = SM can be obtained through the following equation (3.11):

$$S_M = e^{Ln\,S_{ff} - 1} \text{................... ... ...} \quad (3.11)$$

IV. RESULTS AND DISCUSSION

A. Overview of Research Sites

Tulukabessy Street is an urban road located in Mardika village, Sirimau sub-district, Ambon City. The width of the Tulukabessy road is 10.3 meters with a one-way traffic system, the cross section of the Tulukabessy road can be seen in Figure 4.1. Tulukabessy Road has a fairly heavy traffic flow, especially during peak hours. This is because mainly because JalanTulukabessy has a shopping center, motorcycle taxi, directions to the mardika terminal, offices, and places of business / trade on both sides of the road.

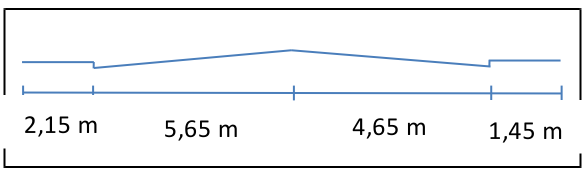

Fig.4.1: Cross Section of the Tulukabessy Road

B. Description of Research Variables

1. Calculation of Traffic Flow / Volume

Data on traffic flow obtained from the survey results in the form of vehicle data every 15 minutes. This data is multiplied by the Equivalence factor of Passenger Cars (EMP) for each type of vehicle then summed so that the traffic volume is obtained for each hour.

Equivalent Value of Passenger Cars (EMP) for each type of vehicle according to MKJI 1997 for urban roads are:

a) Heavy vehicles (HV) = 1.3
b) Light Vehicle (LV) = 1.0
c) Motorcycle (MC) = 0.4

The current / volume survey is conducted for three days, namely on the 24th, 26th and 29th of September 2018 starting at 6:00 a.m. until 19:00 a.m. every day. The processed data is then presented in graphical form which shows the relationship between traffic volume (pcu / hour) and time interval (hour), the graph can be seen in figure 4.2 to figure 4.4. From the graph can be described the condition of the traffic flow at the highest and when the lowest current.

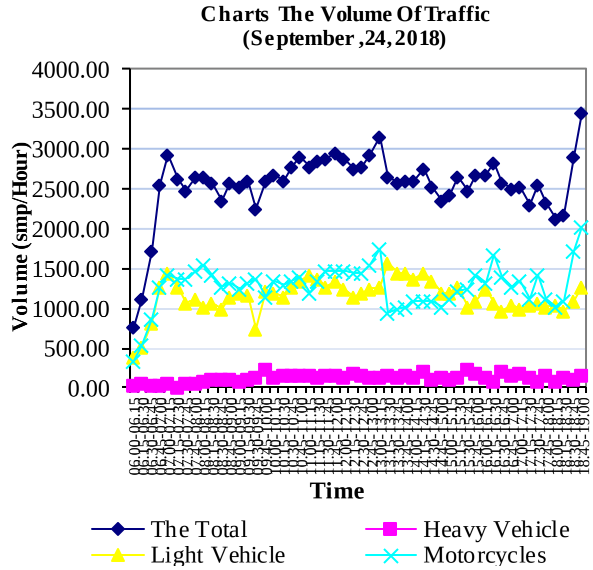

Fig.4.2: Charts the volume of traffic (September 24, 2018)

From graph 4.2 above, it can be seen that the highest traffic volume on September 24, 2018, which is equal to 3468.40 pcu / hour occurs in the afternoon at 18.45-19.00 Wit. For the morning the traffic volume is high at 7:00 a.m. to 7:15 a.m. that is equal to 2922 pcu / hour and during the day at 1:00 a.m. to 13:15 wit at 3144.80 pcu / hour.

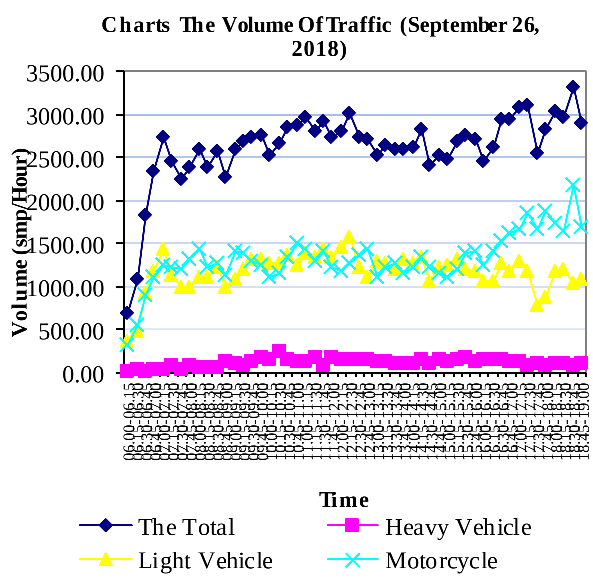

Fig.4.3: Charts the volume of traffic (September 26, 2018)

From graph 4.3 above, it can be seen that the highest traffic volume on September 26, 2018 which is equal to 3324.40 pcu / hour occurs in the afternoon at 18.30-18.45 Wit. For the morning the traffic volume is high at 07.00 a.m. 07.15 Wit which is equal to 2738.40 pcu / hour and during the day at 12.15-12.30 Wit at 3008.40 pcu / hour.

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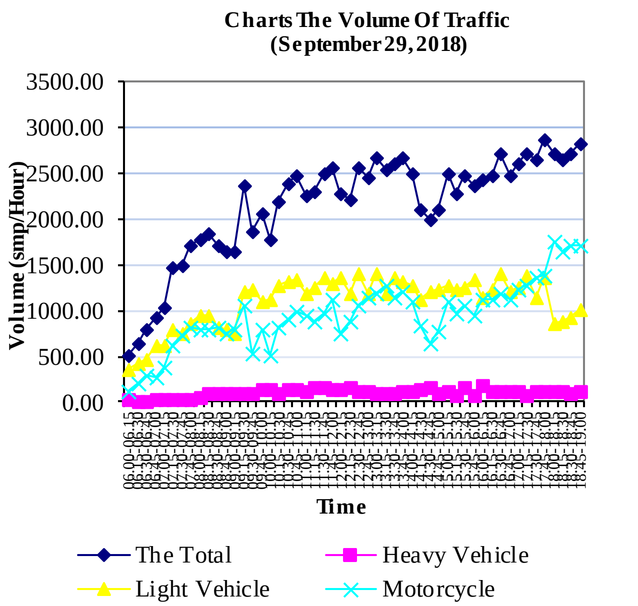

Fig.4.4: Charts the volume of traffic (September 29, 2018)

From figure 4.4, it can be seen that the highest traffic volume on Saturday, September 29, 2018, which is equal to 2871.60 pcu / hour occurs in the afternoon, namely at 17.45-18.00 Wit. For the morning the traffic volume is high at 10:45 a.m. to 11:00 a.m. that is equal to 2475.60 pcu / hour and during the day at 1:00 a.m. to 13:15 wit at 2677,20pcu / hour.

2. Calculation of Vehicle Speed

From the results of the speed survey, the data obtained in the form of travel time from 5 samples for the type of light vehicle every 15 minutes of observation. Travel time data from 20 samples of the vehicle is then calculated on the average travel time of the vehicle at each observation hour (in seconds). The distance taken for the survey is 50 meters long, then to get the vehicle speed data, the distance is divided by the travel time. The speed obtained is still in m / sec so it needs to be converted to units of Km / Hour.

The processed data is presented in graphical form as follows:

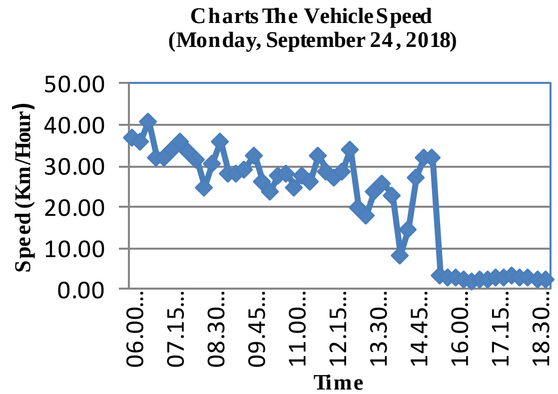

Fig.4.5: Charts the vehicle speed (mondayoctober 24, 2018)

From Figure 4.5 it can be seen at the highest vehicle speed in the morning at 06.30-06.45 Wit at 40.78 Km / Hour while at 16.30-16.45 Wit is the vehicle's lowest speed which is only 1.94 Km / Hour.

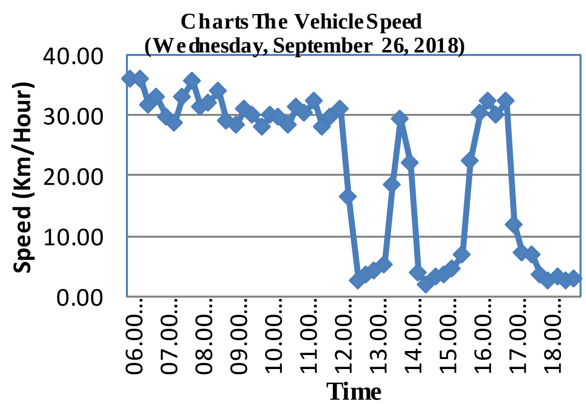

Fig.4.6: Charts the vehicle speed (wednesdayoctober 26, 2018)

From Figure 4.6 it can be seen at the highest vehicle speed in the morning at 06.00-07.00 Wit at 35.94 Km / Hour while at 14.30-14.45 Wit is the lowest speed of the vehicle which is only 1.84 Km / Hour.

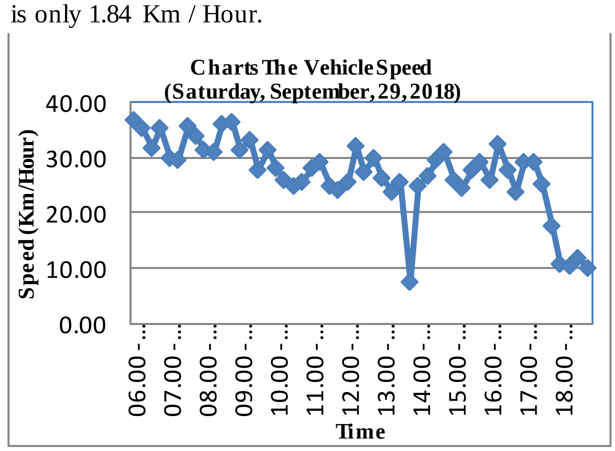

Fig.4.7: Charts the vehicle speed (saturdayoctober 29, 2018)

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From Figure 4.7 above it can be seen at the highest vehicle speed in the morning at 06.00-07.00 Wit at 36.95 Km / Hour while at 13.45-14.00 Wit is the lowest speed of the vehicle which is only 7.63 Km / Hour.

C. Data Testing and Analysis

Daily volume (V) data in junior high / hour and daily average (S) speed data (Km / Hour) are then processed using formula 2.4 to obtain Density (D) data. Then the three variables are processed using the Least Square method in this case the Logarithmic equation (Greenberg Method) and exponential equation (Underwood Method) with the help of SPSS 16 software, to obtain the best method that can represent the traffic parameter relationships on the Tulukabessy road. For traffic parameter data on the three observation days, namely Monday, September 24 2018, Wednesday September 26 2018 and Saturday, September 29, 2018 can be seen the relationship of traffic parameters in this case density and speed based on observations, Logarithmic (Greenberg) method and Exponential method (Underwood) can be seen in figures 4.8, 4.9 and 4.10

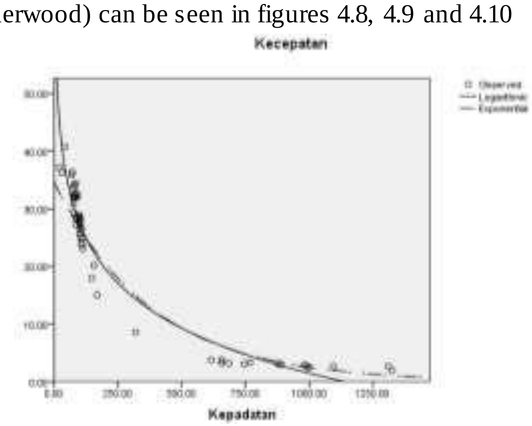

Fig.4.8: Relationship of Traffic Parameters on Monday, September 24, 2018

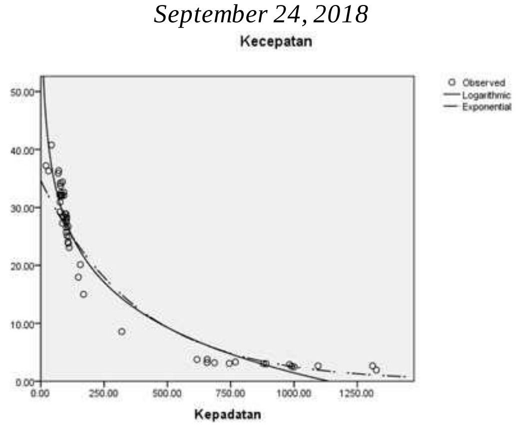

Fig.4.9: Relationship of Traffic Parameters on Wednesday, September 26, 2018

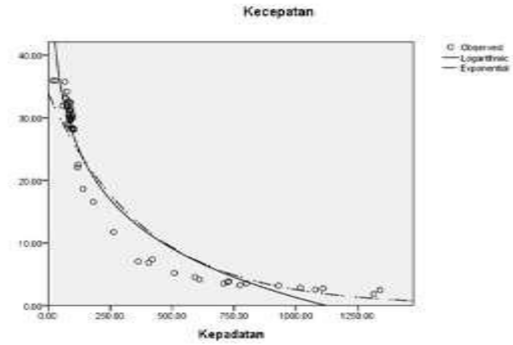

Fig.4.10: Relationship of Traffic Parameters on Saturday, September 29, 2018

D. Discussion

From the results of data analysis with the help of SPSS, the value of the Correlation Coefficient (R) and Determination Coefficient (R2) is obtained for each method on each observation day. Correlation coefficient values range -1 <R <1, which shows the relationship between dependent and independent variables. While the Determination coefficient is the determinant coefficient, which shows the closeness of the relationship between the research variables. If R2 is equal to 1, then the number indicates the regression line matches the data perfectly. To determine the best method and the most suitable for the Tulukabessy road, it can be seen from the results of analysis with SPSS for the value of each coefficient of determination for each observation day at SPSS output, attachment 9. Determination coefficient value obtained by each method for 3 days of observation can be seen in table 4.1.

Table.4.1: Value Coefficient Determination of each method for 3 days of observation

Observation Day	Method	
	Greenberg (Logarithmic)	Underwood (Exponential)
Monday, September 24, 2018	0,942	0,927
Wednesday, September 26, 2018	0,941	0,919
Saturday, September 29, 2018	0,791	0,960

Source: Analysis Results

From table 4.1 above, the best method and the most suitable for the Tulukabessy road is the Underwood (exponential method) method for observing Saturday, September 29, 2018, with the coefficient of determination closest to 1, which is 0.960. For the Greenberg method, the determination coefficient value that is closest to 1 is obtained on Monday, September 24, 2018.

1. The Greenberg Method (Logarithmic)

From the equation Y = A + BX, it is assumed that S = Y and Ln D = X so that through processing data with SPSS, the following results are obtained:

A = 79,793

B = -11,283

From parameters A and B, the following values can be calculated: so and the value of 1178,463

By using the values b and C, a mathematical relationship can be determined between the following parameters:

Speed-density relationship

S = 79,793 - 11,283 Ln ... .……... (4.1)

Volume-density relationship

V = 79,793D - 11,283 D Ln D .... (4.2)

Volume-Speed Relationship

V = 1178,463 S $e^{-0,0886\,S}$ ……….…......(4.3)

2. Underwood Model (Exponential Method)

Through data processing with SPSS, for observations Saturday, September 29, 2018, the Underwood method assumes that the mathematical relationship between speed-density is an exponential function. From the equation Y = A + BX, it is assumed that Ln S = Y and Ln D = X, obtained the following results:

A = Ln 42,073 = 3.7394

B = -0.005

From the above data, S_{ff} = 42.073 km / h, and the maximum density value (DM) can be obtained:

$$D_M = -\frac{1}{B} = \frac{1}{0,005} = 200 \text{ pcu / km}$$

By using the value of Sff = 42.073 km / h and DM = 200 smp / hour, then the mathematical relationship can be determined between the following parameters:

Relationship Speed-Density LnS = 3.7394 - 0.005 D …… .. ……… .. (4.4)

Relationship Volume - Density V = 42,073 D $e^{-0,005\ D}$ ……… .. ……… (4.5)

Relationship Volume - Speed V = 747.88 S - 200 SLn S ... . (4.6)

From the results of the previous analysis, the underwood method is the most suitable method used for the tulukabessy road, so that the maximum volume calculation can be continued by entering the DM value into equation (4.5) or SM into equation (4.6) then VM = 2481,84626 junior / hour.

V. CONCLUSIONS AND SUGGESTIONS

A. Conclusion

The results of this study can be summarized as follows:

1. Relationship between the parameters of the Tulukabessy road traffic and the Greenberg method, as follows:

Relationship of Speed-Density S = 79,793 - 11,283 Ln D

Density Volume V = 79,793D - 11,283 D Ln D

Volume-Speed Relationship V = 1178,463 S e-0,0886 S

2. The relationship between the parameters of the Tulukabessy road section and the Underwood method, as follows:

The Speed-Density Relationship Ln S = 3.7394 - 0.005 D

Volume - Density Relationship V = 42,073 D e-0,005 D

Volume - Speed Relationship V = 747.88 S - 200 S Ln S

3. The most suitable method used for the Tulukabessy road is the Underwood method with a coefficient of determination (R2) = 0.960 with a maximum Density value (DM) = 200 smp / hour maximum volume (VM) is VM = 2481.84626 pcu / hour.

B. Suggestions

This research is input so it needs to be followed up by the parties related to improving the Tulukabessy road facilities such as adding traffic signs, removing side barriers and widening the road to break down the congestion on the Tulukabessy road.

REFERENCES

[1] Anonymous. 1997. Indonesian Road Capacity Manual. Ministry of Public Works, Directorate General of Highways. Jakarta.

[2] Alhani. 2016. Traffic Analysis of Road Capacity in the Suburbs of Pontianak City (Case of Jalan Sungai Raya Dalam). Available at https://www.neliti.com/id/publications/207256/analisa-lalu-lintas-terhadap-kapasitas-jalan-di-pinggiran-kota-pontianak-kasus-j

[3] Apriliansyah. 2011. Comparison of Characteristics of Traffic Flow on the Gunung Sari Road (STA 2 + 100-STA 2 + 800) Section of Surabaya City with Underwood Model and Greenshield Model. Available at http://eprints.upnjatim.ac.id/id/eprint

[4] Hobbs. F.D. 1995.Traffic Planning and Engineering.GadjahMada University Press.Yogyakarta.

[5] Khisty C.J, B.KentLall. 2003. Basics of volume transportation engineering 1. Erlangga. Jakarta.

[6] Mashuri. 2006. Impact of parking vehicles on road bodies on the characteristics of Arterial road traffic. JurnalSMARTek vol.4, No.2.

[7] May Adolf D. 1990.Fundamental Traffic Flow.Prentice Hall. New Jersey

[8] Maelissa Nelda. 2014. Modeling of Traffic Characteristics on One-Way Roads (Case Study: JalanSarapung Manado). Siwalima Journal vol. 2, No. September 2, 2014

[9] Maitimu A, N. Maelissa. 2012. Performance Review and Delay of Unmarked Intersection dr. KayadoeRoad

https://dx.doi.org/10.22161/ijaers.5.12.13 *ISSN: 2349-6495(P) | 2456-1908(O)*

and miss Mount PerumtelRoad Ambon City. Manumata Journal vol. II No. October 2, 2012

[10] Sendow T.K, E. Lintong. 2013. Models of Degree of Saturation and Speed of Vehicles on Urban Roads on the JalanPiereTendean Section. TeknoSipil Journal No. August 11, 2013

[11] Sugiyono. 2009. Statistics for Research. Alfabeta. Bandung

[12] Tamino.z , 2003 , for planning and their presence modeling of transportation can be made an example and disputes and strife about this application is reasonable enough , the bandung institute of technology .Garbage generated by bandung residents

[13] Twibisanahendrata .2007 .The effectiveness of a model characteristic of traffic flow along the highway rungkut standard of a madya medium mayors at city hall jakartasurabaya .The american journal of public civil engineering vol 4 no.1