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The Effect Analysis of Traffic Volume, Velocity and Density in Dr.Siwabessy Salobar Road

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Abstract*—Traffic density has been considered to be affected by the traffic volume and the traffic velocity. This study focuses on investigating the roles of both aspects on the traffic density along the street of Dr. Siwabessy, from Ambon City to Air Salobar or vice versa. This street has been considered to be one busy street in Ambon City with various vehicles passing by along with the crowded pedestrian activities and with new business centrals (e.g. school) along the road describing the complexity of the street traffics. From the study, it was found that the traffic velocity was statisitically the more significant factor in determining the traffic density compared to the traffic volume following the use of the coefficient regression model. The other finding is that the traffic along the street can be classified to be under-saturated*

Keywords*— *Traffic volume, traffic velocity, traffic density, regression model.

I. INTRODUCTION

According to Mashuri (2012) more and more community activity affect the characteristics of traffic flow like speed, volume and traffic density. According to Ekawati et al (2014), one of the main causes of traffic jam is unbalanced road capacity with an increasing number of vehicles. Dr. Siwabessy street in Air Salobar is one of the important streets in Ambon City, which serves the traffic flow from Ambon to Air Salobar. This road is used as a connecting lane from Ambon to Nusaniwe Sub-district. In recent years population growth in Nusaniwe sub-district has been caused the significant increase of vehicles through Dr. Siwabessy street. On the other hand, traffic jam caused by the activity from several new office and school building at this area. So Dr. Siwabessy highway segment will be more crowded because of the volume of vehicles and will affect to the capacity of existing highway. By looking at these conditions it is necessary to do a study to determine the speed, volume and density of roads Dr. Siwabessy-Air Salobar which is a highway that always passes many types of vehicles, as well as daily activities of society. So we will know the road capacity feasibility.

II. LITERATURE

2.1 Highway Definition

Highway are transport infrastructures covering all parts of the road, including auxiliary buildings and equipment intended for traffic. The other hand it means a place passed by vehicle that through a road so that the highway is a very important in all aspects of life. The highway is also affect of an economy and the progress of a country.

2.2. Capasity

The capacity of the highway is the maximum number of vehicles that can pass through the road within a period of one hour without causing traffic jam (Warpani, 1985). According to MKJI (1997) capacity is the maximum current vehicle through a path that can be maintained per unit of hours under certain conditions. The basic equation for calculating road capacity in Indonesian Road Capacity Manual (1997) is:

C : Co x FCw x FCSP x FCSF x FCCS

with :

C : road capacity (smp/hour)

Co : basic capacity (smp/hour)

FCw : preparation of wide traffic lane factor (smp / hour)

FCSP: direction separation adjustment factor

FCSF :adjustment factor due to abstacles

FCCS :adjustment factor of city capacity

For urban road capacity, basic capacity can be seen in table 2.1

Table.2.1 The Basic Capacity of Urban Roads

Type	Basic capacity (smp/hour)
four-divided lane	1650/ lane
Four-undivided lane	1500/lane
Two undivided lane	2900/two lane

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Table.2.2: Preparation of Wide Traffic Lane Factor (fcw)

Type	effective traffic width, (Wc) (m)	FCw
four-divided lane	3.00	0.92
	3.25	0.96
	3.50	1.00
	3.75	1.04
	4.00	1.08
Four-undivided lane	3.00	0.91
	3.25	0.95
	3.50	1.00
	3.75	1.05
	4.00	1.09
Two undivided lane	5	0.56
	6	0.87
	7	1.00
	8	1.14
	9	1.25
	10	1.29
	11	1.34

Table.2.3: Direction Separation Adjustment Factor (FCsp)

direction separation (SP) % - %		50-50	55-45	60-40	65-35	70-30
FCsp	(2/2)	1.00	0.97	0.94	0.91	0.88
	(4/2)	1.00	0.985	0.97	0.955	0.94

Table.2.4: Adjustment Factor Due to Abstacles

Type	Side barriers Class	FCSF			
		Effective width (Ws) (m)			
		≤ 0.5 m	1.0 m	1.5 m	≥ 2 m
4/2 D	VL	0.96	0.98	1.01	1.03
	L	0.94	0.97	1.00	1.02
	M	0.92	0.95	0.98	1.00
	H	0.88	0.92	0.95	0.98
	VH	0.84	0.88	0.92	0.96
4/2UD	VL	0.96	0.99	1.01	1.03
	L	0.94	0.97	1.00	1.02
	M	0.92	0.95	0.98	1.00
	H	0.87	0.91	0.94	0.98
	VH	0.80	0.86	0.90	0.95
(2/2 UD) atau jalan satu arah	VL	0.94	0.96	0.99	1.01
	L	0.92	0.94	0.97	1.00
	M	0.89	0.93	0.95	0.98
	H	0.82	0.86	0.90	0.95
	VH	0.73	0.79	0.85	0.91

Table.2.5: Adjustment Factor of City Capacity (FCcs)

City size	FCcs
< 0.1	0.86
0.1-0.5	0.90
0.5-1.0	0.94
1.0-3.0	1.00

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> 3.0	1.04

2.3. Traffic Volume

The parameter used to determine daily traffic patterns is an average traffic (LHR), LHR obtained by traffic monitoring for 24 hours, in a few days and the result is averaged, expressed in vehicle / day or day / day can be calculated by the formula:

$$Q = \frac{N}{T}$$

with :

Q : volume
N : number of vehicle
T : observation time

2.4. Velocity

Speed is the ratio between distance and time. The formula for calculating speed that is:

$$V = \frac{S}{T};$$

with:

V : velocity (km/hour)
S : distance (km)
T : time(hour)

The relationship between volume, speed, and density is as follows:

$$D = \frac{Q}{Us}$$

with :

D : Traffic density (vehicle/hour)
Q : Traffic volume (vehicle/km)
Us : mean traffic velocity of space (km/hour)

2.6. Saturation ratio

Saturation ratio defined as the ratio of traffic flow Q (smp / hour) to capacity C (smp / hour) is used as the main factor in determining the level of road segment performance.aturation is defined as the following formula;

DS = Q/C

with :

Q : traffic flow
C : capacity

2.7. Relation between Volume, Speed, and Traffic Density

The mathematical relationship between speed, volume, and density can be expressed by the following equation:

$$Q = DxS$$

with:

2.5. Density

Traffic density is the number of vehicles that exceed the capacity of the highway. Density can be calculated based on speed and volume.

Table.2.6: Q/C Ratio

Q/C	Condition
< 0,8	road segment can still serve the volume requirements of vehicles passing through the road
0,8 - 1,0	unstabled condition ,ecause the condition of the road segment can not accommodate the number of vehicles passing through the road
> 1,0	a condition in which the road segment can accommodate the movement of vehicle volume.

Q : volume (SMP/hour)
D : density(vehicle/km)
S : speed (km/hour)

2.8. Passenger Car Unit

The passenger car unit abbreviated as SMP (indonesian factor) is the unit of vehicle in the traffic flow which is equivalent to the light vehicle / passenger car, using the passenger car's equivalence or multiplier factor of the vehicle type into one unit of SMP, where the SMP is influenced by the type / type vehicles, vehicle dimensions, and motion capabilities. The quantities of passenger car units vary according to the Indonesia Road Capacity Manual 1997 shown as follows:

Table.2.2: SMP Factor

Vehicle	(smp)
HV	1,20
LV	1,00
MC	0,25

Table.2.3: Classification of Vehicles

Classification of vehicles	Vehicle
HV	Trucks and Buses
LV	Passenger Car, Mini Bus, Truck pick up
MC	Motorcycle

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III. METHOD

3.1 Location

This research is located on Jln Dr Siwabessy - Air salobar of Ambon Street

3.2 Research Time

This research was conducted on 30 August 2017 until September 2017

3.3 Data Type

1. types of data used are as follows**:**

a. Traffic Volume
b. Speed
c. Road geometric

3.4. Data Analysis Techniques

a. Data Processing Technique

This writing uses the data obtained, with the aim of obtaining an effective approach based on the existing theoretical studies with the following survey steps:

Preliminary studies

-Preliminary study is the process of collecting data to support this writing

- Library Studies

Conducted by collecting references related to the support of writing, which is a theoretical study.

- Data Compilation

Data compilation, is basically a process of collecting, processing and reporting data to get the final result of data half-baked ready to be processed at the stage of data analysis.

- Data Processing and Analysis.

Data processing is an activity for converting raw data that has been obtained into a standard format approached by theoretical studies.

IV. RESULTS AND DISCUSSION

4.1. Traffic Volume Analysis

The number of motor vehicles operating on Dr.Siwabessy road is obtained based on survey during peak hours, in the morning, afternoon and evening, are presented in Table 4.1.

Based on survey results of traffic volume on road Dr. Siwabessy can be seen that the maximum vehicle volume is at 08.00-09.00 with the direction of Ambon - Air Salobar of 1909 vehicles / hour and at 07.00-08.00 with the direction of Air Salobar - Ambon of 1283 vehicles / hour. Subsequently converted into units of passenger cars (smp) using the Highway Manual Capacity Indonesia 1997 for each road segment.

Based on the table 4.5. can be seen for Dr.Siwabessy road segment ratio has less than 1, this indicates that the condition of traffic flow is still below saturated From the above table it is known that in the direction of Ambon to Air Salobar vehicle speed is slower than the direction of Air Salobar to Ambon, this is because vehicles entering Air Salobar area are more dense than vehicles from Ambon to Air Salobar.

Table.4.1: Traffic Volume of Dr.Siwabessy Road

Time	Traffic Volume (Vehicle/hour)	
	Ambon - Air Salobar	Air Salobar - Ambon
06:00 - 07:00	1062	622
07:00 - 08:00	1659	1283
08:00 - 09:00	1909	1003
09:00 - 10:00	839	506
10:00 - 11:00	923	819
11:00 - 12:00	1293	1222
12:00 - 13:00	1625	1001
13:00 - 14:00	1383	1160
14:00 - 15:00	1081	1129
15:00 - 16:00	481	1042
16:00 - 17:00	1085	999
17:00 - 18:00	1148	1102
18:00 - 19:00	1021	1262

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Table.4.2: Dr.Siwabessy Road Traffic direction Ambon to Air Salobar (smp / jam)

Time	Vehicle Classification			Total
	HV	LV	MC	
06:00 - 07:00	10	594.1	238	842.1
07:00 - 08:00	12	1173.9	297.6	1483.5
08:00 - 09:00	13	957	375.6	1345.6
09:00 - 10:00	5	456.3	193.2	654.5
10:00 - 11:00	12	562.9	191.2	766.1
11:00 - 12:00	20	830.7	253.6	1104.3
12:00 - 13:00	22	1136.2	291.6	1449.8
13:00 - 14:00	14	890.5	273.6	1178.1
14:00 - 15:00	15	586.3	246	847.3
15:00 - 16:00	18	601.9	246	865.9
16:00 - 17:00	19	586.3	246	851.3
17:00 - 18:00	14	690.3	241.2	945.5
18:00 - 19:00	13	625.3	210.8	849.1

Table.4.3: Dr.Siwabessy Road Traffic Direction Air Salobar to Ambon (smp / jam)

Time	Vehicle Classification			Total
	HV	LV	MC	
06:00 - 07:00	12	404.3	119.6	535.9
07:00 - 08:00	20	703.3	288.8	1012.1
08:00 - 09:00	8	616.2	208.4	832.6
09:00 - 10:00	5	308.1	105.6	418.7
10:00 - 11:00	8	591.5	142.4	741.9
11:00 - 12:00	12	742.3	255.6	1009.9
12:00 - 13:00	13	551.2	225.6	789.8
13:00 - 14:00	16	718.9	236.4	971.3
14:00 - 15:00	18	694.2	230.8	943
15:00 - 16:00	20	648.7	209.2	877.9
16:00 - 17:00	21	582.4	212	815.4
17:00 - 18:00	13	634.4	240.4	887.8
18:00 - 19:00	16	802.1	251.6	1069.7

4.2. Capasity Calculation

Table.4.4: Result of Road Capacity Calculation

Location		Basic Capasity	Adjustment Factor				Road Capacity (smp / hour)
		(smp/hour)	Line width	Separation of direction	Side Barriers	City ratio	
Dr. Siwabessy Street	Ambon to Air Salobar	2900	0.96	1	0.94	0.93	2433.77
	Arah Air Salobar to Ambon	2900	0.96	1	0.94	0.93	2433.77

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Table.4.5: V / C Ratio Each Lane

Location		Period	Volume	Capasity	VCR	Max VCR
Dr. Siwabessy Street	Ambon to Belakang Soya	Morning	691	3200.79	0.22	0.34
		Noon	963.5	3200.79	0.30	
		Afternoon	1073.8	3200.79	0.34	
		Evening	776.5	3200.79	0.24	
	Belakang Soya to Ambon	Morning	1238.9	3200.79	0.39	0.45
		Noon	1165.4	3200.79	0.36	
		Afternoon	1432.1	3200.79	0.45	
		Evening	1297	3200.79	0.41	

4.3. Velocity analysis

Table.4.6: Velocity analysis at Dr.Siwabessy Street (Ambon-Air Salobar)

Period	Time Mean Speed	Space Mean Speed
Morning	42	42
Noon	42	42
Afternoon	48	48
Evening	44	44

Table.4.7: Velocity Analysis at Dr.Siwabessy Street (Air Salobar –Ambon)

Period	Time Mean Speed	Space Mean Speed
Morning	47	47
Noon	49	49
Afternoon	49	49
Evening	46	46

Table.4.8: Traffic Velocity Recapitulation

Period	Velocity (Km/Hour)			
	Time	Ambon - Air Salobar	Time	Air Salobar - Ambon
Morning	0.00123	41.98	0.00109	47.11
Noon	0.00116	42.24	0.00117	48.89
Afternoon	0.00139	48.00	0.00120	48.89
Evening	0.00146	44.38	0.00117	46.17
Average	0.00131	44.15	0.00	47.76

4.4. Density Analysis

4.4.1. Calculating Traffic Density

Table.4.9: Calculation of Traffic Density of Road Sections Dr.Siwabessy Directions Ambon to Air Salobar.

Time	Ambon - Air Salobar		
	Volume	Velocity	Density
06:00 - 07:00	842.1	41.98	20.06
07:00 - 08:00	1483.5	41.98	35.34
08:00 - 09:00	1345.6	41.98	32.05
09:00 - 10:00	654.5	41.98	15.59

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10:00 - 11:00	766.1	41.98	18.25
11:00 - 12:00	1104.3	41.98	26.31
12:00 - 13:00	1449.8	42.24	34.32
13:00 - 14:00	1178.1	42.24	27.89
14:00 - 15:00	847.3	48	17.65
15:00 - 16:00	865.9	48	18.04
16:00 - 17:00	851.3	48	17.74
17:00 - 18:00	945.5	48	19.70
18:00 - 19:00	849.1	44.38	19.13

Table.4.10: Calculation of Traffic Density of Road directions Air Salobar to Ambon

Time	Air Salobar - Ambon		
	Volume	Velocity	Density
06:00 - 07:00	535.9	47.11	11.38
07:00 - 08:00	1012.1	47.11	21.48
08:00 - 09:00	832.6	47.11	17.67
09:00 - 10:00	418.7	47.11	8.89
10:00 - 11:00	741.9	47.11	15.75
11:00 - 12:00	1009.9	47.11	21.44
12:00 - 13:00	789.8	48.89	16.15
13:00 - 14:00	971.3	48.89	19.87
14:00 - 15:00	943	48.89	19.29
15:00 - 16:00	877.9	48.89	17.96
16:00 - 17:00	815.4	48.89	16.68
17:00 - 18:00	887.8	48.89	18.16
18:00 - 19:00	1069.7	46.17	23.17

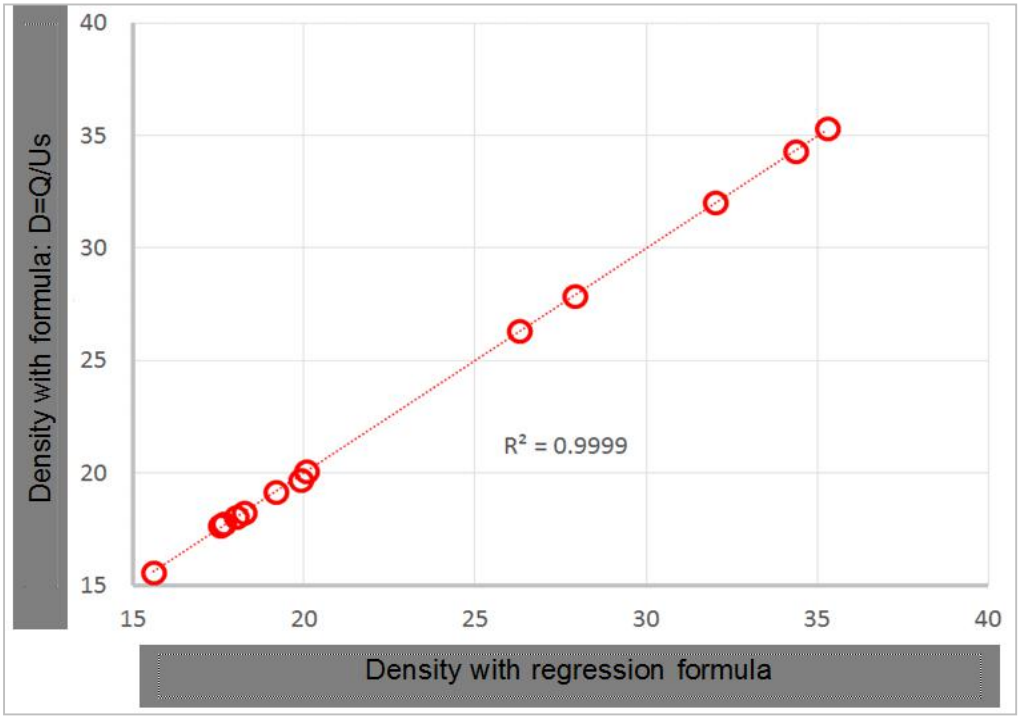

Fig.4.1: The Relationship between Predictions of Vehicle Density Using Regression Formula with the Calculation of Vehicle Density

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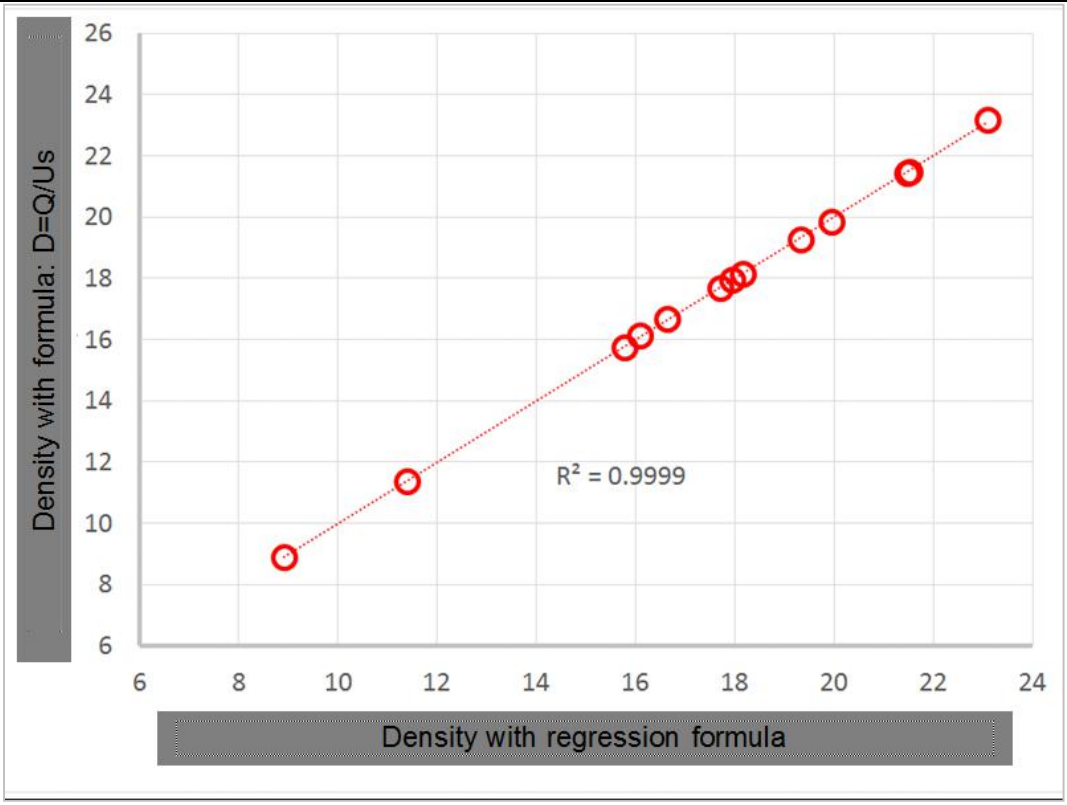

Fig.4.2: The Plot of the Relationship between the Predictions of Vehicle Density Using the Regression Formula with the Calculationof Vehicle Density.

4.5. Relationship Speed, Volume And Density by Regression Analysis

4.5.1. (Ambon to Air Salobar)

The following relationship between volume (Q), speed (Us) and vehicle density (D) by using regression analysis on Dr.Siwabessy road direction Ambon to Air Salobar. By using regression data processing using Excel function, it is known that the regression equation, D = 18,32 - 0,435 [Us] + 0.024 [Q] gives prediction of vehicle density with very high correlation value (R2 = 0.999) to calculation of vehicle density by using formula 2.8 (see Figure 4.1). Furthermore, based on the value of regression model equations, the effect of vehicle speed on the road direction from Ambon to Air Salobar is more dominant.

4.5.2. Air Salobar- Ambon

Relation between volume (Q), speed (Us) and vehicle density (D) by using regression analysis on Dr. Siwabessy road from Air Salobar to Ambon. By using regression data processing using Excel function, it is known that the regression equation, D = 18,67 - 0,396 [Us] + 0.021 [Q] gives prediction of vehicle density with very high correlation value (R2 = 0.999) to calculation of vehicle density by using formula 2.8 (see Figure 4.2). Furthermore, based on the value of regression model equations, the effect of vehicle speed on the road direction from Ambon to Air Salobar is more dominant than the road volume where the regression coefficient of vehicle speed is 0.396 is greater than the regression coefficient of the volume which is 0,021.

V. CONCLUSION

1. Based on the results of the analysis, the flow of Dr.Siwabessy road traffic is said to have not experienced saturation because the ratio of volume to capacity has a value less than 1.
2. Based on linear regression analysis found some important things
   a. Both traffic flow from Ambon to Air Salobar or vice versa shows the dominant influence of vehicle speed (Us) on traffic density (D) compared to traffic volume factor (V)
   b. The regression formula of the relationship between traffic density, vehicle speed and traffic volume for traffic flow from Ambon to Air Salobar or vice versa respectively is D = 18.32 - 0.435 [Us] + 0.024 [Q] and D = 18.67 - 0.396 [Us] + 0.021 [Q]

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