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Traffic Performance Analysis Based on Greenshield, Greenberg and Underwood Modeling on Jalan Raya Batulicin Tanah Bumbu

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ABSTRAK

Saat ini pertumbuhan penduduk semakin pesat dan berbanding lurus dengan pertumbuhan Tingkat kebutuhan masyarakat terhadap jalan tinggi mengakibatkan kemacetan terhadap lalu lintas. Fasilitas umum yang disediakan pemerintah dalam pengelolaan Tata Kota juga berpengaruh terhadap Kemacetan Lalu lintas akibat tidak memperhitungkan Lahan parkir yang cukup untuk pengunjung. Tujuan penelitian ini untuk mengetahui volume dan kecepatan pengguna jalan dan Mengetahui Kinerja Lalu Lintas di ruas Jl.Raya Batulicin, Metode penelitian yang digunakan dalam penelitian ini adalah metode Analisis Model *Greenshield*, Model *Greenberg* dan Model *Underwood* untuk mengetahui Kapasitas pada ruas jalan ditunjang dengan Data Volume Lalu Lintas harian dan Kecepatan Kendaraan Ringan untuk mendapatkan kepadatan pada ruas jalan. Hasil survey volume kendaraan ringan pada ruas jalan Jl.Raya Batulicin yaitu pada hari sabtu yaitu 1162 smp/jam, Kecepatan maksimum kendaraan ringan yaitu 79 km/jam, Kinerja jalan pada ruas jalan Raya Batulicin didapat dari Analisis Permodelan *Greenshield, Greenberg* dan *Underwood* dengan Analisis MKJI 1997, Analisis Permodelan *Greenshield, Greenberg* dan *Underwood* didapat nilai ITP dengan perbandingan V/C didapat nilai maksimum yaitu DS 0,21 dengan nilai ITP B, nilai ITP dengan perbandingan F minimum didapat nilai maksimum yaitu 28,94 km/jam pada hari minggu sehingga nilai ITP nya yaitu D dengan pengertian Jalan mendekati Arus tidak stabil. Adapun Analisis MKJI 1997 yaitu Kapasitasnya 1405 smp/jam sehingga nilai DS maksimum yaitu DS 0,83 pada hari sabtu dengan Volume kendaraan yaitu 1162 smp/jam dengan ITP C artinya arus stabil.

Kata Kunci: Volume Lalu Lintas, Analisis Kecepatan, Model *Greenberg*, ITP, Jl.Raya Batulicin

ABSTRACT

Currently population growth is increasing rapidly and is directly proportional to the growth of the community's demand for high roads resulting in traffic congestion. Public facilities provided by the government in the management of City Planning also affect traffic congestion due to not taking into account sufficient parking space for visitors. The purpose of this study was to determine the volume and speed of road users and to determine traffic performance on the Jalan Raya Batulicin section. The research method used in this study was theModel Analysis method *Greenshield*, the *Greenberg* Model and theModel *Underwood* to determine the capacity on the road section supported by Volume Data. Daily traffic and light vehicle speed to get the density on the road. The results of the survey of the volume of light vehicles on the Jl. Raya Batulicin road, namely on Saturday, which is 1162 smp/hour, the maximum speed of light vehicles is 79 km/hour, road performance on the Jalan Raya Batulicin section is obtained from the analysis of theModeling *Greenshield, Greenberg* and *Underwood* with Analysis MKJI 1997,Modeling Analysis *Greenshield, Greenberg* and *Underwood* obtained the ITP value with a V/C ratio,the maximum value obtained was DS 0.21 with an ITP B value, the ITP value with a minimum F ratio obtained a maximum value of 28.94 km/hour on Sundays so that the ITP value is D with the understanding that the road is approaching an unstable current. The 1997 MKJI analysis is that the capacity is 1405 pcu/hour so that the maximum DS value is 0.83 DS on Saturdays with a vehicle volume of 1162 pcu/hour with ITP C which means the current is stable.

Keywords: Traffic Volume, Speed Analysis,Model *Greenberg*, ITP, Jl. Raya Batulicin

INTRODUCTION

This research was conducted on Jalan Raya Batulicin, Tanah Bumbu Regency. This research was carried out by surveying Road Geometry, Traffic Volume and Traffic Speed by researching in front of the Batulicin Sunday Market and in front of the Batulicin Educational Park. The research location can be seen in Figure 1 below.

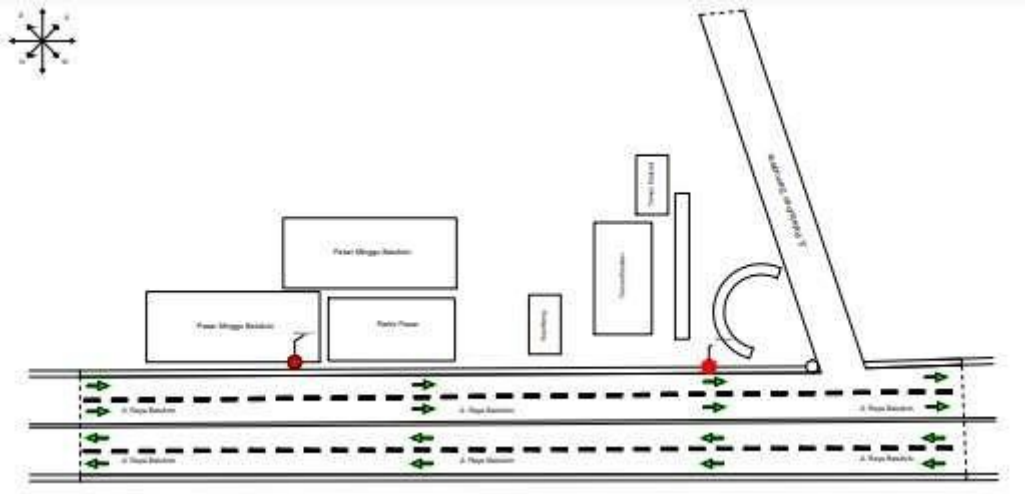

Figure 1 Research Locations

Traffic is a very vital medium for various means of land transportation that connects various locations and even between cities. The smooth traffic of a city is one of the performance parameters and local government management. Smooth traffic is very influential in the hope of convenience in the community to support everything from various aspects of life such as education and so on. The level of community demand for high roads results in traffic congestion.

Traffic congestion problems often occur in areas that have high activity intensity and land use. In addition, traffic congestion occurs due to high traffic volume caused by mixing of through traffic, regional and local traffic. In general, there are 3 factors that cause congestion that is getting worse and worse, namely the continued increase in vehicle ownership (demand), limited resources to carry out the construction of roads and other transportation facilities (supply), and the operation of existing transportation facilities is not yet optimal (operating system).

Jalan Raya Batulicin is the city center road in the Land of Spices, when viewed in terms of road facilities and infrastructure, it is complete with a city structure that is equipped with parks, markets and other public facilities that can be used by the community. Apart from that, public facilities are sometimes the cause of road congestion at certain times,

such as the Education Park and Batulicin Sunday Market which cause an increase in transportation activities, both from traffic volume and activity patterns on the road. To overcome these problems, it is necessary to get traffic management by taking into account the conditions of volume, speed and density so that above the author wants to conduct a traffic survey to find out Traffic Performance Analysis Based on Greenshield, Greenberg and Underwood Modeling on the Jalan Raya Batulicin Tanah Bumbu.

LITERATURE REVIEW

Roads are land transportation infrastructure that has an important role in the transportation sector. The development of roads is directly proportional to the development of human resources and population. The role of the road is very supportive of human activities in various aspects of life. According to Law Number 38 of 2004. As for the parts of the road, namely the Geometry of the Road consisting of the type of road, traffic lanes and lanes, the shoulder of the road, sidewalks and curbs, and the median of the road. And road grouping consists of road classification according to the road network system, road function system, According to road status and Road Class.

Vehicles are elements of traffic on wheels while objects or pedestrians as part of traffic are referred to as elements of traffic (MKJI 1997). Traffic elements that are very influential in the analysis, namely light vehicles (LV), heavy vehicles (HW), motorcycles (MC) and non-motorized vehicles (UM).

The number of vehicles that pass one observation point during a certain period of time is called volume. The unit of traffic volume that is often used in research is the average daily traffic volume.

The relationship between Traffic Volume and Traffic Density is analyzed using 3 models, namely *Greenshield, Greenberg* and *Underwood.*

a. model the *Greenshield*

relationship between speed and density can be seen from the form of a linear curve that is Greenshield modeling. Greenshield model is the initial model used to analyze traffic flow. According to McShane and Roes, the Greenshield Model Calculation can be seen as follows:

$S = Sf - Sf/Dj \cdot D$ ..... (1)

With:

S = Average speed of space (km/hour)

Sf = Average speed of free flow (km/hour)

Dj = Density at traffic jam (pcu/hour) The

relationship between volume and density is obtained from the following equation:

F = Sf. D - Sf/Dj . D2 ..... (2)

If D=F/S, then the relationship between volume and velocity is obtained as follows:

F = Dj. S - Dj/Sf . S2 ..... (3)

known that the values of Sf and Dj are constant values where SF is expressed as free speed with (D=0) and Dj is expressed as density (S=0), so it can be concluded that the relationship between density and velocity is linear with a parabolic curve. To get the Maximum Volume obtained by the following calculation:

Fc = Dj. Sf/4 ..... (4)

With:

Fc = Maximum Volume (pcu/hour)

b. Model *Greenberg's*

Traffic Flow has similarities with fluid flows seen from the equation of motion of the liquid body, the equation is called the Greenberg Model. This model is not valid for small densities because it is close to zero so that the velocity is very infinity and the resulting curve relationship is in the form of a logarithmic curve. Greenberg's model can be described as follows (Mc Shane & Roes in Ali, 1990):

S = Sc In. Dj/D ..... (5)

With:

Sc = Speed at maximum volume (km/hour)

Dj = Density during traffic jam (pcu/hour)

It is known that F=SD, so we get another equation between the relationship between volume and density as follows:

F = Sc.D.In. Dj/D ..... (6)

Equation The relationship between volume and velocity is as follows:

F = S.Dj.exp. (-S)/Sc ..... (7)

The amount of road segment capacity is expressed by the maximum volume value calculated by differentiating the density and speed of each equation relationship so that the following equation is obtained:

Fc = (Dj.Sc)/e ..... (8)

With:

e = exp

c. Model The *Underwood*

relationship between traffic variables, namely speed and density, is a negative exponential relationship with conditions of low traffic flow density because it produces the same speed value as free flow. The underwood model is invalid for high density because at high density the speed does not reach zero, it is called the Underwood model. The equation of the form of the underwood model is as follows (Mc Shane & Roes in Ali, 1990):

S = Sf. exp. (-D)/Dc ..... (9)

With:

Sf = speed at free flow conditions (km/hour)

Dj = Density at maximum volume (pcu/hour)

It is known that F=SD the above equation can be distributed so that the relationship between volume and density is obtained as the following:

F =D.Sf. exp. (-D)/Dc ..... (10)

It is known that D=F/S in the first equation so that the relationship between volume and velocity is obtained as follows:

F = S.Dc. In Sf/S .....

..... (11)

The amount of road segment capacity is expressed by the maximum volume value calculated by defining the density and speed of each relationship equation so that the following equation is obtained:

Fc = (Dj.Sf)/e ..... (12)

With:

e = exp

with the Greendshield, Greendberg and Underwood modeling, the results of the data generated from excel, to calculate the realistic x value then use the Correlation review as table 1.1 The following Correlation:

Table 1 Correlation Table

Pedoman Interpretasi Koefisien Korelasi

Interval Koefisien	Tingkat Hubungan
0,00-0,199	Sangat Rendah
0,20-0,399	Rendah
0,40 – 0,599	Sedang
0,60 – 0,799	Kuat
0,80 – 1,000	Sangat Kuat

Sumber data: Sugiyono (2013:250)

of Urban Road Capacity According to MKJI 1997 For undivided roads, the analysis was carried out on both traffic direction. However, for divided roads, the analysis is carried out separately for each traffic direction. Determining the capacity of urban roads is as follows:

C = Co x Fcw x FCsp x FCsf x FCcs (pcu/hour) ..... (13)

With:

C = Capacity
Co = Basic capacity (pcu/hour)
Fcw = traffic lane width adjustment factor
FCsp = road separation adjustment factor
FCsf = side barrier adjustment factor
FCcs = city size adjustment factor

For Factor determination tables Adjustment of traffic lane widths, road dividers, side barriers and city size can be seen in MKJI 1997.

RESEARCH METHODOLOGY

In this study, a survey was conducted with a total of 4 people, each point is 2 people, the research points are shown in Figure 1.1 Research Locations, This Research conducted for 3 days by conducting a Traffic Speed survey in the form of Light Vehicles (LV) and a Vehicle Volume survey per 5 minutes for 14 hours, from 06.00-10.00 Wita, namely Saturday, Sunday and Monday.

The data obtained in the form of traffic volume data and light vehicle speed (LV) per 5 minutes are converted into hourly traffic volume data. After that, Volume and Speed are then used to find traffic density after that analysis is carried out with 3 models of *Greenshield, Greenberg* and *underwood* to get the maximum capacity and then analyzed using MKJI 1997 to get the capacity. Then calculated the degree of saturation and the level of service to get the results of the analysis using the Table Value of Road Service Level and Characteristics and Service Level Index (ITP) according to MKJI 1997 and Permenhub No. Km 14 of 2006 as follows:

Table 2 Value of Road Service Level and Characteristics of

Tingkat Pelayananan	Karakteristik-Karakteristik	Batas Lingkup V/C
A	Kondisi Arus bebas dengan kecepatan tinggi pengemudi dapat memilih kecepatan yang di inginkan tanpa hambatan	0,00-0,20
B	Arus stabil, tetapi kecepatan operasi mulai dibatasi oleh kondisi lalu lintas. Pengemudidibatasi dalam memilih kecepatan	0,21-0,45
C	Arus Stabil,tetapi kecepatan dan gerak kendaraan dikendalikan. Pengemudi dibatasi dalam memilih kecepatan.	0,46-0,70
D	Arus mendekati tidak stabil,kecepatan masih dikendalikan. V/C masih dapat di tolerir.	0,71-0,85
E	Volume lalu lintas mendekati/berada pada kapasitas,arus tidak stabil,kecepatan terhenti.	0,86-1,00
F	Arus yang dinaksakan atau macet, kecepatan rendah, volume dibawah kapasitas,antrian Panjang dan terjadi hambatan-hambatan.	>1,00

Sources: MKJI 1997

Then Table 1.2 Values of Road Service Levels and characteristics are compared with Table 1.3 Service Level Index (ITP) on secondary collector arterial roads according to Permenhub.No.Km 14 of 2006, Table 1.3 can be seen as follows:

Table 3 Service Level Index (ITP) on secondary collector arterial roads

Tingkat Pelayanan	Karakteristik Operasi Terkait
A	• Arus bebas • Kecepatan perjalanan rata-rata > 80 km/jam • V/C rasio < 0,6 • Load Faktor pada simpangan = 0
B	• Arus stabil • Kecepatan perjalanan rata-rata > 40 km/jam • V/C rasio < 0,7 • Load Faktor pada simpangan < 0,1
C	• Arus stabil • Kecepatan perjalanan rata-rata > 30 km/jam • V/C rasio < 0,8 • Load Faktor pada simpangan < 0,3
D	• Arus tidak stabil • Kecepatan perjalanan rata-rata > 25 km/jam • V/C rasio < 0,9 • Load Faktor pada simpangan < 0,7
E	• Arus tidak stabil,terhambat dengan tundaan yang tidak dapat di tolerir. • Kecepatan perjalanan sekitar 25 km/jam • V=C • Load Faktor pada simpangan < 1
F	• Arus tertahan dan macet • Kecepatan perjalanan sekitar < 15 km/jam km/jam • V/C melebihi 1 • Simpangan jenuh

Source Permenhub.No.Km 14 of 2006

DATA ANALYSIS AND RESULTS

Traffic data is obtained from the results of traffic counting surveys and field measurements. The data obtained are combined in geometric data and traffic data by dividing the flow composition by the type or equivalent type of vehicle in each different method. The road geometry can be seen in Figure 2 as follows:

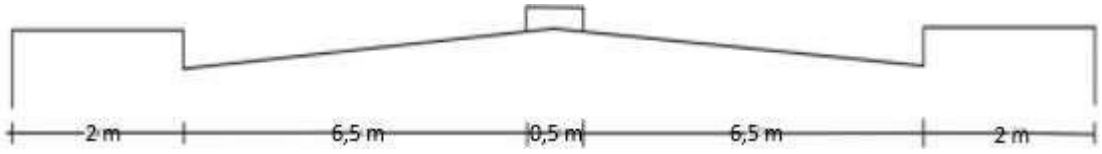

Figure 2 Sections of the Batulicin Highway

1. CrossTraffic Volume Data The

   results of traffic volume analysis are used to calculate traffic density which will later be included in the analysis using modeling (Greenshield, Greendberg and Underwood models), The results of Maximum traffic volume can be seen in Table 4 as follows:

Table 4 Summary of Maximum Traffic Volume on the section being reviewed

Section	Day	Hours (Wita)	Maximum Volume (pcu/hour)
Jl. Raya batulicin (in front of Pasar Minggu) Batulicin	Saturday	17.30-18.30	1162
	Sunday	16.40-17.40	994
	Monday	07.15-08.15	854
Jl. Raya batulicin (in front of Taman edukasi) Batulicin	Saturday	19.00-20.00	1091
	Sunday	16.40-17.40	993
	Monday	07.15-08.15	850

2. Traffic Speed Data TheTraffic

   results ofSpeed analysis are used to compare traffic volume to get traffic density then analyzed using modeling (Model Greenshield, Greendberg and Underwood), Adapum result traffic speeds Maximum can be seen in Table 5 as follows:

Table 5 Summary of Speed Average Maximum cars on the roads under review

Section	Day	Hours (Wita)	Maximum Speed (km/hour)
Jl. Raya batulicin (in front of Pasar Minggu) Batulicin	Saturday	12.15-13.15	79
	Sunday	13.10-14.10 13.25-14.25	67
	Monday	12.35-13.35 12.40-13.40	70
Jl. Raya batulicin (in front of Taman edukasi) Batulicin	Saturday	09.00-10.00	79
	Sunday	13.10-14.10 13.15-14.15	70
	Monday	13.50-14.50 13.55-14.55 14.05-15.05	70

3. Analysis of Data

From the data volume and speed of traffic in can be on the survey, then the traffic density is obtained. The example of the calculation is Jalan Raya Batulicin at the point Jl. Raya Batulicin in front of the Batulicin Sunday market at 18.25-19.25 WITA can be seen in the following calculation:

S = 46.44 km/hour

F = 1036.60 ~ 1037 smp/hour

So: $D = \frac{F}{S}$

D = 1037/46.44

D = 22.32 smp/km

Furthermore, the data is analyzed to obtain the parameter values of the three models, namely the Greenshield Model, Greenberg Model, and Underwood Model using excel software. From the three relationships of speed (S) and density (D) a model of the relationship between the characteristics of volume (F), speed (S) and density (D) of traffic is obtained. The results of the analysis can be seen in Table 6 as follows:

Table 6 Summary of volume, velocity and density on the segment being reviewed

Day	Relationship	Equation Model	R2	R	Vehicle Volume (pcu/hour)	Maximum Speed (km/hour)	Maximum density (pcu/km)
Jl.Raya batulicin (In front of Pasar Minggu)							
Saturday	Greenberg	y=-14,55In(x)+81,223	0,8152	0,9092	7939	81,223	266
Sunday	Greenberg	y=-20,45In(x)+99,484	0,8507	0,9223	4774	99,484	130
Monday	Greenberg	y=-22,83In(x)+109,58	0,7949	0,8916	4897	109,58	121
Jl.Raya batulicin (In fron of Taman Edukasi)							
Saturday	Greenberg	y=-16,63In(x)+93,729	0,8558	0,9251	9668	93,729	280
Sunday	Greenberg	y=-19,06In(x)+100,06	0,7386	0,8594	6148	100,06	167
Monday	Greenberg	y=-27,71In(x)+107,91	0,677	0,8228	5734	107,91	144

4. Calculation of Service Level Analysis and Degree of Saturation

From the analysis obtained in the previous step, the maximum capacity is obtained which is then used to obtain the value of the degree of saturation by comparing it with the average daily traffic volume of the survey results. The calculation method to get the degree of saturation (DS) is as follows:

Traffic volume at 17.30-18.30 WITA = 1161.65

Capacity = 7939

So that the value of the degree of saturation (DS) is

DS = V/C

= 1161.65/7939

= 0.15

Then the results of the DS obtained at each research point on Saturday, Sunday and Tuesday, were analyzed using Table 2 Road Service Level Values and characteristics so that the results of the analysis summary in Table 7 are as follows:

Table 7 Summary of Level Index Service with V/C

Day	Relationship	Hours (Wita)	DS (maksimum)	ITP
Jl.Raya batulicin (In front of Pasar Minggu)				
Saturday	Greenberg	17.30-18.30	0,15	A
Sunday	Greenberg	16.40-17.40	0,21	B
Monday	Greenberg	07.15-08.15	0,17	A
Jl.Raya batulicin (In fron of Taman Edukasi)				
Saturday	Greenberg	19.00-20.00	0,11	A
Sunday	Greenberg	16.0-17.40	0,16	A
Monday	Greenberg	07.15-08.15	0,15	A

From Table 7 above, the average ITP value is "A" with a DS of 0.00-0.20 with the characteristics of free flow conditions with high speed the driver can choose the desired speed without obstacles according to Source: Abubakar et al (1996) and Permenhub.No.Km 14 of 2006 in the book Traffic Engineering by Iphan F.Radam. even though what is happening in the field is not in accordance with this characteristic theory because the reality is not like that. then analyzed using the Service Level Index (ITP) on secondary collector arterial roads according to Permenhub.No.Km 14 of 2006 which refers to the minimum vehicle speed, for speed can be seen in Appendix 4 while the level of service can be seen as follows:

Table 8 Summary of Level Index Service with minimum F

Day	Hours (Wita)	F (km/jam)	ITP	Description
Jl.Raya batulicin (In front of Pasar Minggu)				
Saturday	19.00-20.00	37,67	C	Stable Flow Unstable
Sunday	08.10-09.10	29,89	D	Approaching Flow
Monday	16.55-17.55	33,2	C	Stable Flow Unstable
Jl.Raya batulicin (In front of Taman Edukasi)				
Saturday	19.00-20.00	28,94	D	Approaching Flow
Sunday	17.00-18.00	37,32	C	Stable Flow Unstable

Monday	16.50-17.50	35,73	C	Stable Flow Unstable

From Table 8 above, it can be seen that the results of the ITP analysis using this speed stated that the vehicle speed for Saturday in front of the Batulicin Sunday market experienced a stable flow with ITP C with a minimum speed of 37.67 km/hour, on Sundays it was 29.89 km/hour with ITP D with information approaching unstable current, and on Monday the minimum speed is 33.2 km.hour with ITP, namely C with stable current description. For speed analysis in front of the Batulicin Educational Park, it can be seen that the speed of 28.94 km/hour on Saturday makes the road approach unstable because on Saturday night the vehicle is jammed due to activities and activities in the Education Park, on Sunday the minimum speed the speed is 37.32 km/hour and on Monday the minimum speed is 35.73 km/hour with stable currents.

5. Calculation of Service Level Analysis and Degree of Saturation with Capacity (C) using MKJI 1997.

   Capacity analysis using MKJI, used as a comparison with the capacity obtained when analyzing using three models, namely the Greenshield, Greenberg and Underwood models. The capacity obtained by using the MKJI calculation is as follows:

   It is known:

   Basic capacity = 1650 pcu/hour

   Lane width = 3.25 m (1 lane)

   Directional separator = 50-50

   Side Barriers = moderate City

   size = < 1.0 million (source: Department of Population of Tanbu Regency)

   Calculation:

   C = Co x Fcw x Fcsp x Fcsf x Fccs

   C = 1650 pcu/hour x 1.00 x 1.00 x 0.99 x 0.86

   C = 1405 pcu/hour

   Analysis The degree of saturation of the road according to MKJI 1997 from the Capacity results obtained by the analysis in Table 9 as follows:

Table 9 Analysis of the Degree of Saturation According to the MKJI 1997

Day	Vehicle Volume (pcu/hour)	Capacity (C)	DS	ITP
Jl.Raya batulicin (In front of Pasar Minggu)				
Saturday	1162	1405	0,83	C

Sunday	994	1405	0,71	C
Monday	854	1405	0,61	B
Jl.Raya batulicin (In front of Taman Edukasi)				
Saturday	1091	1405	0,78	C
Sunday	993	1405	0,71	C
Monday	850	1405	0,60	A

Analysis according to MKJI uses traffic volume as a comparison to get the value of the degree of saturation, can be seen in the table the value of C indicates the flow is approaching unstable, the value of B means the current is stable and the value of A indicates the current is close to free current.

CLOSING

The maximum volume of vehicles on Jl. Raya Batulicin (in front of Pasar Minggu) is on Saturday at 17.30-18.30 WITA with a volume of 1162 smp/hour and the maximum volume of vehicles on Jl. Raya Batulicin (in front of Taman Pendidikan) on Saturday at 19.00-20.00 wita with a volume of 1091 smp/hour. The maximum speed of vehicles on Jl. Raya Batulicin (in front of Pasar Minggu) is on Saturday at 12.15-13.15 WITA with a speed of 79 km/hour and the maximum speed of vehicles on Jl. Raya Batulicin (in front of Taman Pendidikan) on Saturday at 09.00-10.00 WITA with a speed of 79 km / h.

The road performance on the Batulicin highway is obtained from the Greenshield, Greenberg and Underwood Modeling Analysis with the 1997 MKJI Analysis, the Greenshield, Greenberg and Underwood Modeling Analysis obtained the ITP value with a V/C ratio, the maximum value is DS 0.21 with an ITP B value, ITP with a minimum F ratio, the maximum value obtained is 28.94 km/hour on Sundays so that the ITP value is D with the understanding that the road is approaching unstable flow. The 1997 MKJI analysis is that the capacity is 1405 pcu/hour so that the maximum DS value is 0.83 DS on Saturdays with a vehicle volume of 1162 pcu/hour with ITP C which means the current is stable.

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