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PERFORMANCE OF THE ROAD AND CONGESTION RULE IN WATURENGGONG DENPASAR

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ABSTRACT
Population growth has an influence on developments in various sectors both formal and informal. As a result of this development, population mobility has also increased, which has an effect on traffic density, which often causes various types of delays, one of which is due to increased traffic volume and side barriers. This name often makes the traffic jams occur so that the disruption of activities and productivity of the community as road users because the road is a means of supporting various activities. This research was conducted with the aim to determine the performance of Denpasar Waturenggong road. The research method used is to collect data consisting of primary data and secondary data. Primary data obtained from the field survey, which consists of road inventory data, traffic volume data and vehicle speed data, while secondary data is obtained from related agencies related to completeness of the survey, namely data on the number of residents of Denpasar city in 2017 and data The Indonesian Road Capacity Manual (MKJI) 1997. From the results of the field survey and data analysis, it can be concluded that the analysis of the performance of the Denpasar Waturenggong road occurred at the highest density on Monday afternoon, which has a volume of 2227.37 pcu / hour, large side barriers 509, 9 per hour / 200meter, road capacity of 1779.2 pcu / hour, degree of saturation of 1.2 pcu / hour, speed of 17.24 km / hour, and level of service are in the F category.

INTRODUCTION
The city of Denpasar has experienced developments in development with an increase in the amount of infrastructure development to meet demands and the needs of urban communities in all sectors, where Denpasar City which has an area

of 127.78 km^2 is the center of all activities in Bali, and its population reaches 897,300 people and the number of vehicle ownership reaches 1,260,286 units (Denpasar in Figures 2017, BPS of Denpasar City) increases the density of traffic, which will be felt on the streets to schools, offices, trade centers, and tourist destinations, especially during peak hours.

With the rapid population growth in the city of Denpasar resulted in increasing economic growth in the community, so as to create an economic strategic area in which the area was built several offices, shops, markets, hospitals, and various businesses that invite people to come, this has resulted in a way increasingly experiencing congestion. One of the Regions which is the center of activity of Denpasar City Residents is on the Waturenggong road.

Where the conditions along the Waturenggong road in 2000 are still in a length state around the road is only a residential area, and at this time the area has become congested due to the rapid growth in the number of vehicles while there was no significant addition or widening of the road, and added to the number there are various kinds of shops, schools, markets, offices, restaurants and various other places of business which result in narrowing of the motorist movement lane, in addition to the roadside used for parking, narrowing is also due to vehicles that stop and the number of street vendors passing through the Waturenggong road.

From the background description above, the formulation of the problems caused is:

a) What is the capacity of the road on the Waturenggong road section?
b) What is the level of service on the Waturenggong road?

LITERATURE SURVEY

Side constraints greatly affect the capacity of a road section. One of the most common forms of side disturbances found in urban areas is parking activities that use road bodies (*Tamin*, 2000), in addition to parking on the shoulder of the road side obstacles also occur due to pedestrians, public transportation and other vehicles stopping, slow vehicles, vehicles in and out. The traffic value (Q) reflects the composition of traffic, by expressing the flow in passenger car units (pcu). All traffic flows (per direction and total) are converted into passenger car units (SMP) using the equivalent of passenger cars (EMP) which are empirically derived (Abbas et al., 2020; MKJI, 1997; Shabbir et al., 2020).

Road segment capacity is the maximum amount of vehicle traffic that can be accommodated on a road segment during certain conditions (geometry design, environment and traffic composition) expressed in terms of passenger period (pcu / hr). Factors that influence the determination of road capacity (MKJI, 1997: V-8; Shariff et al., 2020) are geometric conditions, traffic conditions, environmental conditions.

Road service level (LOS) is one of the methods used to assess road performance which is an indicator of congestion. A road is categorized as experiencing congestion if the LOS calculation results in a value close to 1. In calculating the LOS on a road section, it must first know the road capacity (C) which can be calculated by knowing the basic capacity, the road width adjustment factor, the adjustment factor of the road separator, the factor direction separator adjustment, side obstacle adjustment factors, and city size adjustment factors. The capacity of the road (C) itself actually has a definition as the maximum number of vehicles that can be accommodated on a road segment during certain conditions (Asraf et al., 2020; MKJI, 1997; Shabbir et al., 2020).

Volume is the number of vehicles passing through a point on a motion path per unit of time which is usually used as a vehicle unit per time (Morlok, 1978). The unit used in calculating the volume of traffic (V) is a passenger car unit (SMP). To show the volume of traffic on a road section, it is done by multiplying the number of vehicles that use the road with the passenger car equivalence factor (EMP). *The level of service* (LOS) can be determined by calculating the comparison between the traffic volume and the basic road capacity (V / C). By calculating the value of LOS, it can be seen the classification of the road or the level of service on a particular road section.

PROPOSED METHODOLOGY

Research description

The phase in this study begins with a deepening of the literature that will be used as a guide and reference in carrying out research, then proceed with the introduction of the location to obtain data from field surveys to report preparation as a final project.The method used in this study is a survey method. Where things that will be surveyed include, among others:

1. Road inventory surveys include: type of road, length of the road, size of the shoulder, median, kereb, width of the road.
2. Traffic volume survey.
3. Vehicle speed survey

Location and time of research

The location taken in this study is along the Waturenggong Denpasar road which starts from the Tukadpakerisan junction to the Sudirman junction. Parking inventory surveys and road inventory surveys are conducted when traffic volume is quiet for the smooth implementation of the survey. The travel time survey is carried out one day during peak hours and the traffic volume survey is carried out for three days, namely on two working days and one day on a holiday.

TYPES AND SOURCES OF DATA

Data used in this study consisted of two types of data, namely primary data and secondary data. Primary data in this study are data obtained directly from the field by conducting a survey. In collecting primary data various kinds of surveys are carried out, which are road inventory surveys, vehicle speed surveys, and traffic volume surveys with side barriers.

1. A road inventory survey is to find out the type of road, the length of the road, the shoulder width of the road, the width of the road, and the width of the road lane found at the survey location. The survey results obtained were used in the analysis of the performance of the road sections.

2. Traffic volume survey aims to record each vehicle that passes (passing a certain point or line). Where the volume of traffic is the number of vehicles that pass through a road in a certain time period. From the results of this survey will be used in the analysis of the performance of road sections.
3. Vehicle speed survey aims to calculate the average speed of travel or movement of an object, the name must be known distance and travel time. This average speed is the result of the division of distance with the amount of travel time.

Road Inventory

Survey This survey was conducted to find out the type of road, length of the road, shoulder width of the road, median size and width of the road. From the survey results obtained, it was used to analyze the performance of the road section.
a. The method used is a manual method, namely by measuring each parameter to be measured and recording on the survey form.
b. The tools needed at the time of the survey are: road inventory survey forms, pencils / pens, clipboards, measuring tape / meters and other tools.
c. How to do it. The survey was conducted at a time when the traffic volume was quiet for the smooth running of the survey. The surveyor will measure each of the data needs, for example to measure the width of the road used a tape measure / meter

Secondary data for this study is the data of the population, and data on the number of vehicle ownership. The population of a city influences the performance of roads. Data on population is taken from the Central Statistics Agency (BPS) of Denpasar, from this data it can be seen the capacity of the road section at the study site, and then used to calculate the analysis of the time value of vehicles that cross the Waturenggong Denpasar road section (from the TukadPakerisan road to the intersection Sudirman street).

Research instruments

Theequipment or instruments used in this study include the following.
1) Stationery, used to record all the data needed at the time of the survey.

2) Video*camera,* is used to record the number of vehicles get through road survey site.
3) *Roll meter,* used to measure during the road inventory survey**,** to find out the type of road, the length of the road, the size of the gravel, the width of the shoulder, the size of the median and the width of the road. From the survey results obtained are used to analyze the performance of road sections.
4) *The camera is* used to document the research process.
5) *Microsoft Office Excel,* used to calculate or analyze the results of research data.

Data Analysis

Techniques Data processing and data analysis are the most important steps in a study, where each data is analyzed and a scientific study is carried out to obtain conclusions that answer the problems that have been raised. In this research, the performance of the road sections and the level of road service are analyzed.

Data presentation techniques

To obtain maximum and directed results, steps in processing and analyzing the data obtained are formulated as follows:
a) Preliminary research. Done to get a picture of the problems faced and what steps will be taken next and preparation in obtaining data that will be needed in full.
b) Field survey. Done to get the data needed where the data obtained by conducting surveys directly in the field.
c) Data processing. At this stage, each data obtained will be analyzed and a scientific study will be conducted to obtain conclusions that will address the problems that have been submitted.

RESULTS OF DATA ANALYSIS

Road geometric data road

geometric data is data about the actual condition of the road itself in the field. This road geometric data is in the form of lane width, lane width, shoulder width. From the results of a survey conducted at the study site, it was found that the geometric condition data for the Waturenggong Highway was relatively similar. Data on the geometric conditions of the Waturenggong Road section can be seen in the following table 1:

Table 1. Road geometric data at the study site

Segment Length (m)	Lane Width (m)	Effective Lane Width (m)	Path Width (m)	Effective Path Width (m)	Shoulder Width	
					North	Selatan
200	3.53	3	7.06	6	0.53	0.53

Source: Field survey results, 2018

Traffic volume

Calculation of traffic volume analysis refers to the results of the survey of traffic volume. Traffic volume data that uses the vehicle unit / hour is converted into units of junior high school / hour by multiplying the number of vehicles with the equivalent of passenger cars in Table 2.1 for the type of 2-lane road not divided (2/2 UD). From the analysis of the traffic volume, it is obtained the large volume of traffic and peak hours of traffic from each observation time interval on the Waturenggong Highway.

Based on the results of research the peak hour traffic volume occurs in the afternoon. On Friday the time interval occurs at 16:00 - 17:00 which is equal to 2067.13 pcu / hour. On Sundays, the time interval is 16:00 - 17:00 which is 2020.13 pcu / hour. And on Monday occurs at intervals of time 16:15 - 17:15 that is equal to 2227.38 pcu / hour This is because at that hour is the time to go home from work where on the Waturenggong road there are many places of business that cause an increase in traffic movement at that hour. So for the calculation of the performance analysis of the Waturenggong highway segment, the peak hour afternoon traffic volume data is used where this peak hour can represent the Waturenggong Highway segment observed throughout the survey time. The lowest traffic volume occurs at 06:00 - 07:00 which is 1287 pcu / hour, the highest traffic volume occurs at 16:15 - 17:15 which is 2067.13 pcu / hour. The lowest traffic volume occurs at 06:00 - 07:00 which is 1067 pcu / hour, the highest traffic volume occurs at 16:00 - 17:00 which is 2020.13 pcu / hour. The lowest traffic volume occurs at 06:00 - 07:00 which is 1336 pcu / hour, the highest traffic volume occurs at 16:15 - 17:15 which is 2227 pcu / hour.

Side barriers class analysis

From the results of the analysis of side obstacle survey data that have been carried out, we have obtained various side barriers classes in each segment of Waturenggong Highway. Based on the results of the study, the peak hour occurrence of side barriers on Friday is at the time interval of 16:00 - 17:00 by 489 per hour / 200 meters so that they are included in the class of moderate side barriers, the peak hours of side barriers on Sundays occur at intervals of time 16.00-17.00 for 467.7 per hour / 200 meters so that they are included in the class of moderate side barriers and peak hour side barriers on Monday occur at intervals of 16.15-17.15 amounting to 502.9 per hour / 200 meters so they are included in the high side barriers class . From the results of the three day survey the highest side barriers occurred on Monday which is included in the high side barriers class (H). Because of the large number of traffic pulls that result from the existence of shophouses, restaurants, and homes.

Speed

Speed is the distance traveled by the vehicle per unit time. The following is an analysis of the speed of light vehicles on the Waturenggong Road section, Denpasar.

A) Vehicle speed on Friday

a. West-East Direction

To calculate the speed of light vehicles with a 25-meter observation segment used Formula 2.6 As an example, the calculation of the speed of light vehicles at 06.00-06.15 with observation segments The 25 meters are as follows:

1) Based on the pilot survey the number of samples needed is 2 samples in a 15 minutes interval. From the 2 times the light vehicle travel time will be searched on average.

$$T = \frac{4.51 + 4.12}{2} = 4.3$$

2) The length of the observation segment (L) = 25 meters

3) The average speed of light vehicles (V)

$$V = \frac{L}{T} = \frac{25\ m}{4{,}3 dtk} = \frac{25/1000}{4.3\ /\ 3600}\ \frac{50/1000}{8.5824\ /\ 3600} = 20.86 \text{ km / h}$$

b. East-West Direction

To calculate the speed of light vehicles with a 25-meters observation segment used Formula 2.6 As an example the light vehicle speed calculation is performed at 06.00-06.15 time intervals with the observation segment 25 The meter is as follows:

1) Based on the pilot survey the number of samples needed is 2 samples in a 15 minutes interval. From the 2 times the light vehicle travel time will be searched on average.

$$T = \frac{4.24 + 4.2}{2} = 4.2$$

2) Length of the observation segment (L) = 25 meters

3) Average speed of light vehicles (V)

$$V = \frac{L}{T} = \frac{25\ m}{4.2\ s}\ \frac{50\ m}{9.09\ s} = \frac{25/1000}{4.2\ /\ 3600}\ \frac{50/1000}{9.09\ /\ 3600} = 21.33 \text{ km / hr}$$

Table 4.2 Results of Calculation of Light Vehicle Speeds On Peak Hours on Friday

Time	Hours	Speed of		Speed Average Total Speed of 2 in
		East-West	West	
		Speed-east	Speed	
		average	The average	
		per hour (km / h)	per hour (km / h)	
Peak hours Morning	7 a.m. to 8:00	19.75	20.27	20.01
Peak hours Lunch	11:00 to 12:00	17.48	18.50	17, 99
Hours Peak Afternoon	16.00-17.00	18.21	17.80	18.01

Source: Results of Analysis, 2018

B. Vehicle speed on Sunday

a. West-East Direction

To calculate the speed of light vehicles with a 25 meters observation segment used Formula 2.6 As an example the speed calculation light vehicles at time intervals of 06.00-06.15 with 25 meter observation segments are as follows:

1) Based on the pilot survey the number of samples required is 2 samples in a 15 minutes time interval. From the 2 times the light vehicle travel time will be searched on average.

$$T = \frac{3.27 + 4.25}{2} = 3.8$$

2) The length of the observation segment (L) = 25 meters

3) The average speed of light vehicles (V)

$$V = \frac{L}{T} = \frac{25\ m}{3{,}8dtk} = \frac{25/1000}{3.8\ /\ 3600}\ \frac{50/1000}{8.5824\ /\ 3600} = 23.94\ \text{km / h}$$

b. East-West Direction

To calculate the speed of light vehicles with a 25 meters observation segment used Formula 2.6 As an example the light vehicle speed calculation is performed at 06.00-06.15 time intervals with the observation segment 25 The meter is as follows:

1) Based on the pilot survey the number of samples needed is 2 samples in a 15 minutes interval. From the 2 times the light vehicle travel time will be searched on average.

$$T = \frac{3.21 + 4.41}{2} = 3.8$$

2) Length of the observation segment (L) = 25 meters

3) The average speed of light vehicles (V)

$$V = \frac{L}{T} = \frac{25\ m}{3.8\ s}\frac{50\ m}{9.09\ s} = \frac{25/1000}{3.8\ /\ 3600}\frac{50/1000}{9.09\ /\ 3600} = 23.62\ \text{km / hr}$$

Table 4.3 Results of Calculation of Light Vehicle Speeds on Peak Hours on Sunday

Time	Hours	Speed of		Speed Average Total Speed of 2
		East-West	West	
		Speed-east	Speed	
		average	The average	
		per hour (km / h)	per hour (km / h)	
HoursMorning Peak	8:00 a.m. to 9:00	21.86	21.37	21.62
Hour PeakLunch	11:00 to 12:00	22.17	24.22	23, 19
Hour Peak Afternoon	16:00 to 17:00	18.55	19.52	19.04

Source: Results Analysis, 2018

A. On Monday, vehicle speed

a. East-West Directions

To calculate the speed of light vehicles with a 25 meters observation segment used formula 2.6 for example recount speed light vehicles at time intervals of 06.00-06.15 with a 25 meter observation segment are as follows:

1) Based on the pilot survey the number of samples needed is 2 samples in the 15 minutes time interval t. From the 2 times the light vehicle travel time will be searched on average.

$$T = \frac{3.15 + 4.12}{2} = 3.6$$

2) The length of the observation segment (L) = 25 meters

3) The average speed of light vehicles (V)

$$V = \frac{\square}{\square} = \frac{25\ \square}{3{,}6\square\square\square} = \frac{25/1000}{3.6\ /\ 3600}\frac{50/1000}{8.5824\ /\ 3600} = 24.76\ \text{km / h}$$

b. East-West Direction

To calculate the speed of light vehicles with a 25-meters observation segment used Formula 2.6 As an example the light vehicle speed calculation is done at 06.00-06.15 time intervals with the observation segment 25 The meter is as follows:

1) Based on the pilot survey the number of samples needed is 2 samples in a 15 minutes interval. From the 2 times the light vehicle travel time will be searched on average.

T = 4.29, + 4.28 = 4.3

2 The

2) length of the observation segment (L) = 25 meters

3) The average speed of light vehicles (V)

$$V = \frac{\square}{\square} = \frac{25\ \square}{4.3\ \square\square\square}\ \frac{50\ \square}{9.09\ \square\square\square} = \frac{25/1000}{4.3\ /\ 3600}\ \frac{50/1000}{9.09\ /\ 3600} = 21\ \text{km / h}$$

Table 4.4 Results of Calculation of Light Vehicle Speeds on Peak Hours on Monday

Time	Hours	Speed		Average Speed Total Total 2 directions
		East-West	West-Eastern	
		Speed	Speed	
		average	The average	
		per hour (km / h)	per hour (km / h)	
Morning Peak hours	22.83	08.00-09.00	22.28	22.55
Peak hours Lunch	11:00 to 12:00	18.61	18.68	18.64
hoursAfternoon Peak	16:15 to 17:15	16 , 90	17.54	17.24

Source: Analysis Results, 2018

Analysis of road

Capacity Capacity is the maximum current through a point on the road that can be maintained per unit time under certain conditions In analyzing capacity the following formula is used:

$C = C_O x FC_W \text{ x } FC_{SP} \text{ x } FC_{SF} \text{ x } FC_{CS}$

For the calculation of the amount of capacity that occurs at peak hours of traffic volume on the JalanWaturenggong Denpasar segment, an example calculation is taken roadwith the following steps:

A. Calculation on Friday at peak hour in the morning
1) capacityDetermine basic capacity (C_O)
Road segment type 2/2 UD, then C_O = 2900 pcu / hour (Table 2.6)
2) Adjustment factors for capacity
a) Line width (FC_W)
Effective width = 6 m; then FC_W= 0.87
b) Determining the direction separator (FC_{SP})
East-West Direction $= \frac{1854}{3452}$x 100% = 53.7% = 50%
West-East Direction $= \frac{1598}{3452}$ x 100% = 46.29% = 50%
Then FC_{SP} = 1.00 (Table 2.4)
c) Determine the magnitude of side barriers (FC_{SF})
- Road type with shoulders
- Side barriers class : Medium (M)
- Shoulder width : 0.53 m
Then FC_{SF} = 0.89 (Table 2.6)
d) Determine the size of the city (FCcs)
the total population of 897 300 inhabitants, it FCCS = 0.86
3) capacity
so capacity C = C_OxFC_W x FC_{SP}FCx$_{SF}$ x FC_{CS}
= 2900 x 0,87 x 1,00 x 0,89 x 0.86
= 1,931.1 junior high / hour

Table 4.5 Capacity JalanWaturenggong peak hour on Friday

Hours Peak		Base Capacity	width	Separator	Constraints	Size	Capacity
		C0	Line	Directions	Side	City	Actual
		smp / h	(FCW)	(FCsp)	(FCsf)	FCCS	© smp / hour
morning	07:00 to 08:00	2900	0,87	1	0.89	0.86	1931.10
Lunch	11.00 - 12.00	2900	0.87	1931.10	0.89	0.86	1
Afternoon	16.00 - 17.00	2900	0.87	1931.10	0.89	0.86	1

Source: Analysis, 2018

B. Calculation on Sunday at peak hour in the morning
1) Determine base capacity (C_O)
Road segment type 2/2 UD, then C_O = 2900 pcu / hour

2) Adjustment factor for capacity
a. Path width (FC_W)
Effective width = 6 m; then FC_W= 0.87
b. Determining the direction separator (FC_{SP})
East-West Direction =$\frac{1927.5}{3478}$x 100% = 55.4% = 55%
West-East Direction =$\frac{1550.5}{3478}$ x 100% = 44.5% = 45%
Then FC_{SP} = 0.97 (Table 2.4)
c. Determine the magnitude of side barriers (FC_{SF})
- Road type with shoulders
- Side barriers class : Medium (M)
- Shoulder width : 0.53 m
Then FC_{SF} = 0.89
d. Determine city size (FC_{cs})
Total population of 897,300 inhabitants, then FCcs = 0.86 (Table 2.8)
3) Capacity
Then capacity C = C_OxFC_W x FC_{SP} x FC_{SF} x FC_{CS}
= 2900 x 0.87 x 0.97 x 0 , 89 x 0.86
= 1873.10 smp / hour

Table 4.6 Capacity JalanWaturenggong peak hours on Sunday

hour peak		Base Capacity	width	separator	Constraints	Size	Capacity
		C0	Line	Directions	Side	City	Actual
		smp / h	(FC W)	(FCsp)	(FCsf)	FCCS	© smp / hour
Morning	8:00 a.m. to 9:00	2900	0.87	0.97	0.89	0.86	1873.10
Lunch	11:00 to 12:00	in 2900	to 0.87	1	0.89	0.86	1931.10
Afternoon	4:00 p.m. to 5:00 p.m.	2900	0 , 87	1	0,89	0,86	1931.10

Source: Analysis Results, 2018

C. Calculations on Monday at peak hours of the morning
1) Determinant of basic capacity (C_O)
Type of road segment 2/2 UD, then C_O = 2900 pcu / hour
2) Adjustment factor for capacity
a. Path width (FC_W)

Effective width = 6 m; then FC_W= 0.87 (Table 2.3)
b. Determining the direction separator (FC_{SP})
East-West Direction $=\frac{1983}{3549.5}$x 100% = 55.8% = 60%
West-East Direction $=\frac{1566.5}{3549.5}$ x 100% = 44.1% = 40%
Then FC_{SP} = 0.94 (Table 2.4)
c. Determine the magnitude of side barriers (FC_{SF})
a. Road type with shoulders
b. Side barriers class : Medium (M)
c. Shoulder width : 0.53 m
Then FC_{SF} = 0.89 (Table 2.6)
d. Determine the size of the city (FCcs)
the total population of 897 300 inhabitants, it FCCS = 0.86
3) capacity
so capacity C $= C_O x FC_W$ x $FC_{SP} FCx_{SF}$ x FC_{CS}
= 2900 x 0,87 x 0 , 94 x 0.89 x 0.86
= 1815.24 smp / hour

Table 4.7 Capacity JalanWaturenggong peak hours on Monday

hour peak		baseCapacity	width	separator	Constraints	Size	Capacity
		C0	Biking	Directions	Side	City	Lo
		smp / h	(FCW)	(FCsp)	(FCsf)	FCCS	© smp / hour
Morning	8:00 a.m. to 9:00	2900	0.87	0.94	0.89	0.86	1815.24
Lunch	11:00 to 12:00	in 2900	to 0.87	1	0.89	0.86	1931.10
Afternoon	16:15-17.15	2900	0.87	1	0.82	0.86	1779.22

Source: Analysis Results, 2018

Degree of saturation

The degree of saturation The ratio of current to capacity is used as the main factor in determining the level of road performance based on road segments, which are formulated as follows:

DS = Q / C

For the calculation of the degree of saturation that occurs at peak hours of traffic volume on the Waturenggong Highway in Denpasar, sample calculation is taken degree of road saturation with the following steps:

1) Calculation on Friday at peak hour morning

DS = 1774 / 1931.10 = 0.92

Table 4.8 Calculation of degree of saturation at each peak hour traffic volume on Friday

Peak hours	Time	Volume ago cross (Q) (smp / hour)	Capacity (C) (smp / hour)	The degree of saturation (DS)
Morning	7:00 a.m. to 8:00	in 1774	1931.1042	0,92
Lunch	11:00 to 12:00	1935	1931.1042	1,00
Afternoon	16:00 to 17:00	2067	1931 , 1042	1.07

Source: Analysis Results, 2018

2) Calculation on Sunday at peak hour morning

DS = 1736 / 1873.1 = 0.93

Table 4.9 Calculation of degree of saturation at each peak hour of traffic volume on the day week

Peak hour	Time	Volume ago Traffic(Q) (junior high / hour)	Capacity (C) (junior high / hour)	degree saturation (DS)
Morning	08.00 -09.00	1736	1873.17	0.93
Noon	11.00 -12.00	1888	1931.10	0, 98
Afternoon	16.00 -17.00	2020	1931.10	1.05

Source: Analysis Results, 2018

3) Calculation on Monday at peak hour morning

DS = 1782 / 1815.23 = 0.98

Table 4.10 Calculation of degree of saturation at each peak hour of traffic volume at Monday

Peak hours	Time	Volume Past Traffic(Q) (junior high / hour)	Capacity (C) (junior high / hour)	degree saturation (DS)
Morning	08.00 - 09.00	1782	1815.24	0.98
Afternoon	11.00 - 12.00	2166	1931.10	1 , 12
Evening	16.15 - 17.15	2227	1779.22	1.25

Source: Analysis Results, 2018

Free flow speed analysis free

flow speed is the speed at the zero current level, where the speed chosen by the driver when driving a motorized vehicle without being influenced by the vehicle motorized fabric in the street.flow velocity
Basic freehas the following formula:

$$FV = (FV_O + FV_W) \text{ x } FFV_{SF} \text{ x } FFV_{Cs\ The}$$

Following is an example of free current velocity calculation (FV) on Friday morning

a) Basic free flow speed
road type 2/2 UD
F_{VO} = 44 km / hour (Table 2.9).

b) Adjustment factor for track
width Effective track width 6 m
FV_W= -3 km / h (Table 2.10).

c) Side obstacle adjustment factor
Road type 2/2 UD road with shoulder and with medium side obstacle class (M)
FV_{SF}= 0.87 (Table 2.11).

d) City size adjustment factor
With a population of 897,300 inhabitants
FV_{CS} = 0.90 (Table 2.13).

e) Free current velocity
Then with the following formula obtained free current velocity
$FV = (FV_0 + FV_W) \text{ x } FV_{SF}\text{x } FV_{CS}$
FV = (44 + (-3)) x 0.87 x 0.90 = 32.10 km / hour.

Table 4.11 Calculation of free flow speed on light vehicles with side obstacles.

Time	Clock	Basic free flow speed (F_{VO}) (km / hr)	Correction factor for line width (FVw)	Correction factor		Actual free flow speed (km / hr)
				Side Obstacles (FFV_{SF})	City Size (FF Vcs)	
Morning Peak Hours	07.00- 08.00	44	-3	0.87	0.9	32.10
during the peak hours	11.00-12.00	44	-3	0.87	0.9	32.10
pm Peak hours	16.00-17.00	44	-3	0.87	0.9	32.10

Source : Analysis Results, 2018

A. Following is an example of the calculation of free current velocity (FV) on Sunday morning

a) Basic free flow speed

Type of road 2/2 UD

F_{VO} = 44 km / hour.

b) Adjustment factor for lane

width Effective lane width 6 m

FV_W= -3 km / h

c) Adjaculation factor for side obstacles

Road type 2/2 UD road with shoulder and with medium side obstacle class (M)

FV_{SF}= 0.87 (Table 2.11)

d) Adjustment factor city size

With a population of 897,300 inhabitants

FV_{CS} = 0.90 (Table 2.13)

e) Free flow velocity

Then the following formula is obtained free current velocity

$FV = (FV_0 + FV_W) \times FV_{SF} \times FV_{CS}$

FV = (44 + (- - 3)) x 0.87 x 0.90 = 32.10 km / hour.

Table 4.12 Calculation of free flow velocity on light vehicles with side obstacles.

time	Clock	Basic free flow speed (F_{VO})	Correction factor for line width (FVw)	Correction factor		Actual free flow speed (km / hr)
		(km / hr)		Side Obstacles (FFV_{SF})	City Size (FFVcs)	
Morning Peak Hours	08.00-09.00	44	-3	0,87	0,9	32,103
Hour Peak Daytime	11.00-12.00	44	-3	0,87	0.9	32,103
Hour Peak afternoon	16.00-17.00	44	-3	0,87	0.9	32,103

Source: Results of Analysis, 2018

B. Following example of free flow velocity calculation (FV) on Monday morning

a) Basic free flow speed of
road type 2/2 UD
F_{VO} = 44 km / hour (Table 2.9).

b) Adjustment factor for track
width Effective track width 6 m
FV_W= -3 km / h (Table 2.10).

c) Side obstacle adjustment factor
Road type 2/2 UD road with shoulder and with medium side obstacle class (M)
FV_{SF}= 0.87 (Table 2.11).

d) City size adjustment factor
With a population of 897,300 inhabitants
FV_{CS} = 0.90 (Table 2.13).

e) Free current velocity
Then with the following formula obtained free current velocity
$FV = (FV_0 + FV_W) \times FV_{SF} \times FV_{CS}$
$FV = (44 + (-3)) \times 0.87 \times 0.90 = 32.10$ km / hour.

Table 4.13 Calculation of free flow velocity on light vehicles with side obstacles.

time	Clock	Basic free flow speed (F_{VO}) (km / hr)	Correction factor for line width (FVw)	Correction factor: Side Obstacles (FFV_{SF})	Correction factor: City Size (FFVcs)	Actual free flow speed (km / hr)
Morning Peak Hours	08.00-09.00	44	-3	0.87	0.9	32.10
during the peak hours	11.00-12.00	44	-3	0.87	0.9	32.10
pm Peak hours	16.15-17.15	44	-3	0.78	0.9	28.78

Source : Analysis Results, 2018

Service level analysis

Road service level is one of the methods usedto assess road performance which is an indicator of congestion.

1) The level of road service at the peak hours of Friday

It is known that the degree of saturation on Friday morning is 0.92 and the speed of light vehicles is 20.01 km / hour, on Friday afternoon the degree of saturation is 1.00 and the speed of light vehicles is 17.99 km / hour, and in the afternoon of the week the murder rate was 1.07 and the speed of the light vehicle was 18.01 km / hour.

The level of road service is used as a measure of the quality of road services identified from road capacity and traffic flow. Based on Figure 4.6, it can be seen that the level of service on the Waturenggong Highway on Friday morning is located at level E, which explains that the current is unstable, cannot be determined only from speed, traffic jams (stop) often occur, the volume approaches capacity, and the level of service on Friday afternoon and evening lies at level F which explains that the current is hampered, the speed is low, the volume is above capacity, often congestion occurs for quite a long time.

Table 4.14 Level of road traffic during peak hours Friday

peak hours	Speed	Degrees	Level of
	Average	saturation	Service
		(DS)	
Morning	20.01	0.92	E
Afternoon	17.99	1	F
Afternoon	18.01	1.07	F

Results of analysis (2018)

2) The level of road service at peak hours on Sunday
It is known the degree of saturation on Sunday morning is 0.92 and the speed of light vehicles is 21.62 km / hour, on Sunday afternoon degrees the saturation is 0.97 and the speed of light vehicles is 23.19 km / hour, and on Friday afternoon the degree of killing is 1.04 and the speed of light vehicles

The level of road service is used as a measure of the quality of road services identified from road capacity and traffic flow. Based on Figure 4.6, it can be seen that the level of service of the Waturenggong Highway on Sunday morning and afternoon is located at level E which explains that the current is unstable, cannot be determined solely from speed, traffic jams often occur (stop) for some time, the volume approaches capacity, and the level of service on Sunday afternoon is located at level F which explains that the current is hampered, low speed, volume above capacity, frequent congestion often occurs.

Table 4.15 Level of road traffic during peak hours Sunday

Peak hours	Speed	Degrees	Level of
	Average	saturation	Service
		(DS)	
Morning	23.19	0.92	E
Afternoon	21.63	0.97	E
Evening	19.04	1.04	F

Results of analysis (2018)

The level of road service at peak hours on Monday

It is known that the degree of saturation in Monday morning is 0.98 and the speed of light vehicles is 22 , 55 km / hour, on saturday afternoon the degree of saturation is 1.12 and the speed of light vehicles is 18.64 km / hour, and on Monday afternoon the degree of murder is 1.2 and the speed of light vehicles is 17.24 km / hour. The level of road service is used as a measure of the quality of road services identified from road capacity and traffic flow. Based on Figure 4.6, it can be seen that the level of service of the Waturenggong Highway on Sunday morning is located at level E which explains that the current is unstable, cannot be determined only from speed, traffic jams (stop) often occur, the volume approaches capacity, and the level of service on Sunday afternoon and evening lies at level F which explains that the current is hampered, low speed, volume above capacity, jams often occur for quite a long time.

Table 4.16 Level of road traffic during peak hours Monday

Peak hours	Speed Average	Degrees saturation (DS)	Level of Service
Morning	22.55	0.98	E
Afternoon	18.64	1.12	F
Afternoon	17.24	1.2	F

CONCLUSION

The results of the analysis of the side obstacle classes on the Waturenggong Highway section showed varying side obstacle classes on each day. observations of the occurrence of side barriers at peak hours of Friday morning at 385.7 per hour / 200 meters, peak hours of Friday afternoon at 419.5 per hour / 200 meters, and peak hours of Friday evening at 489.2 per hour / 200 meters, so at peak Friday morning, afternoon and evening are included in the class of moderate side barriers (M). Observation of the occurrence of side barriers at peak hours of Sunday morning is 445.8 per hour / 200 meters, peak hours of Sunday afternoon at 422.5 per hour / 200 meters, and Sunday afternoon peak hours of 467.7 per hour / 200 meters, so that during peak hours Sunday morning, afternoon and evening are included in the class of moderate side barriers (M). And observations of the occurrence of side barriers at morning peak hours of 460.2 per hour / 200 meters, peak hours of Monday afternoon at 427.9 per hour / 200 meters, and peak hours of Monday afternoon at 502.9 per hour / 200 meters, so at peak hours Monday morning, noon is included in the class of moderate side barriers (M), and at peak hours Monday afternoon is included in the class of high side barriers (H). The occurrence of side barriers that occur is very influential on the capacity of the Waturenggong Road section.

The results of performance analysis on the Waturenggong Highway at the peak hours of Friday morning have a road capacity of 1931.1 pcu / hour, a volume of 1774 pcu / hour, a degree of saturation of 0.918, a speed of 20.01 km / h and the service level is at level E, at peak hours on Friday afternoon it has a road capacity of 1931.1 pcu / hour, a volume of 1935.1 pcu / hour, a degree of saturation of 1.0, a speed of 17.99 km / h and the service level is at level F, and at Friday afternoon peak hours have a road capacity of 1931.1 pcu / hour, a volume of 2067.1 pcu / hour, a degree of saturation of 1.07, a speed of 18.01 km / h and the service level is at level F. Observation of performance analysis road at the peak hour of Sunday morning has a road capacity of 1873.17 pcu / hour, volume of 1736 pcu / hour, degree of saturation of 0.92, speed of 21.62 km / h and the level of service is at level E, at peak hours Sunday afternoon has road capacity s by 1931.1 pcu / hour, volume of 1888.1 pcu / hour, degree of saturation of 0.97, speed of 23.19 km / h and the level of service is at level E, and at peak hours Sunday afternoon has a road capacity of 1931.1 pcu / hour, volume of 2020.1 pcu / hour, degree of saturation of 1.04, speed of 19.04 km / hour and level of service are at level F. while the Observation of road performance analysis at peak hours Monday morning has road capacity of 1815.23 smp / hour, volume of 1782 smp / hour, degree of saturation of 0.98, speed of 22.55 km / hour and the level of service is at level E, at peak hours of Monday afternoon has a road capacity of 1931 , 1 pcu / hour, volume of 2166.1 pcu / hour, degree of saturation of 1.12, speed of 18.64 km / hour and level of service are at level F, and at peak hours of Monday afternoon have a road capacity of 1779, 2 pcu / hour, volume of 2227.37 pcu / hour, degree of saturation of 1.2, speed tan is 17.24 km / hour and the service level is at level F. Where the highest peak hour is on monday afternoon.

For related institutions are expected to install additional signs such as no-parking signs and signs are prohibited from stopping and giving out information about traffic safety, either in the banjar or in the local village. Store owners are advised to provide a parking space for customers to park their vehicles. Traffic engineering needs to be done by diverting traffic flow. Strict rules and sanctions for violators who park vehicles on the roadside for the sake of smooth traffic.

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