ANALYSIS OF SOUTH RING ROAD CAPACITY IN MATARAM CITY BY USING THE 1997 ICRM METHOD

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ABSTRACT

Transportation has a very important role for people's lives along with the times, especially in the city of Mataram. The city of Mataram is the capital of the Province of West Nusa Tenggara, which is a center for economic, educational and even other activities. Increasing the volume of vehicles will affect the level of traffic performance which ultimately results in traffic jams. Several factors support the occurrence of congestion, namely increasing population and the need for transportation facilities, vehicles that stop and park, crossing roads, and non-motorized vehicles. This study is about the performance of traffic on the South Ring road using the 1997 Indonesian Road Capacity Manual (ICRM). The purpose of this study was to determine the capacity of the South Ring Road, Mataram. The traffic speed and volume data survey was conducted for five days namely Monday, Wednesday, Friday, Saturday and Sunday using the Moving Car Observer (MCO) method. This survey was conducted from inside a vehicle that moves with the flow. The study was conducted in the morning, afternoon and evening. Morning time starts at 07.00 WITA, at noon starts 12:30 WITA while afternoon research time starts at 16.00 WITA. The survey was carried out 10 times alternating segments that were reviewed, the boundaries of which were intersections. The results of data analysis obtained the amount of capacity on the South Ring road is 1650 pcu/hour.

Keywords: ICRM, Moving Car Observer, South Ring Road, Capacity.

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1. INTRODUCTION

In planning, designing, and determining various transportation system policies, the theory of movement of traffic flows plays a very important role. The ability to accommodate traffic flows is very dependent on the physical condition of the road, both in terms of quality and quantity, as well as the operational characteristics of the traffic. This theory of movement of traffic flow will explain the quality and quantity of traffic flow so that policy or selection of the most appropriate system can be applied to accommodate existing traffic.

To simplify the application of traffic movement theory a mathematical approach is used to analyze the symptoms that take place in traffic flow. One approach to understanding the behavior of traffic is to describe it in the form of mathematical and graphic relationships. An increase in traffic volume will cause changes in traffic behavior. Theoretically there is a fundamental relationship between volume (flow), speed (speed), and density (density). From the relationship of the three variables, it can be seen the maximum traffic flow in other words the capacity of the road. To determine the capacity of a road segment, it can be calculated by ICRM 1997. There are several adjustment factors that need to be studied in determining the capacity of urban road sections using ICRM 1997. The adjustment factors are basic capacity, road width, direction separator, side barriers, and city size. Furthermore, the adjustment factors will be compared in determining the capacity.

The South Ring Road is a four-lane or one-way type road that is on a flat alignment and is also an urban road with a track width of 3.5 m each. South Ring Road is an arterial road in the city of Mataram which has a high volume of vehicles. Along this road there are several business places and offices that cause the accumulation of vehicles on these roads. Therefore, this study will discuss the Capacity Analysis of the South Ring Road Section with the ICRM 1997 Method

Based on the background above, the main problem of the research is how to calculate the capacity of the South Ring road using the 1997 Indonesian Road Capacity Manual (ICRM). The scope of the problem in this study is limited by analysis of urban road capacity using the 1997 Indonesian Road Capacity Manual method and is limited to one study location, namely the South Ring Road in Mataram. The purpose of this study is to calculate the capacity of the South Ring road section with the 1997 Indonesian Road Capacity Manual method

2. THEORITICAL OVERVIEW

2.1. Characteristics of Urban Roads According to ICRM 1997

According to ICRM (1997) urban roads are defined as roads that develop permanently and continuously along all or almost all roads, at least on one side of the road, either in the form of land development or not.

Road geometry is a road building that describes the size or shape of a road, both concerning cross sections, lengths, or other aspects related to the shape or physical nature of the road. As an illustration of the cross section of the road can also be seen in the 1997 ICRM cited as follows.

2.2. Traffic Influence

Speed limits are rarely enforced in urban areas in Indonesia and therefore have little effect on 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 roadside land and so on.

2.3. Traffic Flow Composition

In reality the flow of traffic that occurs in the field is not homogeneous. A number of vehicles of various types, sizes, and properties form a traffic flow. This diversity forms different traffic characteristics for each composition and also influences the overall traffic flow. With this background a quantity is needed that will state the effect of a type of vehicle on the overall traffic flow.

2.4. Passenger Car Equivalent (PCE)

The Directorate General of Highways (IHCM, 1997), explains the basic understanding of passenger car equivalent (pce) is a unit of magnitude that states the equivalence of the effects of various types of vehicles, which are compared with light vehicles to the speed of light vehicles in traffic flow (for passenger cars and light vehicles whose chassis are similar; pce = 1.0). With this magnitude we can judge each traffic composition. Equivalence of passenger cars (PCE) for each type of vehicle depends on the type of road and the total traffic flow expressed in vehicles. Tables 1 show the equivalent values of each type of vehicle to passenger cars issued by the Indonesian Highway Capacity Manual, 1997.

Traffic Flow Characteristics

2.5. Vehicle Volume (Q)

Traffic volume is the number of vehicles that pass a point per unit time at a particular location. In measuring the amount of traffic flow, it is usually expressed in vehicles per day, pcu per hour, and vehicles per minute (ICRM 1997). Traffic volume is calculated based on the Equation 1:

$$V = Q = n / T \quad .(1)$$

With;

V = traffic volume (vehicle/hour, vehicle/min)

Q = rate of flow

n = number of vehicles that passed the observation point

t = observation time interval (hours, seconds)

Traffic Speed (V)

The formula used to calculate the mean speed as shown in Eq.2

$$V = d/t \dots \dots \dots (2)$$

With;

V = speed (km/hr, m/sec)

d = distance (km, m)

t = vehicle travel time (hours, seconds)

2.6. Road Performance

The performance of a road section is a quantative accounting that describes certain conditions that occur in a road section. The performance of the road can be defined; the extent to which the ability of the road to carry out its functions (Morlok, 1978) where according to the 1997 ICRM used as a parameter is the Degree of Saturation (DS). ICRM 1997 also explained that the level of road service could also be calculated based on the Q / C boundary of the road section.

2.7. Capacity

Capacity is defined as the maximum current through a point on the road that can be maintained per unit hour under certain conditions. According to the Urban Road Geometric Standards book issued by the Directorate General of Highways (1999), "Basic Capacity" is defined as the maximum volume of vehicles per hour that can pass through a single lane strip (for multy lanes) or a road lane (for a 4 lane road) on ideal road conditions and road traffic flows. Ideal conditions are stated as conditions where further improvement in road conditions and changes in weather conditions will not result in an increase in capacity value.

Capacity is expressed in units of passenger cars so there needs to be a correction factor for the type of vehicle outside the passenger vehicle (van, pick-up, and jeep). The general equation for calculating the capacity of a road section according to the 1997 Indonesian Road Capacity Manual (ICRM 1997) for an urban road section is as shown in Equation 3 below:

$$C = C_o \times FC_w \times FC_{SP} \times FCSF \times FCCS \quad (3)$$

With;

C = Capacity (pcu/hour)

C_o = base capacity (pcu/hour)

FC_w = Road width adjustment factor

FC_{SP} = Directional separation adjustment factor (only for undivided roads)

$FCSF$ = Adjustment factor of side and shoulder stray / gird

$FCCS$ = City size adjustment factor

Basic Road Capacity

Determined based on the type of road as stated in the Table.1 below

Table 1. Road type with basic capacity

Road Type	Basic capacity (pcu/hour)	Notes
Four Lane with median or one way	1650	Per lane
Four lane without median	1500	Per lane
Two lane without median	2900	Total two ways

2.8. Free Current Speed

Free current speed (FV) is defined as speed at the zero current level. Free flow velocity has been observed through field data collection where the relationship between free flow velocity with geometric conditions and environmental conditions has been determined by the regression method. Light vehicle free flow speed has been chosen as basic criteria for the performance of road segments at currents equal to zero ($= 0$). Free flow speeds for heavy vehicles and motorbikes are also given as a reference. Free flow speed for passenger cars is usually 10-15% higher than other types of light vehicles. The equation for determining the free flow speed has the following general form as written in Equation 4:

$$FV = (FV_0 + FVW) \times FFVSF \times FFVCS \quad (4)$$

With;

FV = speed of free flow of vehicles in field conditions (km / hr).

FV_0 = The speed of the free base flow of the vehicle on the observed road

FVW = Speed adjustment for road width (km / h)

FFVSF = Speed adjustment factor for side barriers and shoulder width or the distance of the obstacle barrier.

FFVCS = Speed adjustment factor for city size

The degree of saturation (DS) is the ratio of the volume value (current value) of traffic to its capacity. This is an illustration of whether a road section has a problem or not, based on the assumption that if a road segment gets closer to its capacity the ease of movement is increasingly limited. Based on the definition of degree of saturation, DS is calculated by formula as seen in Equation 5:

$$DS = Q / C \quad (5)$$

With;

DS = Degree of Saturation

Q = Traffic volume (flow)

3. METHODOLOGY

There are several steps which have been conducted in this study as list below:

- This research begins with the process of identifying problems then formulating the research objectives, as explained in previous section.
- After the research objectives are formulated, the next stage is a preliminary survey for determine the scope of the discussion and limitation of the issues discussed, identification of the data needed, techniques / methods of data collection, including the timing of the survey. This preliminary survey is also supported by literature studies from various sources and references to some previous studies related to this research. Methods for collecting data were Mowing Car Observer Method (Puan, et al, 2014)
- Stages of conducting the survey are the process of collecting data to be processed so that it can be used as input in the subsequent analysis process
- The survey conducted is a traffic survey, with a view to collecting data on the condition of the road being reviewed, such as road geometric data, the magnitude of traffic flow and vehicle speed.(Hobbs, 1995)
- Data obtained from the results of the survey are then processed to analyze the capacity of the road sections. Analysis using the 1997 Indonesian Road Capacity Manual Methods.

4. RESULTS AND DISCUSSION

The road segment reviewed is the South Ring Road. In detail, data on road sections on the South Ring road can be explained as follows:

- a. Consists of 2 lanes, each lane divided into 2 lanes, 1 direction;
- b. The width of each lane is 3.50 m;
- c. Flat alignment;
- d. Urban roads.

Retrieval of traffic volume data using the Moving Car Observer (MCO) method (Puan, et al, 2014). Observation data is recorded and grouped in each direction of movement on the data sheet for the number of vehicles that have been prepared. Traffic volume data in units of vehicle/minute.

Primary data is data obtained from direct observations in the field which include the geometric conditions of road sections and road profiles, volume, speed, and density.

4.1. Traffic Volume Data

The equivalent factor values used in the calculation of traffic volume are sourced from the 1997 Indonesian Road Capacity Manual (ICRM 1997). The factor values used from the ICRM 1997 method are as follows.

Population data is considered as secondary data. Data on population can be obtained from relevant agencies, namely the Central Statistics Agency (BPS) of Mataram City (Anonym, 2018). This secondary data will be used to get the size of the city which can be seen in the 1997 Road Capacity Manual (ICRM 1997).

Data analysis

Using the 1997 ICRM Equation 3 as shown in section 3:

$$C = C_o \times FC_w \times FC_{SP} \times FC_{SF} \times FCCS$$

Then the C_o , FC_w , FC_{SP} , FC_{SF} , and $FCCS$ values are determined with the provisions in the Table 2 as follows:

Table 2. Relationship between type of Road with basic capacity

Tipe Jalan	Tipe Alayemen	Kapasitas dasar (smp/jam)			Catatan
		Jalan Perkotaan	Jalan Luar Kota	Jalan Bebas Hambatan	
Enam atau empat lajur terbagi atau jalan satu arah	Datar	1.650	1.900	2.300	Per lajur
	Bukit		1.850	2.250	
	Gerung		1.800	2.150	
Empat lajur tak terbagi	Datar	1.500	1.700		Per lajur
	Bukit		1.650		
	Gerung		1.600		
Dua lajur tak terbagi	Datar	2.900	3.100	3.400	Total dua arah
	Bukit		3.000	3.300	
	Gerung		2.900	3.200	

C_o (Basic Capacity)

To determine C_o , the following Table 2 can be considered. Based on the above table and field survey data, the South Ring Road is a four-lane or one-way type road that is on a flat alignment and is also an urban road for the South Ring Section. Based on this, the C_o value for each section is:

1. South ring road section: 1650 (pcu/hour)

4.2. Determination of FCw

To determine FCW, the following Table 3 can be considered:

Table 3 Factors adjusting capacity for the width of the traffic lane

Tipe Jalan	Lebar jalur Laju-lintas efektif (W_e) (m)	FCw		
		Jalan Perkotaan	Jalan Luar Kota	Jalan Bebas Hambatan
Enam atau empat lajur terbagi atau jalan satu arah (6/2 D) atau (4/2 D)	Per lajur			
	3.00	0.92	0.91	
	3.25	0.96	0.96	0.96
	3.50	1.00	1.00	1.00
	3.75	1.04	1.03	1.03
	4.00			
Empat lajur tak terbagi (4/2 UD)	Per lajur			
	3.00	0.91	0.91	
	3.25	0.95	0.96	
	3.50	1.00	1.00	
	3.75	1.05	1.03	
	4.00			
Dua lajur tak terbagi (2/2 UD)	Total dua arah			
	5.0	0.56	0.69	
	6.0	0.87	0.91	
	6.5			0.96
	7.0	1.00	1.00	1.00
	7.5			1.04
	8.0	1.14	1.08	
	9.0	1.25	1.15	
	10.0	1.29	1.21	
	11.0	1.34	1.27	

Sumber: MKJI, 1997

Based on the above table and field survey data, the South Ring Road is a four-lane or one-way type road that has an effective width of 3.50 meters and is also an urban road for the South Ring Section. Based on this, the FCW values for each South Ring road are:

1. South ring road section: 1.00

FC_{SP} (Directional adjustment factor (only for undivided roads))

To determine FC_{SP} , the following Table 4 can be seen:

Table 4 Adjustment factors for direction separation (only for undivided roads)

Pemisahan arah SP %-%			50-50	55-45	60-40	65-35	70-30
FC_{SP}	Jalan	Dua lajur (2/2)	1.00	0.97	0.94	0.91	0.88
	Perkotaan	Empat lajur (4/2)	1.00	0.985	0.97	0.955	0.94
FC_{SP}	Jalan	Dua lajur (2/2)	1.00	0.97	0.94	0.91	0.88
	Luar Kota	Empat lajur (4/2)	1.00	0.975	0.95	0.925	0.9
FC_{SP}	Jalan Bebas Hambatan	Dua lajur (2/2)	1.00	0.97	0.94	0.91	0.88

Sumber: MKJI, 1997

Based on the table and field survey data, the South Ring Road is a four-lane or one-way type road that has a 50-50% direction separator and is also an urban road. Based on this, the FCW values for the South Ring road are:

1. South Ring Road Section: 1.00

And in the same way the FC_{SF} and FC_{CS} values are as follows:

South Ring Section

$FCSF = 1.00$

$FCCS = 1.00$

After all the factor values are known, the obtained value of the capacity of the road segment (C) on the South Ring road based on the ICRM 1997 equation is 1650 pcu / hour.

5. CONCLUSION

From the results of research and discussion that has been carried out could be concluded, as follows: Based on the results of the analysis of field conditions data using the ICRM 1997 method, the capacity value (C) on the South Ring road is 1650 pcu/hour.

In my point of view that further research examine the capacity of intersections, out-of-city roads, and other road characteristics using the ICRM 1997 and PKJI 2014 methods

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