Traffic Impact of the Dakota Road Development to Rembige - Mataram Junction Performance; (Case Study Rembige Junction - Mataram)

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Traffic Impact of the Dakota Road Development to Rembige – Mataram Junction Performance; (Case Study Rembige Junction – Mataram)

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Abstract: The development of a region coupled with an increase in the pull of traffic movements should be directly proportional to the increase in transportation facilities and infrastructure. Development of the region without the improvement of transportation facilities and infrastructure will result in performance problems in the transportation facilities and infrastructure. The road intersection is the location of the source of conflict in traffic, one of them is Simpang Rembige Lombok, West Nusa Tenggara, Indonesia. With the construction of the Dakota road, it is expected to break down the flow of traffic from the Tanjung to Ampenan, so that it can reduce the tarffic volume at the intersection to be able to reduce congestion problems.

In this study a review of the influence given to the construction of the Dakota road, the movement of vehicles at the current Rembiga intersection, the influence of the existence of the Dakota road on Rembiga intersection performance and knowing the performance of the traffic lights at the current Rembiga intersection and supposition when the road Dakota isn't there.

By conducting a direct survey as a research method and analyzing data based on the equations in the factors that influence the characteristics of traffic, the influence of the existence of the Dakota road as an alternative route is anticipated that the queue at the Rembiga intersection is significant. This can be seen from the comparison between the total number of traffic movements from the West side (Adi Sucipto road) towards the North side (Dr. Wahidin road) with the total traffic movement across the Dakota road. During peak hours, the total volume of movement of vehicles utilizing the Dakota road as an alternative lane anticipates the queue at the Rembiga intersection of 662.50 skr from 1,532.78 skr or 43.22% with details of 374.80 skr or 24.45% moving from the side North to West and 287.70 skr or 18.77% moves from the West to the North.

Keywords: Dakota Road, traffic, intersection, vehicle volume, saturated flow

1. Introduction

Limited land, the high price of land in urban areas and the increasing demand for housing land resulted in the development of the city began to shift to sub-urban areas as an effort to equalize the distribution of the population. This condition also occurs in the city of Mataram, the capital of West Nusa Tenggara province, which has been designated as Metro City, where the nature of a Metro city is the gradual shifting of land functions, especially agricultural land which has turned into residential or trading areas. The sub-urban areas of Mataram began to function as residential areas with the emergence of KPR (Housing Loans) and then with the existence of government programs namely subsidized houses where according to the Chairman of REI (Real Estate Indonesia) NTB Province that lacked of housing (backlog) NTB has 18,000 units while in 2017 5,000 units have been built while the rest will be built step by step.

Ideally the development of a region with a high traffic flow is directly proportional to the increase in transportation facilities and infrastructure, because if development is only focused on regional development, the problems with the performance of transportation infrastructure, especially roads, will become a time bomb for the city government of Mataram.

Intersection with high traffic movements is the location of sources of traffic conflict that are prone to accidents between vehicles and vehicles or vehicles with pedestrians. This condition is often found in urban road intersections, including Simpang Rembiga in Selaparang sub-district - Mataram City.

The Dakota Road existence is expected to function as a decoder of traffic flow from Tanjung to Ampenan, traffic from both directions is not through the Rembiga intersection so that it can reduce the loading of traffic volume through the intersection. How far this road is able to function as a alternatif to reduce the traffic volume for the Rembiga intersection both on the North side intersection arm (direction Tanjung) and on the West side arm (Ampenan direction) is the purpose of this study. In addition, knowing the movement of

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vehicles at the current Rembiga intersection, the influence of the existence of the Dakota road on increasing the performance of the intersection of Rembiga and knowing the performance of traffic lights at the current Rembiga intersection and if the Dakota road does not exist are also the objectives of this study.

The research was conducted at the Rembiga intersection which is located on the North side of the city of Mataram, while the Dakota road connects the North side Rembiga intersection arm (direction Tanjung) and the West side (direction Mataram / Ampenan). Dakota road and the Rembiga Mataram intersection presented in Figure 1,

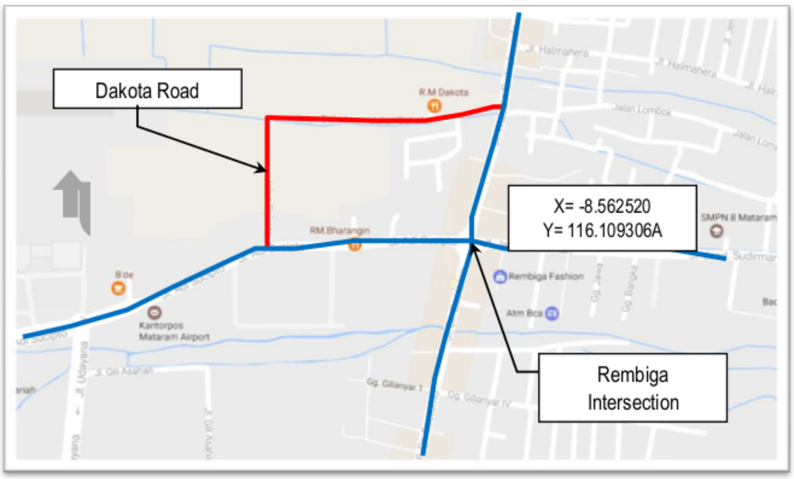


Figure 1.Map of research location

1. Literature review

The research conducted by Irwanto (2014) about the analysis and evaluation of unsignalized intersections on the road Ir. H Juanda and Jalan Pahlawan, Ciputat based on MKJI 1997 explained that changes in intersections from signaling to non-signaling since the 1990s were one of the triggers for a long queue of vehicles due to conflicts over vehicle intersections, especially during peak hours. The purpose of his research is to analyze the degree of saturation which is an indicator of traffic density and to evaluate and look for alternative solutions in an effort to improve intersection performance.

Factors that influence traffic characteristics:

a. Degree of saturation (DJ)

That is the ratio of current to capacity, is used as the main factor in determining traffic behavior in a intersection and road segment. The degree of saturation will indicate whether the road segment will have a capacity problem or not. Equations used:

$$DJ = Q / C \quad \text{......} \quad (1)$$

which :

Q: Traffic flow (skr / hour)
C: Capacity (skr / hour)

b. Capacity (C)

Capacity is defined as the maximum traffic flow that can be maintained (skr / hour)

$$C = S \times H/c \quad \text{......} \quad (2)$$

which :

C	:	intersection capacity (skr/hour)
S	:	saturated flow (skr/hour)
H	:	total of greenlight time in one cycle (sec.)
c	:	cycle time (sec.)

c. Ratio of vehicle stops (R_{KH})

That is the ratio of vehicles to the approach that must stop due to the red signal before passing an intersection with the number of currents in the same phase in the approach, calculated by the equation:

$R_{KH} = 0{,}9 \times (N_Q/(Q \times c)) \times 3600$ …………………………………. (3)

which :

N_Q : average number of vehicles queue (skr) from green sign.
c : cycle time (sec.)
Q : traffic flow from the approach is reviewed(skr/hour)

Number of vehicles stop (N_S) each approach:

$N_S = Q \times R_{KH}$ (skr/hour) ………………………………………………. (4)

$N_{STotal} = \sum N_S / Q_{total}$ …………………………………………………… (5)

d. Green Ratio (R_H)

Is the comparison between the green signal time and the phase time in the approach reviewed.

$R_H = g / c$ ……………………………………………………………… (6)

which :

g : green signal time (sec.).
c : cycle time / phase (sec.)

e. Long of Queue (PA)

Is the average number of vehicle queues (skr) at the start of the green light signal (NQ) calculated as the number of vehicles stopped (skr) remaining from the previous green phase (NQ1) plus the number of vehicles (skr) that arrive and stop in the queue during the red phase (NQ2), calculated by the equation:$N_Q = N_{Q1} + N_{Q2}$ ………………………………………………….. (7)

- if $D_J > 0{,}5$ then :

$$N_{Q1} = 0{,}25c\left[(D_J-1)^2+\sqrt{(D_J-1)^2+\frac{8(D_J-0{,}5)}{c}}\right] \quad (8)$$

- if $D_J \le 0{,}5$ then $N_{Q1} = 0$

$$N_{Q2} = c\cdot\frac{(1-R_H)}{(1-R_H\cdot D_J)}\cdot\frac{Q}{3600} \quad (9)$$

which :

N_{Q2} : the number of vehicles that come during the red phase(skr)
c : cycle time (sec.)
R_H : greenlight ratio
Q : volume of traffic entering outside turns left and continues (skr/sec.)
D_J : degree of saturation

Long of queue (PA) obtained from the multiplication of NQ (skr) with the average area used by one light vehicle (ekr) which is 20 m2, divided by the width of the entry (m). the equation:

$PA = N_Q (20 / L_M)$……………………………………………… (10)

which :

L_M :width of the inlet is measured on the stop line(m)

f. Delay (T)

The delay has the understanding that additional travel time is needed for intersections whencompared to the trajectory without going through an intersection.

Delays in an intersection occur because of two things, namely the traffic delay (TL) and the geometric delay (TG). while the average delay for an approach is calculated using the equation:

$T = T_L + T_G$ ……………………………………………………. (11)

dimana :

T : average delay
T_L : The average traffic delay in an approach is determined by :

$$T_L = c\,.\frac{0{,}5(1-R_H)^2}{(1-R_H\,.D_J)} + \frac{N_{Q1}\,.3600}{c} \quad\text{...........}\quad (12)$$

Note : the calculation results do not apply if the intersection capacity is influenced by "external" factors such as obstruction of the exit due to downstream congestion, or manual or other police regulation.

T_G : the average geometric delay in an approach is determined by :

$$T_G = (1-R_{KH}) \times P_B \times 6 + (R_{KH} \times 4) \quad\text{.........}\quad (13)$$

which :

- c : capacity (skr/hour)
- R_H : greenlight ratio
- D_J : degree of saturation
- N_{Q1} : the amount left from the previous green phase (skr)
- R_{KH} : ratio of vehicles stops
- P_B : ratio of turning vehicles

2. Methodology

Primary data retrieval

The number of vehicles passing an undisturbed line in the upstream approach per unit time (vehicle / hour, ekr / hour) Q notation is used to declare LHRT in units of ekr / day or kend / day. Traffic volume data is taken for 3 (three) days, namely Monday, March 19 2018 until Wednesday, March 21, 2018 at the time:

- Morning: 6:00 - 8:30 a.m., when employees leave for work and when students leave school
- Afternoon: 12.00 - 15.00 hours, when office employees go home to rest and when students go home from school
- Afternoon: 4:00 p.m. - 6:30 p.m., when employees leave work and other community activities.

This traffic volume survey is conducted to record the movements of various types of vehicles on each intersection both turning left, turning right or straight at an interval of 15 (fifteen) minutes. Observation points will be placed on each arm while for the Dakota road recording traffic volume is carried out for traffic entering and exiting the Dakota road through the intersection node on the road of Adi Sucipto (West) and the intersection point on the road Dr. Wahidin (North). The position of the post in this survey can be seen in Figure 2,

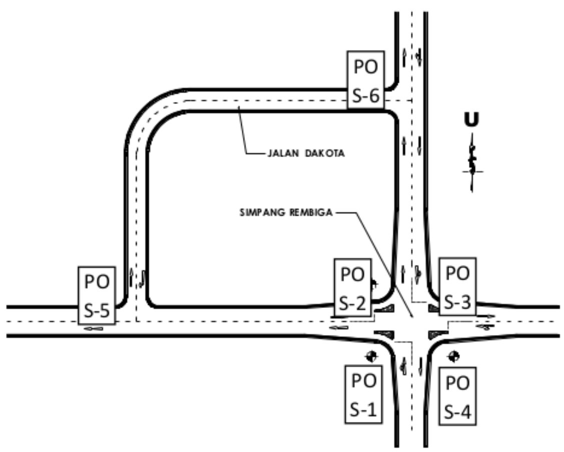


Figure 2. Position of the review post and recording of traffic volume

Post-1: Observed the movement of traffic from the South to the intersection.
Post-2: Observed the movement of traffic from the West to the intersection.
Post-3: Observed the movement of traffic from the North to the intersection.
Post-4: Observed the movement of traffic from the East to the intersection.
Post-5: Observed traffic coming in and out of Dakota from the West.
Post-6: Observed the traffic in and out of the Dakota road from the North.

Data on traffic volume obtained from the field consists of various types of vehicles, later stated in a standard type of vehicle, namely passenger cars known as the Light Vehicle Unit (skr). To get the traffic volume in the skr, conversion factors are needed for each type of vehicle or known as the equivalent of light vehicles (ekr), but beforehand the vehicles classified into groups.

Secondary Data Collection
Secondary data is obtained from the authorized agencies, namely:

Table 1. Secondary data

No.	Description	Agency
1	Map of the National Road Network	- National Road Planning and Supervision (P2JN) of NTB Province Director General of Highways of the Ministry of Public Works and Public Housing
2	Map of the Provincial Road Network	- Road and Bridge Planning Section of the NTB Province Public Works and Public Housing Agency
3	Data on motorized vehicle growth in Mataram	- Department of Land Transportation of the City of Mataram - Land Transportation Agency of NTB Province - Resort Police of Mataram
4	Traffic volume intersection of previous years (if ever done)	- National Road Planning and Supervision (P2JN) of NTB Province - Road and Bridge Planning Section of the NTB Province Public Works and Public Housing Agency - Mataram City Public Works Agency

Population from Mataram Statistics Agency (BPS) data:
From the 2017 BPS data, the total population of Mataram city in 2016 was 459,314 people, while the population in the Selaparang sub-district at the Rembiga intersection was 75,027 with details of 36,624 men and 38,403 women.

Data Collection and Processing Form

Forms used for primary data collection (Traffic Counting) and processing for intersection performance analysis are SIG-I format to SIG-V.

On the SIG-II form, the equivalent number of passenger cars, especially motorcycles with shielded ekr, is used as an ecr value of 0.15 while MKJI 1997 uses a value of 0.20. For form SIG-IV the basic value of saturated current (So) is used formulation 775 x We (effective width) while MKJI 1997 uses formulation 600 x We (Effective width).

This difference is based on conclusions taken by Prof. Dr-Ing. Ir. Ahmad Munawar, M.Sc at the symposium in Yokohama, Japan on 25-29 July 2006 with the theme Queues and Delays at Signalized Intersections, Indonesian Experience on the 5th International Symposium on Highway Capacity and Quality of Service.

3. Analysis and discussion

Observation of the traffic operation

Observations are also made on traffic signals that include the number of phases, the time of each phase and the movement of traffic signals. This traffic signal movement includes cycle time, green time, yellow time, red time, green intervals and total lost time. The signal phase used at this intersection is a 4 (four) phase traffic arrangement with departing currents one by one for each intersection arm, while traffic turning left on all intersection arms is permitted to continue. The observation of traffic movements is shown in figure 3 while the traffic signal time in table 2,

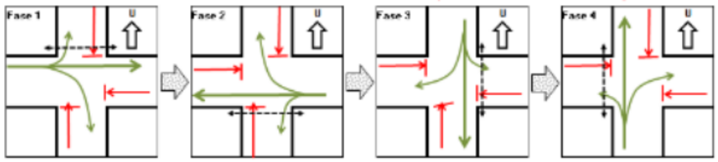


Table 2. Movement of intersection traffic signals

Signal	Cycle Time (sec.)	Time (second)					
		Red	Green	Yellow	All red	Between Green	Green dissapear
Phase 1 (North)	101	82	23	2	4	6	24
Phase 2 (East)		80	19	2	4	6	
Phase 3 (South)		83	17	2	4	6	
Phade 4 (West)		82	18	2	4	6	

Source: Results of observations and calculations
The amount of all red is obtained from:
All Red = Cycle time - □ (green time- yellow time)
While inter green time is obtained from:
Inter green = All red time + yellow time.

Table 3. Volume recapitations and peak hours of intersection traffic movements

	Morning		Noon		Afternoon	
	Peak Volume	Peak Hour	Peak Volume	Peak Hour	Peak Volume	Peak Hour
Day -1	2.410,14	07.15-08.15	2.377,48	12.45 - 13.45	2.266,28	16.15 - 17.15
Day -2	2.227,20	07.15-08.15	2.475,20	14.00 - 15.00	2.309,19	17.30 - 18.30
Day -3	2.232,21	07.30-08.30	2.225,75	14.00 - 15.00	2.276,83	17.30 - 18.30
Maximum	2.410,14	07.15-08.15	2.475,20	14.00 - 15.00	2.309,19	17.30 - 18.30

Peak hour during 3 day of observation	
Day -2	
Noon	
14.00 - 15.00	2.475,20

Images of traffic movement volume at the intersection during peak hours for 3 days of observation such as the following:

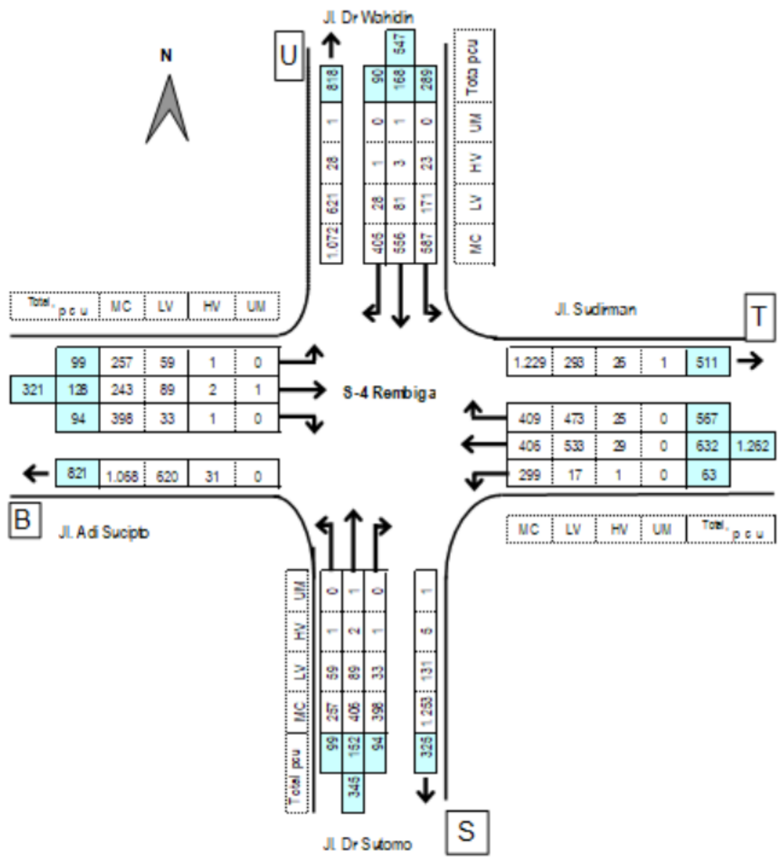


Figure 4. Cross traffic movement during peak hours for 3 days of observation

Commulative Dakota and Simpang road traffic movements Basically the total traffic movement at the Rembiga intersection from the Adi Sucipto (Westarm)road which turns left towards Dr. Wahidin (North arm) is a combination of traffic coming from the road of Adi Sucipto (West arm) and turning left towards the road Dr. Wahidin (North arm) at the Rembiga intersection, coupled with traffic coming from the direction of the Adi Sucipto (West arm) road but into the Dakota road and out on the road Dr. Wahidin (North arm).

Otherwise, the movement of traffic from Dr. Wahidin (North arm) that turns right towards the road Adi Sucipto (West arm) is a combination of traffic coming from Dr. Wahidin (North arm) and turn right towards Adi Sucipto (West arm) road at the Rembiga intersection, plus the traffic coming from the direction of Dr. Wahidin (North arm) via the Dakota road and exits on the road Adi Sucipto (West arm). In accordance with the purpose of the research is to determine the performance of the Rembiga intersection signal if the Dakota road is not built, then the traffic movement at the Rembiga intersection will increase especially for traffic coming from the West (Adi Sucipto road) towards the North (Dr. Wahidin road) or vice versa from North to West. Combined traffic movement data when peak hours are displayed in the following table:

Table 4. Combined classified traffic movement at the Rembiga intersection and Dakota road at peak hours

Peak hour	Day	Description		Vehichles Clasification															
				MC	LV	HV	UM	MC	LV	HV	UM	MC	LV	HV	UM	MC	LV	HV	UM
14.00 - 15.00	II	Dakota Street	in from west	778	171	0	0												
			out from north					781	172	0	0								
			in from north									1.298	169	7	2				
			out from west													1.283	158	7	2
		Rembiga Intersection	From west to the north					257	59	1	0								
			From North to the west													405	28	1	0
		Total =		778	171	0	0	1.038	231	1	0	1.298	169	7	2	1.688	186	8	2

Source: Calculation results

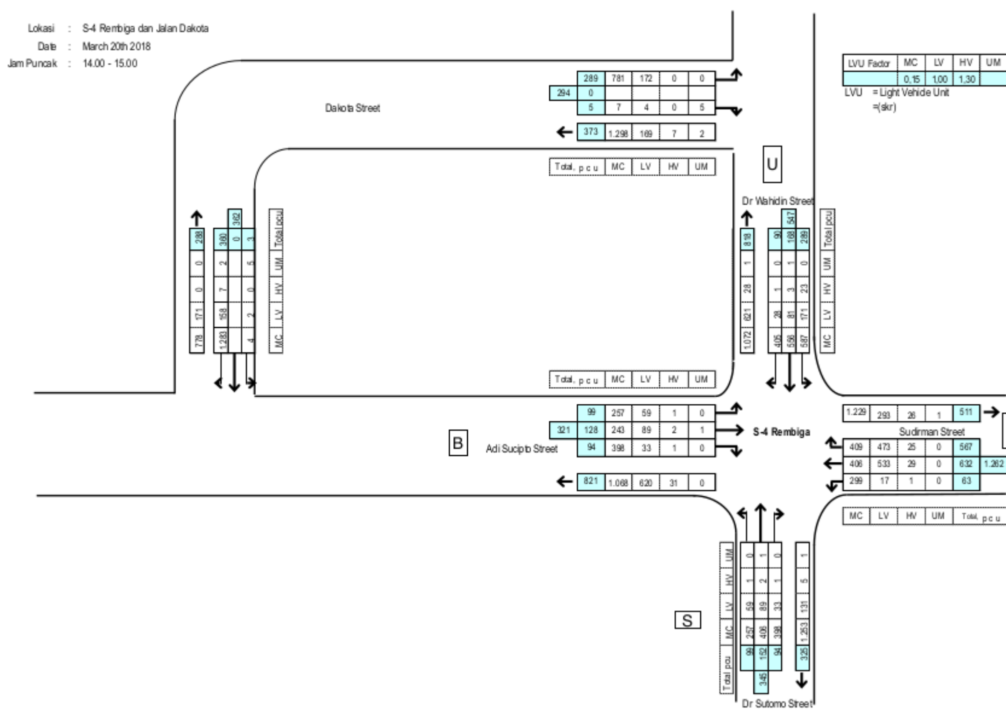
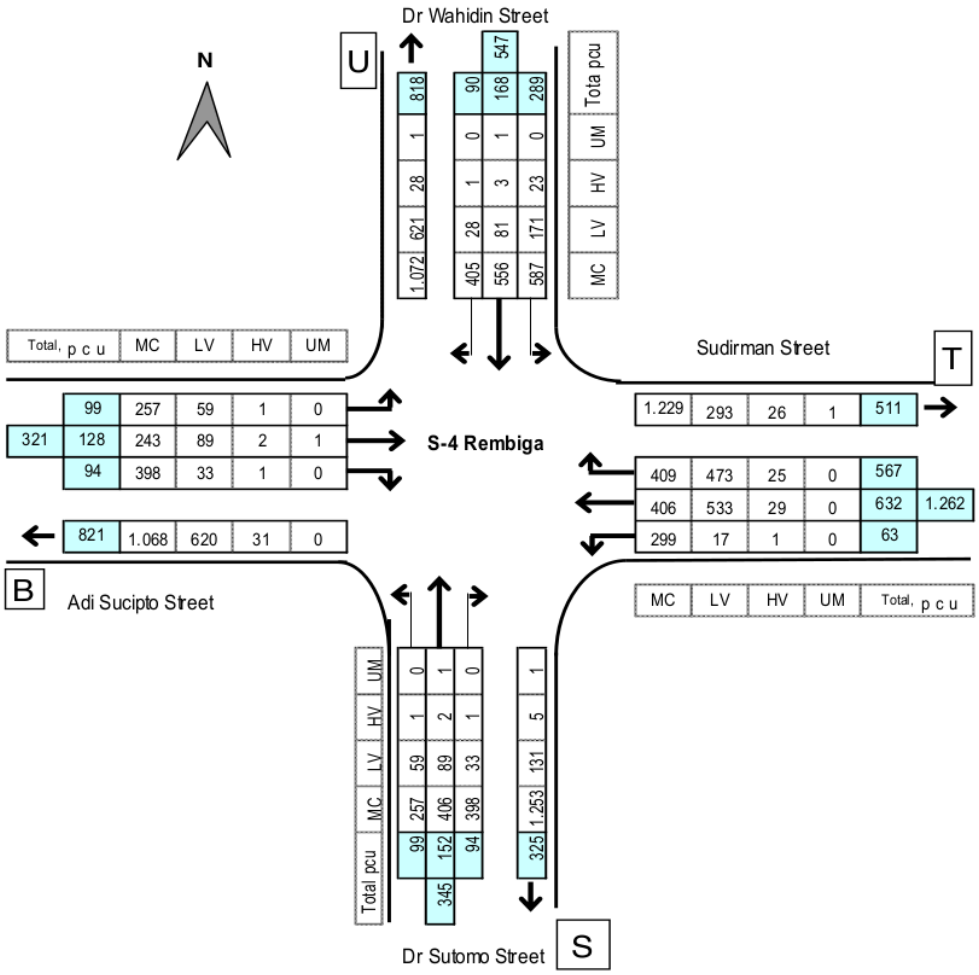


Figure 5. Traffic movements at the Rembiga intersection and Dakota road during peak hours

Location : S-4 Rembiga
Day : II (Two)
Date Tuesday, March 20th 2C
Peak Hour : 14.00 - 15.00



LVU Factor	MC	LV	HV	UM
	0,15	1,00	1,30	

LVU = Light Vehicle Unit
= (skr)

Figure 6. Traffic movement at the Rembiga intersection during peak hours if the Dakota road is not present

Table 5. Recapitulation of the calculation on combined traffic movements at intersection and Dakota road

Description	Unit	Intersection arm			
		Dr Wahidin Street (North)	Sudirman Street (East)	Dr Sutomo Street (South)	Adi Sucipto Street (West)
Saturated flow basic (S_o)	(skr/hour)	2480,00	5270,00	4495,00	3797,50
Turn left ratio (R_{BKi})		0,234	0,145	0,334	0,623
Turn rigjt ratio (R_{BKa})		0,573	0,414	0,347	0,212
Adjustment factors					
Side obstacle (F_{HS})		0,93			
City size (F_{UK})		0,83			
Slopingness (F_G)		1,0			
Aprking vehicles (F_P)		0,789	0,908	0,966	1,057
Turn left (R_{BKi})		0,962	0,977	0,947	0,900
Turn right (R_{BKa})		1,149	1,108	1,090	1,055
Saturated flow adjustment (S)	(skr/hour)	1669,77	3995,69	3460,15	2942,73
Cycle time	(second)	-125,6			
Dissapear greenlight time	(second)	24,0			
Flow ratio		0,716	0,351	0,129	0,130
Number of flow ratio		1,326			
Phase ratio		0,540	0,265	0,097	0,098
Greenlight time	(second)	-80,78	-39,59	-14,58	-14,66
Capacity (C)	(skr/hour)	1073,88	1259,20	401,70	343,42
Traffic flow	(skr/hour)	1195,90	1402,28	447,34	382,44
Total of traffic flow	(skr/hour)	3427,96			
Number of vehicles B_{Ki} / B_{KiT}	(skr)	837,53			
Saturated degree (D_J)		1,114	1,114	1,114	1,114
Greenlight ratio (R_H)		0,64	0,32	0,12	0,12
Number of queue vehicles					
The average queue at the start of the green signal (N	skr	13,53	24,96	11,49	10,37
Vehicle left in the previous green phase (N_{Q1})	skr	66,00	76,58	27,33	23,92
Vehicles that come during red time (N_{Q2})	skr	-52,47	-51,63	-15,85	-13,55
Queue length (P_A)	meter	92	128	66	69
Vehicles stops ratio (R_{KH})		-0,29	-0,46	-0,66	-0,70
Numbers of vehicle stop	skr	-349	-644	-296	-267
Total of vehicle stop	skr	-1556			
Delay (T)					
Average of traffic delay (T_L)	(second)	193,08	173,57	188,59	194,39
Average of geometric delay (T_G)	(second)	0,00	0,00	0,00	0,00
Delay average (T)	(second)	193,08	173,57	188,59	194,39
Delay total	(second)	230903,35	243387,69	84362,39	74343,38
Delay number	(second)	632996,80			
Average of intersection delay	(sec./skr)	148,40			
	(min./skr)	2,47			
Service Level of each intersection arm		F			

Source: calculation results

With a current ratio that exceeds 1 that is 1.326 produces an unrealistic cycle time value because it is negative, this indicates that the performance of the Rembiga intersection has exceeded saturation with existing conditions and situations both from traffic flow, intersecting geometric conditions and the operation of the current signal .

In the case of unrealistic and negative cycle times, according to the conclusions taken by Prof. Dr-Ing. Ir. Ahmad Munawar, M.Sc at the Proceedings Forum in the 15th ITS (Intelligent Transport System) Asia - Pacific Form & Exhibition 2017 event in Hong Kong on 26-29 June 2017 with the theme Platoon Dispersion Modeling of Mixed Road Traffic to Optimize Signal Setting over Arterial North Ring Road Link in Yogyakarta (A9) gives a cycle time of 210 seconds.

On the basis of these conclusions for the Rembiga intersection, adjusting the cycle time is used for 200 seconds. The results obtained by adjusting the cycle time are as shown in the following table:
The combined analysis of traffic movements assuming the Dakota road is not built and the Dakota road condition has been built as it is today, shown in the following table:

Table 6. Recapitulation of combined traffic movement calculations at Dakota intersections and roads with adjusted cycle times.

Description	Unit	Intersection arm			
		Dr Wahidin Street (North)	Sudirman Street (East)	Dr Sutomo Street (South)	Adi Sucipto Street (West)
Saturated flow basic (S_o)	(skr/hour)	2480,00	5270,00	4495,00	3797,50
Turn left ratio (R_{BKi})		0,234	0,145	0,334	0,623
Turn rigjt ratio (R_{BKa})		0,573	0,414	0,347	0,212
Adjustment factors					
Side obstacle (F_{HS})		0,93			
City size (F_{UK})		0,83			
Slopingness (F_G)		1,0			
Aprking vehicles (F_P)		0,789	0,908	0,966	1,057
Turn left (R_{BKi})		0,962	0,977	0,947	0,900
Turn right (R_{BKa})		1,149	1,108	1,090	1,055
Saturated flow adjustment (S)	(skr/hour)	1669,77	3995,69	3460,15	2942,73
Cycle time	(second)	200,0			
Dissapear greenlight time	(second)	24,0			
Flow ratio		0,716	0,351	0,129	0,130
Number of flow ratio		1,326			
Phase ratio		0,540	0,265	0,097	0,098
Greenlight time	(second)	95,03	46,57	17,15	17,24
Capacity (C)	(skr/hour)	793,42	930,34	296,79	253,73
Traffic flow	(skr/hour)	1195,90	1402,28	447,34	382,44
Total of traffic flow	(skr/hour)	3427,96			
Number of vehicles B_{Ki} / B_{KiT}	(skr)	837,53			
Saturated degree (D_J)		1,507	1,507	1,507	1,507
Greenlight ratio (R_H)		0,48	0,23	0,09	0,09
Number of queue vehicles		0,00	0,00	0,00	0,00
The average queue at the start of the green signal (N	skr	326,08	330,02	103,31	88,60
Vehicle left in the previous green phase (N_{Q1})	skr	203,21	237,94	77,21	66,28
Vehicles that come during red time (N_{Q2})	skr	122,87	92,08	26,09	22,32
Queue length (P_A)	meter	1881	1549	497	489
Vehicles stops ratio (R_{KH})		4,42	3,81	3,74	3,75
Numbers of vehicle stop	skr	5282	5346	1674	1435
Total of vehicle stop	skr	13738			
Delay (T)		0,00	0,00	0,00	0,00
Average of traffic delay (T_L)	(second)	1019,08	1011,39	1032,57	1036,42
Average of geometric delay (T_G)	(second)	1,11	5,83	3,78	1,22
Delay average (T)	(second)	1020,19	1017,22	1036,35	1037,64
Delay total	(second)	1220044,6	1426427,8	463600,2	396839,3
Delay number	(second)	3506911,93			
Average of intersection delay	(sec./skr)	822,16			
	(min./skr)	13,70			
Service Level of each intersection arm		F			

Source: calculation results

The combined analysis of traffic movements assuming the Dakota road is not built and the Dakota road condition has been built as it is today, shown in the following table:

Table 7. Analysis of the performance of the Rembiga intersection with and without the Dakota road

Descriptions	Unit	Performance of Rembiga Intersection							
		Conditions if the Dakota road is not built				Current Conditions (There's Dakota Road)			
		Dr Wahidin Street (North)	Sudirman Street (East)	Dr Sutomo Street (South)	Adi Sucipto Street (West)	Dr Wahidin Street (North)	Sudirman Street (East)	Dr Sutomo Street (South)	Adi Sucipto Street (West)
Saturated flow basic (S_o)	(skr/hour)	2480,00	5270,00	4495,00	3797,50	2480,00	5270,00	4495,00	3797,50
Turn left ratio (R_{BKi})		0,23	0,14	0,33	0,62	0,42	0,14	0,25	0,29
Turn right ratio (R_{BKa})		0,57	0,41	0,35	0,21	0,23	0,41	0,35	0,40
Adjustment factors									
Turn left (F_{BKi})		0,96	0,98	0,95	0,90	0,93	0,98	0,96	0,95
Turn right (F_{BKa})		1,15	1,11	1,09	1,06	1,06	1,11	1,09	1,10
Saturated flow adjustment (S)	(skr/hour)	1669,77	3995,69	3460,15	2942,73	1493,76	3995,69	3506,53	3258,16
Dissapear Green time	(second)	24,0				24,0			
Flow ratio		0,72	0,35	0,13	0,13	0,33	0,35	0,13	0,11
Number of flow ratio		1,326				0,922			
Capacity (C)	(skr/hour)	793,42	930,34	296,79	253,73	516,15	1451,63	463,08	369,15
Traffic flow	(skr/hour)	1195,90	1402,28	447,34	382,44	498,60	1402,28	447,34	356,60
Total of traffic flow	(skr/hour)	3427,96				2704,82			
Number of vehicles B_{Ki} / B_{KiT}	(skr)	837,53				549,83			
Saturated degree (D_J)		1,51	1,51	1,51	1,51	0,966	0,966	0,966	0,966
The average queue at the start of the green signal (N_Q)	skr	326,08	330,02	103,31	88,60	78,72	210,04	71,95	58,34
Length of queue (P_A)	meter	1881,19	1549,34	496,55	488,61	465	990	349	326
Delay (T)									
Average of traffic delay (T_L)	(second)	1019,08	1011,39	1032,57	1036,42	220,23	187,97	281,99	296,20
Average of delay (T)	(second)	1020,19	1017,22	1036,35	1037,64	224,23	191,92	285,99	300,20
Total of delay	(second)	1220044,65	1426427,81	463600,21	396839,26	111801,86	269126,92	127934,21	107049,91
Number of delay	(second)	3506911,93				615912,91			
Average of intersection delay	(sec./skr)	822,16				189,24			
	(min./skr)	13,70				3,15			

Sumber: Hasil Perhitungan

4. Conclusions and Suggestions

Conclusion

Based on the research and analysis result of the Rembiga intersection performance related to the existence of the Dakota road, several conclusions were obtained:

- The current description of the Rembiga intersectionperformance is as follows:
  The highest traffic volume at the Rembiga intersection for 3 (three) days observation occurred on the 2nd day (Tuesday, March 20, 2018) at 14.00-15.00 WIB where the total movement of vehicles in light vehicles (skr) is 2,475 with details 1,665 light vehicles, 117 heavy vehicles and 693.2 motorbikes. The largest volume of traffic flow on the East side arm is 1,261.6 skr, then the North side arm 547.3 skr, then the South side arm 345.3 skr and the West side 320,9 skr.
- The influence of the existence of the Dakota road as an alternative route to anticipate the queue at the Rembiga intersection is quite significant. This can be seen from the comparison between the total number of traffic movements from the West side (Adi Sucipto road) towards the North side (Dr. Wahidin road) or with the total traffic movement across the Dakota road. During peak hours, the total volume of movement of vehicles utilizing the Dakota road as an alternative lane anticipates the queue at the Rembiga intersection of 662.50 skr from 1,532.78 skr or 43.22% with details of 374.80 skr or 24.45% moving from the side North to West and 287.70 skr or 18.77% moves from the West to the North.
- The current performance of traffic light signals at the Rembiga intersection needs to be sought for alternative solutions and efforts to improve traffic management, this is based on the parameters obtained from the results of the analysis, namely:
  - ✓ The current critical ratio is 0.930 while if the Dakota road does not exist, the current ratio reaches 1.326. This shows that the current intersection condition requires an evaluation of the signal phase intersection because the critical current (RF) ratio is already quite high (RF> 0.8).
  - ✓ Saturation degree (DJ) at the current intersection is 0.970 which means it has exceeded the recommended upper limit of 0.85 while if the Dakota road is not present (not built) the value of

saturation reaches 1.114. This condition causes long queues in peak traffic conditions.

- ✓ The queue length at peak hours in each approach is 465.1 meters on the North side arm, 990.3 meters on the East side arm, 349.4 meters on the south side arm and 326.3 meters on the West side arm.
- ✓ With a critical current ratio of 0.930 (close to 1) causing a large cycle time (c) and an increase in average delay also becomes high. The delay that occurs at the current intersection is 209.1 sec/skr or 3.48 min./skr. Meanwhile, if the Dakota road is not built the critical current ratio value exceeds 1, which means that the intersection has exceeded saturation and the Webster formula produces an unrealistic cycle time value because it is negative. In this condition the cycle time value is set to 200 seconds to produce other performance parameters from the Rembiga intersection not negative or realistic values.produce other performance parameters from the Rembiga intersection not negative or realistic values.

Suggestions

1. With the current intersection, it isnecessary for competent stakeholders to evaluate the intersection performance, given the intersection delay is in the F service category, which means the traffic jam or arrival flow exceeds the capacity of the intersection.
2. Noting the geometric conditions of the intersection, the most possible performance improvement is the management of traffic light signal management, but the thing that should be considered is the duration of waiting for pedestrians who will cross the road on the intersection arm.
3. Considering that the peak volume of traffic flow that is the basis for calculating intersection performance does not occur continuously, but is fluctuating, it is recommended that further research is carried out at the Rembiga intersection which will result in a varied arrangement of hourly traffic signals using the OSCADY program (English) or AASIDRA (Australia).
4. It is necessary to do a separate study of the formation of a new intersection, namely the three intersections between the streets of Dakota by the way Dr. Wahidin (on the North side intersection arm) given the current conditions in the field there are often long queues when traffic movements will enter the Dakota road from the North.

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