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Performance Analysis of Road Section and Unsignalized Intersections in Order to Prevent Traffic Jams on Jl H. Djole – Jl. Pasar Lama

Muhammad Isradi, Natasha Diaz Nareswari, Andri Irfan Rifai, Amar Mufhidin
Faculty of Engineering, University Mercu Buana Jakarta, Indonesia
isradi@mercubuana.ac.id, Natashadiaz868@gmail.com, andrirfan@yahoo.com, amarmufhidin@gmail.com

Joewono Prasetijo
Faculty of Engineering, University Tun Hussein Onn Malaysia, Malaysia
joewono@uthm.edu.my

Abstract

The unsignalized intersection of Jalan H Djole – Jalan Pasar Lama is located in Bekasi City is a commercial area with densely populated settlements and dense economic activity every day. Lack of facilities and infrastructure led to traffic jams on the intersection. A analysis is needed that aims to determine the volume of the vehicle, the performance of road sections and intersections which are measured based on capacity, degree of saturation, and level of service. And then alternative solutions to improve the performance of these roads and intersections.
The analytical method used is the Indonesian Road Capacity Manual 1997. The data required in this study are primary data in the form of road geometric data, traffic volume, vehicle speed data and side friction data. As well as secondary data such as location maps, land use, and population data.
Based on the results of the analysis that has been carried out, the highest traffic volume at the intersection occurs on Friday, 17.00 - 18.00 WIB, with a DS value of 1.06 and LOS F. Alternative solutions that can be given at the intersection are vehicles on minor roads A and C You can only turn left, with the alternative solution, the DS values are 0.73 and LOS C. Whereas on the roads it has DS values of 0.71 and LOS C. An alternative solution that can be given to roads is to reduce the level of side friction around the segment. Street. With this alternative solution, the DS value is 0.65 and LOS B.

Keywords
Degree of Saturation , Intersection Performance, Jalan H Djole, Level of Service ,Road Performance

1. Introduction

Bekasi City is one of the cities in West Java Province with the largest population. Based on data from the Central Statistics Agency, Bekasi City has a population of 3,083,644 million people in 2020, this number is an increase of 2.3% compared to the previous year of 3,013,851 people. The increasing population growth has made mobility in Bekasi City also develop rapidly, where to support this mobility the community needs adequate facilities and infrastructure. The need for this means of transportation encourages the growth of private vehicle use in Bekasi City. Increasing the number of vehicles will cause congestion and congestion if transportation facilities and infrastructure are not upgraded. Inadequate road network facilities will cause traffic congestion problems (Ismawanda, Zajuli 2018).

Congestion is a situation or condition of stagnation or stopping of traffic caused by the large number of vehicles exceeding road capacity (Monica, D., Hariyanto, & Putro 2012). The problem of traffic congestion seems to have become a special characteristic of big cities in developing countries, including Indonesia Tamin, (1992). Congestion and long queues generally occur at intersections, both intersections with signal and non-signal.

One of the intersections that has experienced long traffic delays in Bekasi City, namely the 4 intersections with no signaling H. Djole Street - Pasar Lama Street, this intersection is a commercial area with densely populated settlements and dense economic activity every day. Along the Jalan H Djole section is one of the accesses to Jl. Old Market - Jl. Prapatan - Jl. Kp. Bantar Gebang, there are commercial places, cafes, SDN Padurenan, restaurants, and others. On Jalan Pasar Lama there is a market, SDN Bantar Gebang I, residents' houses, commerce, and others. Seeing the problems that occur both on roads and intersections with no signaling on Jalan H. Djole - Jalan Pasar

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Lama, it is necessary to conduct research to determine the performance of these roads and intersections and then look for alternative solutions for congestion at these sections and intersections.

Figure 1 Intersection Situation on Jl H Djole – Jl Ps Lama

Source : Author, 2020

2. Research Methodology

The method of analysis used is quantitative methods. Where this method consists of several stages, namely the preparation stage which discusses the preliminary survey, the data collection stage that discusses how to collect data, the analysis stage which discusses how to process and analyze data carried out by MKJI 1997 for urban roads and unsignalized intersections, as well as the evaluation and refinement stages.

The data used in the calculation of the performance analysis of roads and intersections without signal include primary and secondary data. Primary data is obtained by conducting a direct survey at the research location, including:

1. Geometric Conditions
2. Environmental Conditions
3. Traffic Data
4. Side Obstacles Data
5. Existing Speed Data

While secondary data is obtained from related agencies as a research basis, secondary data which Required in this study include:

1. Population Data
2. Location Map
3. Land Use

The research was conducted during peak hours, namely morning, afternoon, and evening for 3 days on Monday (2 November 2020), Friday (6 November 2020), and Saturday (7 November 2020). The research was conducted for 2 hours, the time used for the survey was 06.30 - 08.30, 11.30 - 13.30, 17.00 - 19.00 with the consideration that each period there is a rush hour.

3. Result And Analysis

3.1. Performance Analysis of Unsignalized Intersections

Performance analysis of the unsignalized intersection is carried out at the four lanes intersection. The recapitulated data are primary data in the from of geometric, enviromental data, and traffic data obtained throught direct observation and survey at the reesearch location. As well as secondary data obtained from related agencies.

3.1.1. Intersection Geometric Data

Intersection of Jalan H. Djole - Jalan Pasar Lama is an intersection with type 422 which means an intersection of 4 arms with 2 lanes on the minor road and 2 lanes on the main road. The existing geometric data at the intersection includes :

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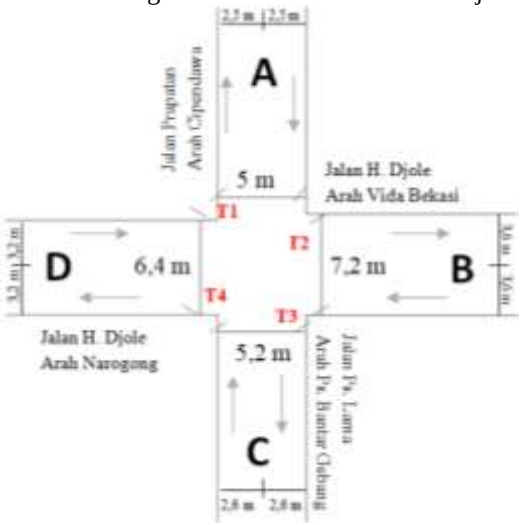
Table 1. Existing Geometrik Intersection Data

Description	Roads			
	Jl. H D jole (B A rm)	Jl. H D jole (D A rm)	Jl. Prapatan (A A rm)	Jl. Ps Lama (C A rm)
Road type	Major	Major	Major	Major
Lane Width(m)	3,6	3,2	2,5	2,6
Road Width(m)	2x3,6	2x3,2	2x2,5	2x2,6
Road Shoulder (m)	-	-	-	-
Median Width(m)	-	-	-	-
Side walk Width(m)	-	-	-	-

Source : Result Analysis, 2020

Figure 2 Ilustration of Unsignalized Intersection of Jl H Djole – Jl Ps Lama



Source : Author, 2020

3.1.2. Intersection Traffic Data

The densest traffic volume occurs on Friday and the peak hours are 5-6 PM with Qtotal = 3810 pcu / hour. This data will be used as a reference for calculating the unsignalized intersection analysis.

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Table 2 Intersection Survey Result Friday, 6 November 2020 at 5 – 6 PM

Approach		Friday, November 6, 2020 (5-6 PM)						
		LV	LV (emp : 1)	HV	HV (emp : 1.3)	MC	MC	MC
		Vech/hour	Pcu/hour	Vech/hour	Pcu/hour	Vech/hour	Pcu/hour	Vech/hour
Jalan H.Djole arah Narongon (Arm D)	LT	123	123	8	10,4	351	175,5	6
	ST	102	102	4	5,2	378	185	4
	RT	95	95	5	6,5	317	158,5	5
Jalan Prapatan arah cipendawa (arm A)	LT	175	175	14	18,2	563	281,5	6
	ST	113	113	12	15,6	401	200,5	3
	RT	75	75	7	9,1	326	163	6
Jalan H. Djole arah Vida Bekasi (Arm B)	LT	132	132	6	7,8	632	316	4
	ST	108	108	8	10,4	473	236,5	4
	RT	96	96	12	15,6	254	127	3
Jalan Ps. Bantar Gebang (Arm C)	LT	132	132	13	16,9	359	179,5	7
	ST	109	109	13	16,9	257	128,5	8
	RT	125	125	8	10,4	253	126,5	4
		1385	1385	110	143	4564	2282	60
Total				6113				Vech/hour
Total				3810				Pcu/hour

Source : Result Analysis, 2020

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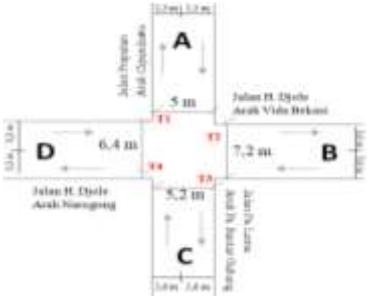
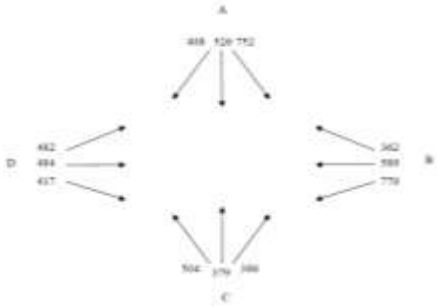
Table 3. Formulir USIG I of Intersection Jl H Djole – Jl Pasar Lama

UNSIGNALIZED INTERSECTION FORMULAR USIG 1 : TRAFFIC FLOW GEOMERI	City : Bekasi Major Road : Jl. H Djole Minor Road : Jl. Pasar Lama - Jl. Prapatan Intersection type : Unsiganlised Periode : Evening	Day & Date : Friday , November 6,2020 Created By : Natasha Diaz Nareswari Weather : sunny Hours Strart : 5PM Hours Finish : 6 PM

Intersection Geometri



Traffic Flow



1	KOMPOSISI LALU LINTAS		LV% :		HV% :		MC% :		Faktor-smp		Faktor-k
	ARUS LALU LINTAS	Arah	Kendaraan Ringan LV		Kendaraan Berat HV		Sepeda Motor MC		Kendaraan Bermotor Total MV		KendaranTak Bermotor UM kend/jam
	Pendekat		kend/jam	emp = 1,0 smp/jam	kend/jam	emp = 1,3 smp/jam	kend/jam	emp = 0,5 smp/jam	kend/jam	smp/jam	Rasio belok
2	Jl. Minor: A	LT	175	175	14	18.2	563	281.5	752	474.7	0.45	6
3		ST	113	113	12	15.6	401	200.5	526	329.1		3
4		RT	75	75	7	9.1	326	163	408	247.1	0.24	6
5		Total	363	363	33	42.9	1290	645	1686	1050.9		15
6	Jl. Minor: C	LT	132	132	13	16.9	359	179.5	504	328.4	0.40	7
7		ST	109	109	13	16.9	257	128.5	379	254.4		8
8		RT	125	125	8	10.4	253	126.5	386	261.9	0.30	4
9		Total	366	366	34	44.2	869	434.5	1269	844.7		19
10	Jl. Minor Total A + C		729	729	67	87.1	2159	1079.5	2955	1895.6		34
11	Jl. Utama: D	LT	123	123	8	10.4	351	175.5	482	308.9	0.35	6
12		ST	102	102	4	5.2	378	189	484	296.2		4
13		RT	95	95	5	6.5	317	158.5	417	260	0.30	5
14		Total	320	320	17	22.1	1046	523	1383	865.1		15
15	Jl. Utama: B	LT	132	132	6	7.8	632	316	770	455.8	0.45	4
16		ST	108	108	8	10.4	473	236.5	589	354.9		4
17		RT	96	96	12	15.6	254	127	362	238.6	0.21	3
18		Total	336	336	26	33.8	1359	679.5	1721	1049.3		11
19	Jl. Utama Total B + D		656	656	43	55.9	2405	1202.5	3104	1914.4		26
20	Utama + Minor	LT	562	562	41	53.3	1905	952.5	2508	1567.8	0.41	23
21		ST	432	432	37	48.1	1509	754.5	1978	1234.6		19
22		RT	391	391	32	41.6	1150	575	1573	1007.6	0.26	18
23	Utama + Minor Total		1385	1385	110	143	4564	2282	6059	3810	0.67	60
24						Rasio Jl. Minor / (Jl. Utama +Minor) Total				0.498	UM/MV :	0.010

Source : Result Analysis, 2020

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3.1.2. The Calculation Results of Unsignalized Intersection

Table 4 Capacity of Intersections of Jl H Djole – Jl Ps Lama

Basic Capacity Co pcu/hour	Capacity Adjustment Factor							Capacity (C) pcu/hour
	Average Approach Width Fw	Major Road Median FM	City Size Fcs	Side Barrier Factor FRSU	Left Turn Adjustment Factor FLT	Right Turn Adjustment Factor FRT	Mirror Road Adjustment Factor FMI	
2900	0,958	1	1,05	0,92	1,5	1	0,89	3583

Source : Result Analysis, 2020

Table 5 Traffic Behavior Intersection of Jl H Djole – Jl Ps Lama

Traffic Flow (Q) pcu/hour	Degree of Saturation DS	Intersection Traffic Delays DT I	Major Road Traffic Delays DT MA	Mirror Road Traffic Delays DT MI	Intersection Geometric Delays (DG)	Intersection Delays (D)	Queue Opportunities (QP%)	Target
3810	1,06	18,31	12,43	24,25	4	22,31	45-90%	DS≤0,75

Source : Result Analysis, 2020

From the results of the analysis using the Indonesian Road Capacity Manual Method (MKJI) 1997, Unsignalized Intersection Jl. H Djole - Jl Pasar Lama has a degree of saturation of 1.06 which exceeds the target of the study, namely ≤ 0.75 and is at the Level of Service Class F. Therefore, it is necessary to have an alternative solution so that the density at the intersection of Jl. H Djole - Jl. The Old Market can be overcome.

3.1.3. Alternative Solution for Intersection

3.1.3.1. Alternative 1

Alternative 1 is done by removing side obstacles by:

1. Putting signs prohibited from stopping or parking around the intersection, namely by changing the value of the sidefrom 0.92 to 1
2. FrictionOrganizing public transportation so that it is not too much Stopping time around the intersection
3. Ordering and making signs are prohibited from selling around the intersection area

3.1.3.2. Alternative 2

Alternative 2 is done by:

1. Placement of traffic signs is prohibited from stopping around the intersection, namely by changing the value of side barriers from 0.92 to 1.
2. Prohibition straight on arm A and arm C

3.1.3.3. Alternative 3

Alternative 3 is done by:

1. Placement of traffic signs is prohibited from stopping around the intersection, namely by changing the value of the side resistance from 0.92 to 1.
2. Prohibition of going straight and turning right directly at arms A and C

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Table 6 Recapitulation of Existing Calculations and Alternatives for Intersections

UNSIGNALIZED INTERSECTION FORMULIR USIG - II ANALYSIS	Date : 6 November 2020	Created By :	Natasha Diaz Nareswari
	City : Bekasi	City Size :	> 3 Million
	Major Road : Jl. H Djole	Road Environtment :	Commercial
	Minor Road : Jl Pasar Lama - Jl Prapatan	Side Barrier :	High
	Data Soal : -	Survey Time :	5-6 PM

1. Intersection Approach Width

Options	Number of The Arms of The Intersection	Approach Width (m) Minor Road W_A	Minor Road W_C	Minor Road W_{AC}	Major Road W_B	Major Road W_D	Major Road W_{BD}	The Average of The Approach Width	Number of Lanes Minor Road	Number of Lanes Major Road	Intersection Type
Existing	4	2.5	2.6	2.55	3.6	3.2	3.4	2.98	2	2	422
Alternative 1	4	2.5	2.6	2.55	3.6	3.2	3.4	2.98	2	2	422
Alternative 2	4	2.5	2.6	2.55	3.6	3.2	3.4	2.98	2	2	422
Alternative 3	4	2.5	2.6	2.55	3.6	3.2	3.4	2.98	2	2	422

2. Capacity

Options	Basic Capacity Value Co pcu/hour	Capacity Adjustment Factor: Average Approach Width F_W	Major Road Median F_M	City Size F_{CS}	Side Barrier Factor F_{RSU}	Left Turn Adjustment Factor F_{LT}	Right Turn Adjustment Factor F_{RT}	Minor Road Adjustment Factor F_{MI}	Capacity (C) pcu/hour
Existing	2900	0.958	1	1.05	0.92	1.5	1	0.89	3583
Alternative 1	2900	0.958	1	1.05	1	1.5	1	0.89	3894
Alternative 2	2900	0.958	1	1.05	1	1.7	1	0.89	4414
Alternative 3	2900	0.958	1	1.05	1	2	1	0.89	5192

3. Traffic Behavior

Options	Traffic Flow (Q) pcu/hour	Degree of Saturation (DS)	Intersection Traffic Delays DT_1	Major Road Traffic Delays DT_{MA}	Minor Road Traffic Delays DT_{MI}	Intersection Geometric Delays DG	Intersection Delays (D)	Queue Opportunities QP%	Level of Service	Target
Existing	3810	1.06	18.31	12.43	24.25	4	22.31	45 - 90	F	DS ≤ 0,75
Alternative 1	3810	0.98	14.14	9.97	18.35	4	18.14	39- 76	E	DS ≤ 0,75
Alternative 2	3810	0.86	10.37	7.56	13.21	4	14.37	30 - 59	D	DS ≤ 0,75
Alternative 3	3810	0.73	7.85	5.82	9.9	4	11.85	22 - 44	C	DS ≤ 0,75

Noted
Alternatif 1 : Remove side barrier from high to low
Alternatif 2 : Remove side barrier from high to low, Installation of direct prohibition signs straight on the arm A and arm C
Alternatif 3 : Remove side barrier from high to low, Installation of direct prohibition signs straight and turn right on the arm A and arm C

Source : Result Analysis, 2020

3.2. Performance Analysis of Road Section

For the analysis of roads carried out on Jalan H. Djole. The recapitulated data are data obtained through observations and on-site surveys.

3.2.1. Road Section Geometric Data

Geometric conditions of the road sections required for the calculation are as follows :
Road Section Name : Jalan H. Djole
Road Type : 2/2 UD
Width per Lane : 3,6 meter

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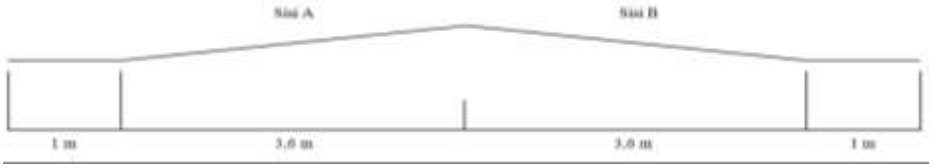
City Size : Very Big (> 3,0 Million)
Environment Type : Commercial
Median : No
Alignment Type : Flat
Traffic Signs : No
Road Marking : No

Figure 3 Condition of section of Jl H Djole



Source : Author, 2020

3.2.1. Road Traffic Volume Data

Traffic data were obtained from direct surveys at the research location for 3 days. On Monday, November 2, 2020, Friday, November 6, 2020 and Saturday, November 7, 2020. From the survey results, it was found that the heaviest traffic volume occurred on Friday, November 6, 2020. 17.00 - 18.00 at 1841 pcu / hour.

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Table 7 Traffic Volume Data Heavist

Time	Vehicle Total									
	LV		HV		MC		UM		TOTAL	
	Vech/hour	Pcu/hour	Vech/hour	Pcu/hour	Vech/hour	Pcu/hour	Vech/hour	Pcu/hour	Vech/hour	Pcu/hour
06.30 - 06.45	164	164	12	14.4	783	195.75	5	0	964	374.15
06.45 - 07.00	169	169	10	12	781	195.25	2	0	962	376.25
07.00 - 07.15	167	167	7	8.4	795	198.75	1	0	970	374.15
07.15 - 07.30	165	165	11	13.2	797	199.25	3	0	976	377.45
TOTAL	**665**	**665**	**40**	**48**	**3156**	**789**	**11**	**0**	**3872**	**1502**
07.30 - 07.45	194	194	15	18	793	198.25	3	0	1005	410.25
07.45 - 08.00	192	192	11	13.2	731	182.75	3	0	937	387.95
08.00 - 08.15	191	191	12	14.4	739	184.75	4	0	946	390.15
08.15 - 08.30	187	187	12	14.4	769	192.25	2	0	970	393.65
TOTAL	**764**	**764**	**50**	**60**	**3032**	**758**	**12**	**0**	**3858**	**1582**
11.30 - 11.45	175	175	13	15.6	605	151.25	6	0	799	341.85
11.45 - 12.00	176	176	14	16.8	625	156.25	4	0	819	349.05
12.00 - 12.15	184	184	8	9.6	647	161.75	5	0	844	355.35
12.15 - 12.30	181	181	10	12	675	168.75	3	0	869	361.75
TOTAL	**716**	**716**	**45**	**54**	**2552**	**638**	**18**	**0**	**3331**	**1408**
12.30 - 12.45	176	176	13	15.6	857	214.25	5	0	1051	405.85
12.45 - 13.00	172	172	17	20.4	829	207.25	3	0	1021	399.65
13.00 - 13.15	175	175	11	13.2	843	210.75	4	0	1033	398.95
13.15 - 13.30	179	179	19	22.8	835	208.75	5	0	1038	410.55
TOTAL	**702**	**702**	**60**	**72**	**3364**	**841**	**17**	**0**	**4143**	**1615**
17.00 - 17.15	188	188	13	15.6	1065	266.25	6	0	1272	469.85
17.15 - 17.30	185	185	12	14.4	1043	260.75	2	0	1242	460.15
17.30 - 17.45	189	189	9	10.8	1039	259.75	3	0	1240	459.55
17.45 - 18.00	190	190	6	7.2	1017	254.25	0	0	1213	451.45
TOTAL	**752**	**752**	**40**	**48**	**4164**	**1041**	**11**	**0**	**4967**	**1841**
18.00 - 18.15	201	201	8	9.6	925	231.25	5	0	1139	441.85
18.15 - 18.30	202	202	7	8.4	941	235.25	0	0	1150	445.65
18.30 - 18.45	217	217	4	4.8	889	222.25	4	0	1114	444.05
18.45 - 19.00	205	205	1	1.2	841	210.25	0	0	1047	416.45
TOTAL	**825**	**825**	**20**	**24**	**3596**	**899**	**9**	**0**	**4450**	**1748**

Source : Result Analysis, 2020

3.2.1 The Calculation Results of Road Section

Table 8 Actual Speed on The Jl H Djole

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Time	Vida Direction						Narogong Direction					
	HV	Averge Speed	LV	Averge Speed	MC	Averge Speed	HV	Averge Speed	LV	Averge Speed	MC	Averge Speed
Morning	33	30	36	33	37	35	26	25	33	32	35	34
	28		30		38		27		29		28	
	29		33		30		24		31		33	
Afternoon	31	29	38	35	40	36	28	27	35	24	36	35
	26		32		32		24		30		33	
	30		35		36		26		33		34	
Evening	24	26	28	30	35	33	25	23	31	29	30	31
	28		32		31		22		34		33	
	26		30		33		21		27		32	

Source : Result Analysis, 2020

Table 9 Capacity

Road Section Prameters	Jalan H Djole (2/2 UD)
Co	2900
FCW	1,028
FCSP	0,97
FCSP	0,86
FCCS	1,04
C	2586

Source : Result Analysis, 2020

The value of the degree of saturation is used as the main factor that can determine the level of service of a road, whether the roads are researched has a capacity problem or not. The degree of saturation is obtained from the ratio of traffic flow (Q) pcu / hour to capacity (C) pcu / hour. The degree of saturation can be calculated using the formula:

DS = Q / C
DS = 1841 / 2586
DS = 0,71

Table 10 Degree of Saturation of Jl H Djole – Jl Pasar Lama

Road	Time	Traffic Volume (Q)	Rad Capacity (C)	Degree of Saturation (DS)
Jalan H Djole	Morning	1582	2586	0,61
	Afternoon	1615	2586	0,62
	Evening	1841	2586	0,71

Source : Result Analysis, 2020

Table 11 Level of Service of Road Section

Time	Traffic Volume	Capacity (C)	Free Flow Speed	Degree of Saturation (DS)	Average Speed of The Vehicle (FV_{LV})	Level of service (LOS)
	Pcu/hour	Pcu/hour	Km/hour		Km/hour	
Morning	1582	2586	39,51	0,61	31	B
Afternoon	1615	2586	39,51	0,62	31	B
Evening	1841	2586	39,51	0,71	30	C

Source : Result Analysis, 2020

4. Conclusion

From the results of the field survey and the results of data analysis calculations that have been carried out, some conclusions can be drawn as follows :

1. Intersection The four un-signaled roads on Jalan H Djole - Jalan Pasar Lama have peak traffic volumes that occur on Fridays t on November 6, 2020, which is 3810 pcu / hour.
2. Whereas on Jalan H Djole, it has a peak traffic volume of 1841 pcu / hour
3. The results of the analysis of the performance of the four-way intersection on Jalan H Djole - Jalan Pasar Lama, get the degree of saturation (DS) of 1.06, the intersection delay 22.31 sec / pcu, chances queues 45-

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90%, and the intersection service level F, indicates that at this intersection and restrained currents occur long queues, while the analysis of the performance of road on Jalan H Djole, on to the degree of saturation (DS) in the morning it is 0.61 and the level of service B, then in the afternoon you get the value of the degree of saturation of 0.62 and the level of service B, and in the afternoon you get the value of the degree of saturation of 0.71 and the level of service C.

4. Planned 3 alternatives for the four-way intersection of Jalan H Djole - Jalan Pasar Lama includes :

a. Alternative 1, which is to remove side obstacles by : Putting signs that are prohibited from stopping or parking around the intersection, y namely by changing the value of side barriers from 0.92 to 1, Ordering public transportation so that it does not stop too long around the intersection, Ordering and making signs prohibited from selling around the intersection area
b. Alternative 2 is placing traffic signs prohibited from stopping around the intersection, namely by changing value of side friction from 0.92 to 1, straight prohibition on arm A and arm C
c. Alternative 3, namely placing traffic signs is prohibited from stopping around the intersection, namely by changing the value of the side friction from 0.92 to 1, Prohibition straight straight and turn right directly on arms A and C

Of the three alternatives, the right solution to solve congestion at the unmarked intersection that meets the target is alternative 3 with DS = 0.73, the intersection delay = 11.85 and the level of service at the intersection of C.

As for the road segment, an alternative is given in the form of removing obstacles amping by: placing signs prohibited from stopping or parking around roads, namely by changing the value of side friction from high to low. So that the value of FCSF = 0.94. With these alternatives, you can get the DS value in the morning = 0.56 pcu / hour and level of service A, DS at noon = 0.57 pcu / hour and level of service A, then DS in the afternoon = 0.65 pcu / hour and level of service B.

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Biographies

Muhammad Isradi., born in Kandangan on 18 August 1972. He is secretary of study program of Civil Engineering of Mercu Buana University. He earned his Bachelor Degree in Civil Engineer from Muhammadiyah Malang University in 1998 with the title of his thesis is One Way Flat Plate Planning at Ratu Plaza Madiun. Then he earned his master degree in Civil Engineer with concentration in Transportation from Brawijaya University in 2001 with the title of thesis is Model Analysis of Family Movement Awakening in Resident Area Sawojajar Malang. He also teaches several courses such as Pavement Planning, Road Geometric Planning, Transportation Planningm and Environmental Engineering.

Natasha Diaz Nareswari., born in Jakarta on 17 June 1999. She is pursuing a Bachelor's Degree in Civil Engineering Study Program at Mercu Buana University and will graduate in 2021. Graduated from South Tambun 5 High School, East Bekasi in 2017. She was a lecturer assistant in subject on Building Materials and Alternate Materials in 2018 she has also been a committee at several seminars on Civil Engineering : International and Workshop of Civil Engineering “Concrete Technology Engineering & Design” in 2019, Seminar National of Civil Engineering “Manajemen Kawasan Transit-Oriented Development Modern” in 2019 and then International and Workshop of Civil Engineering “Sustainability On Industry And Community : Impact Of Research And Publication” in 2019.

Andri Irfan Rifai., is a Senior Lecturer of Civil Engineering and Planning. He completed the PhD at the Universitas Indonesia & Universidade do Minho with Sandwich Program Scholarship from the Directorate General og Higher Education and LPDP scholarship. He has been teaching for more than 19 years and much active to applied his knowledge in the project construction in Indonesia. His research interest ranges from pavement management system to advanced data mining techniques for transportation engineering. He has published more than 50 papers in journals and 2 books.

Amar Mufhidin., born in Majalengka on 16 June 1991. He is lecturer of some program study : Pavement Planning, Road Geometric Planning, and Transportation Planning. He earned his Bachelor Degree in Civil Engineering from Indonesia University of Education, and he earned his Master Degree in Civil Enginer wit

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concentration in transportation from Bandung Institute of Technology. He has expertise certificate of road pavement from Lembaga Pengatur Jasa Konstruksi. And he is still active in road project in Indonesia.

Joewono Prasetijo., born in Pontianak on 18 October 1969. He earned his Engineer title in Civil Engineering in Tanjungpura University, Pontianak, Indonesia in 1993. He earned his Master of Science in Road and Transportation Engineering from Delft University of Technology, The Netherlands in 1996. He earned his Doctoer Ingenieur from Ruhr-Universität Bochum, Germany in 1996. Now he is a Head of Department of Rail Transportation Engineering Technology, Faculty of Engineering Technology, University Tun Hussein Onn Malaysia.