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SIGNALIZED INTERSECTION PERFORMANCE ANALYSIS OF ROUNDABOUT CIGASONG- MAJALENGKA

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ABSTRACT

The signalized intersection at the Cigasong roundabout in Majalengka City is where the Majalengka-Cikijing road, Majalengka-Rajagaluh road, Sindangkasih troops road and Majalengka-Jatiwangi road meet. The traffic problem that often occurs at the Cigasong roundabout is traffic jams, especially at every rush hour the traffic flow increases more densely than at other times. In various regions in Indonesia, traffic lights can also have a negative impact on traffic activities that occur. in urban areas. The aim of this research is to find out how the signalized intersection at the Cigasong roundabout performs, so that traffic problems caused by the many factors above can be resolved. By conducting research on the signalized intersection located at the Cigasong roundabout in Majalengka City, we can gather a number of information about the signalized intersection that coincides with this roundabout, which means that if there is a roundabout there should not be a signalized intersection. Basically, the function of a roundabout is to slow down the speed of vehicles, in contrast to signalized intersections where the average vehicle speed is very fast when the light is green. The Cigasong roundabout is classified as a fairly large roundabout because this roundabout is also a roundabout which connects several road routes to various areas in Majalengka to several sub-districts such as Cigasong, Jatiwangi, Maja and Rajagaluh, as well as directions to other cities such as Cirebon, Indramayu, Kuningan. With this, there will be a suggestion that will be the answer to the problem of signalized intersections located at the Cigasong Roundabout, Majalengka City, so that it can be resolved through research, the results of which are in accordance with what is happening at the roundabout and so that this suggestion can be realized at the Cigasong Roundabout, Majalengka City.

1. Introduction

Vehicle traffic is considered to be the root of many problems, namely congestion, crashes, and pollution (Marzoug, Lakouari, Pérez Cruz, & Vega Gómez, 2022). A signalized intersection is an intersection with traffic lights that are used to facilitate traffic flow [2]. Several countries already use signalized intersections, one of which is Japan, where many intersections already operate under signalized intersection control. The main control method at signalized intersections is used to overcome increasingly high traffic congestion.

With a population of 269,682,026 people, Indonesia is one of the largest countries with the largest population in the world [3]. The country of Indonesia has many problems and complex problems that have not been resolved, one of which is the performance of intersections in Indonesia. According to MKJI 1997, intersection performance is defined as a quantitative description of the operational status of intersections and intersection facilities which is usually expressed in terms of road capacity, vehicle

speed, and traffic behavior. cross [4]. Due to the lack of intersection performance, traffic flow on urban roads is largely hampered [5].

Road intersections are an important component of the urban traffic network (Pathivada & Perumal, 2019). Bandung, whose population density continues to increase every year and is one of the largest metropolises in West Java Province, has developed quite rapidly [7]. The increase in population has resulted in congestion on roads. Where traffic jams are a problem because there are more and more vehicles circulating on the highway, causing the travel time required to move to become longer. In general, the problem of high delay values often occurs at several intersections in Bandung City.

One of the integral parts of the urban network is a signalized intersection (Zheng & Liu, 2017). Like the signalized intersection at the Cigasong roundabout, precisely on the Majalengka-Jatiwangi road, which is the access road to the economic center, the traffic problem that often occurs at the Cigasong roundabout is traffic jams, especially at every rush hour the traffic flow increases more densely than at other times. Other problems that occur at intersections are traffic conflicts due to uneven road widths, undisciplined drivers, and inappropriate traffic lights which can cause travel time delays at intersections and traffic queues. (Nina, Hidayat, & Kurnia, 2019).

Through traffic engineering efforts, it will be easier to overcome traffic problems caused by the many factors above. To achieve efficiency and smoothness at the four intersections at the Cigasong roundabout, it is necessary to carry out an analysis of the intersection performance to the 1997 Indonesian Road Capacity Manual (MKJI) guidelines [10]. Regarding the problems that occur at the fourth intersection of the Cigasong Roundabout, solutions are provided so that there are no obstacles to traffic activities and prevent traffic jams from occurring at the fourth intersection of the Cigasong Roundabout.

2. Literature Review

2.1 Signalized intersections

The most dangerous highways because of the complicated traffic conflict movements and frequent stop-and-go traffic are Intersections (Yuan & Abdel-Aty, 2018). Currently, people's need for traffic activities is very high because it is a tool for work and other activities. The scale of installing traffic lights in urban areas is enormous because other methods of traffic management are not possible [12]. Therefore, there are now many signalized intersections in urban environments that aim to minimize traffic jams. Signalized intersections also play a role in regulating urban traffic flow, increasing energy consumption, and slowing vehicle traffic (Dong, et al., 2022).

In various regions in Indonesia, traffic lights can also hurt traffic activities that occur in urban areas. Traffic lights are designed for safe traffic management, but if they operate inefficiently, they can exacerbate traffic jams, and increase fuel consumption and vehicle emissions (Dong, Liu, & Yin, 2022). Therefore, every traffic light must have good traffic management to reduce traffic jams. Besides that, controlling and managing traffic signs is a challenge in the traffic system because it ensures the safety of vehicle traffic (Tomar, Sreedevi, & Pandey, 2022).

Intersections are planned as conflict points in urban traffic networks and play an important role in optimizing traffic mobility (Chen, Wang, Xu, Wang, & Li, 2021). At these road intersections, the factors that cause congestion are large traffic volumes, undisciplined drivers, road access to economic centers, and inappropriate traffic lights which can cause travel time delays at intersections and traffic queues. In overcoming traffic jams, it is necessary to Pay attention to the route at the intersection to optimize vehicle movement at the intersection during green time (Maulana & Aldriansyah, 2020).

Therefore, in this research the place that will be the research location is the signalized intersection at Bundara Cigasong. The intersection at the Cigasong roundabout in Majalengka City is where the K.H Abdul Halim Road, Majalengka-Rajagaluh Road, Majalengka-Cikijing Road, and Majalengka-Jatiwangi Road meet.

2.2 Roundabout

A circular intersection where all vehicles move clockwise around a circular island in the center is defined as a Roundabout (Hang, Huang, Hu, Xing, & Lv, 2021). Roundabouts are a type of intersection control commonly used in urban and non-urban areas. Main traffic is traffic that is already at the roundabout which takes precedence or is given the opportunity by vehicles wanting to enter the roundabout.

Roundabouts are considered the safest type of intersection, causing drivers to reduce speed, change the type of conflict, and reduce the severity of accidents (Riccardi, et al., 2022). A roundabout consists of a directional drive around a central island, which can be flat or raised. This type of traffic circle creates a rotational movement of traffic flow, replacing the crossing movement with a series of cross-sections (sani, 2022).

2.3 Traffic Flow

Traffic flow itself can be influenced by road capacity and the geometric condition of the road. The transport permeability and capacity of city streets will depend primarily on the geometric characteristics of the street, the cycle time of the controlled intersection, and also on the traffic composition of vehicles (Abdurakhmanov, 2022). The role of traffic flow is quite important for good traffic management. Accurate traffic forecasts are effective references for implementing traffic management strategies, planning travel routes, and assessing public transport risks (Zhou, Chen, & Lin, 2022).

Recording traffic flow is usually done by calculating average daily traffic. Average daily traffic flow is obtained by counting the number of vehicles crossing a road. Usually, the recording time is during peak hours, namely in the morning, evening, and afternoon. From the AADT data, it can be concluded that road utilization is planned and prioritized for road improvements that are needed and appropriate, and for planning new road construction projects there are sources of information (Baffoe-Twum, Asa, & Awuku, 2022).

3. Method

3.1 Types of research

The qualitative method used in this research is a traffic survey. Thus, the qualitative method is research carried out directly. The data from this traffic survey will be used as real primary data.

3.2 Research sites

The location of this research was at Cigasong Roundabout, Majalengka. At this location, there is a signalized intersection. The research location is in the picture.

3.2.1. Research sites

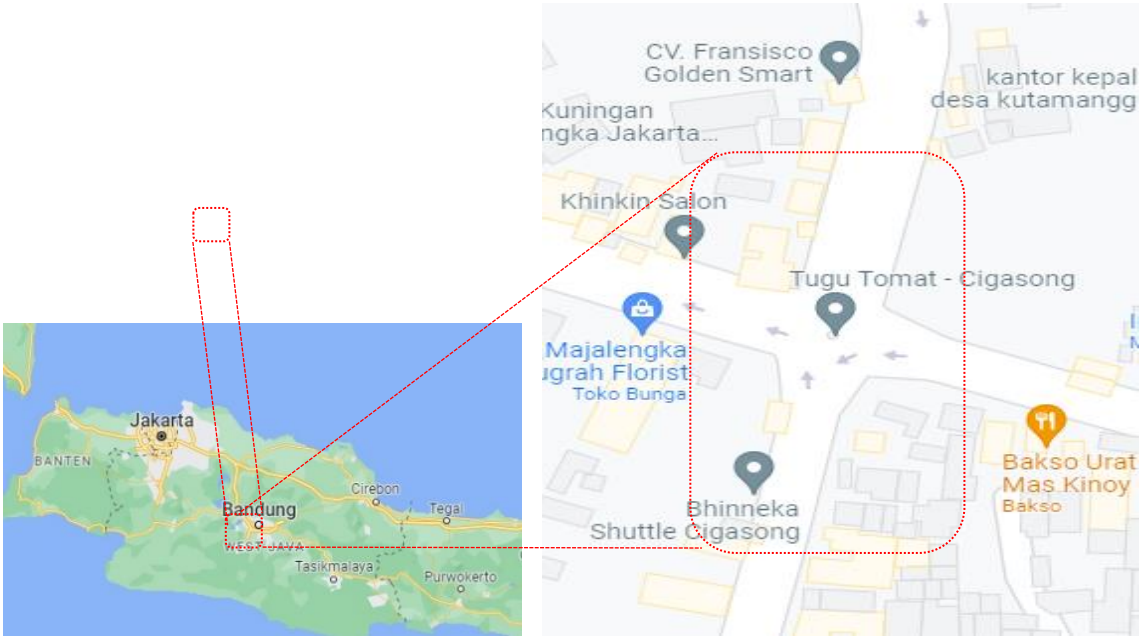

Figure 1. Research Location

3.3 Data collection

The method used in this research aims to collect accurate data or material which is also called a data collection method. The traffic survey aims to collect information that accurately describes the actual traffic situation in the area (Paľo, Caban, Kiktová, & Černický, 2019). From this survey, the required primary data will be obtained, where primary data is data from field surveys which are researched and then recorded.

Primary data is data obtained from field surveys and used as the main data in the research. This data is needed to calculate the volume of vehicles at the intersection. The traffic survey was carried out by 4 people with 1 person placed in each lane at this intersection. The survey itself was carried out within 1 day during peak hours in the morning, afternoon, and evening.

However, in this research secondary data is also needed, namely data on the population in the Majalengka district, and this research also requires some data obtained from the Indonesian Road Capacity Manual (MKJI 1997).

4. Results and discussion

Data calculations also require primary data for this research. This rimer data was obtained from research results and is real data. The method used in the calculation process is the 1997 MKJI method

4.1 Road Geometrics

The road geometrics in this study were obtained by conducting a direct survey at the intersection with the Cigasong signal. In these four directions, there is a median that is the same size, namely 2 meters. The road types in the four directions are all 4/2 UD road types. The four directions have their respective dimensions in the north direction, namely 7 meters with a total of 14 meters, while in the east direction, it is the same as the north direction, namely 7 meters with a total of 14 meters, while for the south and

west directions, the road width is the same, namely 7.5 meters with a total 15 meters. The results of theroad geometric survey are in Figure 2.

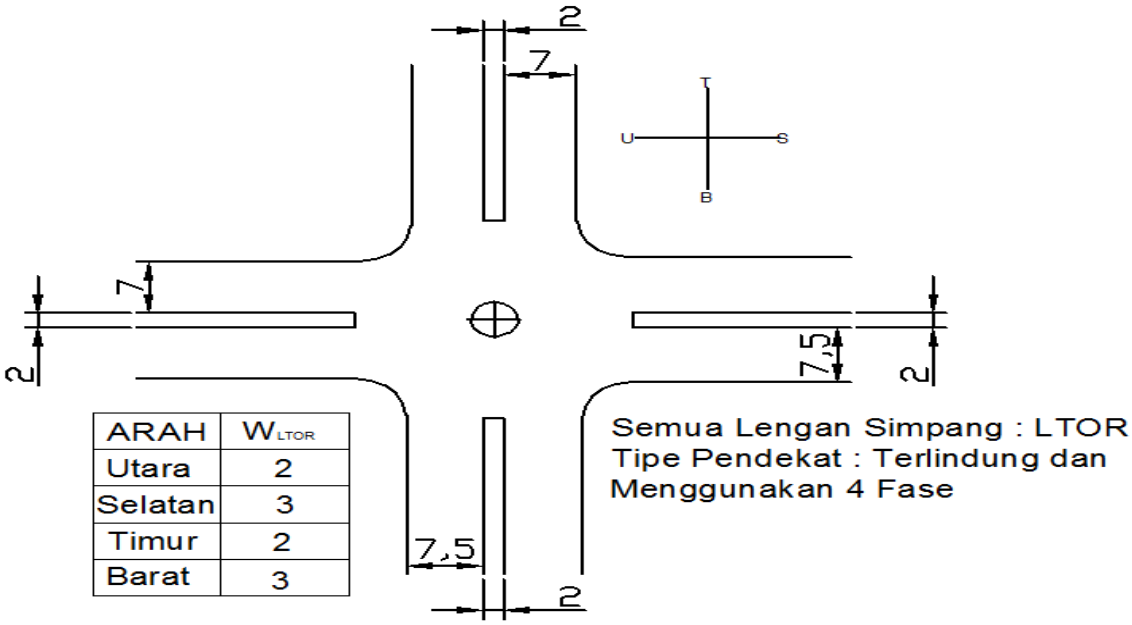

Figure 2. Road Geometric

The type of the four approaches is the Protected type. Which has a Wltor of 2 each for the north and east directions. Meanwhile, for the south and west directions, it is 3.

Table 1. Geometric Recapitulation

Direction	Wltor	Wa	We
North	3	7,5	4,5
South	2	7	5
East	2	7	5
West	3	7,5	4,5

From the results of the table above, the effective width in each direction can be seen. With an effective width of 4.5 in the north and east directions. Meanwhile, for the south and west directions, it is 5.

4.2 Traffic Volume

The traffic volume itself depends on the results of peak traffic surveys in the morning, afternoon, and evening on weekends. According to the survey results, it was found that the peak flow itself was during the afternoon rush hour, namely 16:30-17:30. See Appendix 1 for volume traffic data.

4.3 Intersection Traffic Flow

The data obtained from the traffic volume calculation results:

Table 2. Traffic Flow

Direction	pcu/hour
North	535,6
South	593,65
East	680,15
West	548,7

From the table above, it is found that traffic flow in the North direction is 535.6 pcu/hour, in the South direction 593.65 pcu/hour, in the West direction 548.7. Therefore, the smallest traffic flow occurs in the North direction or Jl. Majalengka-Cikijing. Meanwhile, the peak flow that occurs at the intersection is in the east direction or on the Majalengka-Rajagaluh road, amounting to 680.19 pcu/hour.

4.4 Saturation Current

Saturation current is the basic saturation current (So), namely the saturation current under normal conditions, multiplied by an adjustment factor (F) for deviations from actual conditions. Table 3 shows the calculated saturation current.

Table 3. Saturation Current (smp/jam hijau)

Direction	So	Fcs	FSF	Fg	Fp	Frt	Flt	S
North	4497	1	0,91	1	0,82	1	1	3355,661
South	4198	1	0,91	1	0,77	1	1	2941,539
East	4198	1	0,91	1	0,75	1	1	2865,135
West	4497	1	0,91	1	0,79	1	1	3232,893

The results in Table 3 are the results of saturated current calculations. In the north direction, it is 335,661, in the south direction it is 2941,539, in the east direction it is 2865,135, and in the west direction it is 3232,893. So the largest saturation current is obtained, namely 3355.661 in the north direction. Meanwhile, the smallest saturated current is in the east direction at 2865.135.

4.5 Saturation Current Ratio

The formula for the saturation current ratio is FR=Q/S. The results of the saturation current ratio are in Table 4.

Table 4. Saturation Current Ratio

Direction	Q	S	FR	∑Fr
North	535,6	3355,661	0,159611	0,76854
South	593,65	2941,539	0,201816	
East	680,15	2865,135	0,237388	
West	548,7	3232,893	0,169724	

Based on the table above, the saturation current ratio is 0.159611 in the north direction, 0.201816 in the south direction, 0.237388 in the east direction, and 0.169724 in the west direction. So the overall saturation current ratio from the four directions is 0.76854. With the east direction being the largest saturation current ratio of 0.237488.

4.5 Cycle Time

After getting some of the data above, calculate the cycle time (S). The results of these calculations are in the calculations below. After getting some of the data above, calculate the cycle time (S). The results of these calculations are in the calculations below.

c=(1,5 x 16+5)/ (1-0,768)
c=125 det

4.6 Green Time

The formula for calculating your own Green Time:

g= (c-LTI) x (FR/∑FR)

Thus the results of these calculations are in Table 5.

Table 5. Green Time

Direction	G	
North	23	det
South	29	det
East	34	det
West	24	det

It can be seen in Table 5. Which is the green time in each direction. In the north direction, the green time is 23 seconds, in the south direction it is 29 seconds, in the east direction it is 34 seconds, and in the west direction, it is 24 seconds. Thus, the longest and fastest green times are from the east and north respectively with a time of 34 seconds and 23 seconds.

4.7 Road Capacity

The road capacity to accommodate the highest vehicle volume is in the east direction, named, ly 771.71104 pcs/hour. After following the steps above, the road capacity data is obtained in Table 6.

Table 6. Road Capacity

Direction	C
North	607,70195
South	673,56641
East	771,71104
West	622,56544

Based on the table above, it produces road capacities in all four directions. The capacity in the north direction is 607.70195 pcu/hour, in the south direction 673.56641, in the east direction 771.71104, and

in the west direction 622.56544. The largest road capacity is in the east direction, namely, 771.71104 pcs/hour. Meanwhile, the smallest road capacity is in the north direction at 607.70195.

4.8 Degree of Saturation and Level of Services

The result of calculating the degree of saturation in the west, south, north, and east directions is 0.8 and the value of the level of road service is creeping density. These results certainly increase the risk of traffic jams at peak flows. contained in table 7.

Tabel 7. Degree of Saturation and Level of Service

Direction	C	DS	LOS
Norh	607,70195	0,8813531	Padat Merayap
South	673,56641	0,8813533	Padat Merayap
East	771,71104	0,8813532	Padat Merayap
West	622,56544	0,8813531	Padat Merayap

Based on the table above, it can be seen that the degree of saturation in the four directions has a value of 0.88. It can be concluded that the degree of saturation in all four directions is the same, namely, 0.88 and according to MKJI 1997 this figure is included in the creeping dense category.

5. Conclusions and Suggestions

5.1 Conclusions

This research concludes that the peak traffic flow at the intersection is obtained, namely on weekends during the afternoon rush hour, precisely at 16:30-17:30. The degree of saturation for each direction is 0.88. The road's capacity to accommodate traffic volumes in each direction, namely in the north direction 607.7 pcu/hour, south 673.5 pcu/hour, east 771.7 pcu/hour, and west 622.5 pcu/hour. The resulting degree of saturation is quite high, causing the value of the service level to creep up. These results will increase the risk of traffic jams at this intersection. So attention is needed in carrying out good traffic management

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Code Pendekat	Direction	Light Vehicles (LV) protected emp=1,0 Challenged emp=1,0			Heavy Vehicles (HV) protected emp=1,3 Challenged emp=1,3			Motorcye (MC) protected emp=0,25 Challenged emp=0,25			Motor Vehicle TOTAL MV			Rasio Berbelok	
		Vehicles/Hour	PCU/Hour		Vehicles/Hour	PCU/Hour		Vehicles/Hour	PCU/Hour		Vehicles/Hour	PCU/Hour		PLT (%)	PRT (%)
			protected	Challenged		protected	Challenged		protected	Challenged		protected	Challenged		
North	LT	127		127	11		14,3	223		55,75	361		197,05	28	
	ST	75		75	23		29,9	342		85,5	440		190,4		
	RT	32		32	8		10,4	423		105,75	463		148,15		37
	TOTAL	**234**		**234**	**42**		**54,6**	**988**		**247**	**1264**		**535,6**		
South	LT	79		79	47		61,1	170		42,5	296		182,6	26	
	ST	96		96	63		81,9	331		82,75	490		260,65		
	RT	64		64	13		16,9	278		69,5	355		150,4		31
	TOTAL	**239**		**239**	**123**		**159,9**	**779**		**194,75**	**1141**		**593,65**		
East	LT	84		84	8		10,4	253		63,25	345		157,65	23	
	ST	102		102	17		22,1	498		124,5	617		248,6		
	RT	149		149	33		42,9	328		82	510		273,9		35
	TOTAL	**335**		**335**	**58**		**75,4**	**1079**		**269,75**	**1472**		**680,15**		
West	LT	56		56	32		41,6	219		54,75	307		152,35	25	
	ST	62		62	19		24,7	390		97,5	471		184,2		
	RT	68		68	43		55,9	353		88,25	464		212,15		37
	TOTAL	**186**		**186**	**94**		**122,2**	**962**		**240,5**	**1242**		**548,7**		

Lampiran 1. Traffic Volume