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PERFORMANCE ANALYSIS OF NON-SIGNALIZED INTERSECTIONS: A CASE OF INTERSECTION OF JALAN KARTINI - MAJALENGKA

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ABSTRACT

As the number of transport increases, the congestion and accidents on the highway increase. Accidents or traffic jams can be caused by an intersection, especially at unsignalized intersections. In Indonesia, accidents and vehicles continue to increase, especially at intersections. Apart from growing accidents, density is also increasing due to increasing or increasing human activity. Research at unsignalized intersections is carried out to prevent increased density and ensure traffic conditions run smoothly. The location of the study to be carried out is at an unsignalized intersection in the Majalengka district. The method used in this research is quantitative, and the data collection technique used is by entering primary and secondary data. Four-way intersection This round has four approaches, each with two paths. The results obtained from calculating traffic volume by conducting direct surveys in the field for three days are divided into two: total flow volume and flow volume of main roads and minor roads. The essential capacity (C0) obtained at a four-way intersection Babakan is 2/2 UD, 2900. Meanwhile, the level of service at the intersection depends on the degree of saturation obtained from the traffic flow value divided by the load capacity. In the previous chapter, the value of the degree of saturation in the north, east, west, and south directions is very high, causing the level of service to be poor. The research results can be used to conclude that the level of service at the four-way intersection Babakan will be more optimal if the load capacity can be increased so that the degree of saturation is low and does not cause high traffic jams.

1. Introduction

Intersections are the main obstacles to urban traffic [1]; intersections are the most essential part of a highway. Why is that? This is because the safety, efficiency, speed, and road service level depend on intersection planning. If categorized, intersections are divided into two, namely signalized intersections and unsignalized intersections. As the number of transport increases, the congestion and accidents on the highway increase. Accidents or traffic jams can be caused by an intersection, especially at unsignalized intersections. Even in some countries, intersections without signals affect accident rates. For example, published data in China show that the number of accidents at intersections accounts for 30% of the total accidents; 36% of the data is shown in the United States, 43% in Europe, and 42.2% in Japan [2].

Accidents and traffic jams that occur at unsignalized intersections also happen in the Asian region. In India, the annual accident report 2015 shows that about 49% of accidents were reported at road junctions [3]. Not only looking at the accident rate, traffic jams often occur at unsignalized intersections.

The increase in the amount of transportation causes this. Additionally, increasing human activity is also a factor causing traffic jams, especially at unsignalized intersections.

In Indonesia, the number of accidents continues to increase along with the increase in vehicles, especially at intersections. Apart from increasing accidents, density is also growing due to increasing or increasing human activity. One of the factors that can cause traffic jams and accidents, especially at intersections, is driver behavior that does not comply with specified rules, one of which is drivers who drive irregularly. The expanding means of transportation will cause traffic jams if facilities and infrastructure are not improved [4]. Driver behavior and road-supporting facilities and infrastructure, especially at intersections, are factors causing accidents and congestion.

Majalengka is one of the cities in West Java which always experiences an increase in population every year. According to the Majalengka Regency Central Statistics Agency, in 2021, there will be 1,318.97 people living in the Majalengka area. So, it is unsurprising that in Majalengka, transportation facilities, and the population's daily activities have increased. It is possible that in Majalengka, there will always be traffic jams and accidents, even though the level of density and accidents that occur is not like in big cities. If you look at Majalengka, many intersections have no signals, which is one of the factors causing accidents and traffic jams. This can be seen at the unsignalized intersection of JL Babakan - JL Letkol Abdul Gani - JL Kartini, where crowds often occur, especially on weekdays, when crowds occur when returning home or at the end of activities. The arrangement of unsignalized intersections causes movement at these intersections to become irregular, and traffic jams often occur [5]. The lack of road facilities and infrastructure causes traffic jams and accidents at these intersections.

Crowds and accidents can happen anywhere and anytime, especially at road intersections. A signalized intersection is an intersection that has several lanes and is equipped with signal settings. Meanwhile, unsignalized intersections need to be equipped with signal settings. Unsignalized intersections are one of the causes of accidents that result in traffic jams on the highway. Not only that, unsignalized intersections also cause irregular traffic conditions. Research at unsignalized intersections is carried out to prevent increased density and ensure traffic conditions run smoothly. Apart from that, this research aims to facilitate transportation in an era of increasing transportation facilities.

2. Literatur Review

2.1 Traffic Performance

Fast urbanization introduces growing city populations and presents significant mobility and sustainability challenges [6]. Traffic is the movement of vehicles and people in a traffic space or a system directly connected to road facilities with main components. Meanwhile, traffic space is an infrastructure that moves vehicles, people, roads, and supporting facilities. The three main components of traffic are people, roads, and vehicles. Apart from having components, traffic also has management, which aims to ensure safety, security, and smooth traffic. In traffic, traffic performance is a critical thing to pay attention to. Why is that? If traffic performance can run well, then smooth traffic can be achieved.

A traffic accident involves a motor vehicle involved in an incident that causes damage, injury, or even death. Traffic accidents affect traffic flow and operations and cause severe injuries and even fatalities [7]. Factors that cause traffic accidents include environmental conditions, vehicles, roads, and road user negligence. Many traffic accidents also occur due to negligence of road users, such as not obeying traffic rules, driving at high speed, and even driving without awareness. Damage to road facilities and material loss are two consequences of traffic accidents. The occurrence of traffic accidents caused by several factors can disrupt road performance. If the traffic congestion level can be automatically detected, it will be easier to relieve the traffic jams [8].

The traffic jams waste our time and resources and create more pollution and accidents [9]. Apart from accidents, congestion cannot be avoided in traffic. The occurrence of accidents can result in congested roads. Traffic density can be interpreted as a condition where it accumulates or exceeds capacity on certain road sections. It is not just traffic accidents that can cause traffic congestion. However, with increasing urbanization and cheaper vehicle access, traffic congestion is a recurring problem in many large cities [10]. In this case, traffic congestion occurs due to a lack of improvement in traffic performance.

2.2 Intersection

An intersection is a meeting point between two or more roads. Conflicts can occur at intersections or crossroads, and congestion often occurs. In urban areas, intersection plays an essential role in safety, traffic efficiency, and fuel economy, considering the conflicting merging maneuvers [11]. Flow control at intersections is one of the traffic procedures. Traffic control at intersections is a severe problem, especially in urban areas where traffic volume has recently grown drastically [12].

As the number of vehicles increases, the density of roads also increases. The speedy growth of vehicles has brought tremendous pressure on urban traffic, which has seriously affected people's daily lives [13]. One of them is at the intersection area because there is an intersection or meeting point which causes traffic congestion. Recently, traffic congestion has become a severe problem in most cities. Since the capacity of the road is limited, it is challenging to handle the increasing traffic flow [14].

Intersections are usually considered the bottlenecks for traffic flows in urban transportation networks [15]. This is due to the increasing number of vehicles or even negligence of road users. It is not only the increase in the number of vehicles that is an indicator of the cause of traffic congestion. However, inadequate facilities are also one of the causes. Increasing intersectional traffic density can harm road users, including those who need higher comfort when driving.

2.3 Unsignalized Intersection

At unsignalized intersections, the traffic volume is small, and there is no traffic signal control [16]. An unsignalized intersection is an intersection or meeting between two or even more roads where each point is not equipped with a traffic light as a traffic signal. Conflicts between traffic flows at unsignalized intersections cannot be effectively separated in time and space, leading to safety issues that must be addressed [17]. Problems at unsignalized intersections are relatively higher than problems at signalized intersections. Traffic congestion and accidents can also occur at unsignalized intersections because unsignalized intersections are not equipped with traffic signs.

Not only that, the driver's speed can also cause traffic accidents, especially at unsignalized intersections. Increased understanding of the causes of traffic accidents, particularly congestion, would reduce the economic and social costs associated with accidents [18]. Driving awareness also needs to be considered for the safety of road users. Please notice and respond to other road users to avoid collisions [19]. Be orderly and obey traffic rules when driving to avoid traffic accidents.

Orderly traffic compliance has become a problem in various cities and provinces in Indonesia [20]. The lack or absence of traffic signs at intersections also causes traffic congestion and accidents. Especially on two-way roads, traffic congestion, and accidents will increase if there are no traffic lights. The four-way intersection Babakan Jawa road section has two directions and needs to be equipped with traffic lights, which results in congestion and traffic accidents. Therefore, it is necessary to improve road support facilities to increase security, safety, and comfort for road users.

3. Methodology

3.1 Types of Research

The method used in this research is quantitative methods. The quantitative method can be interpreted as a research process using numbers and statistics and an analysis of data that can be measured. The research is also known as empirical research, as it can be accurately and precisely measured [21]. The technique used in this quantitative method is to observe trends in activity at the intersection and record activity at the intersection. Thus, in this research, a survey was carried out directly at the place to be studied.

3.2 Research Location

The location of the research to be carried out is at an unsignalized intersection in the Majalengka district. To be more precise, see Figure 1—research location.

Figure. 1 Research Location

3.3 Data collection

The data collection technique used in the research is entering primary and secondary data. To address the key research objectives, this research used qualitative and quantitative methods and a combination of primary and secondary sources [22]. Primary data was obtained from direct field surveys to obtain geometric conditions and traffic flow data. Meanwhile, secondary data was obtained from location maps, which were used to analyze unsignalized intersections.

The field survey was carried out for three days: Monday, Thursday, and Saturday. The observation period was conducted in the morning, afternoon, and evening. Where observations are carried out within 1 hour divided into 15 minutes. The survey at this unsignalized intersection was carried out at 4 points. Where is the first point? At each approach point, there is one surveyor to observe and record vehicles passing at the intersection.

4. Result and Discussion

4.1 Geometric Data

Table. 1 Intersection Geometry Data

No	Approach	Road Type	Effective Width	Road Conditions
1	A (Jl. Letkol Abd. Gani)	2/2 UD	6,5 m	Mayor
2	B (Jl. Babakan)	2/2 UD	6,5 m	Mayor
3	C (Jl. Kartini)	2/2 UD	6,5 m	Mayor
4	D (Jl. Babakan)	2/2 UD	4,5 m	Minor

Source: MKJI 1997

This four-way intersection has four approaches, where each approach has two lanes. Each approach has a different effective width and different road conditions. There are three main routes and one small route at this four-way intersection. The results of the Babakan four-way intersection geometry data are in Table 1.

4.2 Traffic Volume

Table. 2 Intersection Geometry Data

Arus Lalu Lintas	Arah	LV		HV		MC		Total kendaraan	
		kend/jam	emp = 1,0	kend/jam	emp = 1,3	kend/jam	emp = 0,5	Kend/jam	smp/jam
A (Jl. Letkol Abd. Gani)	LT	125	125	5	6,5	322	161	452	292,5
west	ST	509	509	1	1,3	463	231,5	973	741,8
	RT	90	90	2	2,6	196	97,5	287	190,1
	Total	724	724	8	10,4	981	490	1712	1224,4
B (Jl. Babakan)	LT	116	116	3	3,9	182	91	31	210,9
nort	ST	422	422	4	5,2	528	264	964	691,2
	RT	45	45	5	6,5	211	105,5	261	157
	Total	583	583	12	15,6	921	460,5	1256	1059,1
C (Jl. Kartini)	LT	44	44	3	3,9	168	79	205	126,9
east	ST	449	449	9	11,7	926	464	1386	924,7
	RT	119	119	2	2,6	262	131	363	252,6
	Total	612	612	14	18,2	1356	674	1954	1304,2
Jl. Utama Total		1919	1919	34	44,2	3258	1624,5	4922	3587,7
D (Jl. Babakan)	LT	70	70	1	1,3	110	55	181	126,3
sout	ST	590	590	8	10,4	925	462,5	1523	1062,9
	RT	87	87	5	6,5	161	80,5	253	1363,2
Jl. Minor Total		747	747	14	18,2	1196	598	1957	2552,4
Utama + Minor	LT	355	355	12	15,6	772	306	1139	756,6
	ST	1970	1970	22	28,6	2844	1422	4836	3420,6
	RT	341	341	14	18,2	829	414,5	1184	773,7
Utama + Minor Total		2666	2666	48	62,4	4445	2142,5	7159	4950,9
Rasio Jl. Minor/(Jl. Utama + Minor)Total									0,4509 UM/MV

Source: MKJI 1997

The results obtained from calculating traffic volume by conducting direct surveys in the field for three days are divided into two: total flow volume and flow volume of main roads and minor roads. From the results of the traffic flow review, it was found that LV was 2666 SMP/hour, MC was 2142.5 SMP/hour, and HV was 62.4 SMP/hour. It was obtained at 3587.7 pcu/hour on main roads, and on minor roads, it was 2552.4 SMP/hour.

The peak hours are Mondays from 16.00 – 17.00, with a traffic flow volume of 4950.9 SMP/hour. The results of this traffic volume can be seen in Table 2. Traffic Flow

4.3 Capacity

Table. 3 Road Capacity

Direction	Basic Capacity (Co)	FW	FM	FCS	FCsf	FRT	FLT	FMI	Capacity (C)
Nourth	2900	1,17	1	1	0,82	0,84	1,33	0,258	801,952
South	2900	1,01	1	1	0,73	0,84	1,33	0,258	616,301
East	2900	1,17	1	1	0,82	0,84	1,33	0,258	801,952
West	2900	1,17	1	1	0,82	0,84	1,33	0,258	801,952

Source: MKJI 1997

The essential capacity (C0) obtained at a four-way intersection Babakan is 2/2 UD, which is 2900. The approach width in the north, east, and west directions is 6.5 meters with a value of 1,17. Meanwhile, the width of the approach to the south is 4,5 with a value of 1,01. The direction separation factor or road median at Simpang Empat Babakan is 50:50, so the value obtained in the 1997 MKJI is 1.

Then, the size of the city of Majalengka in 2021 is more than 1.3 million, and the MKJI value is 1. The side resistance factor in the south direction is classified as high, while the side resistance factor in the north, east, and west directions is categorized as very high with an MKJI value of 0,82. In the south direction, the MKJI value is 0,73. Furthermore, the respective turn ratio factor for left turns is 1.33, and the correct turn ratio is 0,84. From this data, a calculation of road capacity at Simpang Empat Babakan can be obtained, as seen in Table 3—road Capacity.

4.4 Level of Service

Table. 4 Level of Service

	Traffic Flow(Q)	Capacity (C)	Degree of Saturation (DS)	LOS
Direction	Smp/jam	Smp/jam		
North	1059,1	801,952	1,320652698	buruk
South	2552,4	616,301	4,141482887	buruk
East	1304,2	801,952	1,626281984	buruk
West	1224,4	801,952	1,526774775	buruk

Source: MKJI 1997

The level of service at the intersection depends on the degree of saturation obtained from the traffic flow value divided by the load capacity. So, the degree of saturation for each road is obtained: for the north direction, it is 1,32, the south direction is 4,14, the east direction is 1,62, and the west direction is 1.53. The result of this degree of saturation makes the level of service at the four-way intersection of Babakan very unstable.

5. Conclusion

Based on the data obtained in the previous chapter, the peak traffic flow occurs on Mondays in the afternoon or at the interval 16.00 – 17.00 with a traffic flow volume value of 4950,9 SMP/hour. The road capacity at the four-way intersection Babakan dramatically influences the value of the degree of saturation. It can be seen in the previous chapter that the value of the degree of saturation in the north, east, west, and south directions is very high, causing the level of service to be poor. The results of this research can conclude that the level of service at the four-way intersection Babakan will be more optimal if the load capacity can be increased so that the degree of saturation will be low and will not cause high congestion.

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