

THE UNSIGNALLED INTERSECTION PERFORMANCE ANALYSIS OF ARTERIAL ACCESS ROAD AT KARAWANG BARAT 1 TOLL GATE, WEST JAVA

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ABSTRACT

An intersection is the confluence of different directions of the road. In general, traffic conflicts often occur in intersectional areas. Congestion can occur due to the dense volume of vehicles and the absence of traffic lights. This study aims to determine the performance of an unsignalled intersection in accommodating vehicles passing through it. What this means is that this unsignalled interchange does not cause congestion due to the irregularity of the driver of the vehicle. Primary data collection in this study was carried out directly, namely recording the size of the road width at the intersection and taking survey data on the number of vehicles directly at the intersection. After analyzing the calculation results, it was found that the road capacity value (C) was obtained at 3469 pcu/hour. This value is below the maximum base capacity ($C_0 = 5144.42$ smp/h). Based on the results of calculation analysis from survey data, it shows the value of the degree of saturation (DS) of 0.67 sec/pcu. If the degree of saturation (DS) is <0.70 , then the degree of saturation at the intersection falls into the low category. In the calculation obtained, the probability of queuing at the intersection (QP) is 19 - 38%.

INTRODUCTION

Transportation is moving people or objects from one location to another by vehicle, either engined or human-powered vehicles. Transportation is essential for the functioning of any society. Transportation affects the location and range of productive and recreational activities; the location of residence; and the range and supply of goods and services available for consumption (Bruton, 2021). The transportation system has become fundamental to the economic growth of all nations. Nevertheless, many cities in the world face uncontrolled growth in traffic volumes. With many vehicles being one of the causes of congestion, congestion also results in increased air pollution, waste of fuel, and reduced level of comfort in traffic. Transportation is one of the primary sources of atmospheric pollution in urban areas (Guerrero-Ibáñez, Zeadally, & Contreras-Castillo, 2018); (Rifai & Arifin, 2020); (Mavrin, Magdin, Shepelev, & Danilov, 2020).

A crossroads or a meeting place for the flow of traffic from several lanes is a place that is usually a source of congestion (Kozlak & Wach, 2018). Therefore, at intersections, often when the current is opposite, there is a conflict when vehicles cut each other and a traffic jam at the intersection. In addition, the behavior of drivers crossing intersections or joining traffic from other roads can be a source of conflict with other road users (Szajowski & Włodarczyk, 2020). In intersections that do not have many violations, more than intersections are signaled

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because of the lack of instructions for motorists to take appropriate actions, which may cause traffic jams, queues, or accidents.

Some intersections need to be signaled in urban areas and cause conflicts or traffic problems. It is due to the increasing population and economic growth rates around the road. The need for mobility in a city increases in line with the development of a country. A severe problem in urban areas is the high population density which causes traffic conditions to become congested/saturated in critical areas of a city, which increases driving travel time (Prakoso, 2018); (Zambrano-Martinez et al., 2019).

After observation, one of the uninhabited intersections has caused many traffic conflicts and often results in congestion. It happened at the intersection of Jalan International Karawang Barat, which connects the KIIC Arterial Exit, West Karawang Toll Gate. In general, uncited intersections are widely used not only in urban residential areas but also on rural roads and inland areas as crossroads between local roads and neighborhoods where traffic is relatively quiet. Many motor vehicles generally cause problems with these intersection ring working hours in the morning and evening (Nurkafi, Cahyo, Winarto, & Candra, 2019); (Isradi, Tarastanty, Philanthropist, Mufhidin, & Prasetyo, 2021).

The formulation of this research problem is how the performance of the interchange of KIIC Arterial Road, West Karawang Toll Gate 1, and West Karawang International Road with calculations using the MKJI method. The purpose of researching the performance of this three-stroke interchange is to determine the interchange capacity (C), degree of saturation (DS), and delay of the intersection (D). Hopefully, this paper can add insight, knowledge, and experience to analyzing the traffic performance of three-arm intersections without signals. The hope of making this paper for the Government and the Community is to provide input to the government and the community related to traffic at the following intersection and find solutions to the congestion problem at this intersection. Hopefully, this research can provide solutions to cases at the intersection and become a reference for subsequent researchers in scientific research.

Literature Review

Traffic Performance On Interchanges

An intersection is where two or more highways meet and cross (Wang, C, X, & V, 2017). Junctions are primarily studied in Architecture, Civil and Traffic Engineering, and Urban Planning. Studies in this domain are concerned with intersection design and construction to optimize traffic loads, road safety, and travel time (Fogliaroni, Bucher, Jankovic, & Giannopoulos, 2018). Interchanges are generally the leading cause of congestion because, at intersections, there is a decrease in speed or a slowdown in speed due to vehicle activities.

Interchanges are classified into interchanges with traffic lights and interchanges without traffic lights. Intersections can only be safe with or without traffic lights if traffic rules and regulations are observed. Most research on road junctions is always done on signaled intersections, with little research on uncited intersections. Uncited intersections are widespread in general among developing and undeveloped countries. However, intersections also exist in developed countries (Olayode, Tartibu, Okwu, & Uchechi, 2020).

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The traffic system is a very interactive social system since it consists of various individuals who use different forms of transport. Road and transport users will interact with each other for mobility through the traffic environment. In addition, these road users are required to adapt to applicable traffic rules to avoid conflicts. The traffic characteristics of a road system result from the interaction of a road user or driver with his vehicle and the road itself (Madigan et al., 2019).

Road Capacity at Simpang

The capacity of the unsignalized interchange depends on the composition of the flow, the intensity of the mixed flow of traffic flows, and the probability of the driver receiving a secondary boundary interval of the direction of movement (Pospelov, Kostin, Martyakhin, & Komarova, 2021). Traffic volume Congestion is the number of vehicles passing through a point on a section of road in a specific time interval expressed in units of vehicles at a particular time (Desmi & Yanti, 2019).

The high capacity of vehicles will trigger congestion and unstable traffic flow. (Jiang, et al., 2018) Traffic congestion is one of the main issues affecting the socioeconomic activities of developed countries worldwide. Humans seem to accept that traffic delays are inevitable reluctantly. However, these traffic delays often lead to dire consequences for road users. The parameter of traffic flow of vehicle volume represents the total number of vehicles on the road over a while (Kashinath S. A., 2021).

The leading causes of traffic congestion are the road's indiscipline, the high traffic volume, the inadequate carrying space of the road system, and the negative control and management of traffic (Bichi, 2018). The inability of transport infrastructure facilities to accommodate this flow of movement may indicate a limited number of roads on that vehicles can travel. As the volume of traffic increases or changes its characteristics, the section of road initially able to accommodate the number of existing vehicles longer will show its inability to serve the increasing needs (Malluluang, Alwi, & Rustamaji, 2017).

METHODS

The systematic scientific research process must begin with identifying the right problem. The study occurred at the intersection of KIIC Arterial Road, West Karawang Toll Gate 1, and West Karawang International Road. The performance analysis methodology follows the ICHM 1997 (Indonesian Road Capacity Manual). Traffic data is collected in the morning and evening. Data retrieval at peak times aims to obtain the maximum value or the highest peak of the number of vehicles passing through the intersection. Therefore, it is necessary to make in-depth observations of this research (Rifai, Hadiwardoyo, Correia, & Pereira, 2016); (Philanthropist, Rifai, Ramadan, & Isradi). The research conducted on the intersection can be seen in Figure 1.

Data is one of the main strengths in compiling scientific research and modeling. The first data collection in this study is by direct survey at the intersection location to obtain geometric road data and (Rifai A. I., 2015) traffic count data. This data is called Primary data. Meanwhile, the so-called secondary data is in the form of data on the number of Karawang residents. Karawang population data is obtained by visiting the official website of the Central Statistics Agency of Karawang Regency.

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Figure 1. Research Map Location

RESULTS AND DISCUSSION

Geometric Conditions

The survey was conducted at a traffic-free intersection in Karawang City, West Java, Indonesia, with a population of 2,370,488 people from 2018 to 2020, according to data from the Central Statistics Agency of Karawang Regency (Karawang, 2022). Based on this data, it is recommended that Karawang City is included in the Big City Size Class. The neighborhood type of road belongs to the commercial category, with a low class of side resistance. Furthermore, data collection is carried out primarily. The data taken includes geometry data from intersections to be analyzed, such as road names, road types, and road widths. The following are the results of the primary data of geometric conditions in **Table 1**.

Table 1. Data Results of Road Geometric Conditions

Street Names	Jl. Mayor/Main 1 Jl. International Karawang Barat	Jl. Major/Main 2 West Karawang Toll Gate Direction 1	Jl. Minor KIIC Artery Street
Road Type	4/2D	4/2D	2/2UD
Road Functions	Primary Artery	Primary Artery	Secondary arteries
Road Width	14 m	14 m	7 m
Median	0.5m	0.5m	-

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Traffic Conditions

Vehicle calculation data collection was carried out directly on Saturday, November 19, 2022. The calculation is carried out in the morning and evening. Calculation at 06.00 - 08.00 WIB and 16.00 - 18.00 WIB. The survey shows that the busiest volume in the traffic flow of this intersection is (Q) of 3469 pcu/hour, with a total number of vehicles of 4307 vehicle/hour, from Jalan International Karawang Barat (Approach B), the total number of vehicles turning left is 2671 vehicle/hour, and straight vehicles are 300 vehicle/hour. From Jalan Arterial KIIC (Approach A), the total number of vehicles turning left is 85 vehicle/hour, and vehicles turning right is 822 vehicle/hour. From West Karawang Toll Gate 1 (Approach D), the total number of vehicles is straight at 364 vehicle/hour, and vehicles turn right at 65 vehicle/hour. A sketch of the number of vehicles passing on the traffic that occurred can be seen in Figure 2.

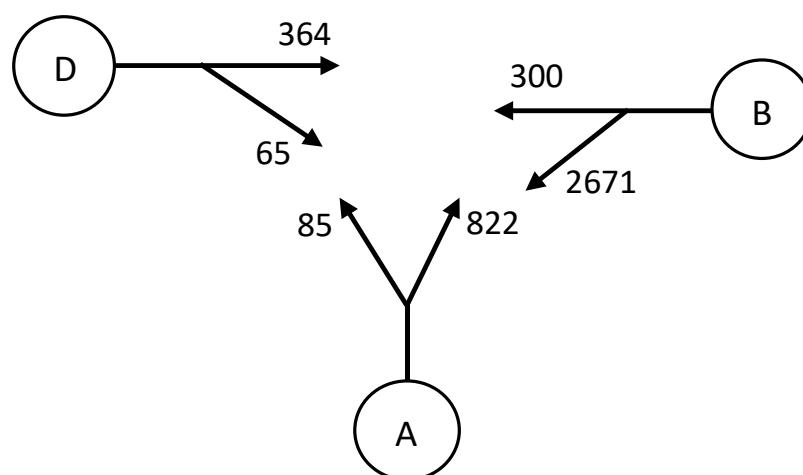


Figure 2. Number of Vehicles per Hour

Calculating Road Capacity

Based on the road geometry data, it is known collectively for each based on the intersection and capacity adjustment factors. The data is entered in the table for easy calculation. The fundamental capacity and adjustment factor are taken from the Indonesian Road Capacity Manual (IHCM 1997). Junctions were analyzed based on the base capacity of C_0 (pcu/h), and capacity adjustment factors were obtained from primary road geometry data and vehicle calculations. These include the driveway's average width, the main road's median aspect, the city's size factor, the side barrier factor, the total turnover rate, and the side ratio. From this data, the road capacity (C) is 5144.42 pcu/hour, all data is entered in Table 2.

Table 2. Capacity Adjustment Factors

Choice	Basic Capacity pcu/h	Capacity Adjustment Factors							capacity pcu/h
		Average Short Width	Main Street Median	City Size	Side Resistance	Turn left	Turn Right	Minor /Total	
	C_0	FW	FM	FCS	e FSRU	FLT	FRT	FMI	C
1	3200	1.07	1.1	1.0	0.90	1.79	0.90	0.99	5144.42

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Table 3. Traffic Behavior

Choice	Traffic Flow pcu/hour	Degree of Saturation	Interchange Traffic Delays	Traffic Delays on Main Road	Traffic Delays on Minor Road	Interchange Geometric Delay	Junction Delay	Queuing Opportunities	Goal
	(Q)	(DS)	(DTI)	(DTMA)	(DTMI)	(DG)	(D)	QP (%)	
1	3469	0.67	7.04	5.246	13.61	4	11.04	19 – 38%	

Based on Table 3, the actual road capacity value (C) is 5144.42 pcu/hour. The traffic behavior of the intersection is then calculated by obtaining the actual road capacity value. Among them is the degree of saturation, the delay of intersection traffic, the delay of traffic on the main road and minor roads, the geometric delay, the delay of the intersection, and the opportunity to queue.

CONCLUSION

From the results of the analysis, it is known that the interchange performance of KIIC Arterial Road, West Karawang Toll Gate 1, and West Karawang International Road. The traffic flow value or maximum capacity of the vehicle survey results is 3469 pcu/hour, The base capacity value of C_0 is 5144.42 pcu/hour. That is, the performance value of this road is below its maximum base capacity. Nevertheless, it shows that the road is still able to accommodate vehicles. The results of the study calculation showed that the degree of saturation (DS) was 0.67 sec/pcu. If the saturation level (DS) < 0.70, then the saturation level is in a small category. The Primary Traffic Delay (DT_{MA}) value was 5,246 sec/pcu, the secondary road traffic delay (DT_{MI}) was 13.61 sec/pcu, and the total traffic delay at the intersection (DT_I) was 7.04 sec/pcu. The transition delay (D) is 11.04 sec/pcu. In the calculation obtained, the probability of queuing at the intersection (QP) is 19 - 38%.

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