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PERFORMANCE INTERSECTION OF PANGLIMA SUDIRMAN – UNTUNG SUROPATI NORTH STREET OF MALANG CITY

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ABSTRAK

Construction of Malang Kota Baru railway station causes attraction and traffic generation and increases traffic volume at the intersection of Jalan Panglima Sudirman - Jalan Untung Suropati causing traffic jams, this is supported by empirical data obtained from survey results "In one day the train 7 trips out with the route Malang – Surabaya, Malang – Jakarta, Malang – Bandung, Malang – Blitar, Malang – Banyuwangi, Malang – Mojokerto, Malang – Jogyakarta". The performance of an intersection is a major factor in determining the right treatment to optimize the function of the road network. The aims of this study are: to know the existing condition of the intersection. The primary data used is (1) Geometric Condition (2) Traffic Flow. The survey was conducted for 7 days to collect primary data and then was processed according to the method of the Indonesian Road Capacity Manual (MKJI, 1997). The survey results obtained the highest peak hour volume on Saturday with a total of 7913 vehicles/hour level of service (LOS) at this intersection can be categorized as sufficient (C). The results of the analysis obtained a degree of saturation value of 0.54. The delay that occurs is 9.783 sec/smp. The probability of a queue of vehicles is 36.5% - 57.5%.

Keywords: *Capacity; Degree Of Delay; Saturation; Queuing Opportunities.*

1. Introduction

Intersections are an integral part of the road network. In urban areas there are usually many intersections, places where drivers must decide to go straight or turn and change roads to reach one destination [1]. The existence of intersections cannot be avoided in the urban transportation system, this is also what happened in Malang City. As a major city located on the island of Java. Intersections must be considered to expedite the flow of transportation in urban areas. Therefore, its existence must be managed properly to facilitate the movement of transportation flows. Most movements generally occur in the morning, afternoon, and evening where people carry out routine activities so that at certain hours at these intersections queues for delayed vehicles become longer. due to road congestion. This condition is exacerbated by the construction of new city stations which cause attraction and traffic generation and increase traffic volume resulting in traffic jams. which is supported by empirical data obtained from survey results, namely that in one day the train outbound trips 7 times with travel routes Malang – Surabaya, Malang – Jakarta, Malang – Bandung, Malang – Blitar, Malang – Banyuwangi, Malang – Mojokerto, Malang – Jogyakarta.

Under normal circumstances, all train cars have 109 seats, but with the current conditions, due to the presence of Covid-19, train passengers have decreased by up to 75%. (source: from the results of an interview with Mr. Agus at Kota Baru Station on Tuesday, 01/22/2021 at 13:15). Another obstacle that causes traffic jams is the existence of tourist attractions, thus increasing the number of road users who use them for access to places of activity, especially during rush hours. The purpose of this research is to know the existing condition of the intersection, the performance of the intersection, and know what alternatives should be used to overcome or minimize congestion at the

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intersection. Most movements generally occur in the morning, afternoon and evening where people carry out their routine activities so that at certain hours at these intersections queues for delayed vehicles become longer due to road congestion.

2. Material and Methods

An unsignalized intersection is an intersection or meeting in a plane between two or more highway lanes with each intersection, and at intersection points not equipped with lights as intersection signs [2]. According to the 1997 Indonesian Road Capacity Manual (MKJI), the last composition

a) light vehicle (Light Vehicle, LV), namely motorized vehicles with two axles with 4 wheels and an axle distance of 2.0 -3.0 m. Light vehicles include passenger cars, microbuses, pick-ups, and small trucks.
b) Heavy vehicles (Heavy Vehicle, HV), namely motorized vehicles with an axle distance of more than 3.5 m usually with more than 4 wheels. Heavy vehicles include buses, two-axle trucks, and combination trucks according to the classification of the Highways.
c) Motorcycle (Motor Cycle, MC), namely for motorized vehicles with two wheels and three-wheeled vehicles.
d) Unmotorized vehicles (Unmotorized, UM), namely vehicles driven by two humans. Non-motorized vehicles include bicycles, rickshaws, horse carts, and strollers [3].

Each type of vehicle has different characteristics because it has different dimensions, speeds, and acceleration. For the analysis, the unit used is the passenger car unit (smp). The types of vehicles must be converted into passenger car units (emp) [4] which can be seen in Table 1.

Table 1. Equivalent Mobile Passenger Value

Transportation type	Emp value
Light vehicle	1,0
Heavy vehicle	1,3
Motor vehicle	0,5

Source: MKJI, 1997

The total capacity for all intersection arms is the result of multiplying the basic capacity (Co), namely capacity under certain conditions (ideal) and adjustment factors (F), taking into account the influence of field conditions on capacity (MKJI, 1997). [5] unsignalized intersection capacity is calculated by equation 1

$C = CO \times FW \times FM \times FCS \times FRSU \times FLT \times FRT \times FMI$ (smp/hour)..(1)

Basic capacity is the total crossroads capacity for a certain predetermined condition. [6] The basic capacity (CO) for each type of intersection can be seen in Table 2.

Table 2. Basic Capacity According to Type of Intersection

Kode IT	Basic capacity (smp/hour)
322	2700
342	2900
342 atau 344	3200
422	2900
424 atau 444	3400

Source: MKJI, 1997

The degree of saturation is the ratio of current to capacity, calculated in smp/hour

$DS = Q_{TOT} / C$ ....(2)

Information :

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DS: degree of saturation

Q_{TOT}: The total flow of motorized vehicles at the intersection is expressed in vehicles/hour, smp/hour, or LHRT (Average daily traffic, smp/hour)
C : Capacity (smp/jam) [7]

Delay is the additional travel time to pass through the intersection when compared to the situation without the intersection, which consists of traffic delays and geometric delays. Traffic delay (DS) is waiting time due to traffic interaction with conflicting traffic and geometric delay (DG) is time delayed due to slowing and accelerating disturbed and uninterrupted traffic (MKJI, 1997). [8] The calculated traffic delays in unsignalized intersections are as follows:

Average traffic delay DT1 (second/smp) is the average delay for all vehicles entering the intersection. The DT1 delay was determined from the empirical relationship between the DT1 delay and the degree of saturation of the DS.

For DS ≤ 0,6
DT1 = 2+8,2078*DS – (1-DS)*2 .... (3)
For DS > 0,6
DT1 = 1,0504 / (0,274 – 0,2042*DS) – (1-DS)*2 .... (4)

The average traffic delay for minor roads is the average traffic delay for all vehicles entering the intersection via the major road.

For ≤ 0,6
DTMA = 1,8 + 5,8234 * DS – (1-DS)*1,8 .... (5)
For > 0,6
DTMA = 1,05034 / (0,346-0,246*DS)-(1-DS)*1,8 .... (6)

The average traffic delay on minor roads is determined based on the average traffic delay (DTI) and the average traffic delay on major roads (DTMA).

DTMI = QTOT*DTI-QMA*DTMA / QMI .... (7)
Information:
QMA = Total main/major road flow (smp/hour)
QMI = Total minor road flow (smp/hour)

The geometric delay of the intersection is the average geometric delay of all motorized vehicles entering the intersection. DG is calculated using Equation (8)

For DS < 0,6
DG = (1-DS)*(PT*6+(1-PT)*3)+DS*4 .... (8)
For DS ≥ 1,0 : DG = 4
Information :
DG = Geometry intersection delay (sec/hour)
DS = degree of saturation
PT = Total turning ratio
Intersection delay is calculated using Equation 9
D = DG + DT1 (sec/smp) .... (9)
Information :
DG = intersection geometric delay (sec/smp)
DT1 = intersection traffic delay (sec/smp)

The value limit of the QP queue probability (%) is determined from the empirical relationship between the QP queue probability (%) and the degree of saturation (DS). Queue opportunities with upper and lower bounds can be obtained by using Equation 10 and Equation 11 (MKJI, 1997).

QP % upper limit = 47,71*DS-24,68*DS2 + 56,47*DS3 .... (10)
QP % lower limit = 9,02*DS+20,66*DS2+10,49* DS3 .... (11)

A flowchart is the steps to be taken in the research so that the research is following the established corridors. The research flowchart can be seen in the following figure 1.

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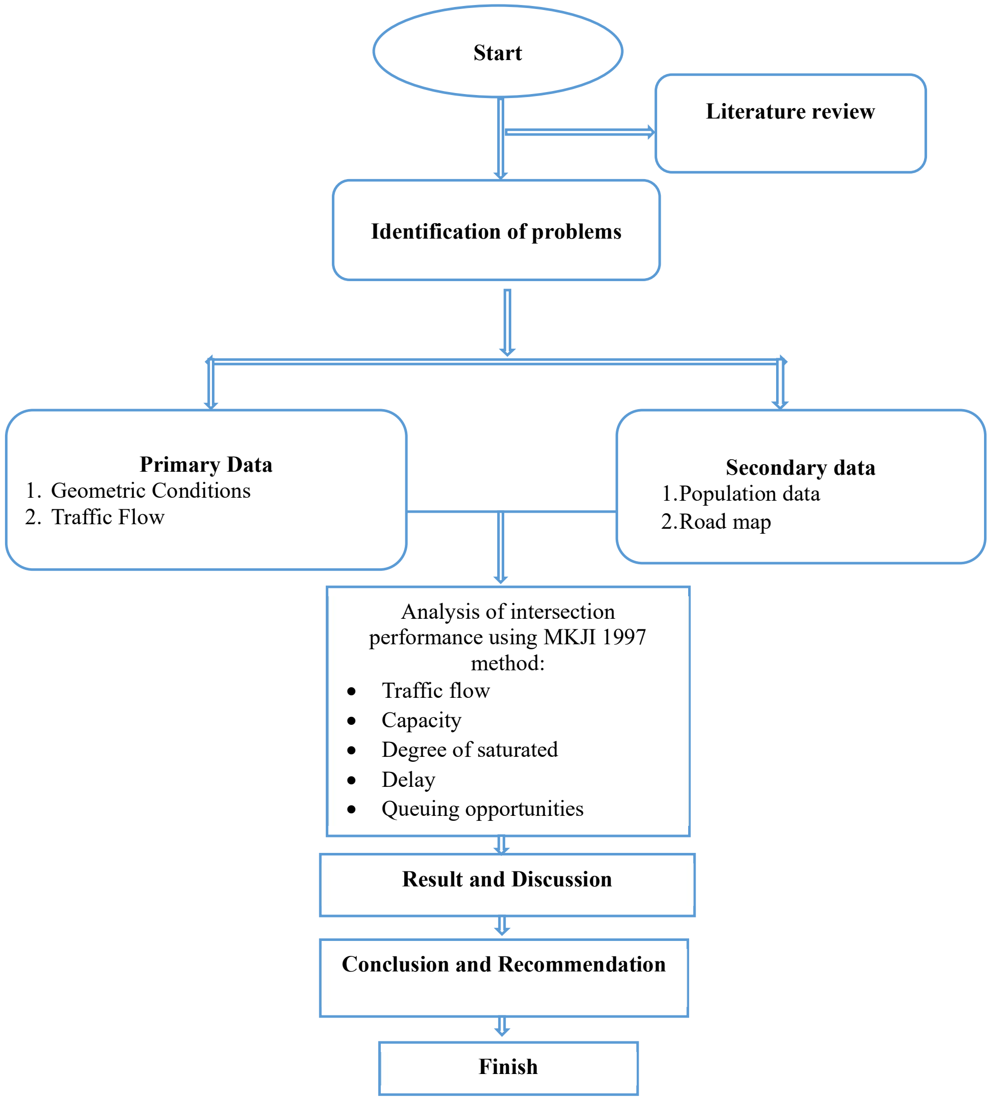

Figure 1. Research Flowchart

The research starts by identifying the problems that occur in the formulation of the problem and then comparing it with what theory can support the study. After the problem is found then determine the research variables to classify primary and secondary data. The primary data used is (1) geometric condition (2) Traffic Flow, the secondary data used is (1) Population data (2) Road map. The survey was conducted for 7 days to collect primary data and then the data was processed according to the method [9] to obtain data on traffic flow, capacity, degree of saturation, delay, and queuing opportunities which were then drawn conclusions and discussion.

3. Result and Discussion

Panglima Sudirman - Untung Suropati North Intersection has geometric conditions with three arms with specifications as shown in the following Table 3. Determination of the main road at the intersection in this study is the road that is considered the most important at the intersection and has a larger traffic volume. The main road approach is Panglima Sudirman Street, while the minor road approach is Untung Suropati North Street.

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Table 3. Unsignalized Intersection Geometry

Number of cross arms	approach width				Number of Road		intersection type
	Main Road		Minor Road	Average approach width (W1)	Main Road	Minor Road	
	WA	WB	WC				
3	9,08	9,08	8,28	8,8	2	2	322

Source: Analysis results, 2021

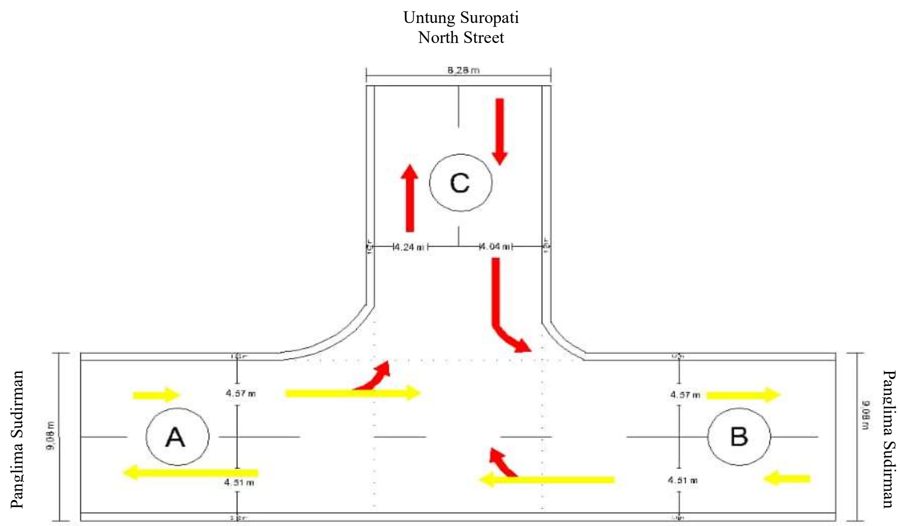

Figure 2. Intersection Geometric Conditions

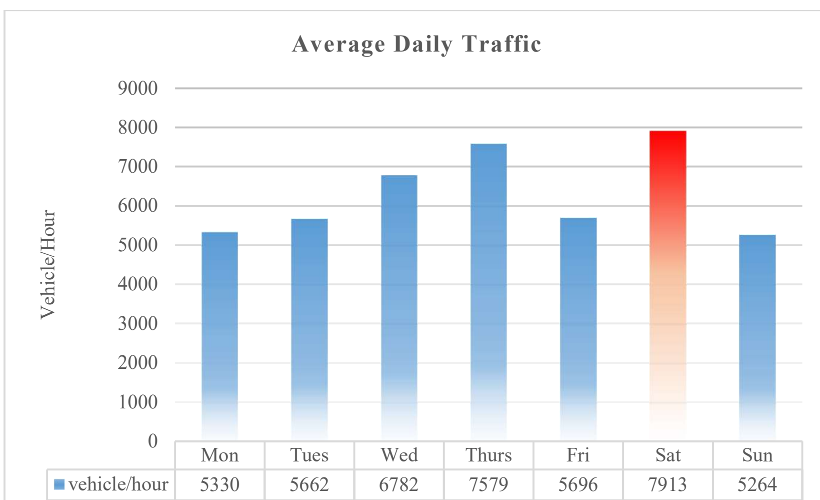

Figure 3. Average daily traffic

Traffic flow is the number of traffic elements passing through the approach per unit of time (smp/hour). The value of traffic flow is obtained from a traffic enumeration survey. Peak hours are determined by looking at the highest volume of vehicles crossing Jalan Panglima Sudirman - Jalan Untung Suropati Utara. Based on the survey results, the highest peak hour volume in the first and second weeks is on Saturday in the first week at 15.00 – 16.00 with data 7913 vehicle/hour.

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Based on MKJI 1997, the basic capacity at an unsignalized intersection is seen based on the type of intersection. The unsignalized intersection of Jalan Panglima Sudirman – Jalan Untung Suropati Utara has an intersection type of 322 because it consists of 3 arms with 2 lanes each on both the main and minor roads and there is no median, so the basic capacity value for this intersection is 2,700.

Approach width adjustment obtained with the input variable is the average width of all approaches (W) and the type of intersection.

Table 4. Approach width adjustment factor (FW)

Intersection Type	W (m)	Fw
322	8,81	1,40

Source: Analysis results, 2021

The main road median adjustment factor is seen based on whether or not there is a median on the main road approach. At the unsignalized intersection of Jalan Panglima Sudirman - Jalan Untung Suropati Utara there is no median at the main road approach, so the value of FM = 1.00.

The adjustment factor for city size is seen based on city size and population. Malang City is a medium-sized city with a population of 843,810 people in 2021 [10], so the city size adjustment factor has a value of 0.94.

Table 5. Adjustment Factor (F_{RSU})

Road Environment Type Class	Side Resistance Class	Non-motorized Vehicle Ratio	F_{RSU}
Commercial	Currently	0,004	0,94

Source: Analysis results, 2021

The intersection capacity is obtained from the calculation of the basic capacity multiplied by the adjustment factors at unsignalized intersections. The capacity of the unsignalized intersection Jln. Panglima Sudirman - Untung Surpati Utara is 6373.5137 pcu/hour. The degree of saturation is obtained from the division between the total traffic flow divided by the capacity value 0.54.B Intersection traffic delay (DT1) = 5.535 sec/pcu and Conclusion for the delay value (D) = 4.248 sec/smp. The probability of a queue of vehicles is 36.5% - 57.5% of the degree of saturation obtained.

From the prediction results of vehicles entering/exiting the new city station area, a capacity value of 12549.67 is obtained with a degree of saturation value of 0.05. This proves that the existing conditions affect road performance with predictions of the volume of traffic that crosses the Panglima Sudirman road to the new city station area.

Analysis of the performance of the intersection of Jalan Panglima Sudirman - Jalan Untung Suropati Utara obtained a capacity value of 6373.5137 pcu/hour of traffic flow of 7913 vehicles/hour. smaller than 0.75. and the delay that occurs is 9,783 sec/smp. The possibility of a queue of vehicles occurring is 36.5% - 57.5% of the degree of saturation obtained. So it can be concluded that the road can still serve vehicles well. the imposition of the Kota Baru station building affects the performance of the intersection on Jalan Panglima Sudirman - Jalan Untung Suropati Utara from the predicted results of vehicles entering/exiting from the Kota Baru station to Jalan Panglima Sudirman with an increase in the degree of saturation from 0.54 to 0.59. This research is supported by several previous studies, including research by Rocky Huliselan and Muhamad Rusmin with the title Analysis of capacity and performance of unsignalized intersections R.A. Kartini in 2019 in this study the data analysis used was USIG I and USIG II according to the 1997 MKJI guidelines, the same as the analysis I used in this study. Points to be compared or analyzed in this study include the capacity and performance of intersections. [11] The next research by Juda Suwandi with title impact of traffic in the Ministry of Public Works and Public Housing (PUPR) in 2020. Points to be compared or analyzed in this study include analysis of the impact of traffic on whether the infrastructure can serve (existing) traffic [12][13].

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4. Conclusions

Existing condition of the new city station building affects the performance of the intersection on Jalan Panglima Sudirman - Jalan Untung Suropati Utara. From the prediction results of vehicles entering/exiting the Kota Baru station area towards the obtained capacity value of 12549.67 with a degree of saturation value of 0.05. This proves that the existing conditions affect road performance with predictions of the volume of traffic that crosses the Panglima Sudirman road to the new city station area. and the increase in the value of DS after the operation of the new city station from 0.54 to 0.59. Analysis of the performance of Jalan Panglima Sudirman - Jalan Untung Suropati Utara obtained a capacity value of 6373.5137 pcu/hour of traffic flow of 7913 vehicles/hour. To improve the performance of the intersection, an alternative that can be used is the prohibition of turning right from major A and minor C roads and requiring the prohibition of stopping and parking prohibited along Jalan Panglima Sudirman. The level of service at the intersection before the alternative entry into service C was applied if using the alternative prohibition on turning right and prohibiting parking by looking at the existing conditions around the intersection, the calculation results obtained a degree of saturation value of 0.22 with a level of service B (stable traffic) analyzed based on the MKJI guidelines 1997.

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